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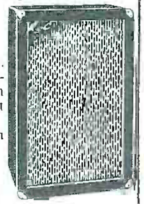

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T15/70 15″ 70w	£28·00	£19·95
T15/100 15″ 100w	£41·00	£29·95
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Rating RMS Imp 8-15 ohms

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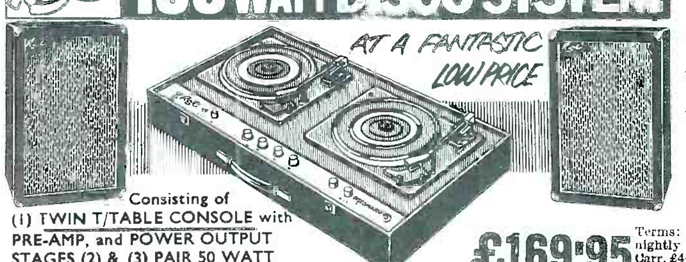

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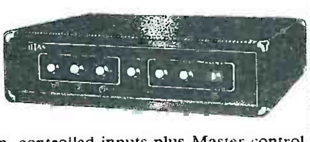

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☐ GENERAL INTEREST

Our May issue will be published on 6 April
(for details see page 33)

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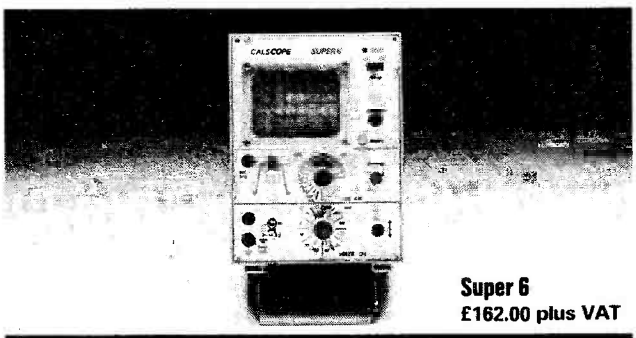

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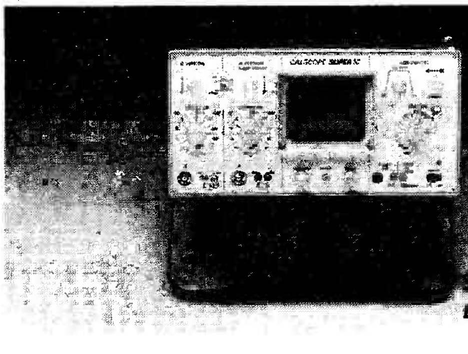

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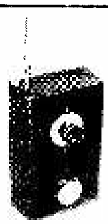
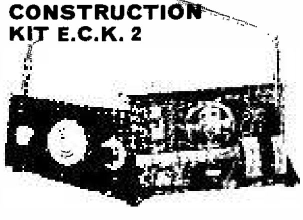


Build this converter kit and receive the aircraft band by placing it by the side of a radio tuned to medium wave or the VHF band and operating as shown in the instructions supplied free with all parts.
Uses a retractable chrome-plated telescopic aerial, gain control, V.H.F. tuning capacitor, transistor, etc. Size $5\frac{1}{2}'' \times 1\frac{1}{2}'' \times 3\frac{1}{2}''$.
All parts including case and plans.

£4·95 + P & P and Ins. 60p

ELECTRONIC CONSTRUCTION KIT E.C.K. 2



Self Contained Multi-Band V.H.F. Receiver Kit.
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Complete kit of parts

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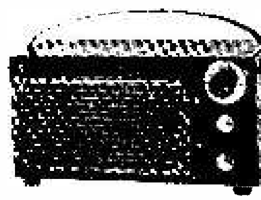

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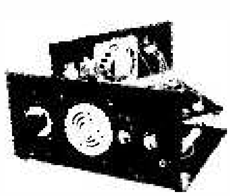
EDU KIT JUNIOR



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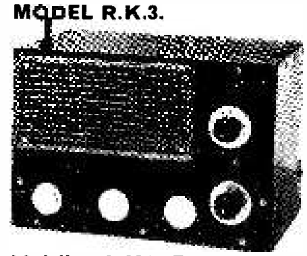
All parts including Loudspeaker, Earpiece, M.W. Ferrite Road Aerial, Capacitors, Resistors, Transistors, etc. Complete kit of parts including construction plans.

£6·95 + P & P and Ins. 90p

NEW ROAMER TEN MODEL R.K.3.



Multiband V.H.F. and A.M. Receiver. 13 Transistors and Six Diodes. Quality 6" × 3" Loudspeaker
With Multiband V.H.F. section covering Mobiles, Aircraft, T.V. Sound, Public Service Band, Local V.H.F. Stations, etc. and Multiband A.M. section with Airspaced Tuning Capacitor for easier and accurate tuning, covering M.W.1, M.W.2, L.W. Three Short Wave Bands S.W.1, S.W.2, S.W.3 and Trawler Band. Built-in Ferrite Rod Aerial for Medium Wave, Long Wave and Trawler Band, etc., Chrome-plated 7 section Telescopic Aerial, angled and rotatable for peak Short Wave and V.H.F. reception. Push-Pull output using 600mW Transistors. Gain. Wave-Change and Tone Controls. Plus two Slider Switches. Powered by P.P.9—9 volt Battery.

Complete kit of parts including carrying strap. Building Instructions and operating Manuals.

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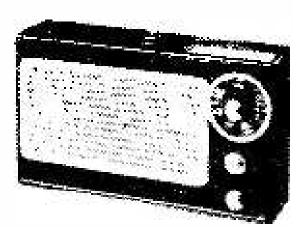
E.V.6 PLUS ONE



Build this exciting new design. Now with 7 Transistors and 4 diodes. MW/LW. Powered by 9V battery. Ferrite rod aerial, tuning condenser, volume control, and now with 3in. loudspeaker. Attractive case with red speaker grille. Size 9in. × $5\frac{1}{4}$in. × $2\frac{3}{4}$in. approx. All parts including Case and Plans.
Total Building Costs:

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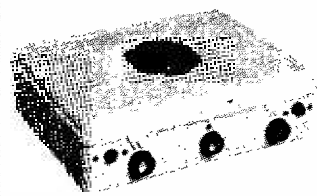

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● Signal Injector ● Transistor Tester NPN-PNP ● 7 Transistor Loudspeaker Radio MW/LW ● 5 Transistor Short Wave Radio.

Components include:
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A compact small radio kit covering Medium Wave and Long Wave bands. Rugged Micanite construction and simple square design allows for easy carrying and positioning. Ideal for the Garage, Workroom, Kitchen, etc., has seven Transistors and four Diodes, quality Loudspeaker, ready wound Ferrite Rod Aerial and Carrying Strap. Size $4\frac{3}{8}'' \times 4\frac{3}{8}'' \times 4\frac{3}{8}$. All parts and plans excluding 9v PP7 Battery.

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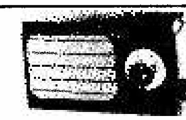
POCKET FIVE



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1G6GT	1·00	6AX4	1·00	6H6GT	·50	9U8	·45	20D1	·70	77	·75
1H5GT	1·00	6B8G	·75	6J5GT	·80	10C2	1·00	20D4	2·50	85A2	1·75
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1LD5	1·00	6BC8	1·00	6J7G	·50	10D1	1·00	20L1	1·20	90C1	1·50
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1N5GT	1·00	6BG6G	1·00	6JU8A	1·00	10F1	1·50	20P3	1·00	150C2	1·20
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4GK5	1·00	6C10	1·00	6R7G	1·00	12AV6	·80	30FL2	1·20	7193	·60
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5R4GY	1·20	6C12	·55	6SC7GT	1·00	12BA6	·60	30L15	1·00	9002	·75
5T4	2·00	6CD6G	4·00	6SG7	·80	12BE6	·85	30L17	1·00	9006	·75
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5V4G	1·00	6CL6	·75	6SJ7	·80	12E1	3·50	30P12	1·00	ACPEN	2·00
5Y3GT	·65	6CL8A	1·00	6SK7	1·00	12J5GT	·45	30P19/30P4	1·00	AC2PEN	1·50
5Z3	1·50	6CM7	1·00	6SK7GT	·70	12J7GT	·75	30P16	·50	AC2PEN/DD	1·50
5Z4G	·75	6CS6	·75	6SL7G	2·00	12K5	1·50	30P18	·65	AC6PEN	1·00
5Z4GT	1·00	6CU5	1·00	6SN7G	2·00	12K7GT	·60	30PL1	2·20	AC/P4	1·50
6/30L2	1·00	6D3	1·00	6SQ7	·80	12K8	·75	30PL12	·65	ACTH1	1·50
6A8G	1·40	6DE7	1·00	6U4GT	1·00	12Q7GT	·60	30PL13	1·30	AL60	2·00
6AC7	·85	6DT6A	·85	6U7G	1·00	12SA7	·75	30PL14	1·50	ARP3	·60
6AG5	·65	6EW6	·85	6U8	·55	12SC7	·55	30PL15	1·30	ATP4	·50
6AG7	·80	6E5	2·00	6V6G	·60	12SG7	1·00	35A3	1·00	AZ1	1·00
6AH6	1·00	6F1	1·00	6X4	·95	12SH7	·50	35C5	·80	AZ31	1·10
6AJ5	·70	6F6G	·80	6X5GT	·60	12SJ7	·60	35D5	1·00	AZ41	·60
6AJ8	·55	6F12	·70	6Y6G	1·00	12SK7	·60	35L6GT	·85	B36	2·00
6AK5	·55	6F14	1·00	6Y7G	2·00	12SN7GT	2·00	35W4	·60	B719	·50
6AK6	1·50	6F15	·85	7A7	1·50	12SQ7	·80	35Z3	1·00		
6AK8	·50	6F16	1·00	7B6	1·50	12SQ7GT	·80				
6AL5	·40	6F18	1·00	7B7	1·00						
6AM6	·70	6F23	1·00	7D6	2·00						

B729	1·00	EB34	·50	EF92	·75	HL42DD	1·50	PEN45	1·50	UF41	1·10	AA120	·18	BF180	·35
BL63	2·00	EB91	·40	EF93	·65	HN309	2·00	PEN45DD	1·50	UF80	·50	AA129	·18	BF181	·47
CL33	2·00	EBC41	1·50	EF94	·62	HVR2	1·00	PEN46	1·00	UF85	·50	AAZ13	·21	BF185	·47
CV6	·60	EBC81	1·00	EF95	·55	HVR2A	1·00	PEN453DD	2·00	UF89	·55	AC107	·18	BFY50	·26
CV63	1·00	EBC90	·75	EF97	·90	KT2	1·00	PENDD4020	2·00	UL41	1·00	AC113	·30	BFY51	·23
CV988	·25	EBC91	·75	EF98	·90	KT8	3·00	PFL200	1·35	UL84	·90	AC126	·14	BFY52	·23
CY1C	1·00	EBF80	1·00	EF183	·55	KT32	1·00	PL33	1·50	UM80	1·00	AC127	·20	BY100	·21
CY31	1·00	EBF83	1·00	EF184	·55	KT41	1·50	PL36	1·00	UM84	1·50	AC128	·30	BY114	·21
D1	·50	EBF89	·50	EF804	6·25	KT44	2·50	PL81	·65	UU9	1·00	AC132	·23	BY126	·18
D63	·50	EBL21	2·00	EH90	·75	KT63	·80	PL81A	·75	UU12	·50	AC154	·30	BY127	·21
DAC32	1·00	EC52	1·00	EK90	·70	KT66	3·50	PL82	·50	UY41	·75	AC156	·30	BYZ10	·30
DAF91	·40	EC53	1·50	EL32	1·00	KT71	1·00	PL83	·50	UY42	·75	AC157	·30	BYZ11	·30
DAF96	1·00	EC54	1·50	EL34	2·50	KT81	2·50	PL84	·65	UY85	·70	AC165	·30	BYZ12	·30
DC90	1·00	EC86	1·00	EL37	3·00	KT88	6·75	PL95	1·00	U10	1·50	AC166	·30	BYZ13	·30
DD4	1·00	EC88	1·00	EL41	1·00	L63	·80	PL504/500	1·20	U12/14	1·50	AC168	·44	FSY11A	·26
DF33	1·00	EC90	·50	EL81	1·00	LN119	·75	PL505	3·10	U18	2·50	AC176	·64	FSY41A	·26
DF91	·40	EC92	1·00	EL83	1·00	LN309	2·00	PL508	1·85	U19	4·00	AC177	·32	OA9	·14
DF92	·30	EC97	1·00	EL84	·50	LZ319	·80	PL509	3·10	U25	1·00	ACY18	·35	OA47	·12
DL96	1·00	ECC32	1·00	EL86	·80	M8136	2·00	PL519	3·75	U26	·90	ACY19	·35	OA70	·18
DH63	·75	ECC33	2·00	EL90	·85	M8137	2·00	PT4D	1·50	U33	2·00	ACY20	·35	OA73	·18
DH76	·50	ECC35	2·00	EL95	·95	M8162	2·00	PY31	·50	U35	2·00	ACY21	·35	OA79	·11
DH77	·75	ECC40	1·25	EL360	2·50	M8195	3·00	PY33/2	·50	U37	2·00	ACY22	·35	OA81	·11
DH81	1·50	ECC81	·52	EL506	2·50	MHL4	1·50	PY80	·50	U81	1·00	ACY28	·35	OA85	·11
DK32	1·00	ECC82	·62	EL509	2·50	MHLD6	1·50	PY81	·60	U191	·50	AD140	·50	OA90	·14
DK40	1·50	ECC83	·62	EM80	1·00	MX40	1·50	PY82	·50	U251	1·00	AD161	·53	OA91	·11
DK91	·50	ECC84	·50	EM81	1·00	N150	1·00	PY83	·60	U301	1·00	AF114	·30	OA95	·11
DK92	1·00	ECC85	·50	EM83	1·00	N308	1·50	PY88	1·12	U403	1·50	AF115	·30	OC36	1·00
DL33	1·00	ECC86	2·00	EM84	1·00	N709	·50	PY500A	2·05	U404	·75	AF117	·23	OC44	·35
DK96	1·00	ECC88	·72	EM85	1·00	P61	·75	PY800	·65	U801	1·00	AF121	·35	CC70	·14
DL63	1·00	ECC91	·50	EM87	1·45	PABC80	·45	PY801	·65	U4020	1·00	AF124	·36	OC71	·20
DL82	1·50	ECC189	1·00	EMM803	2·50	PC86	·80	PZ30	·50	VP23	1·00	AF180	·56	OC72	·13
DL92	.65	ECC804	1·00	EY51	·80	PC88	·80	QQV03/10	2·75	VP41	1·00	AF186	·64	OC74	·26
DL94	1·00	ECC807	2·80	EY81	1·50	PC92	·85	QS95/10	1·00	VR150	1·25	BA115	·16	OC75	·13
DL96	1·00	ECF80	·65	EY83	1.50	PC95	1·00	QV04/7	3·00	VU111	1·00	BA116	·21	OC76	·18
DM70	1·50	ECF82	.55	EY86/7	·50	PC97	·80	QV06/20	4·70	VU120	1·00	BA129	·14	OC77	·32
DM71	1·75	ECF86	·80	EY88	1·00	PC900	·75	R10	5·00	VU133	1·00	BA130	·12	OC78	·18
DW4	1·50	ECH35	2·00	EY91	1·00	PCC84	·40	R19	1·00	W107	1·00	BA148	·20	OC78D	·18
DY51	2·00	ECH42	1·00	EY500	1·45	PCC85	·55	UABC80	·60	W729	1·50	BA153	·18	OC81	·30
DY87/6	·55	ECH81	·55	EZ35	·60	PCC88	·65	UAF42	·75	X41	1·50	BC107	·14	OC81D	·30
DY802	·55	ECH83	1·00	EZ40	1·00	PCC89	·55	UBC41	·70	**Transistors & Diodes**		BC108	·14	OC82	·13
E80CC	4·75	ECH84	·80	EZ41	1·00	PCC189	·65	UBC81	·55	1N4744	·16	BC109	·14	OC82D	·13
E80CF	6·00	ECL80	·60	EZ80	·50	PCF80	·80	UBF80	·55	2N404	·21	BC113	·30	OC83	·23
E80F	5·50	ECL82	·60	EZ81	·50	PCF82	·45	UBF89	·60	2N966	·61	BC115	·18	OC84	·28
E81CC	2·00	ECL83	1·50	EZ90	·95	PCF84	1·00	UBL21	2·00	2N1756	·58	BC116	·30	OC123	·26
E82CC	2·00	ECL85	1·00	FC4	1·50	PCF86	·65	UC92	.60	2N2147	·99	BC118	·26	OC169	·50
E83F	3·50	ECL86	·70	GY501	1·40	PCF200	1·55	UCC84	1·00	2N2297	·26	BCY10	·53	OC171	·40
E88CC	1·20	ECLL800	10·00	GZ30	·75	PCF201	1·45	UCC85	·55	2N2369	·50	BCY12	·58	OC172	·41
E92CC	4·50	EF22	1·50	GZ32	1·00	PCF801	·60	UCF80	·80	2N3053	·38	BCY33	·23	OC204	·50
E180CC	5·00	EF36	1·00	GZ33	4·00	PCF802	·85	UCH21	2·00	2N3121	2·90	BCY34	·26	OC206	1·05
E180F	5·50	EF37A	2·50	GZ34	2·25	PCF805	2·25	UCH42	1·00	2N3703	·23	BCY38	·26		
E182CC	5·50	EF40	2·00	GZ37	4·00	PCF806	·70	UCH81	·65	2N3709	·23	BF158	·21		
E188CC	5·00	EF41	1·00	HABC80	1·00	PCH200	1·20	UCL82	·75	AA119	·18	BF159	·30		
E280F	12·50	EF73	2·00	HL13C	1·00	PCL82	·65	UCL83	1·00			BF163	·23		
E1148	·75	EF80	·45	HL23	1·50	PCL83	2·00					BF173	·44		
EA50	·50	EF83	1·70	HL23DD	1·00	PCL84	·70								
EA76	1·60	EF85	·50	HL41	1·50	PCL86	·85								
EABC80	·50	EF86	·55	HL41DD	1·50	PCL805	·85								
EAC91	·55	EF89	·60			PEN25	1·00								
EAF42	1·25	EF91	·70												
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(Nov. 75 article by A. C. Ainslie) ***Copy of original article supplied on request***

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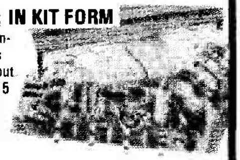

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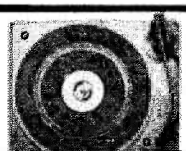
Belt drive chassis turntable unit semi automatic, cueing device. **£24.95** p&p £2.55

A.D.C. QLM 30 Mk III Magnetic Cartridge to suit. **£7.75**



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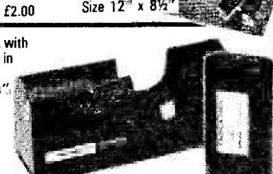

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240 Volts AC Complete **with tuning dial** Circuit diagram.

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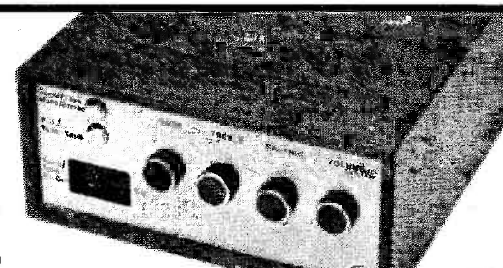

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SPECIAL OFFER. The above 50 watt amp plus 4 Goodmans Type 8P. 8" speakers. Package price £45.00 + £4.00 P&P.

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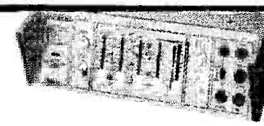

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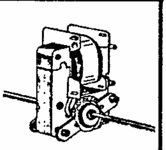

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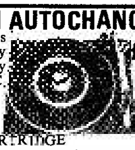

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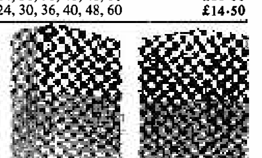

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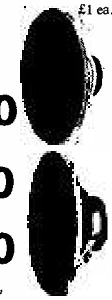

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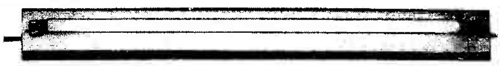

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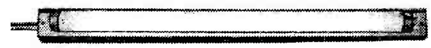

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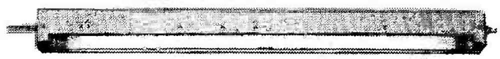

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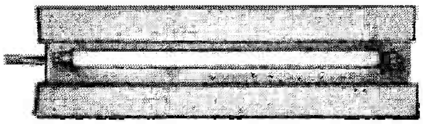

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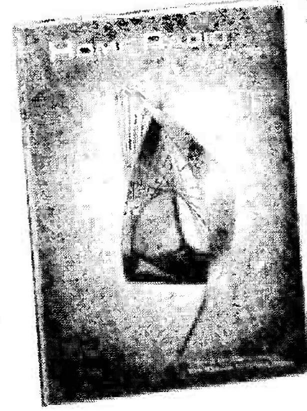

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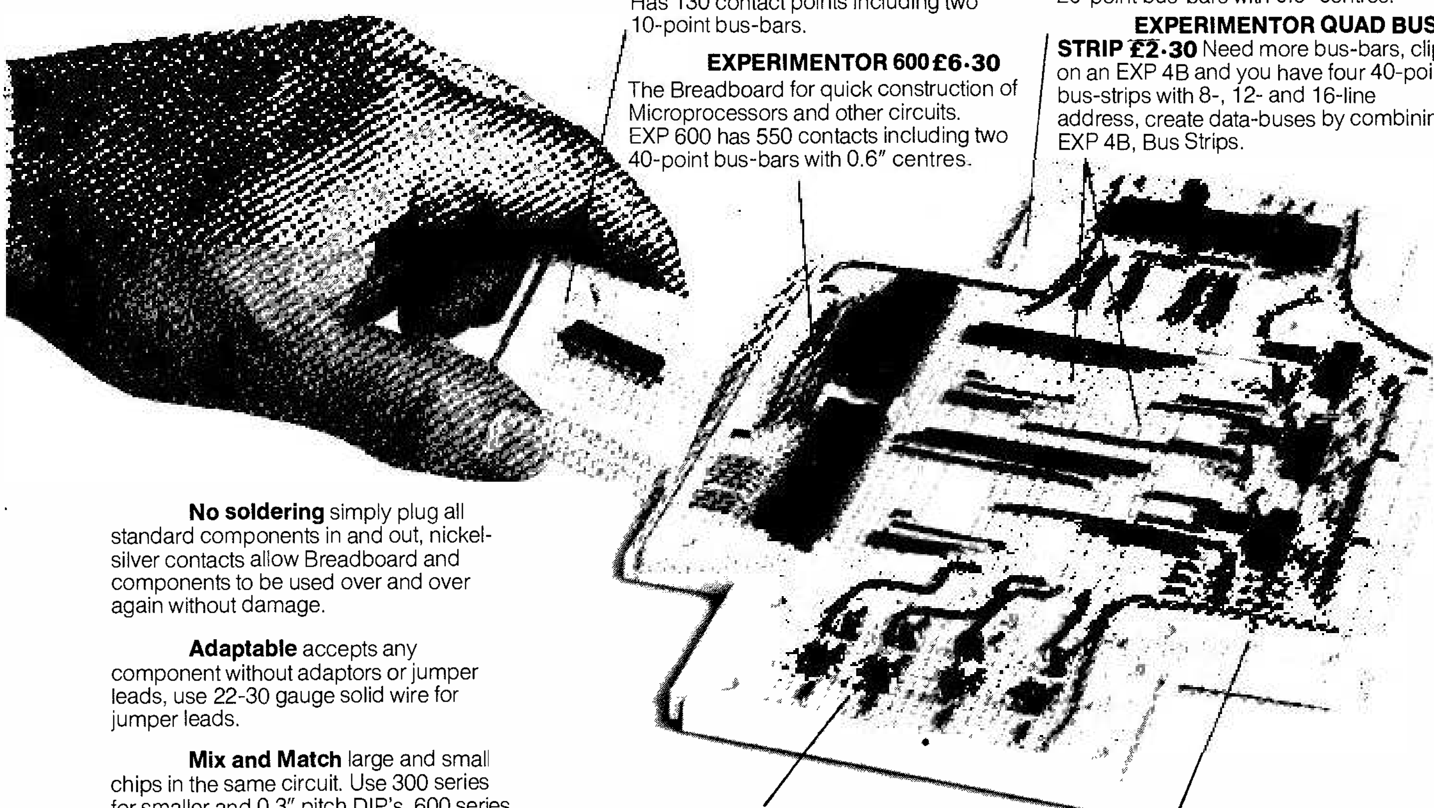
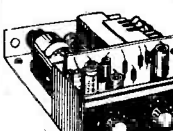


SUPERSOUND 13 HI-FI MONO AMPLIFIER



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An advanced solid state general purpose mono amplifier suitable for Public Address system, Disco, Guitar, Gram., etc. Features 3 individually controlled inputs (each input has a separate 2 stage preamp). Input 1. 15mv into 47k. Input 2. 15mv into 47k. (suitable for use with mic. or guitar etc.). Input 3 200mv into 1 meg. suitable for gram. tuner, or tape etc. Full mixing facilities with full range bass & treble controls. All inputs plug into standard jack sockets on front panel. Output socket on rear of chassis for an 8 ohm or 16 ohm speaker. Output in excess of 20 watts R.M.S. Very attractively finished purpose built cabinet made from black vinyl covered steel, with a brushed anodised aluminium front escutcheon. For ac mains operation 200/240v. Size approx. 12¼" w. × 5" h. × 7½" d. Special introductory Price £28·00 + £2·50 carr. & pkg.

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Only £8·40 each + p. & p. (one 90p, two £1·10).
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SIZE 2" × 3" × ½" ready built. Pre-aligned and tested for 9-16V neg. earth operation. Can be fitted to almost any FM VHF radio or tuner. Stereo beacon light can be fitted if required. Full details and instructions (inclusive of hints and tips) supplied. £6·00 plus 20p. P. & P. Stereo beacon light if required 40p extra.

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Overall Size 12"w. × 8"d. × 2¾"h.
Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

AMPLIFIER KIT	.. ..	**£14·50** P. & P. 80p
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A solid state stereo amplifier chassis, with an output of 3-4 watts per channel into 8 ohm speakers. Using the latest high technology integrated circuit amplifiers with built in short term thermal overload protection. All components including rectifier smoothing capacitor, fuse, tone control, volume controls, 2 pin din speaker sockets & 5 pin din tape rec./play socket are mounted on the printed circuit panel, size approx. 9¼" × 2¼" × 1" max. depth. Supplied brand new & tested, with knobs, brushed anodised aluminium 2 way escutcheon (to allow the amplifier to be mounted horizontally or vertically) at only **£10·00** plus 50p P. & P. Mains transformer with an output of 17v a/c at 500m/a can be supplied at **£2·00** + 40p P & P if required. Full connection details supplied.

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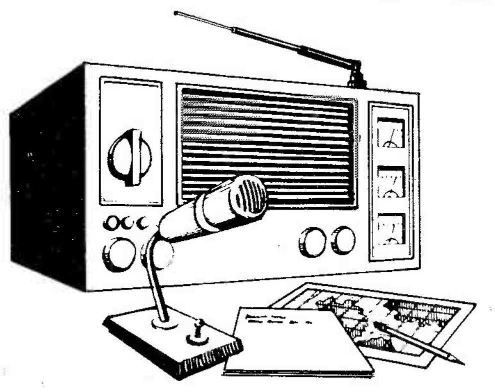

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SENSITIVITY	3·0 μV
BANDWIDTH	250 kHz
SPURIOUS REJECTION	50 dB
SELECTIVITY ± 400 kHz	55 dB
AUDIO OUTPUT (22·5 kHz deviation)	100 mV
STEREO SEPARATION	30 dB
SUPPLY REQUIREMENTS	20 to 30V (90mA max)
AERIAL IMPEDANCE	75 ohms
DIMENSIONS	240mm × 110mm × 32mm

The 450 Tuner provides instant programme selection at the touch of a button ensuring accurate tuning of 4 pre-selected stations, any of which may be altered as often as you choose, simply by changing the settings of the pre-set controls. Features include FET input stage. Vari-Cap diode tuning. Switched AFC LED Stereo Indicator.

Stereo 30

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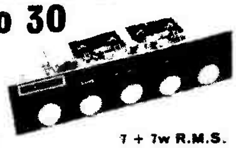


7 + 7w R.M.S.

£19·18
+ 66p p&p
+ 12½% VAT

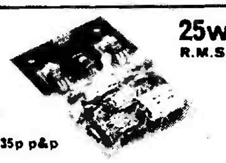
OUTPUT POWER	7 Watts RMS
LOAD IMPEDANCE	8 ohms
TOTAL HARMONIC DISTORTION	Less than ·5% (Typically ·3%)
FREQUENCY RESPONSE	50 Hz to 20 kHz ± 3dBs
TONE CONTROL RANGE	± 12 dBs at 100Hz and 10kHz
SENSITIVITY	190 mV for full output
INPUT IMPEDANCE	1 M ohms
TRANSFORMER REQUIREMENTS	22 V.A.C. rated at 1A
DIMENSIONS (Less controls and panel)	200mm × 130mm × 33mm

The Stereo 30 comprises a complete stereo pre-amplifier, power amplifiers and power supply. This, with only the addition of a transformer or overwind will produce a high quality audio unit suitable for use with a wide range of inputs i.e. high quality ceramic pick-up, stereo tuner, stereo tape deck etc. Simple to install, capable of producing really first class results, this unit is supplied with full instructions, black front panel, knobs, main switch, fuse and fuse holder and universal mounting brackets.

AL60

25w R.M.S.

AUDIO AMPLIFIER MODULE 25 Watts RMS



£4·69 + 35p p&p
+ 12½% VAT

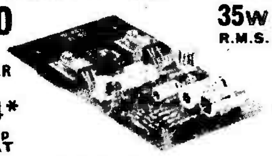
OUTPUT POWER	25 Watts RMS
SUPPLY	30–50 V
LOAD IMPEDANCE	8–16 ohms
TOTAL HARMONIC DISTORTION	Less than ·1% (Typically ·06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz × 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm × 64mm × 15mm

This high quality audio amplifier module is for use in audio equipment and stereo amplifiers and provides output powers up to 25 RMS with distortion levels below 0·1%.

AL80

35w R.M.S.

AUDIO AMPLIFIER MODULE



£7·34*
+ 35p p&p
+ 8% VAT

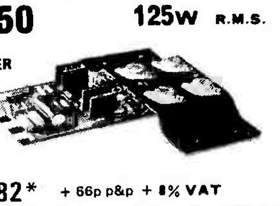
OUTPUT POWER	35 Watts RMS
SUPPLY	40–60 V
LOAD IMPEDANCE	8–16 ohms
TOTAL HARMONIC DISTORTION	Less than ·1% (Typically ·06%)
FREQUENCY RESPONSE	20 Hz to 30 kHz × 2 dBs
SENSITIVITY	280 mV for full output
MAX. HEAT SINK TEMPERATURE	90°C
DIMENSIONS	103mm × 64mm × 15mm

The AL80 is similar in design to the AL60 above and is of the same high quality but provides output powers up to 35W with distortion levels below 0·1%.

AL250

125w R.M.S.

POWER AMPLIFIER



£17·82* + 66p p&p + 8% VAT

OUTPUT POWER	125 Watts RMS continuous
OPERATING VOLTAGE	50–80 V
LOADS	4–16 ohms
FREQUENCY RESPONSE	25 Hz 20 kHz measured at 100 Watts
SENSITIVITY FOR 100 WATTS O/P AT 1 kHz	450 mV
INPUT IMPEDANCE	33 K ohms
TOTAL HARMONIC DISTORTION 50 WATTS into 4 ohms / 50 WATTS into 8 ohms	0·1% / 0·06%

This unit, designated AL250, is a power amplifier providing an output of up to 125W RMS, into a 4 ohm load.

AL30A

10w R.M.S.

AUDIO AMPLIFIER MODULES

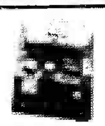
£3·79 + 35p p&p
+ 12½% VAT

MAXIMUM SUPPLY VOLTAGE	30 V
POWER OUTPUT for 2% THD	10 Watts RMS
TOTAL HARMONIC DISTORTION	Less than ·25%
LOAD IMPEDANCE	8–16 ohms
INPUT IMPEDANCE	100 K ohms
FREQUENCY RESPONSE	50 Hz–25 kHz ± 3 dBs
SENSITIVITY	75 mV for full output
DIMENSIONS	74mm × 63mm × 28mm

These low cost 10 watt modules offer the utmost in reliability and performance, whilst being compact in size.

SPM80

STABILISED POWER SUPPLY



£4·40 + 35p p&p
+ 12½% VAT

INPUT A.C. VOLTAGE	33–40V
OUTPUT D.C. VOLTAGE	33 V nominal
OUTPUT CURRENT	10 mA–1·5 amps
OVERLOAD CURRENT	1·7 amps approx.
DIMENSIONS	105mm × 63mm × 30mm

Designed to power two AL60s at 15 Watts per channel simultaneously. Circuit Techniques include full short circuit protection.

PA100

STEREO PRE-AMPLIFIER

£16·05
+ 40p p&p
+ 12½% VAT

FREQUENCY RESPONSE	20 Hz to 20 kHz × 1 dB
TOTAL HARMONIC DISTORTION	Less than ·1% (Typically ·07%)
SENSITIVITY INPUTS 1. TAPE	100 mV/100 K ohms (For an output 250 mV)
2. RADIO TUNER	100 mV/100 K ohms
3. MAGNETIC P.U.	3·5 mV/50 K ohms
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
BASS CONTROL RANGE	± 15 dBs at 75 Hz
TREBLE CONTROL RANGE	+ 10–20 dBs at 15 kHz
SIGNAL/NOISE RATIO	Better than 65 dBs (All inputs)
INPUT OVERLOAD	Better than 26 dBs (All inputs)
SUPPLY	20 to 40 V
DIMENSIONS	300 × 90 × 33mm (less controls)

A top quality stereo pre-amplifier and tone control unit, the PA100 provides a comprehensive solution to the front end requirements of stereo amplifiers or audio units. The six push button selector switch gives a choice of inputs together with two filters for high and low frequencies.

MPA30

MAGNETIC CARTRIDGE PRE-AMPLIFIER

£2·98
+ 35p p&p
+ 12½% VAT

Enjoy the quality of a magnetic cartridge with your existing ceramic equipment using the MPA 30 which is a high quality pre-amplifier enabling magnetic cartridges to be used where facilities exist for the use of ceramic cartridges only.

SENSITIVITY	3·5 mV for 100 mV output
EQUALISATION	Within ± 1 dB from 20 Hz to 20 kHz
INPUT IMPEDANCE	50 K ohms
SUPPLY	18 to 30 V—re earth
DIMENSIONS	110 × 50 × 25mm (inc DIN socket)

PA12

STEREO PRE-AMPLIFIER

£7·78
+ 35p p&p
+ 12½% VAT

The PA12 Stereo Pre-Amplifier chassis is designed and recommended for use with the AL 20/30 Audio Amplifier Modules, the PS12 power supply and the T538 Transformer. Features include on/off volume, Balance, Bass and Treble controls. Complete with tape output.

FREQUENCY RESPONSE	20 Hz–20 kHz (—3dB)
BASS CONTROL	± 12 dB at 60 Hz
TREBLE CONTROL	± 14 dB at 10 kHz
INPUT IMPEDANCE	1 Meg. ohm
INPUT SENSITIVITY	300 mV
CROSSTALK	—60 dB
SIGNAL/NOISE RATIO	—65 dB
OVERLOAD FACTOR	± 20 dB
TAPE OUTPUT IMPEDANCE	25 K ohms
DIMENSIONS	152mm × 84mm × 25mm

PS12 POWER SUPPLY MODULE

Power supply for AL20A-30A, PA12, S450 etc.
Transformer T538.

Input A.C. Voltage 15–20V.
Output D.C. Voltage 22–30V approx. (Dependent upon input.)
Output Current 800mA maximum.
Dimensions 60 × 43 × 26mm.

£1·90
+ 12½% VAT + 35p p&p.

BP124 SIREN ALARM MODULE

American Police screamer powered from any 12 volt supply into 4 or 8 ohm speaker. Ideal for car burglar alarm, freezer break-down, and other security purposes.

ONLY £3·50
+ 8% VAT + 35p p&p. 5 WATTs —

MA60 HI-FI AMPLIFIER KIT

Build you own top quality amplifier, save yourself pounds. The MA60 kit comprises the following BI-kits modules, 2 × AL60 amps, 1 × PA100 pre-amp, 1 × SPM80 stab. power supply, 1 × BMT80 transf. giving 15 watts RMS per channel STEREO. All modules covered by the BI-PAK satisfaction or money back guarantee. Details of the above modules are in this ad.
Price £32·00 + 12½% VAT + 62p p&p.

TC60 KIT

A beautifully designed genuine TEAK WOOD veneered cabinet to put the professional touches to your home built amplifier. Full set of parts incl. Front & Back Panels, Knobs, Chassis, Fuses, Sockets, Noen, etc. Ideal for the MA60. Size: 425mm × 290mm × 95mm.
Price £19·95 + 12½% VAT + 86p p&p

TRANSFORMERS

T538 For use with S.450 AL30A MPA30
Order No. 2036 Price: £3·20 + 55p p&p + 12½% VAT
T2050 For use with Stereo 30
Order No. 2050 Price: £3·25 + 55p p&p + 12½% VAT
BMT80 For use with AL60 SPM80
Order No. 2034 Price: £5·40 + 86p p&p + 12½% VAT
BMT250 For use with AL250
Order No. 2035 Price: £6·35 + £1·10 p&p + 12½% VAT
2040. For use with AL60
Order No. 2040 Price £5·20 + 80p p&p + 12½% V.A.T.
2041. For use with AL80, AL120 and AL250
Order No. 2041. Price £6·80 + 86p p&p + 12½% V.A.T

CASES

TEAK 30. 32 × 23 × 8cm. designed mainly for use with our stereo 30 Audio System but has proved very helpful to home constructors. Fitted with solid uncut front and back. o/n 139. £5·95. + 12½% V.A.T. p&p 70p.

TEAK 60. 42 × 29 × 9cm. for use with AL60/MK60 Audio Kit. Useful for the home constructor requiring an amplifier sleeve – has no front or back panel. o/n 140. £7.00. + 12½% V.A.T. p&p 85p.

Citizen's Band—Yes or No?

THE mention of a Citizens' Band for the UK can be relied upon to generate strong feelings, one way or another, among people with any interest in radio. This is evident from the letters received in response to J. S Goodier's proposals published in our December issue. A selection of these letters appears on page 29.

On the right, we print the text of a letter sent recently to the Prime Minister by the Citizens Band Association, urging the introduction of a UK CB service on a v.h.f. band. The Association's comments on four arguments against CB, while certainly valid in themselves, leave several questions unanswered. The adoption of a band other than 27MHz has undoubted advantages from the point of view of reducing interference and illegal long-distance working, and providing a boost for the UK electronics industry. But what would be the price of these sophisticated v.h.f. sets? If it's anything like that of hand-portable transceivers operating in the marine or private-mobile v.h.f. and u.h.f. bands, it seems unlikely that many would be sold to private individuals.

If 27MHz equipment continued to be imported and used, then little would have been gained. It is alleged that several thousand 27MHz sets are presently operating regularly in a net in north London, but apart from an occasional prosecution there is little that the Home Office can do to control them. How would that situation be changed by introducing a legal service in parallel, on another band? And no doubt many would plead for the quoted 15 000 existing users to be allowed to continue to operate their sets, though this figure does rather pale into insignificance against the current 66 000 licensed users of radio model control and the numerous radio-paging systems having a long-standing legal right to the 27MHz band in the UK. At the very least, the government would need to introduce legislation banning further imports of 27MHz CB equipment.

Though the Association quotes several US authorities as now backing the use of CB as an aid to road safety, there have in the past been numerous published reports of CB channels being swamped, leaving broken-down road users and others unable to contact assistance. With the present growing contempt for law and order in some sections of the community, it seems unlikely that we would be spared the interfering carriers, high-powered transmitters, obscene language or continuous music which have plagued CB in other countries.

There is no simple answer to these problems, and little use is served by claiming that there is. Whatever solution may be adopted is going to be unpopular with a lot of people.

PW PERSONALITY

Peter Metalli—Art Editor

From art school, Peter began his career in a newspaper feature agency in Fleet Street, receiving a solid grounding in drawing and publication methods. He remained there for 17 years, interrupted by four years (1943–47), in which he served in the RAF as a Flight Engineer.

In 1955 Peter joined "George Newnes" (incorporated now within IPC) working in the general art department "servicing" the "Practical Group" magazines, and from there graduated to his present position in *PW*.

Peter, Gwen his wife, and daughter Angela, have all settled happily in Bournemouth after their move from Essex, following the company's relocation from London to Poole, Dorset.

Married son, Peter, and wife Alice, still back in Essex, have recently made him a proud grandfather.

Interests are model cars and aircraft, stamps, DIY and gardening.

Citizens Band Association

The Rt. Hon. Mr J. Callaghan, MP, PC,
The House of Commons,
London SW1
January 12th, 1979

Dear Prime Minister,

I am writing to you to ask you to reconsider your Government's opposition to the introduction of Citizens Band Radio in this country.

Eire and ourselves are the only countries left in Europe which do not allow private citizens some form of short range radio communication. While care must be exercised to license a system which offers efficiency without interrupting other services, is it not somewhat repressive to deny the private citizen any access to short range communication in his everyday affairs?

In the past four main arguments have been advanced against CB:

(i) It may be used by criminals and for undesirable purposes;
(ii) The administration required to control it would be prohibitively complex;
(iii) No frequencies exist which might be used for such a purpose; and
(iv) Those countries which have it wish they did not.

I should like to comment on these objections in order:

(i) At present any criminals who use CB equipment are unlikely to be heard. As soon as CB is legal, however, the presence of large numbers of CB users ensures that criminals using CB are heard and quite probably located and arrested. In the USA any criminal who is fool enough to try to use CB is almost invariably detected.
(ii) Modern "silicon chip" technology makes it not only possible but simple to fit every CB set sold, at the factory, with a unique identifying signal which cannot be tampered with without the resources of a microelectronics factory and without which the CB set will not transmit. The extra cost of such identification would be under 50p per set. Such a device makes the identification of CB sets simple and reduces the administrative costs of a CB service to a low level. It also increases the impracticality of the criminal or anti-social use of CB.
(iii) Although there are no unallocated frequencies available for CB there are many MHz of spectrum throughout the v.h.f. and u.h.f. region which, though allocated, are thoroughly under-used. In particular the 220–240MHz range has unused sectors (some never used since 1944), there is space around 900MHz, and the v.h.f. television channels are now so unused that spectrum there might well become available in the near future. Very little spectrum is needed for a Citizens Band—0·5 to 1MHz would be ample and even 200kHz could provide a reasonable service—and given political will it could be found.
(iv) This last reason is the weakest of all, though frequently advanced in official circles. In the USA it is Federal policy to encourage the use of CB radio because of its contribution to road safety, as a recent memorandum from the Secretary of the Department of Transportation, the Chairman of the Interstate Commerce Commission and the Chairman of the Federal Communications Commission makes plain. Over thirty countries, including a number not noted for their liberal regimes, now have CB and although there are inevitably some problems the benefits so far outweigh them that none regret introducing it.

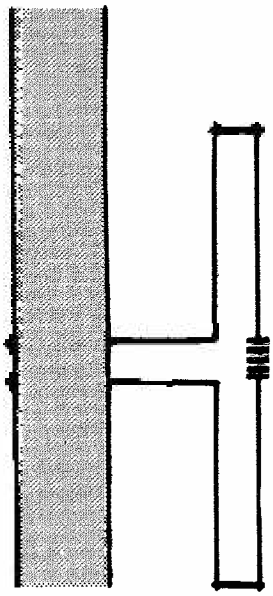
However, I am not writing to you now to rehearse a dialogue which is some years old. There is at present a real danger of a less satisfactory form of CB being adopted in Britain in the future if action is not taken soon to define a better alternative.

In the past year three organisations, the National Electronics Council, the British Radio Equipment Manufacturers Association and the Electronic Engineering Association, have prepared reports on Citizens Band Radio in Britain. All are agreed that the Government should introduce CB and all are agreed that the American 27MHz a.m. standard used in most countries having CB is unsuitable for a small, densely-populated island like our own on various grounds including television interference, the probability of the market being swamped by equipment built in the Far East for the American market and the availability of equipment, legitimately manufactured for the 10 metre Amateur service, which can boost 27MHz transmitters to illegally high powers. Instead they (and the Citizens Band Association) propose v.h.f. and frequency modulation (f.m.). Such a system offers many advantages including local manufacture (four British manufacturers are already prepared to manufacture such sets should CB be legalised), minimal interference and higher quality.

However, many people, angered by the continued illegality of CB in Britain, are now importing American and European equipment and using is illegally. The Citizens Band Association estimates that there are now some 15 000 illegal users in this country and that their number is growing by about 1000 per month. If this continues your own or some future Government will be forced, as happened in Australia, to legalise what is being done. There will then be no possibility of introducing a more sophisticated system or such controls as the automatic identification mentioned above—it will be necessary to legalise another American-style system with most of the American problems. The CBA would prefer such a system to none at all but we feel that we would have missed a golden opportunity of leading the World into a new generation of Citizens Band Radio.

I therefore most earnestly urge you to reconsider your Government's opposition to CB and legalise a sophisticated v.h.f. system, with whatever controls you or your advisers may consider necessary, before you or your successors are forced, by pressure of illegal use, to permit the use of American 27MHz equipment.

Yours sincerely,
James M. Bryant,
President, Citizens Band Association



VHF/UHF FOLDED COLINEAR AERIAL ARRAY

Fred JUDD G2BCX

This aerial is a two-element colinear design for vertically polarised (omni-directional) radiation. It may be constructed for use on either the 2m or 70cm amateur bands and is a development of the very successful "Slim Jim", published in April 1978.

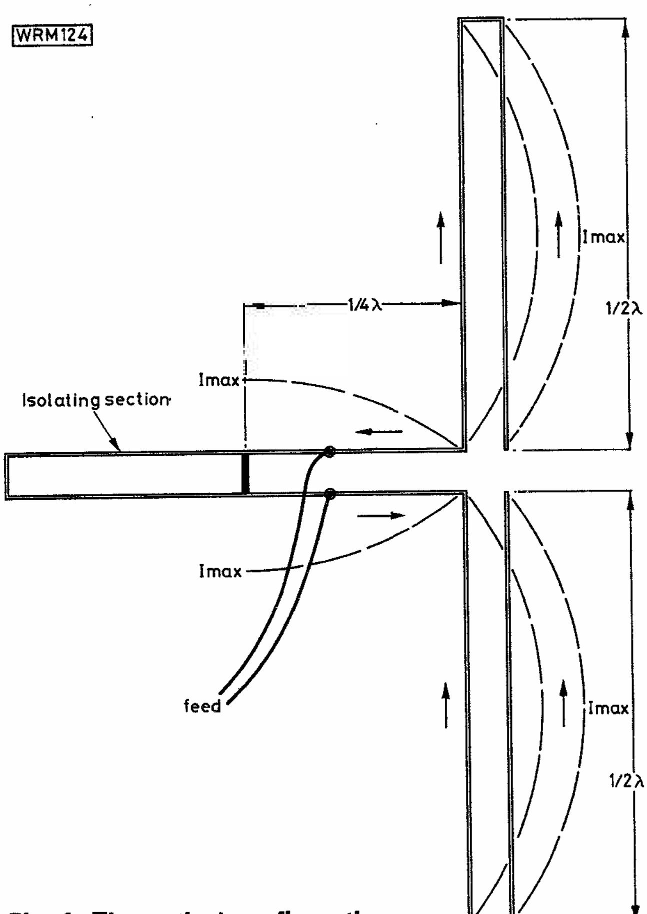


Fig. 1: Theoretical configuration of the colinear array

Two folded half-wave elements driven in phase from a quarter-wave stub constitute the active parts of the device, originally built for use on the Norwich 70cm repeater. The requirement called for a pair of aerials with at least 3dB gain which could be mounted on a mast without undue effect on their omni-directional properties—i.e. with minimal distortion of the otherwise circular radiation pattern.

The theoretical configuration is shown in Fig. 1. Experimentation indicated that the minimum tolerable distance from a metal mast producing the least effect on radiation was $0{\cdot}625\lambda$. Accordingly, a long stub section is employed which also serves as a supporting mount for the aerial.

The folded radiating elements are voltage driven from a quarter-wave section of the whole stub, the current distribution being indicated by the arrows. The increase in gain over a conventional two-element colinear (gain normally around 1·8dB) is obtained by the use of the folded elements, which contribute an additional 1·6dB. This aerial therefore has a total gain of 3dB over a dipole. Note the break between the return sections, necessary to create a standing wave.

Construction

The diagram of Fig. 2 should provide enough information to enable this aerial to be constructed for either 70cm or 2m, detailed dimensions being given in Table 1. For u.h.f. the aerial will self-support but for v.h.f. some form of boom at right-angles to the mast may be necessary to take the weight of the stub and elements—which are, of course appreciably longer than their u.h.f. counterparts. This could be constructed from wood, and reach at least as far as the quarter-wave section shorting bar. An alternative would be the use of larger diameter tubing for the elements and stubs, say 12·7mm ($\frac{1}{2}$in).

Connections to the feed point must be protected from rain and the prototype used an oblong plastic box with tight-fitting lid for this purpose. The insulator linking the two folded element sections should be of high quality material, such as ptfe, which is drilled to fit over the ends.

A piece of aluminium about 10mm square may be used for the quarter-wave shorting bar, drilled to take the stub lines and tapped for the 4BA screws which lock the bar to the lines. Element dimensions are given for both versions, the velocity factor having been taken into account.

Adjustment

When the aerial has been completed it should be set up in fairly clear surroundings, approximately 2 metres above ground, with the full length of feeder cable attached. Adjust the feed tapping points and quarter-wave point (shorting bar) for maximum power and v.s.w.r. All v.h.f. aerials operate most efficiently when high up and clear of rooftops or other obstacles, such as tall trees. This is particularly true in the case of colinears with zero-angle radiation. Sizeable trees in full leaf can attenuate v.h.f. and u.h.f. signals by as much as 20dB when placed in the path of radiation, even in dry weather. Brickwork can reduce signals by 10dB or more.

The vertical angle polar pattern of Fig. 3 was taken from the Author's display unit and clearly shows the radiation characteristics of the u.h.f. prototype.

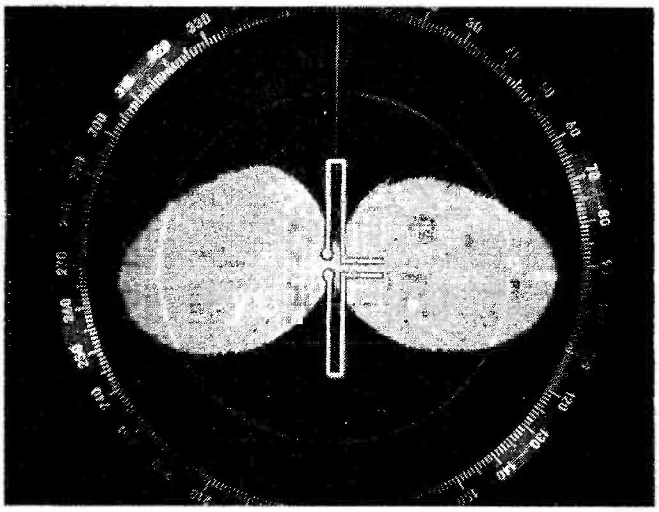
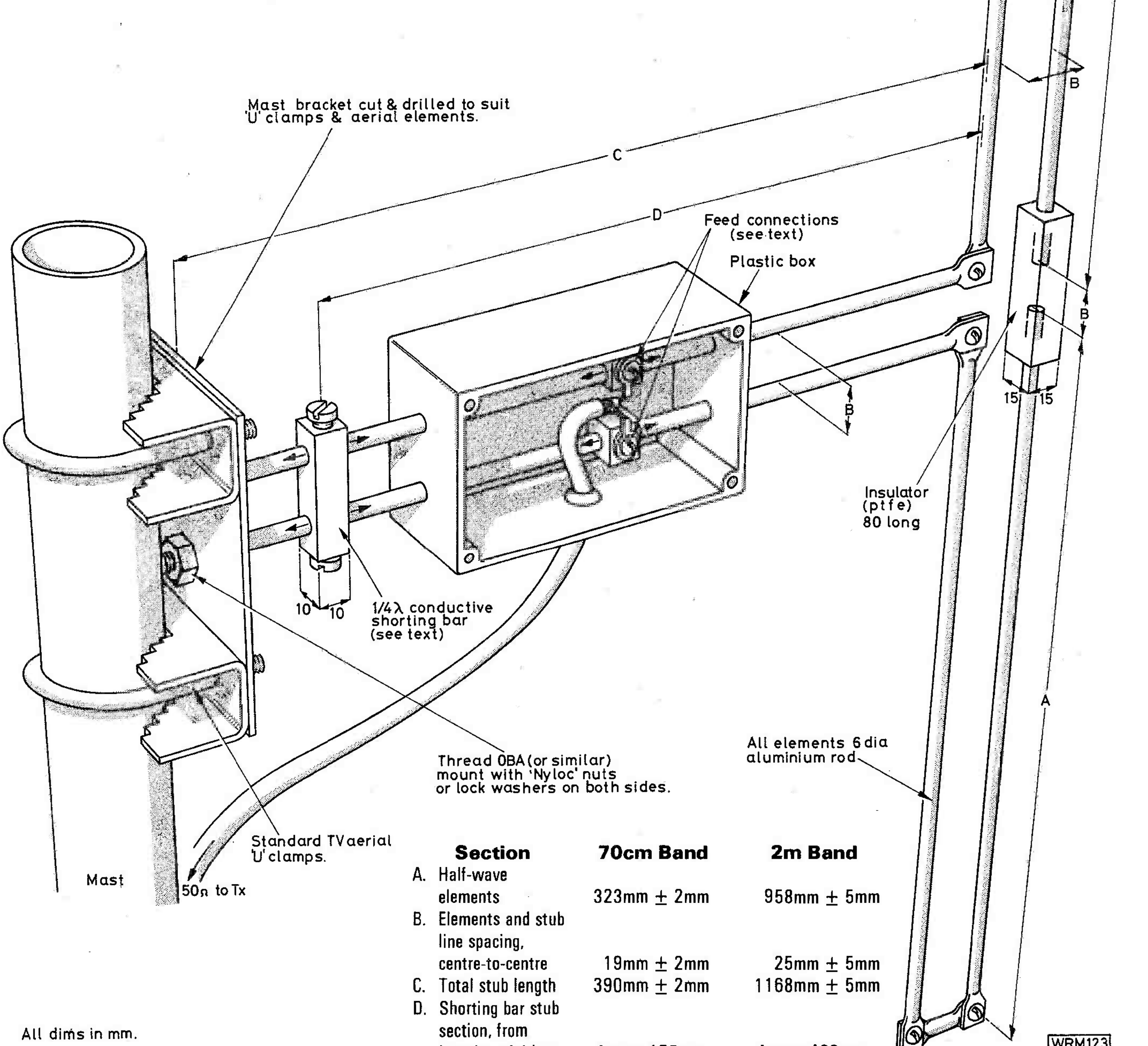


Fig. 3: Vertical polar pattern of the 70cm prototype

Fig. 2: Constructional details



Section	70cm Band	2m Band
A. Half-wave elements	323mm ± 2mm	958mm ± 5mm
B. Elements and stub line spacing, centre-to-centre	19mm ± 2mm	25mm ± 5mm
C. Total stub length	390mm ± 2mm	1168mm ± 5mm
D. Shorting bar stub section, from junction of driven elements	Approx 175mm (see text)	Approx 469mm (see text)

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

MPU evaluation kit

Now available on an off-the-shelf basis from Distronic are two low-cost microprocessor development systems for the RCA CDP1800 COSMAC m.p.u. family. Costing £100 (plus VAT), the CDP18S020 evaluation kit is a complete kit of components for building an evaluation board for the CDP1802 COSMAC m.p.u., while the CDP18S021 Microterminal, which costs only £70 (plus VAT), is a low-cost, hand-held, non-hard-copy alternative to a teletypewriter data terminal.

The two systems are ideally suited to combined operation. The evaluation kit represents a valuable first step in the development of COSMAC programs and prototype systems, and incorporates on-board utility read-only memory for terminal control. The Microterminal provides a convenient means of controlling a COSMAC system, reading and modifying memory, and providing hexadecimal input/output capability. *Distronic Ltd., 50–51 Burnt Mill, Elizabeth Way, Harlow, Essex. Tel: (0279) 32947/39701.*

On Station

For those interested in the whole spectrum of broadcasting, two recent publications are relevant. The 1979 *"World Radio and TV Handbook"*, according to its Assistant Editor, contains comprehensive information on the world's transmitters (including recent frequency changes) and details of operating times, languages, DX clubs, time signal broadcasts, and even religious broadcasting organisations. The book is available at a cost of £8·50 from *Billboard Publications, via Argus Books Ltd., 14 St. James Rd., Watford, Herts, at your bookshop.*

"Radio Stations Guide", by B. B. Babani and M. Jay, has been considerably up-dated, and contains basic information on the world's radio broadcast transmitters, with a special supplement covering the changes in long- and medium-wave transmissions in the United Kingdom. This guide is available at a cost of £1·45 direct from the publisher: *Bernard Babani (publishing) Ltd., The Grampians, Shepherd's Bush Rd., London W6 7NF.*

Rally date

The North Midlands Mobile Rally organised by The Midland Amateur Radio Society and The Stoke-on-Trent Amateur Radio Society, will take place on Sunday, 29 April 1979, at Drayton Manor Park near Tamworth, Staffordshire. The Park is located on the A4091, which is within easy reach of the M1, M5 and M6 motorways.

The rally will open at 11.30am and visitors will be made very welcome. There will be a talk-in on 2 metres and 70 centimetres. For further details contact: *Norman Gutteridge G8BHE, 68 Max Road, Quinton, Birmingham B32 1LB. Tel: 021-422 9787.*

Testing m.p.u.s

Programme details and synopses of papers for "Microtest", the Symposium on the testing, maintenance and reliability of microprocessor-based equipment, being held at the University of Sussex, from 4pm on Monday, 2 April 1979, until midday on Thursday, 5 April 1979, have now been finalised.

The papers being presented are from Industry, the Universities, Government Departments, and the Post Office.

The Symposium is being organised by the Society of Electronic and Radio Technicians in association with the IERE and the Microprocessor Application Group of the IEE.

The Symposium will open with a Keynote Address given by Colin Crook, Managing Director of Rank Precision Industries Ltd. on the evening of 2 April.

Further information and registration forms are available from: *The Symposium Secretary (MS), SERT, Faraday House, 8-10 Charing Cross Road, London WC2H 0HP. Tel: 01-240 1152.*

New catalogues

Tirro Electronics, the mail order division of "Ritro" has issued a new, combined, catalogue/price-list/order form, available from them free of charge.

Products listed include a whole range of components from the AMICOS m.p.u. system, to resistors, diodes and capacitors. Other useful items included are transformers, i.c.s, aerials, tools, books, etc.

Each item is clearly priced (VAT included), with discounts for quantity orders. *Tirro Electronics, Grenfell Place, Maidenhead, Berkshire. Tel: (0628) 36229.*

Chloride Exide have just issued an updated list of their dry batteries and torches.

In twelve A4 pages plus covers, it gives all necessary information about high-power batteries; transistor equipment batteries; calculator batteries; extra power transistor batteries; low and high tension batteries; torch, lamp and special purpose batteries. It also includes an equivalents list, dry battery terminal diagrams and coloured illustrations of the top ten popular types.

Available on request from: *Chloride Automotive Batteries Ltd., Chequers Lane, Dagenham, Essex RM9 6PX.*

Home Radio

Due to a massive rise in the rent asked for their current premises, Home Radio (Components) Ltd., of Mitcham, Surrey are moving to new offices at the end of March. Because of this, they will be unable to maintain their retail counter facilities, and will in future trade by mail order only.

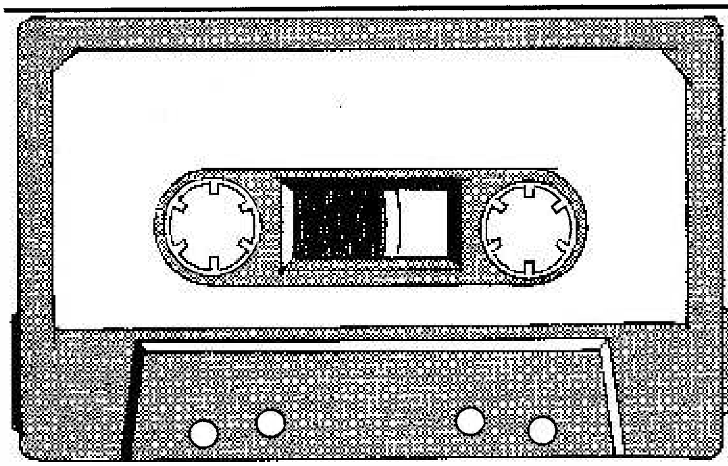
To dispose of some surplus stock items, there will be lots of bargains available **to callers only** in a clearance sale from 24–31 March at the existing address, 9am–5pm daily (close 1pm on Wednesday).

The new postal address for mail order will be notified as soon as possible. For the present, customers should continue to write to: *Home Radio (Components) Ltd., Dept. PW, 234–240 London Road, Mitcham, Surrey CR4 3HD.*

Can I Help You!

Are you the secretary, organiser or general dog's body of your local radio club or any other group whose functions may interest readers of *PW*. If so, let me know and I will endeavour to publicise your rally, get-together whatever, through this column. Remember though, we compile the magazine some time ahead of publication day (e.g. this note was written in mid-January), so, the earlier I can have details, the better.

Alan Martin



THE CASSETTE TAPE MEDIUM

pause

Part 1

Gordon J. KING

Having in mind the miniscule 0·6mm tracks of the Compact Cassette, and the low tape/head velocity of a mere 4·75cm/s, it seems incredible that the medium is currently capable of high quality recording and replay up to frequencies approaching 20kHz, and it is still improving. When the Compact Cassette system was launched by Philips way back in the Fifties the quality by today's hi-fi standards was, frankly, abysmal. The noise floor was little more than 40dB below signal peaks of some 5 per cent distortion, the upper-frequency response commenced rolling-off around 7 to 8kHz, and the wow and flutter figures could easily reach 0·5 per cent or more!

Assisted by the recent noise reduction systems, notably Dolby B, and the new psuedo-chrome (*Cr*) and pure *Cr* tapes, a noise floor as low as 65dB (CCIR/ARM-weighted) relative to an output of 3 per cent 3rd-order distortion threshold is readily achievable at middle frequencies, which is virtually as good as can be expected from the best gramophone records. At the recording levels likely to be experienced in the treble regions by the vast majority of home recordists, the response holds well to frequencies of 15kHz or more (which is the upper limit of most gramophone records and f.m. radio), while dramatic improvements to tape transport mechanisms have decreased the wow and flutter to less than 0·1 per cent DIN-weighted peak.

With these sort of performance figures, therefore, it is little wonder that more audiophiles and music lovers are turning to the cassette deck as a primary source of programme signal, which is regarded as having the edge on the record deck in terms of its recording attribute, if not in absolute music quality.

If a recording is made of a top quality gramophone record or stereo radio programme with a contemporary hi-fi deck using good tape, it is often difficult to determine conclusively whether one is hearing the original or the recording. Yes, the state-of-art is to this standard. Indeed, there are people who claim that the recording sometimes auditions more favourably than the original, which would appear to have significance, in that the replay distortion is "disguising" some of the less palatable distortion plaguing the original programme signal, but this is a different story!

So far as pre-recorded cassettes (e.g., Musicassettes) are concerned, the quality of the equivalent gramophone records is generally better. It is also more convenient to locate a particular track on a disc than on a cassette record, but even this cassette shortfall is being resolved by the microprocessor chip, such as found in the Optonica up-market cassette decks, for quickly locating a required section of music for replay, without the frustration of having to make experimental fast winds and rewinds.

Cassette Shortcomings

So far, then, it might be supposed that the compact cassette medium no longer has any shortcomings and that all the problems have been resolved. This is certainly not true. For example, the medium cannot yet compete with wider-track reel-to-reel tape running at higher speed. However, with some of the latest tapes the performance can currently exceed that of reel-to-reel tape running at 9·5cm/s, which is a truly remarkably achievement.

When the pure metal particle tapes are more readily available, along with machines to do them full justice, then the improvement will be even more dramatic, and we shall probably be able to obtain the existing cassette performance with a tape speed half that of the existing cassette tape speed! Conversely, by retaining the existing cassette speed, the performance will be lifted virtually to match that of most domestic type reel-to-reel machines running at high speed.

The biggest shortcoming of the cassette medium can be described with one word—compression. A tape can assimilate only a certain amount of magnetism depending on its magnetic properties. If the magnetising force is increased by passing an increasing current through the winding of the recording head, the magnetic flux density of the tape will increase until it can accept no more magnetism. At this point no matter how much more the force is increased there will be no further increase in tape flux. This means that the tape is fully saturated since all the available magnetic domains are then in alignment.

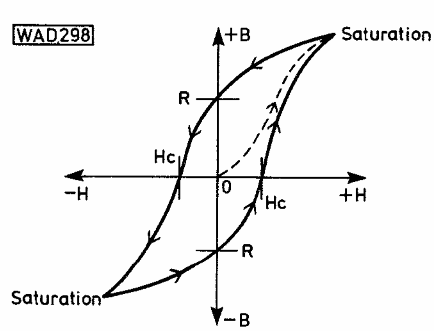


Fig. 1: Hysteresis loop of magnetisation. See text for description

The hysteresis loop in Fig. 1 describes the path taken by flux *(B)* as the magnetising force *(H)* is increased first in one direction, decreased, and then increased in the opposite direction. Initially, the flux follows the broken-line up to saturation; it then falls back from saturation as the force is reduced to zero, and rises to saturation in the opposite direction as the force is increased in the opposite direction. The loop shows that after the tape has been magnetised and the force is reduced to zero a flux remains on the tape of value *(R)* which is, in fact, the magnetism which has been imparted to the tape and retained by it. Points *(R)* on the loop are called the remanent points and thus signify the remanent magnetism remaining on the tape after the force has been removed.

The loop also shows that once the tape has been magnetised, an opposite field of force H_c is required to pull the remanent flux down to zero again, and hence to demagnetise the tape. This is called the coercive force, so the greater the coercivity of the tape, the better it holds its magnetism and the harder it is to demagnetise, which can be useful, particularly for recording high frequencies.

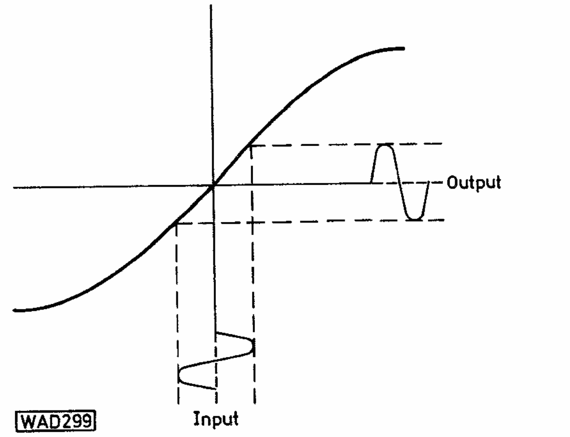


Fig. 2: Transfer characteristic of magnetic tape showing non-linearity of odd-order terms, which is responsible for odd-order distortion on the output signal. The curve takes account of the correction provided by the h.f. bias

Transfer Non-Linearity

To combat the severe non-linearity at low values of magnetising force, the signal for recording is superimposed on a high-frequency sinewave of around 100kHz. This caused the magnetic force, resulting from the signal, to swing on the upper reaches of the two halves of the *BH* curve, which are more linear than the lower reaches. Even so, the resulting transfer characteristic is still not very linear, particularly as the signal pushes the tape towards saturation, which means that in spite of the recording signal being of very low distortion, the replay signal is bound to carry a greater level of distortion, especially at high recording levels.

The nature of the transfer characteristic, after the improvement by the h.f. biasing has been taken into account, is shown in Fig. 2. As this type of curve contains odd-order terms, most of the distortion is odd-harmonic, such as 3rd, 5th, 7th, etc., harmonic, with the 3rd harmonic predominating. Moreover, because the curve goes more non-linear as the tape approaches saturation, so the 3rd harmonic distortion increases. If the signal being recorded is so strong as to push the tape into saturation, then there can be just as much 3rd- and odd-order distortion as there is fundamental! Hence the reason why cassette recordings sound abysmally poor when they are over-recorded on signal peaks.

The maximum output level (MOL) of a tape refers to the level of flux that it can accommodate up to a specified level of distortion—usually 3 per cent. In the SI units, magnetic flux density is expressed in webers per metre (Wb/m), but as tape flux is so small the expression nWb/m is used, where n is the nano or 10^{-9} multiplying factor. Some idea of the flux level on a tape can be gleaned from the fact that the majority of Japanese cassette decks show +3VU on their meters when the recorded tape flux corresponds to about 200nWb/m which, incidentally, is the Dolby noise reduction reference level. This means, then, that at 0VU the tape flux is about 141·5nWb/m (e.g., 3dB down from 200nWb/m, which is 200 × 0·707).

The curves in Fig. 3 give some indication of how the 3rd harmonic distortion increases with increasing tape flux, based on the average of five different tapes as used in domestic cassette decks at low, middle and high frequencies. It should be noted that different machines and tapes of different samples might well result in a different distribution. For convenience, lines have been drawn to indicate the 0dB 200nWb/m point on the horizontal scale and the 3 per cent distortion point on the vertical scale.

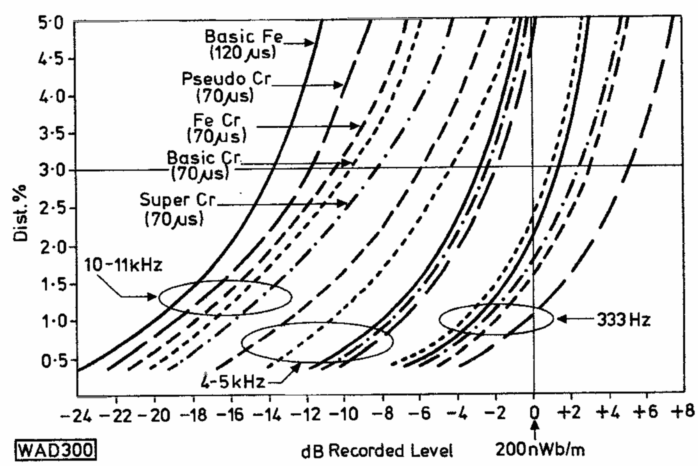


Fig. 3: Curves showing how the distortion increases at three different frequencies as the recorded level and hence the tape flux is increased. The results represent the averages of a number of samples and batches of the tape types indicated, when used with domestic cassette decks

The curves show that with this particular combination the pseudo-*Cr* tape (such as Maxell UDXL II, TDK SA, etc.) is capable of the greatest flux at the low frequency of 333Hz where, to the 3 per cent distortion point, a flux of +5dB (corresponding to about 356nWb/m) can be accommodated. The basic *Fe* will only yield about +1dB, basic *Cr* a trifle less, *Cr* Super (a recent BASF formulation) about +2·5 (depending on bias), and ferrous-chrome *(FeCr)* about +3dB. Clearly, then, the pseudo-*Cr* is a clear winner so far as sheer flux is concerned at l.f.

Although a good deal of music energy and peaks reside at low and middle frequencies, this is not the whole story because high quality music can undoubtedly contain quite high-amplitude transients at much higher frequencies. Looking at the curves applicable to 10–11kHz, it will be seen that the distribution has altered somewhat, for now the greatest flux is yielded by the Super *Cr* to 3 per cent distortion at about −8dB (80nWb/m). The pseudo-*Cr* is down to about −12dB (50nWb/m), while the basic *Fe* is at the bottom at about −14dB (40nWb/m). The basic *Cr* is quite respectable at −10dB (63nWb/m) and the *FeCr* is not bad at −11dB (56nWb/m). These curves, then, indicate that *Cr* and *FeCr* are good upper-frequency performers.

The middle-frequency curves fail to reveal the upper-frequency attribute of the *Cr* and *FeCr* tapes, since the pseudo-*Cr* is still showing the highest flux at −2dB (159nWb/m). Nevertheless, the Super *Cr* is not far behind, nor is the basic *Cr*. The lowest output is given by the *FeCr* at −6dB (100nWb/m).

These curves, then, signify that as the frequency of the recorded signal increases, so the tape arrives at the beginning of saturation at decreasing levels of flux. If we were to record a tape at a constant level over the frequency spectrum, starting at, say, 200nWb/m at 333Hz, on replay we would find that the flux carried by the tape would gradually decrease with increasing frequency, as shown in Fig. 4. The upper-frequency roll-off of the curve is caused by the progressively increasing compression (that is, the inability of the tape to retain a given high level of magnetic flux as the frequency is increased).

This is the result of self-demagnetisation of the high-frequency, short-wavelength magnetic domains recorded on the tape oxide. For each half-cycle of recording signal the equivalent of a miniscule bar magnet is produced on the oxide, and because the poles get closer together as the frequency of the signal is raised, the ability of the magnet to sustain its strength is diminished.

The recorded wavelength is equal to the tape velocity divided by the frequency in Hz. Thus, at 15kHz and at the cassette speed of 4·75cm/s, the wavelength is a mere 3·16µm, so each magnet has a length of 1·58µm. Little wonder, then, that there is a strong tendency towards demagnetisation! It is noteworthy that the length of the gap of the replay head must be of a similar small order fully to define the high-frequency components of the signal.

During recording, pre-emphasis is applied to the signal current fed to the head to help combat the h.f. loss. However, if excessive magnetic force is applied to the tape, the tape tends to demagnetise while it is actually being recorded, which can further worsen the compression distortion at h.f. Tapes which give the best h.f. performance with the least compression and hence h.f. distortion, are those of relatively high coercivity, such as the recent *Cr, FeCr* and the latest high-energy *Fe* and pseudo-*Cr* formulations, the first mentioned particularly including the BASF *Cr* Super if the programme material warrants the extra price and the machine can do full justice to the tape.

Although there are more factors involved in tape choice, the performance at h.f. cannot be over-stressed for the adequate recording of high quality material, from microphone channels direct, from electronic music-making devices, and from synthesisers where the peaks and energy at h.f. are likely to be relatively high. For dubbing from gramophone records and f.m. stereo radio, tape choice is less exacting (but it is desirable always to use the best that can be afforded and never cheap non-proprietary brands which can quickly shed their oxide and clog up the head gaps) because of the limited high-frequency energy and signal peaks of this nature of signal.

Although the curve in Fig. 4 is interesting, more useful are those curves which refer a given level of distortion to tape flux over the lower, middle and upper parts of the frequency spectrum. Since odd-order distortion

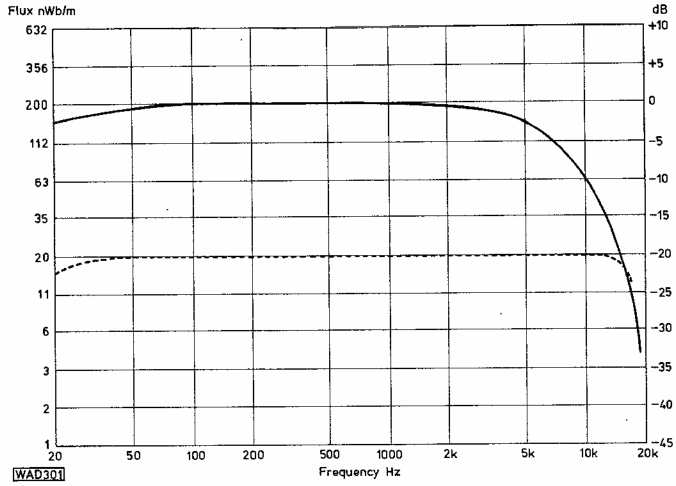


Fig. 4: Compression curve. The magnetic flux assimilated by a tape recorded at high level corresponding to 200nWb/m at 333Hz falls off with frequency as shown. To avoid the effect of compression, the frequency response is taken at a recording level at least 20dB below 200nWb/m, a curve shown by the broken-line is then achieved provided the bias and equalisation are set to suit the tape. If the bias is too low the upper frequencies will tend to show a boost, while if too high the upper frequencies will tend towards early roll-off

predominates (particularly 3rd-order), the distortion measured is 3rd harmonic at l.f. (around 333Hz) and 3rd-order intermodulation distortion at upper-middle (4–5kHz) and h.f. (10–11kHz).

There is no difficulty in measuring 3rd harmonic at l.f., for at 333Hz it falls at 999Hz, which is well within the passband of the system. At upper-middle and particularly h.f., the 3rd harmonic is likely to fall outside the passband and be affected by the replay equalisation. To avoid this, two-tone driving signals are used of f_1 and f_2 and the 3rd-order IM products of $2f_1 - f_2$ and $2f_2 - f_1$ measured in ratio to the driving signals. Since there is a mathematical relationship between 3rd harmonic and 3rd-order distortion, perfect correlation is achieved provided due attention is taken of the difference between the crest factors of the single-tone and two-tone signals.

For hi-fi applications, an upper limit distortion threshold of 3 per cent would appear to be appropriate, so the plan, then, is to find the flux assimilation of the tape when used with a specific domestic machine (or batch of such machines—taking the average) over the spectrum for 3 per cent distortion threshold.

NEXT MONTH

Spectral distortion, bias and equalisation, head problems, noise floor and dynamic range

letters

The Editor,
PRACTICAL WIRELESS,
Westover House,
West Quay Road, Poole,
Dorset BH15 1JG

The letter from J. S. Goodier regarding Citizen's Band in the UK, which appeared in our December 1978 issue, provoked a flood of letters from readers. These were fairly evenly divided between "for" and "against" CB. Several writers took violent exception to Mr Goodier's suggestion that part of the 2 metre band should be allocated for novice use, as a substitute for a Citizen's Band in the UK. We print here a selection of the letters received.

Sir: I have recently returned from Australia, where Citizen's Band radio has been legal for just over a year. I feel, however, that the Australian service follows too closely the American service. I also feel that the biggest problem with these two services is that a licence is far too easily obtained, and that a bad frequency band and emission type have been employed. A CB service could be introduced in this country, with heavy modifications to the American system of licensing.

I think that the following would greatly reduce the problems of such a service:

1. Correct radio procedure should be used, with proper station identification at the beginning and end of each transmission; only normal speech should be allowed, such as would be used on the telephone, with no "10-codes", which seem to make up the total vocabulary of many CBers.
2. The 11 metre h.f. band should be maintained, but the frequencies used changed to, say, 26MHz–27MHz (11·538m–11·111m), thus avoiding any overseas contacts. This band can be used in its entirety, perhaps utilising v.f.o. controlled transceivers, and allowing plenty of space for everyone.
3. Emission should be s.s.b. only, avoiding a.m. heterodyning and giving less overcrowding and more signal clarity.
4. A maximum output of 15W p.e.p. to be allowed, with no directional or gain antennas of the beam or quad type.
5. Licensees would be required to undergo an examination on regulations, including possible interference problems and remedies, a procedural test, and show a basic knowledge of antennas for the frequencies used and their alignment.
6. A licence fee of £7 to £10 should be charged and a callsign allocated once the examination had been passed. A callsign could take the form SD123W, etc., where SD indicates the county, 123 is the licence number, and W is the initial of the town in which the licensee lives.

I feel that the "Toms, Dicks and Harrys" could be greatly reduced by the initial pre-licensing exam. There is obviously a demand for a service in the UK, so with the appropriate licensing conditions there is no valid reason for such a service to be denied to us.

Gerald Yates
Watcombe
Torquay

Sir: I do not think that Mr Goodier's idea of a novices' amateur band on 144·5–145·0MHz would be accepted by present 2m users. The code-free facility of the present G8-type licence should not be beyond the capability of any interested enthusiasts, and any lowering of the licensing requirements would certainly make channelised f.m. on 2m sound like CB.

Anyhow, quite a lot of the 144·5MHz region and upwards is used for s.s.b. contacts, and 144·90–145·0MHz is used for beacon facilities. As one amateur using s.s.b. on 2m and trying for beacons here in Ireland (both their reception from distant places and their establishment here too), I would not welcome private communication type facilities in the band.

We here in EI (Eire) have just been given the facility of a code-free v.h.f. licence, so we welcome the increased use of 2m throughout the country. Only a small percentage of present amateurs are active on v.h.f. here—the silence has to be heard to be believed.

Perhaps the supporters of a novice type band could try for additional frequency allocations in the v.h.f. spectrum, say, 100–105MHz, 220–225MHz, 400MHz, or some other unused band. Enthusiasm for private communications should be directed positively towards a technical service with technical requirements for operation, and also giving the home electronics industries a chance to manufacture the equipment. Re-crystalling of expensive imported 2m f.m. equipment should be made very, very difficult. CB on 27MHz has caused havoc in the USA, not only from the TV interference aspect but also by upsetting the balance of trade. A novices' v.h.f. band is a possibility for the UK.

Des Walsh EI5CD
Carrick on Suir
Co Tipperary

Sir: Why is it every now and then some crank wants to do something with 2m below 145MHz? First G3RKL wanted to put repeaters and channels for s.s.b. Letters in *Radio Communication* told him where to put them! Now a reader in Stockport wants it for CB.

The 2m band from 145MHz down is for amateur use—true amateur—with DX, RTTY, SSTV and all modes. If our reader gets a good 2m receiver and antenna, he will be able to hear these signals.

The only people we want on the air in G-land are those who have passed the RAE.

John Tye
Dereham
Norfolk

Sir: Your correspondent J. S. Goodier suggests that if a Citizen's Band was permitted in the UK "they will come in their millions".

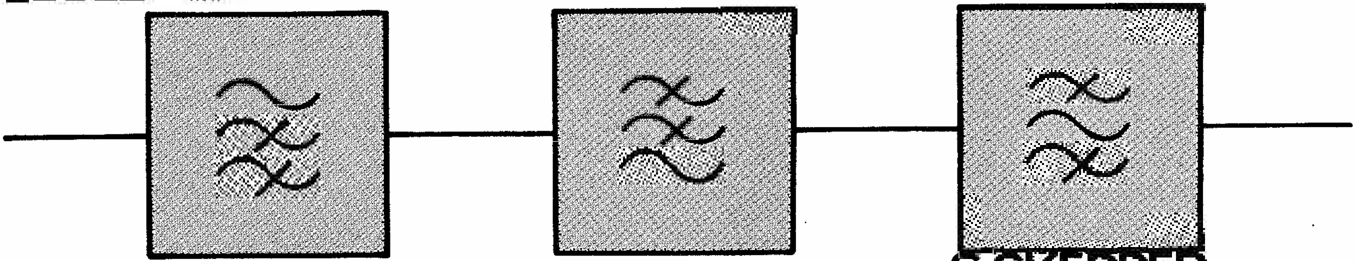
We must assume more than, say 1 million—perhaps as many as 5 million. If we take the price for an average 2 metre transceiver equipment, let's say £200, then the total market for 5 million sets will be worth £1000 million. On this will be charged 8 per cent VAT, which comes to £80 million. Good grief, man, what is the Chancellor of the Exchequer waiting for?

Who is fooling who? Cut the b******t and legalise what other sensible countries have already done.

J. Acton
Iver
Bucks

continued on page 67

SIMPLE AUDIO FILTER DESIGN



S.SKEPPER

Knowing how to design a filter for a pre-amp or mixer is a very handy thing if you do a lot of playing with audio circuits, but can be uphill work if your knowledge of maths does not extend a great deal beyond Ohm's Law. If you fit into this category then despair no more! To design passable (if you will pardon the pun) filter circuits, all one needs is a (modified) version of Ohm's Law (a pocket calculator helps, too!).

The simplest type of filter is the CR filter, so called because it uses only capacitors and resistors. Fig. 1(a) shows a low-pass filter, and Fig. 1(b) a high-pass filter.

Low Pass

The low-pass filter works like this: at low frequencies, the reactance (a.c. resistance) of C is much larger than the resistance of R, so the circuit functions as a voltage divider. Because the reactance of C (called X_c) is so much larger than R, the voltage dropped across R is very small, and the output is very nearly the same as the input. As the input frequency rises, the reactance C drops until, at a certain frequency called the cut-off frequency (abbreviated F_c), X_c equals R.

If we have a voltage divider composed of two equal resistors, then the output is exactly half the input. This is the frequency that gives the filter its name, e.g., we talk of a "10kHz low-pass filter", meaning it halves a 10kHz signal and rejects all frequencies above, because as the input signal rises above the cut-off frequency, X_c gets smaller and smaller and the output drops off correspondingly. When we design a filter, we have to take into account the input impedance of the amplifier or pre-amp, Z in the circuits.

Now let's design a filter. The three things we may know or may not know are C, R and F_c, so the three formulae for calculating them are shown below:

$$F_c = \frac{1}{6{\cdot}28 \times R \times C}$$

$$R = \frac{1}{6{\cdot}28 \times F_c \times C}$$

$$C = \frac{1}{6{\cdot}28 \times F_c \times R}$$

1. Design a scratch filter for an amplifier with an input Z of 100kΩ.

Scratch filters reject at about 15kHz, so we know F_c approximately. As a general rule, at F_c, R should equal Z, so we now know R; 100kΩ. All that leaves is C. From the above equation we get:

C in μF
R in kΩ
F_c in kHz

$$C = \frac{1}{6{\cdot}28 \times 15 \times 100}$$

$$= \frac{1}{9420}$$

$$= 0{\cdot}0001 \text{ or } 100\text{pF}$$

To check, work out the other two equations;

$$R = \frac{1}{6{\cdot}28 \times 15 \times 0{\cdot}0001}$$

$$= \frac{1}{0{\cdot}0094}$$

$$= 106\text{k}\Omega$$

$$F_c = \frac{1}{6{\cdot}28 \times 100 \times 0{\cdot}0001}$$

$$= \frac{1}{0{\cdot}0628}$$

$$= 15{\cdot}9\text{kHz}$$

Both results are near enough, considering we are only working to four decimal places.

High Pass

The high-pass filter (Fig. 1(b)), in the same way as the low-pass filter, has a point where the output is half the input: the cut-off frequency. Because the capacitor and resistor are inverted, the output rises as the frequency rises and so the circuit rejects frequencies below F_c. The equations for calculating C, R, and F_c are the same as for the low-pass filter.

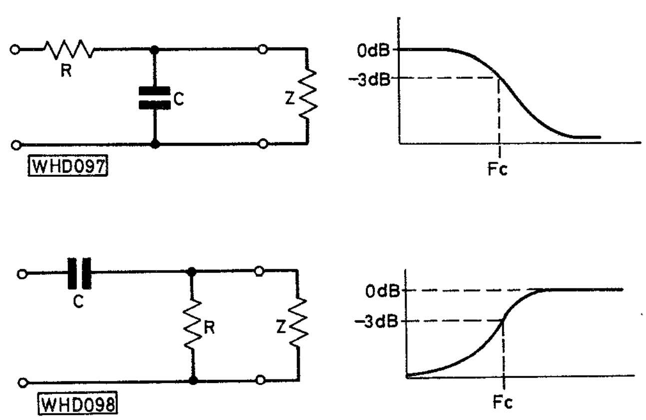


Fig. 1: Basic filter circuits and their response curves: (a) (Top) Low-pass. (b) (Bottom) High-pass

2. Design a rumble filter for a pre-amp with an input Z of 250kΩ. Rumble is mechanical noise from a record deck motor, and occurs at frequencies below about 25Hz, so we know F_c (25Hz) and R (250kΩ);

$$C = \frac{1}{6{\cdot}28 \times 0{\cdot}025 \times 250}$$

$$= 0{\cdot}025\mu F$$

Band Pass

Finally, let us look at band-pass filters. The simplest form of band-pass filter is shown in Fig. 2. It is simply a combination of Fig. 1(a) and 1(b). Band-pass filters are used for a variety of things, such as "middle" channel separation in tone controls, or combined rumble and scratch filters. The only limitation of this circuit is that the upper cut-off frequency, F_h, must be at least ten times the lower cut-off frequency, F_l, or interaction between the two circuits will occur, and the filter will not have a smooth response curve. Only two equations are given, as R = Z, and Z is usually known. Units are in kHz, kΩ and μF.

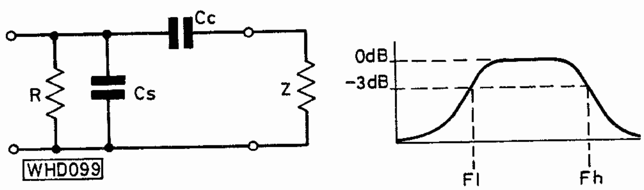


Fig. 2: A band-pass filter circuit and response

C_s determines F_h:

$$C_s = \frac{R + Z}{6{\cdot}28 \times F_h \times R \times Z}$$

C_c determines F_l:

$$C_c = \frac{1}{6{\cdot}28 \times F_l \times (R + Z)}$$

3. Calculate a combined rumble and scratch filter for an amplifier with an input Z of 50kΩ. R = Z = 50kΩ. F_h wants to be, say 12kHz, and F_l about 40Hz.

$$C_s = \frac{50 + 50}{6{\cdot}28 \times 12 \times 50 \times 50}$$

$$= \frac{100}{188\,400}$$

$$= 0{\cdot}0005\mu F \text{ or } 500pF$$

$$C_c = \frac{1}{6{\cdot}28 \times 0{\cdot}04 \times (50 + 50)}$$

$$= \frac{1}{25{\cdot}12}$$

$$= 0{\cdot}03\mu F$$

Phase Shift

The output signal from a CR network will always differ in phase (to a greater or lesser degree) from the input signal. Whether this is important depends on the application. In this introductory article, the effects of phase shift have been ignored. ●

KINDLY NOTE!

PW "Hythe" Receiver, February 1979.

IFT1 is Denco type IFT18/465.
IFT2 is filter type CFT455 from Ambit.
IFT4 is Denco type IFT13.

Referring to the circuit diagram Fig. 2, presets VR4 and VR5 appear on the overlay (Fig. 4) as VR1 and VR2 respectively.

In Fig. 2, L2 (collector of Tr3) is unmarked. The BZY88/C6V2 diode from the junction of R17/L2 to ground should be shown at D1 (not D3).

The following may help those who are having difficulty locating specialised components:

The Denco coils are available from Maplin or Watford Electronics; C. Bowes & Co. Ltd., 4 Wood Street, Cheadle, Cheshire (Tel: 061 428 4497) supply the p.c.b. Front panels may be obtained from D. J. Pattle, "Juniper", Hillbury Road, Alderholt, Fordingbridge, Hants (Tel: 0425 52081). The vernier drive is Home Radio Type DL66—it is necessary to re-calibrate the scale. Suitable knobs are available from Marshalls or West Hyde Developments. Instrument case Type BC2121 is from West Hyde Developments. The signal-strength meter is RS Components Type 259-561 from Ace Mailtronics. Where no address is shown, see index to advertisers.

Wimborne Music Centre, October 1978.

The 2N6133 power transistors are incorrectly shown as "2N6103". RCA type BRC6103 is suitable, but alternative complementary pairs may be fitted where supplies are short, TIP41A/TIP42A being an example.

PLEASE MENTION PRACTICAL WIRELESS WHEN REPLYING TO ADVERTISEMENTS

Follow-up to PW Sandbanks METAL DETECTOR

P. J. WALES

The more experienced constructor, having built his "Sandbanks", may wish to increase its performance, and these notes are a guide as to how that may be achieved.

The locator works by transmitting a heavy magnetic field over the find (which we shall call the subject) and comparing the decay of that field in the subject, to the decay in the coil. Hence, if the rate of decay in the subject is faster than that in the coil, the subject will not be detected. Thus the first item to evaluate is the coil.

Energy Storage

To detect small and fast-conducting objects such as gold, silver or copper, the energy stored in the coil must be as low as possible. The energy is stored in three ways. First the magnetism, which we want as large as possible, secondly the inductance, which is very low in an air-cored inductor, and thirdly and most importantly, the capacitance, which has no effect other than to slow down the rate of decay of the magnetic field. The capacitance is produced by the proximity of the conductors in the coil, and they are only separated by the thickness of the insulating varnish, so a significant improvement can be obtained by insulating the wire used for the coil with a pvc sleeve. Greater gains can be obtained by winding the coil, with the extra insulation, in a neat manner so that the inside turns are as far away from the outside turns as possible. This leads us on to a flat coil which has about two-thirds of the capacitance of the wire bundle coil. However, it is very difficult to wind, but if you succeed, then Araldite the coil before potting it or the turns may move in the potting compound. By far the best solution is to use a printed circuit coil, as designed by the author and available from Plessis Electronics, Castle house, Old Road, Leighton Buzzard, Beds, which has a capacitance of about half that of a wire bundle.

Coil Shape and Size

The next stage in the coil design is to alter the size of the coil. Generally speaking, to maintain the same parameters within the machine, it is necessary to increase the number of turns when reducing the diameter of the coil. A small coil will locate objects very accurately, but its range is reduced. For greater range, the coil can be increased in diameter, and as a rough guide, doubling the coil size will double the range, within limits.

Square coils also have a lot to offer, because the range on a square coil is greater than that on a round coil of a similar size. Even greater range can be obtained by using a rectangular coil, and the optimum ratio of the sides is 4:1. One manufacturer of machines using the Pulse Induction principle offers a coil 1·83 × 0·48m (72 × 18in) as a standard with one of his detectors.

Modifications

Experimenting with coils for enormous range is very easy, but finding nails 3m under hard ground is not very rewarding, so stay within reason. In order to take maximum advantage of any reduction in coil capacitance achieved, it is necessary to reduce the time between the transmit pulse and the sample pulse, called the delay time. The shorter the delay time, the more sensitive the detector is to gold. The delay time in the PW "Sandbanks" is altered by changing the value of R31 and R32. It is easiest to replace these two with 47kΩ presets during tests, putting in suitable resistors when a satisfactory performance has been reached. It is best to check the delay time using a double-beam oscilloscope, but lacking one of these, the control VR2 should be set to its midpoint and VR1 adjusted to ensure that the output of the 709 is at 0V. Then reducing the added presets until the speaker just starts clicking ensures the optimum delay time.

Internal Delays

It may be argued that the internal circuits produce their own delays and this is certainly true, but the circuit has a fall time of 3 microseconds and this is quite fast enough. No improvement was obtained with a £4·50 r.f. power transistor and low-capacitance diodes. The capacitance at the coil connections was measured as 231pF and an ordinary coil as 681pF. Reducing the 100Ω resistor R7 will reduce the decay time but it will also reduce the current in the coil and its damping effect will alter, so leave it alone.

When you have wound the coil that meets with your requirements, do not forget to waterproof it and make it rigid. If it is left loose, the machine will drift all over the places as the coil capacitance changes when the coil moves. ●

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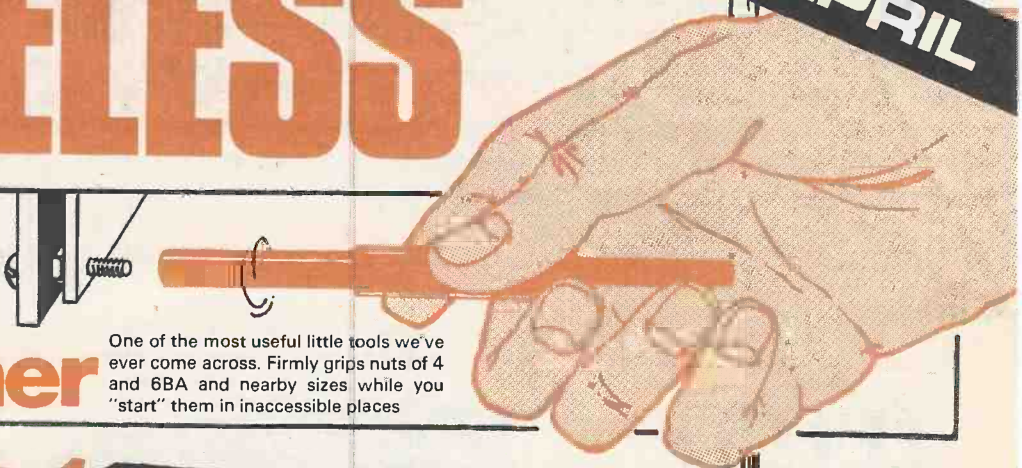

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Fred Judd seeks to dispel some of the misunderstanding among radio enthusiasts about what v.s.w.r. really is, and what it means.

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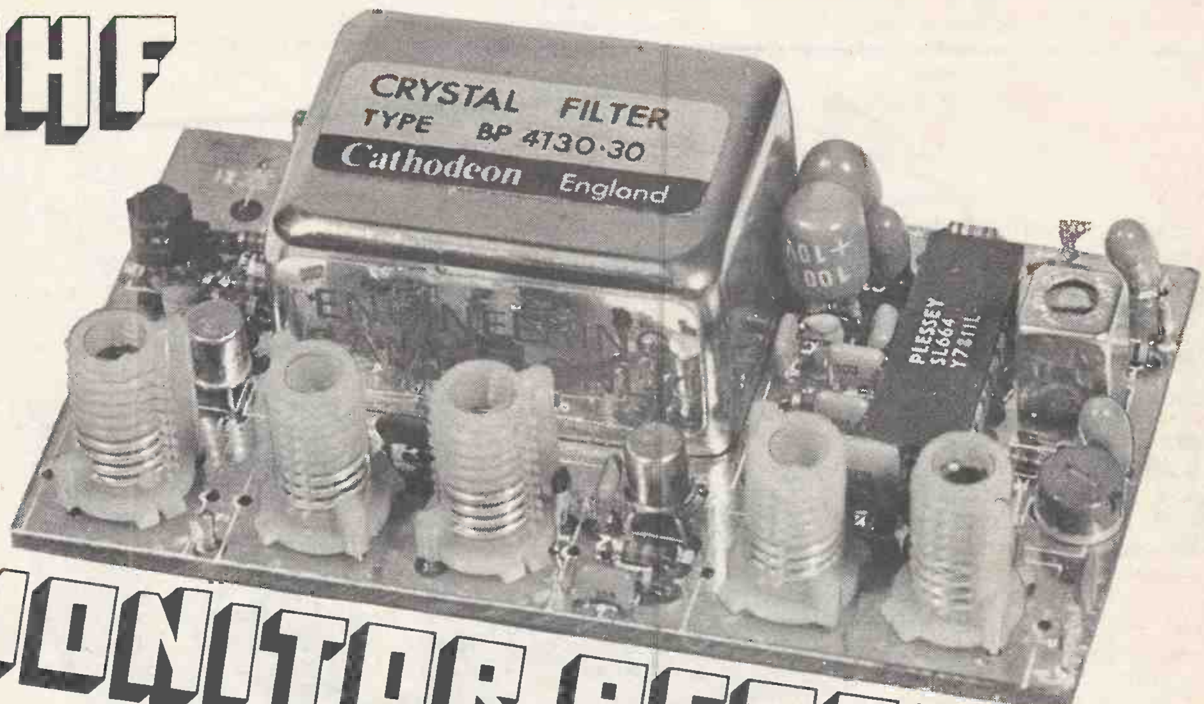
Checks live, open-circuit or earthed wires, ignition timing, and battery voltage rise on charge. Build one and keep it in your car, ready for an electrical breakdown

This article describes the construction of a miniature, high-performance v.h.f. receiver for narrow-band frequency modulation, based on the Plessey SL6640 integrated circuit. The SL6640 is a complete i.f. strip, detector and audio system for n.b.f.m., requiring the minimum of external components. It consumes only 3·5mA of current in the standby mode and can produce 200mW of audio.

The receiver is so simple that it may be built even by the relatively inexperienced, and yet it gives a professional account of itself with a sensitivity better than 0·4μV for a 20dB signal-to-noise ratio. Physically, the module is only 46 × 82mm (1·8 × 3·2in) and although the details given are for operation within the 144MHz (2m) amateur band, the receiver will easily tune to marine v.h.f. channels, and could be used to keep a watch on, say, channel 16, the distress and calling frequency. In this respect it would be a useful project for the yachtsman or small boat-owner, and is licensable for use on board such vessels.

VHF MONITOR RECEIVER



*James M. BRYANT B Sc

The circuit diagram of the complete receiver is given in Fig. 1. It can be seen to consist of a double-tuned input arrangement feeding a dual-gate m.o.s.f.e.t. amplifier with a gain of 18dB. Another double-tuned circuit couples the amplifier to a second dual-gate m.o.s.f.e.t. which acts as a mixer whose conversion gain falls around 12dB. The local oscillator uses a *pnp* v.h.f. transistor in an overtone configuration.

A crystal filter, specially designed by Cathodeon, filters the 10·7MHz signal and then passes it directly to the

* *Applications Manager, Radio Communications Group, Plessey Semiconductors, Cheney Manor, Swindon Wilts*

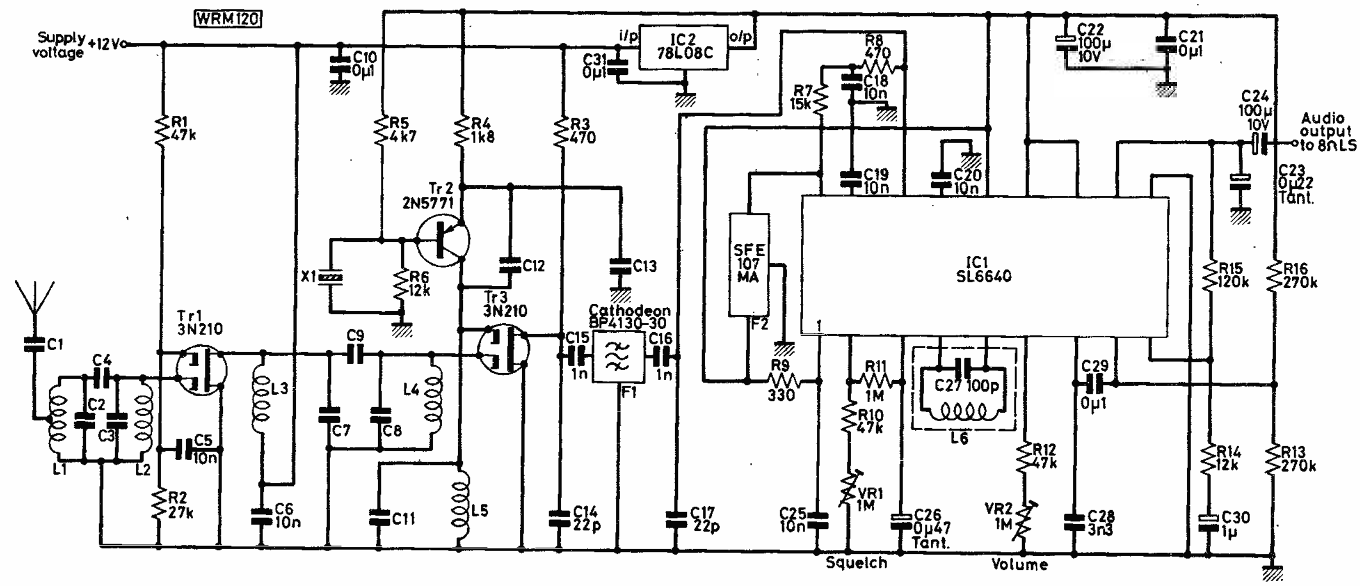


Fig. 1: Complete circuit diagram of the single-channel version of the receiver

SL6640, which performs the functions of i.f. pre-amplifier, main i.f. limiting amplifier, quadrature detector, squelch and audio output stages.

Dual-gate m.o.s.f.e.t. devices were selected on the grounds of their good noise (about 4–6dB) and inter-modulation performance. They will cope with large off-channel signals with the minimum of intermodulation distortion. Prototypes used the 3N210 in a plastic encapsulation, but 3N211, 3N201 or 40673 devices in the metal TO-72 packages will fit the board and work equally well.

Only five components, in addition to the capacitors and inductors of the tuned circuits, are employed in the r.f. amplifier: the m.o.s.f.e.t., two resistors to bias gate 2 of the m.o.s.f.e.t. and two decoupling capacitors. Standard Toko coils are used throughout, and the small ceramic capacitors are of ITW manufacture. At 2m, C2 is 12pF, C3–6·8pF, C7–8·2pF and C8–6·8pF. *Note that C4 and C9 are not "real" components, but represent stray capacitance.*

A 2N5771 *pnp* transistor has been chosen for the local oscillator. This reduces the number of devices necessary in the circuit, as the collector load coil is at d.c. ground potential and hence no coupling or bias components are needed for the second gate of the mixer m.o.s.f.e.t.

The oscillator is very simple and reliable, using only nine components. Any additional expense incurred by the selection of overtone crystals is easily justified against the increased complexity and power consumption of multiplier stages.

In the case of a 2m receiver, C12 may have to be omitted or may be found to be as large as 1·8pF, a certain amount of experimentation being necessary to determine the optimum value. Capacitor C13 will not usually be required; C11 is 6·8pF and L5 a Toko S18/301–SN-0300.

Using 7th or 9th overtone crystals can lead to oscillator starting problems, but this circuit has been rigorously tested and found to be completely reliable, provided the supply voltage remains stable. Crystal frequencies are calculated from the formula:

Crystal frequency = Carrier frequency minus 10·7MHz

If the receiver is required to work on more than one channel, some sort of d.c. switching will have to be evolved, as long leads are not permissible. Such techniques will be found to complement the use of scanners. A suitable method is shown in Fig. 2, where the diodes should exhibit low-capacitance characteristics, such as the 1N4313.

The mixer consists of another dual-gate m.o.s.f.e.t. with both gates at d.c. ground. Signals are applied to gate 1, whilst gate 2 is connected to the oscillator tank circuit, which drives it with about 2 volts r.m.s. of r.f. Better conversion gain and a lower local oscillator could be achieved by biasing gate 2 between 2·5 and 4·5 volts, but this would degrade the strong-signal performance of the front-end.

Two signals of 100mV, one 50kHz and the other 100kHz off-channel, could be tolerated by the prototypes without receiving an intermodulation product. Never-the-less, an even better performance may be obtained by sacrificing some front-end gain—and therefore sensitivity.

The mixer drives a crystal filter, designed specifically by Cathodeon for this receiver, which has a relatively low terminating impedance of 470Ω at 25pF—eminently suited to the output of the dual-gate m.o.s.f.e.t. and the input of the SL6640. Other filters, some appreciably cheaper, are acknowledged as being available, but will almost certainly present the constructor with problems, due to their different terminating impedances. Although C14 and C17 may be changed if necessary, it is not possible to increase the value of R3 and R8 above 820Ω without upsetting the operation of both Tr3 and IC1. A reduction of their values, on the other hand, will cause the gain to deteriorate.

From the filter, the signal is applied to the pre-amplifier input (pin 16) of the SL6640, which has a gain of 46dB and an output impedance of 330Ω. This matches the interstage ceramic filter between its output (pin 18) and the main i.f. amplifier input (pin 14). The pre-amplifier is biased, via R7 and R8, from its own output: R8 sets its input impedance and C18 decouples the bias line. Similarly, R9 and C25 provide bias and decoupling for the main i.f. amplifier input.

The interstage filter is intended only to limit broadband noise within the i.f. and not to determine the receiver pass-band. Thus an inexpensive ceramic device is employed for this purpose.

About 60dB gain is available from the i.f. amplifier, giving the SL6640 in total an overall sensitivity of about 10μV. Such high gain makes bias decoupling essential and this is achieved by C19 and C20. The output of the main i.f. goes to the quadrature detector and squelch system.

The squelch works by detecting the amount of limiting in the i.f. amplifier, pre-set VR1 determining the operating threshold. This control could be panel-mounted, if required.

Resistor R11 sets the hysteresis of the squelch—that is, the amount by which the signal must drop in order to mute the receiver. With R11 at 390kΩ and an 8 volt supply this is about 7–9dB. A reduction to 4–6dB is possible by increasing R11 to 1·5MΩ.

The muting arrangements control power to the detector and audio stages. In the absence of a signal they turn off, reducing the total current drain to around 3·5mA. Under "signal applied" conditions, the current consumption would be in the region of 8mA plus the amount drawn by the audio output stage.

A squelch output is also present on pin 3 of the SL6640, which is "high" in the absence of a signal and "low" when a signal is detected. This logic may be employed to control a scanner, if a multi-channel receiver is ultimately constructed, or to illuminate a l.e.d. status indicator (Fig. 3). The inclusion of C26 on pin 3 prevents the squelch fluttering if rapid changes of signal level occur.

The detector is self-contained, with the exception of the quadrature coil (Toko) connected between pins 4 and 5. Plessey Semiconductors SL6640 i.c. is intended for narrow-band f.m. applications and should not be confused with such devices as the CA3089, TBA120 and CA3189, which are essentially for the domestic market and similar wide-band situations. It works well even with 10·7MHz i.f.s, as the *Q* of the quadrature coil is not loaded by the resistance of the i.c. Signal-to-noise ratios of 50dB for 2kHz deviation with a 10·7MHz i.f. can easily be achieved, whilst to produce the same performance from, say, a CA3089 would require either a 455kHz i.f. or a crystal quadrature element.

The detected audio is routed via a d.c. "volume control" (VR2) to the a.f. output stage. Any residual r.f. is filtered out by C28, C29 being used for interstage coupling. The potentiometer VR2 would normally be located on the front panel. Note that the output is at its highest when the resistance of this control is at *maximum.*

The a.f. output stage is biased by R13 and R16, negative feedback being applied via R14, R15 and C30. Overall gain can be varied by altering the value of R14, but this should not be reduced to below 1·2kΩ, if excessive distortion is to be avoided. Up to 200mW output is possible with the 8 volt supply. Any h.f. instability is decoupled by the tantalum capacitor C23.

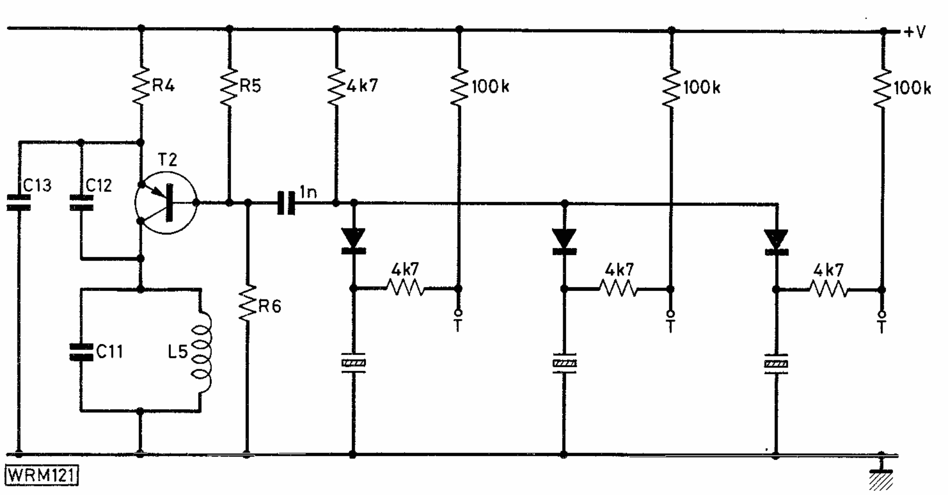
The receiver module is powered from an 11–15 volt supply, which is reduced to 8 volts and regulated by IC2 for the crystal oscillator and the SL6640. Decoupling is provided in several places by 0·1μF ceramic capacitors. If the supply source impedance is likely to exceed 2Ω, l.f. decoupling may also be a necessary—a capacitor of a few hundred microfarads being called for.

Readily-available components were part of the design philosophy, so this aspect should present no problems to the constructor. The printed circuit board uses minimal-inductance layout techniques which are very effective at v.h.f. and quite easy to assemble. *Note that plated-through holes are necessary and all components should be mounted as close to the board as possible.*

The alignment of the receiver is fairly simple, but of course if the constructor has access to an r.f. millivoltmeter and a good oscilloscope really professional performance can be attained.

Alignment

Initially the crystal oscillator coil L5 is adjusted for maximum output, consistent with reliable starting. To avoid loading the oscillator, the test probe should be connected to the drain of the m.o.s.f.e.t. Tr3 (mixer): coils L1, L2, L3, L4 are adjusted in turn for maximum gain from the aerial input.



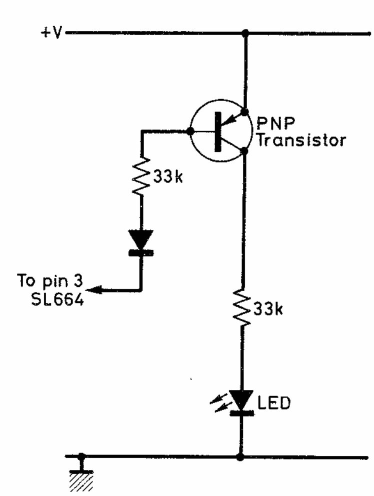
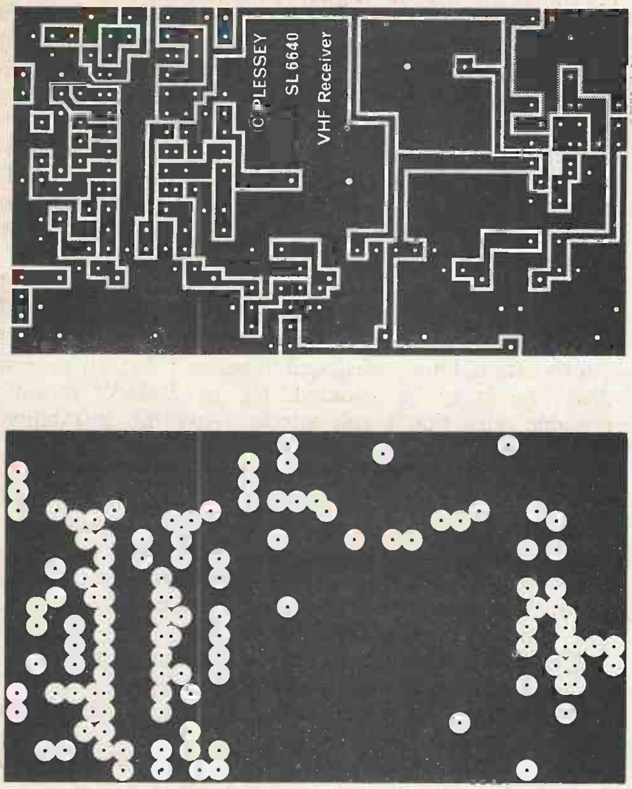


Fig. 2 (left): Adding multi-channel facilities. Grounding one terminal "T" activates the associated crystal

Fig. 3 (right): Driving a l.e.d. squelch indicator requires this simple buffer stage



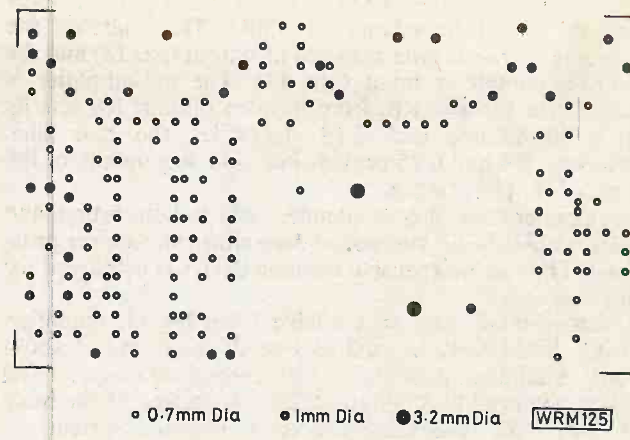
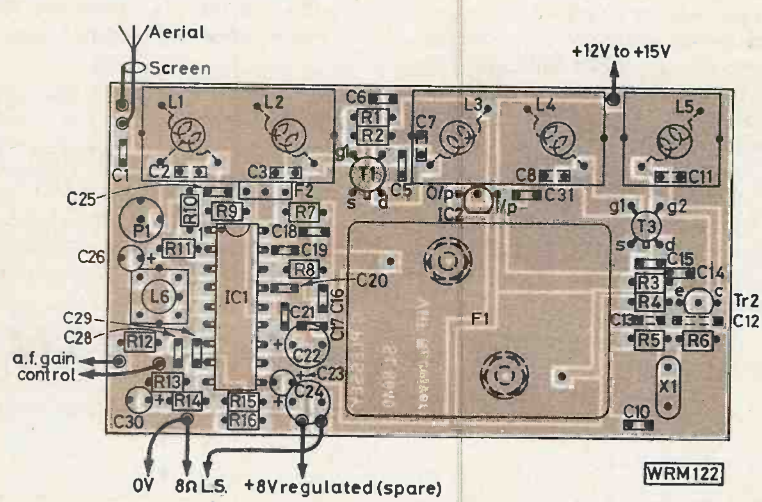


Fig. 4 (left): Full-size track patterns for the p.c.b. showing non-component side (top) and component side (bottom)

Fig. 5 (above): Drilling drawing for the p.c.b.

Fig. 6 (below): Component layout. The ground-plane pattern on the component side of the board is shown in orange tone



Feed a 10·7MHz frequency-modulated signal to the input side of the crystal filter. Now, with full audio gain and minimum setting of the squelch resistor, tune the quadrature coil for minimum distortion at the output. If clipping occurs, back off the audio gain slightly.

Adjustment without instrumentation is, of course, somewhat less precise. Never-the-less, acceptable results can be obtained and lack of test equipment should not deter the constructor from building this project.

With the presence of a strong v.h.f. signal, tune the local oscillator coil L5 until it is heard at maximum volume and minimum distortion. Having done this, turn the power on and off several times to ensure that the oscillator will always start.

Next, set the quadrature coil for minimum apparent distortion with the squelch potentiometer at minimum resistance. Then reduce the strength of the alignment signal, perhaps by using progressively smaller aerial lengths, tuning L1, L2, L3 and L4 at each stage for the best signal-to-noise ratio.

Finally, the squelch control is set so that muting occurs when the signal-to-noise ratio becomes unacceptably low.

★ components

Resistors
⅛ watt carbon

330Ω	1	R9
470Ω	2	R3, 8
1·8kΩ	1	R4
4·7kΩ	1	R5
12kΩ	2	R6, 14
15kΩ	1	R7
27kΩ	1	R2
47kΩ	3	R1, 10, 12
120kΩ	1	R15
270kΩ	2	R13, 16
1MΩ	1	R11

Potentiometers
**Miniature, round, linear law preset. Plessey type 416*

1MΩ	1	VR1 mute threshold

Miniature log law, panel mounting

1MΩ	1	VR2

Capacitors
***ITW type M2 monolithic*

22pF	2	C14, 17 (but see text)
1nF	3	C1, 15, 16
3·3nF	1	C28
10nF	7	C5, 6, 10, 18, 19, 20, 25

Ceramic Plate

0·1µF	3	C21, 29, 31

Tantalum Bead

0·22µF	1	C23 35V type
0·47µF	1	C26 35V type
1µF	1	C30 35V type
100µF	1	C24 6V type
100µF	1	C22 10V type

Note: C2–4, 7–9, 11–13 see text C27 is part of coil assembly.

Filters

****BP4130–30	1	F1
SFE10·7	1	F2 (Ambit)

Semiconductors
Transistors

3N210	2	Tr1, 3 (or 3N201, 3N211, 40673)
2N5771	1	Tr2

Integrated Circuits

***SL6640	1	IC1
µA78LO8C	1	IC2

Crystal(s)
*****7th overtone, Type WW239

Inductors

Toko S18/301 –SN-032	1	L1 (Ambit)
Toko S18/301 –SN-0300	4	L2–5 (Ambit)
Toko 85–4402SEJ	1	L6 (Ambit)

Printed Circuit Board
The special p.c.b. for this project is available from Ambit International. Kelan Engineering Ltd., 27–29 Leadhall Lane, Harrogate, Yorkshire HG2 9NJ. Tel: 0423 879126, are also able to offer a multi-channel option, using 3rd overtone crystals.

Hardware
Two double coil screening cans are required for L2-L3, L4-L5 and a single can for L1. These are obtainable from Ambit International.

COMPONENT SOURCES

*Preset available from Ambit International.
**ITW capacitors available from ITW Electronics, Darville Ho., 4 Oxford Road East, Windsor, Berks and Ambit International.
***SL6640 available from Catronics or Ambit International.
****BP4130–30 available from Cathodeon Crystals Ltd, Linton, Cambridge CB1 6JU. Tel: 0223 891501.
*****7th overtone crystals available from Webster Electronics, Rose Mills, Hort Bridge, Ilminster, Somerset TA19 9PS. *Important:* specify crystal Type WW239 with channel (carrier) frequency *and* crystal frequency (carrier minus 10·7) when placing order.

With a calibrated signal generator, this point should be between 0·15 and 0·5µV—however, it is preferable to set the squelch to a signal-to-noise ratio, rather than to an absolute input voltage.

No instrument case or mechanical details are given for this project, but the receiver is a complete module, requiring only the addition of a battery, volume control, squelch control and small loudspeaker as external components. It could therefore easily be constructed within an existing receiver, using the incoming v.h.f. signal to mute and over-ride the normal programme. For example, the marine version on channel 16 could mute an m.f. signal, or indeed another v.h.f. signal, thus giving priority to channel 16 traffic. On the other hand, it could easily be a self-contained unit.

Multi-channel Conversion

If coverage of more than one channel is necessary, then the circuit of Fig. 2 can be regarded as a working basis, and could probably be accommodated on a small sub-assembly. If a multi-channel facility is decided on at the outset, a small extension could possibly be made to the printed circuit board.

The 7th overtone WW239 crystals are relatively expensive, but on the other hand the end-product will hold its own with many professional receivers of its type. The original design work for this project was carried out for a specific professional application, and the specification of this version has in no way been degraded. ●

Wireless went to War

Ron HAM

In the 1830s, Samuel B. Morse invented a code which was used by signallers to convey military information along thousands of miles of telegraph lines during the American Civil War (1861–1865) and, some 40 years later, Alexander Graham Bell's telephone was extensively used by both sides throughout World War I.

To find out more about communications during that war, the author spoke to several old-timers who were there. One, Bert Knight, now 90 years old, a veteran of the Rifle Brigade, remembers seeing telephone cables at Ypres being laid from a large drum, mounted on a limber drawn by a team of horses, and signalmen in dugouts wearing headphones. However, this means of communications had its drawbacks because, the cables, whether overhead or underground, were vulnerable to secret tapping by enemy signalmen, calculated cutting of the wires, and being totally destroyed by artillery bombardment.

During the last decade of the 19th century, men like Edouard Branly, Oliver Lodge (later knighted), and Guglielmo Marconi, to name a few, were pioneering a means of transmitting both the Morse code and the human voice over great distances without wires. Before their ideas were fifty years old, wire-less communications (later called radio) was used during two world wars on land, sea and in the air.

The Great War

Wireless during the 1914/18 war rested mainly with the electric spark transmitter and receivers, using a coherer or catswhisker and crystal detectors and, for amplification, a limited range of bright-emitter (triode) valves, so called because their high filament current produced a lot of light.

Wireless installations were also vulnerable to enemy action, mainly because the high aerials required gave away the position of a signals unit to enemy spotters. Also, the noise from the transmitter spark gap and the receiver tuning buzzer could be heard for some distance on a quiet night.

The late Bill Longmire, G3TKL, joined the signals section of the 26th Canadian Battalion in 1914 and after three months training had to pass in Morse at 12 w.p.m. with buzzer, lamp and heliograph, and in semaphore and flags. "Serving in France in 1915," said Bill, "I found that war was a bloody business and that communications (by land-line) were not only most important but also dangerous." He used a "D3" telephone set, phone and Morse, with a single-strand wire and an earth return. Later, Bill transferred to the Canadian Corps wireless section to learn the basic facts of radio and then was selected for a special, three week, training course in London. At the end of the course, a team of three could erect an aerial consisting of a 100ft long wire on two 24ft masts, with guys, earth rods and counterpoise, in under five minutes. On returning to France, Bill saw action at Vimy Ridge, and was told to set up a wireless station on a front where shell fire kept land lines out of action. For such an advanced post Bill said: "An NCO and two men with a 24-hour watch and frequent checks with headquarters station, were required. Usually we had a 2–3 week stretch in the line if the enemy was not too active."

The trench set illustrated in Fig. 1 consists of a spark transmitter, spark-gap and coil at bottom right, and a crystal detector receiver on top, with its tuning buzzer on front left. The output meter, stud-type aerial matching switch and Morse key are mounted on the top panel, all beautifully engineered and housed in a mahogany cabinet. Bill said that this type of set, plus six 6 volt storage batteries, aerial masts and earth mat was the equipment used in an advanced station. When possible, they tried to select a site for the station which was concealed from the enemy and had easy access from the rear for delivery, by carrying party or mules, of their food and replacement batteries.

Most messages were passed in cypher, code words and callsigns being changed daily, their lighting was by candle and heating by coke. Around midnight, the news could be

Fig. 1: 50 watt Trench set made by the Marconi Company

copied from Poldhu, Cornwall; Eiffel Tower, Paris; or Naum, Germany. "The extra copy taken to the local infantry or artillery cook-house was always good for a handout," said Bill, but Passchendaele was an exception. "Ten days in, four operators and self, one killed, four wounded, but station was able to handle all traffic in spite of the antenna being shot down eight times."

Wireless in the Air

Mark Denny, G6DN, said: "Before the war many amateurs became proficient in Morse by following a programme which started with a session of listening to the Eiffel Tower news bulletin, which was sent at 12 w.p.m. with a T1 note. Then followed a period of receiving the news from a German station at about 15 w.p.m. The final achievement was the ability to copy Cleethorpes Naval Station weather report sent at 10pm each day. This was initially at 20 w.p.m. and repeated at 25 w.p.m." At that time the Navy required aspirants for entry to their W/T branch to copy, for five minutes, without error, a message in clear at 25 w.p.m.

In 1914, Mark entered the Royal Navy as a Wireless Telegraphist and in 1915 was commissioned in the (Army) Royal Flying Corps, later the RAF. While in the RN he was posted to a Naval Airship Station and along with a group of W/T matelots had to unpack and assemble the wireless equipment for airships, which consisted of a "Stirling" spark coil and a Marconi crystal receiver plus a hand-operated winch containing over 300ft of wire, with a lead weight attached, for the aerial. Mark said: "We were ordered to install the apparatus in the airships and to assemble a ground station without delay. Our difficulty was that, whilst every material item necessary was provided, no written instructions or wiring diagrams were available. This is where our amateur, pre-knowledge of radio helped and we were on the air to the C/O's satisfaction."

The author showed Mark Denny a photograph of the Marconi transmitter in Fig. 2 and he recognised it as the type he used in the RNAS airships and in the RFC and said: "I used to feel rather apprehensive when adjusting the tuning clips on the helix, considering the thousands of cubic feet of hydrogen gas just above your head."

Their best DX from air to ground was a QSO with Malta Naval Station from the English Channel, using a half-inch spark coil. Sending Morse messages by spark, situated only a few feet below a gas bag, was one of the hazards of life in those days.

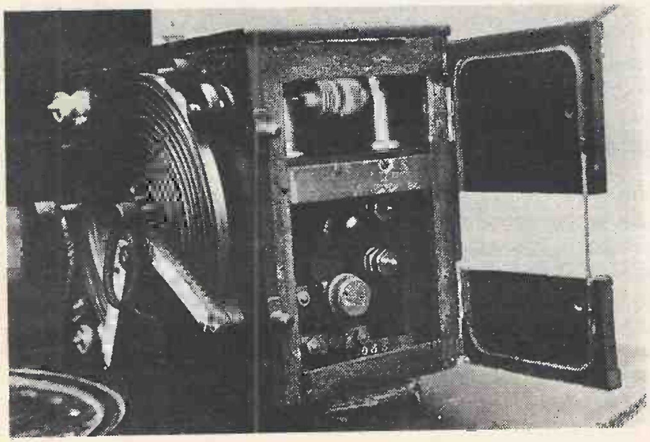


Fig. 2: Marconi spark transmitter from World War I

Fig. 3: Short-wave Tuner, Mark III made by Johnson and Philips

Aerial Installation

As a wireless officer in the RFC, Mark saw active service in France. At one stage he was supplied with portable sets, especially flown out from England for the use of certain gentlemen who were deposited over the lines, and later he listened to their transmissions. Soon after he established listening posts in "No Mans Land" and still has his pass permitting him to advance in front of the front line. Like Bill Longmire with his 24ft masts, Mark also had aerial problems to solve. While in France, they used steel rods which were a loose fit in their rifle barrels, and marched down a village street firing these rods with cords attached over opposite houses. On joining the cords with aerial wire, they soon had an excellent antenna.

Later, back in England, Mark put up the first ground-to-air telephony stations for the Air Defence of Great Britain, which involved getting up in the early hours, before the traffic was about, because one antenna was across Horse Guards Parade, from the Foreign Office to the Horse Guards building in Whitehall, and from the Horse Guards to the War Office, just over the road in Whitehall.

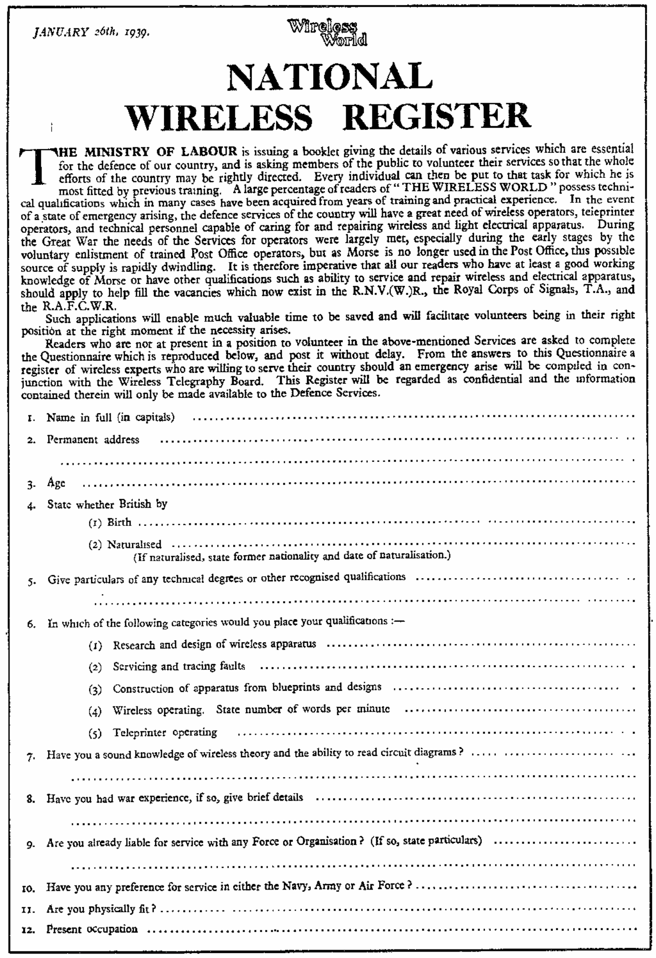
The late John Clarricoats, G6CL, referring to the RFC in the *T & R Bulletin* (then the journal of the RSGB), December, 1939, wrote: "The chief job of the 1915–1918 wireless operator was to act as "the ears" between a roving plane and the battery to which he was attached; his equipment was primitive (usually a Mark III tuner) and his only means of communication with the observing machine was by means of "white" ground strips which, sad to relate, seldom lived up to their name." Mark Denny also remembers the Mark III tuner, as the set supplied to them on the Western Front, and used by RFC wireless operators in their dugouts in conjunction with the Royal Artillery batteries.

The Wireless Reserves

In the 21 years which elapsed between the two world wars, radio made fantastic strides both in broadcasting and short-wave communications around the world, and it is well-known that amateur radio enthusiasts played their full part in both fields.

With the war clouds gathering again in the early 1930s, the authorities, knowing there would be a need for trained wireless operators if war came, once more called upon the amateur radio enthusiasts for assistance. On August 26, 1932, *Wireless World* commented: "At last British wireless amateurs are to be given the opportunity to assist His Majesty's Forces"; when they reported that: "The Secretary of the Admiralty announces the institution of a Royal Naval Wireless Auxiliary Reserve (RNWAR) in Great Britain and Northern Ireland, to be recruited largely from Wireless Amateurs owning transmitting sets." One of the objects of the RNWAR was, "to provide a reserve of operators trained in Naval procedure, for Naval service afloat or ashore in war or emergency."

The setting up of this organisation was the result of careful work by officials of the Admiralty and the Radio Society of Great Britain, as was the establishment, by the Air Ministry, in September, 1938, of the Royal Air Force Civilian Wireless Reserve (RAFCWR). The announcement, by the Air Ministry, reported in *Wireless World,* December 29, 1938, made it clear that the CWR was to "consist largely of amateur experimenters which would, if the need arose, provide a reserve of personnel experienced in the operating procedure of the RAF." Both the RNWAR and the RAFCWR attracted several thousand radio enthusiasts from all walks of life. They divided the United Kingdom into areas where small groups could train to the required military standard. Experimental sections were manned by experienced radio amateurs who dealt with the design of transmitters and receivers to meet a particular section's needs; and all in harmony with the signals branch of their respective service.


JANUARY 26th, 1939. Wireless World

NATIONAL WIRELESS REGISTER

THE MINISTRY OF LABOUR is issuing a booklet giving the details of various services which are essential for the defence of our country, and is asking members of the public to volunteer their services so that the whole efforts of the country may be rightly directed. Every individual can then be put to that task for which he is most fitted by previous training. A large percentage of readers of "THE WIRELESS WORLD" possess technical qualifications which in many cases have been acquired from years of training and practical experience. In the event of a state of emergency arising, the defence services of the country will have a great need of wireless operators, teleprinter operators, and technical personnel capable of caring for and repairing wireless and light electrical apparatus. During the Great War the needs of the Services for operators were largely met, especially during the early stages by the voluntary enlistment of trained Post Office operators, but as Morse is no longer used in the Post Office, this possible source of supply is rapidly dwindling. It is therefore imperative that all our readers who have at least a good working knowledge of Morse or have other qualifications such as ability to service and repair wireless and electrical apparatus, should apply to help fill the vacancies which now exist in the R.N.V.(W.)R., the Royal Corps of Signals, T.A., and the R.A.F.C.W.R.

Such applications will enable much valuable time to be saved and will facilitate volunteers being in their right position at the right moment if the necessity arises.

Readers who are not at present in a position to volunteer in the above-mentioned Services are asked to complete the Questionnaire which is reproduced below, and post it without delay. From the answers to this Questionnaire a register of wireless experts who are willing to serve their country should an emergency arise will be compiled in conjunction with the Wireless Telegraphy Board. This Register will be regarded as confidential and the information contained therein will only be made available to the Defence Services.

1. Name in full (in capitals) ....
2. Permanent address ....
3. Age ....
4. State whether British by
   (1) Birth ....
   (2) Naturalised ....
   (If naturalised, state former nationality and date of naturalisation.)
5. Give particulars of any technical degrees or other recognised qualifications ....
6. In which of the following categories would you place your qualifications :—
   (1) Research and design of wireless apparatus ....
   (2) Servicing and tracing faults ....
   (3) Construction of apparatus from blueprints and designs ....
   (4) Wireless operating. State number of words per minute ....
   (5) Teleprinter operating ....
7. Have you a sound knowledge of wireless theory and the ability to read circuit diagrams? ....
8. Have you had war experience, if so, give brief details ....
9. Are you already liable for service with any Force or Organisation? (If so, state particulars) ....
10. Have you any preference for service in either the Navy, Army or Air Force? ....
11. Are you physically fit? ....
12. Present occupation ....

Fig. 4: National Wireless Register, published in *Wireless World* on 26 January, 1939

National Wireless Register

Both the RSGB, through their journal, *The T & R Bulletin,* and *Wireless World* frequently reported the progress of the Wireless Reserves and, furthermore, *Wireless World* did much to find out what radio skills were available among their readers that would be of use to the armed forces in the event of war.

In their editorial on January 26, 1939, *Wireless World* comments: "In the event of an emergency which would require everyone to put himself at the service of the Country, the moment will arise when every individual will ask where he can offer his services so that such qualifications as he may possess will be of greatest value." As a pull-out in the same and some subsequent issues, *WW* enclosed a printed OHMS form, addressed on one side to . . . Secretary, Wireless Telegraphy Board, c/o Admiralty, Whitehall SW1, and with a general and technical ability questionnaire on the other. This document, Fig. 4, was

continued on page 60

THE PW 'WINTON'

Stereo Amplifier

Part 2

E.A.RULE

As the p.c.b. must be mounted into the chassis before the other parts, we will start construction by assembling the components onto the boards.

The leads of the components should be preformed and inserted into the holes, as shown in the component overlay Fig. 7. Turn the p.c.b. over so that it rests on a sponge or foam mat, which will then hold the components in close contact with the p.c.b. while they are soldered into place.

Coils

Before assembling the main p.c.b., the two coils L1a and L1b should be made up as shown in Fig. 6. Each coil consists of 30 turns of 18 s.w.g. insulated wire wound in three layers of ten turns each. The internal diameter of the first layer is 8mm. If masking tape is wound over each layer after winding, the turns will stay in place while the next layer is wound. When the coil is completed the 1W 10Ω resistor is fed through the centre of the coil and the leads soldered to the coil as shown. The coil ends are then opened out to a spacing of 22·5mm to fit the p.c.b. It will, of course, be necessary to scrape the insulation from the coil ends before soldering.

Assembly should start with the terminal pins, which will be a tight fit and can be tapped into place with a light hammer, but you must support the p.c.b. from behind when doing this. Insert them from the top of the p.c.b. and then turn the board over and solder the pins to the track.

Once the pins are in place, the suggested order of assembly is resistors, small capacitors, transistors, electrolytics, switches, etc.

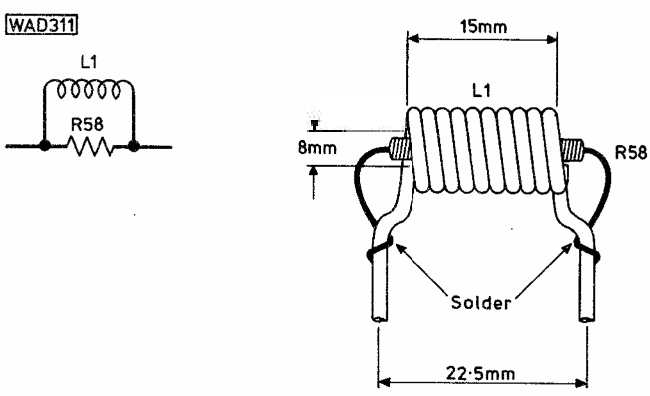


Fig. 6: Winding details of the two coils L1. Internal diameter 8mm; Length 15mm; 3 layers of 10 turns each (Total 30 turns) 18 s.w.g. enamel copper wire. R58 is 10Ω 1W carbon resistor

Switches

Be sure to mount all electrolytics the correct way round as indicated on the overlay. This also applies to diodes and i.c.s. When fitting the push-button unit to the p.c.b., first make sure that all the pins are straight, then "walk" the pins into the holes by starting at one end of the switch with the switch at a slight angle to the p.c.b. and gradually lower the switch pins into the holes as the switch is levelled out. Make sure that the switch is parallel to, and in close contact with, the top of the p.c.b. before soldering the pins to the track, otherwise the push-buttons will not align with the front panel holes.

Use only the components specified as only then will the specification, of which the Winton is capable, be achieved.

Chassis

The main chassis is made in the form of an inverted "U" from aluminium sheet and the overall size required, before bending, is 462 × 298mm + twice the bend allowance for the thickness of metal used, i.e., 462 × 300mm when using 1·2mm thick (18 s.w.g.) aluminium. Most d.i.y. suppliers will cut aluminium to size for a small charge, and it is well worth having this done as it will save work and ensure a "square sided" chassis. The author used aluminium of 2mm (16 s.w.g.) thickness for the main chassis but has access to a bender capable of folding this thickness. Unless a suitable bender is available, the 1·2mm material will be found easier to work with and will still provide adequate strength.

Mark out the chassis as shown in the drawing (Fig. 14), not forgetting to scribe two lines to allow for the thickness of metal used when bending.

The centre height of the push-button holes must be 20mm above the inside edge of the bent-up chassis, and this is the reason for scribing two lines. If the bottom line is used as the guide line in the bender the holes should be correctly positioned after bending.

Cut-outs

After drilling, all the holes should be deburred. The four large rectangular cut-outs in the chassis are provided so that the underside of the p.c.b. can be reached, as it would be almost impossible to remove and/or test the p.c.b. otherwise. These cut-outs are made using an Abrafile blade fitted to a standard hacksaw, any burrs being removed with a suitable file.

When all the holes and cut-outs have been made the chassis can be bent up. Make sure you bend it the correct way!!

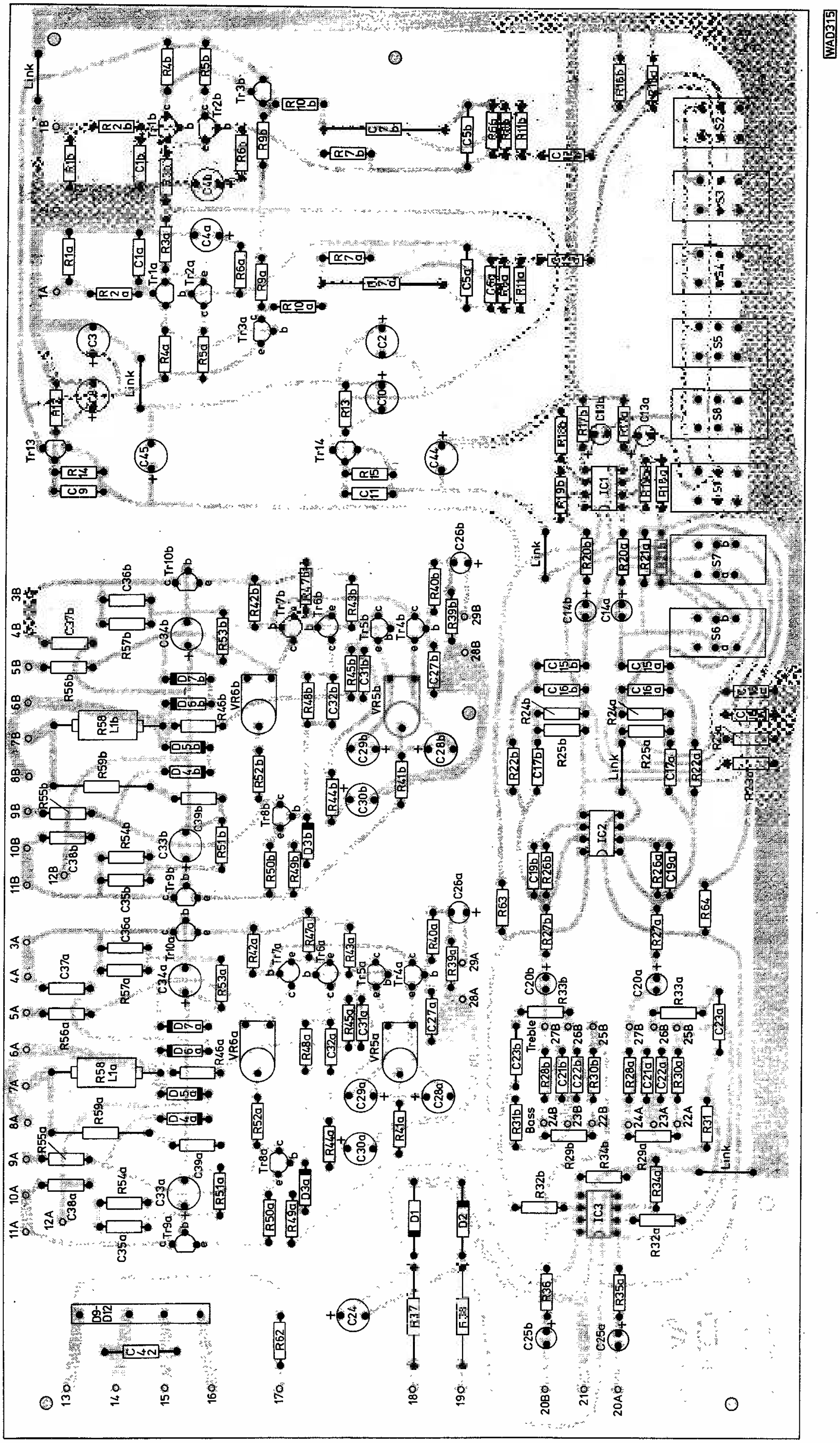
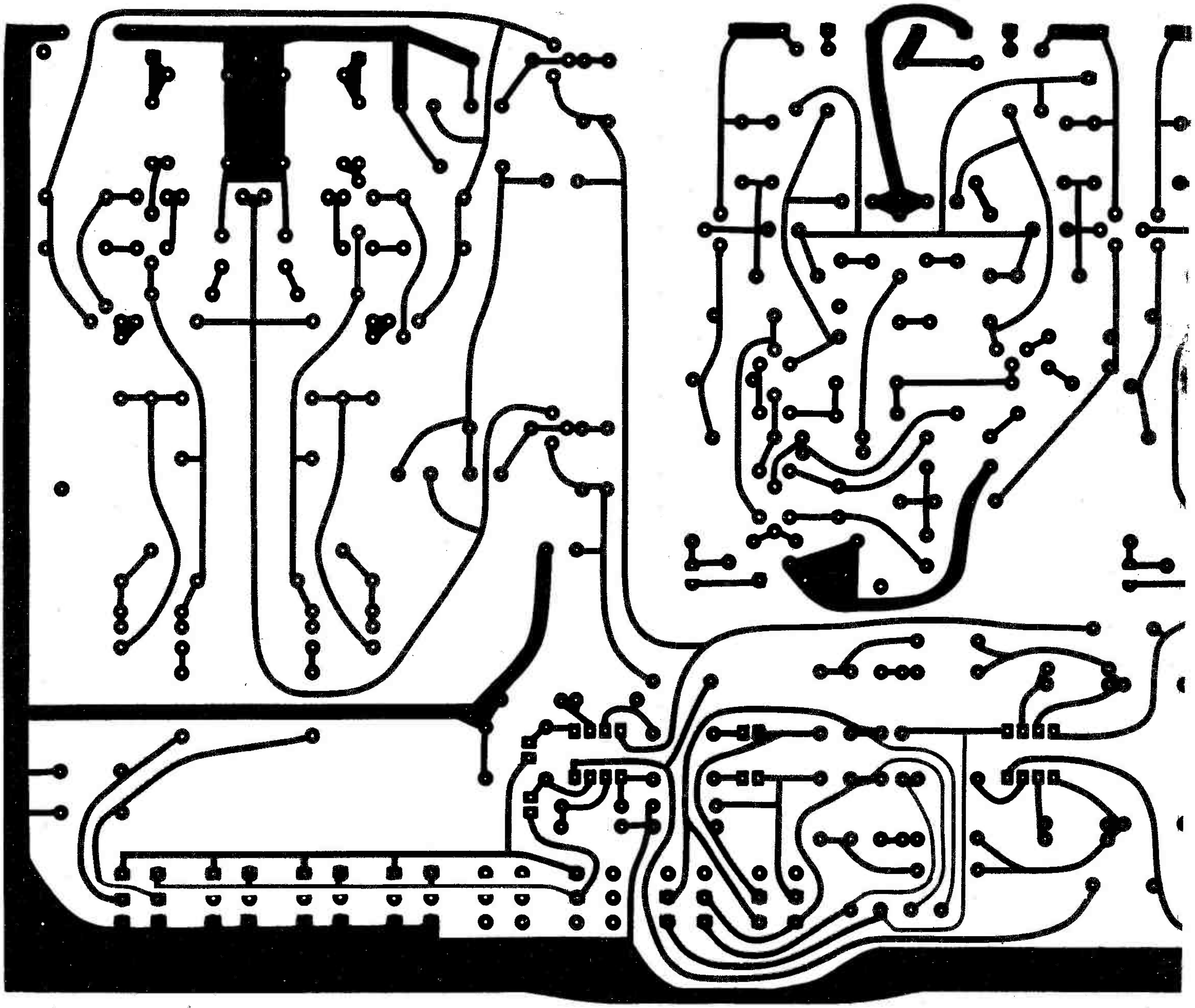
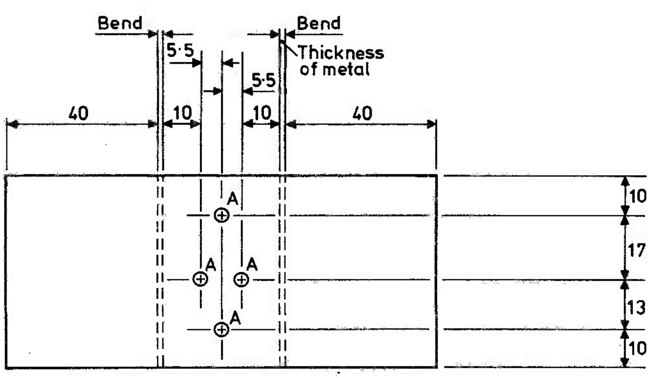


Fig. 7: Component layout for the PW Winton amplifier. This is shown slightly reduced in size

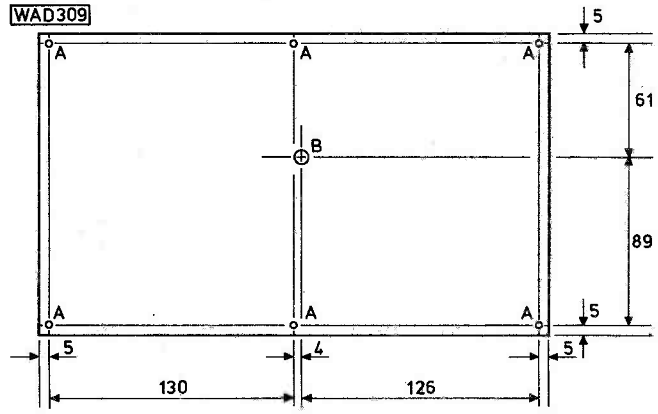




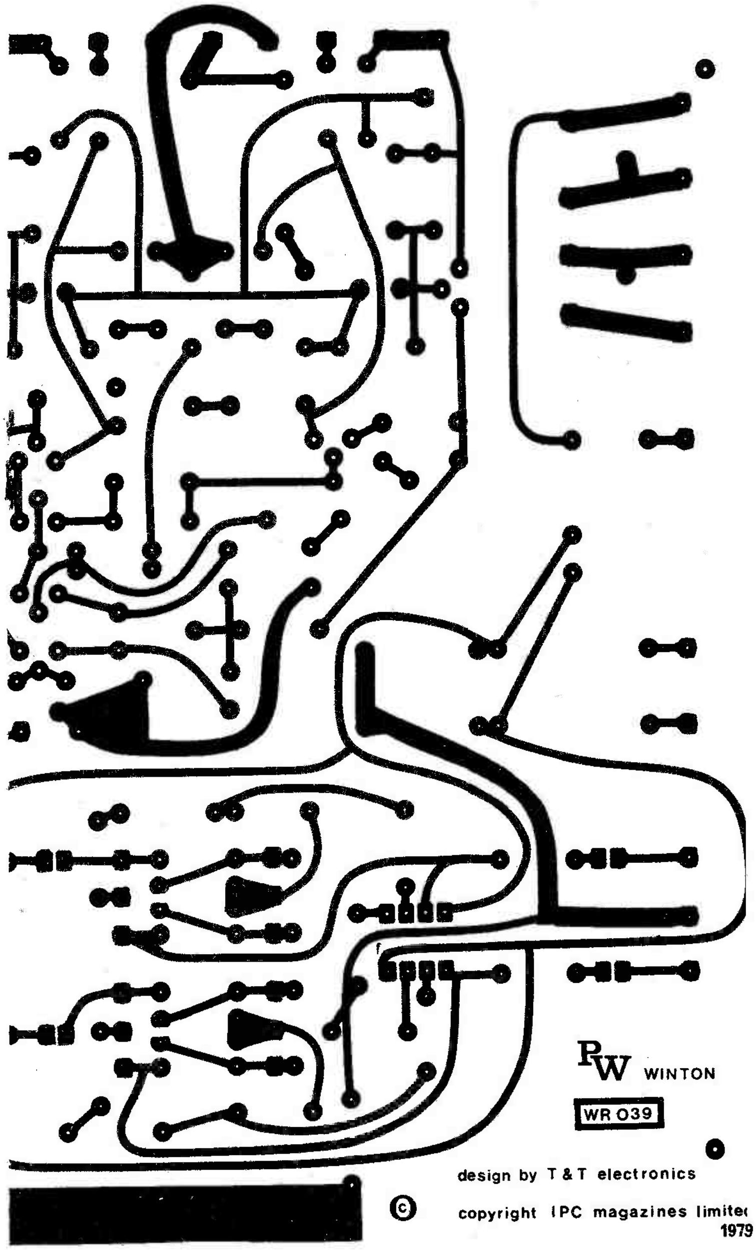
Hole sizes
A 4mm Dia.

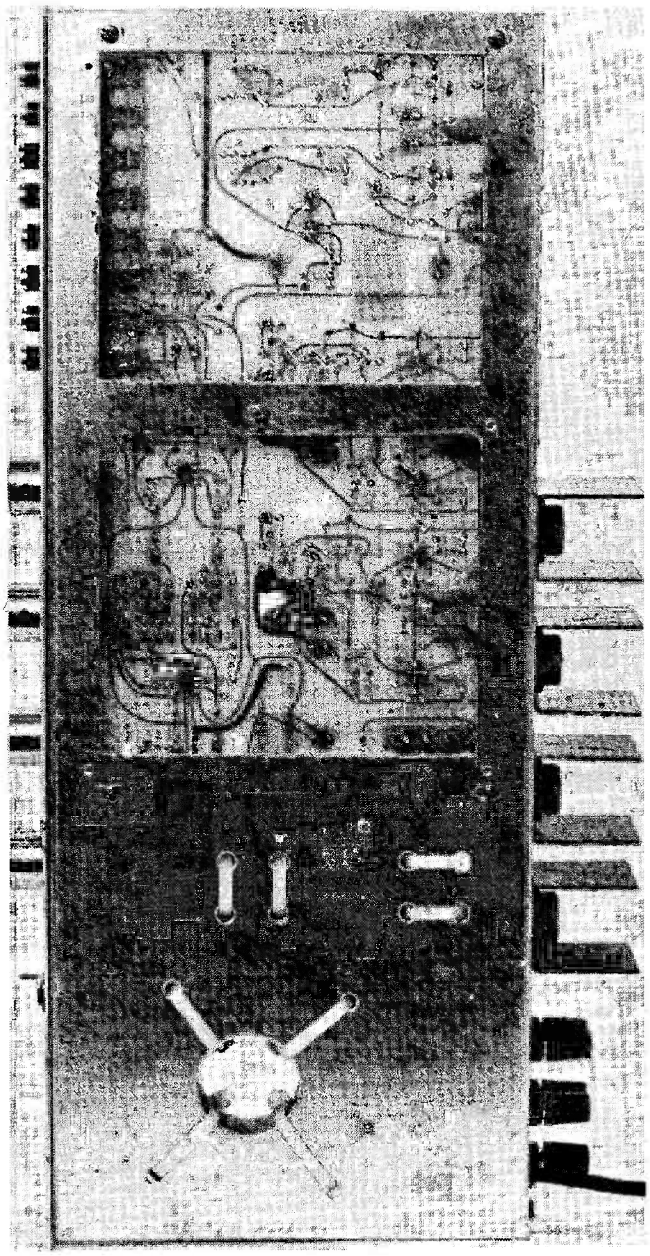
WAD308

WAD309



Hole sizes
A 4mm Dia.
B 8mm Dia.





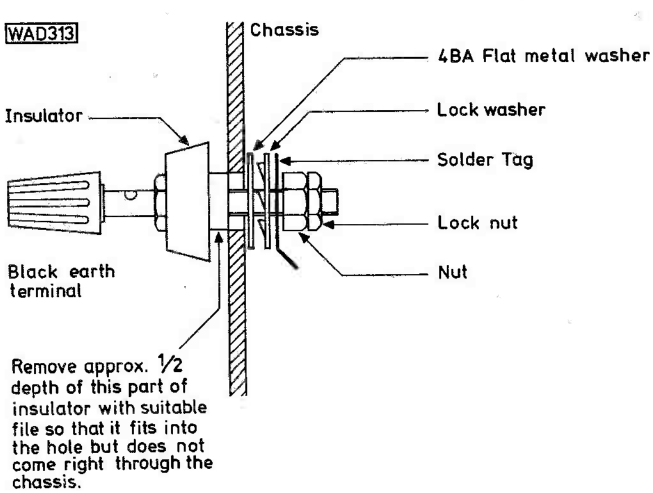
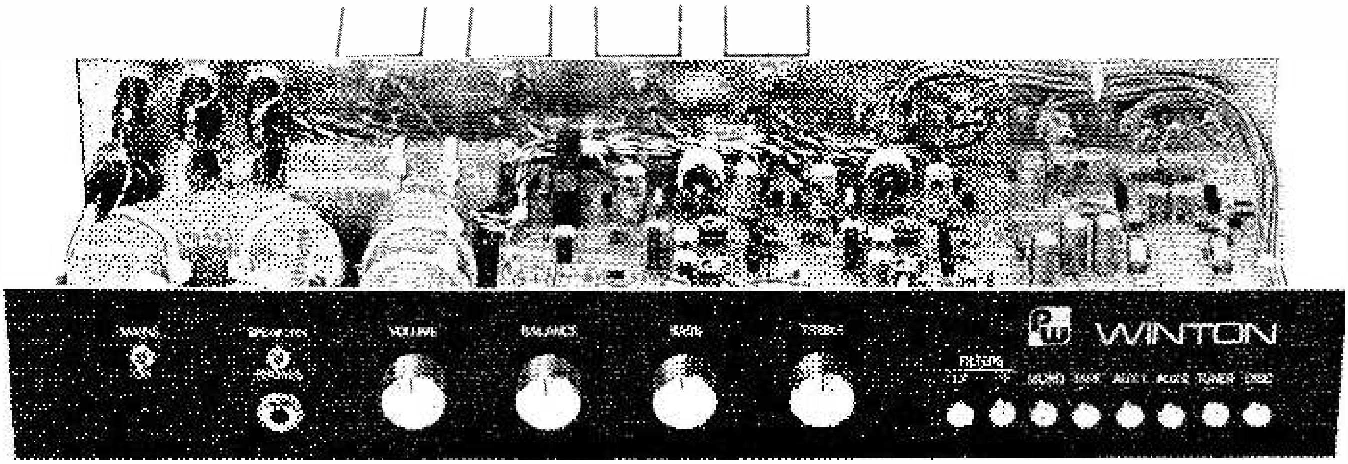


Fig. 8: Above left, the full size copper track pattern of the PW Winton printed circuit board

Fig. 9: Far left, details of the output transistor heat-sinks. Four of these are needed made from 1·2mm thick aluminium sheet with all burrs removed and the mounting surfaces absolutely flat. Paint matt black when completed

Fig. 10: Centre, the baseplate which covers the cut-outs in the aluminium chassis. Only one is needed from 1·2mm thick aluminium

Fig. 11: Left, details of the earth terminal assembly



Heat Sinks

The four heat sinks can be made from the aluminium removed from the four rectangular cut-outs and should be made up as shown in Fig. 9. It is very important that the holes on the heat sinks are completely free from burrs, also the part in the centre should be flat and any high spots removed with a suitable file. The power f.e.t.s must be mounted on a perfectly flat surface and the parts used for this must be filed flat and freed of burrs.

Once the p.c.b. is fully assembled it should be very carefully checked for any errors. If possible get someone else to check your work for you. When you are satisfied that it is correct, it can be assembled into the main chassis.

First, fix the five p.c.b. pillars onto the chassis. These are held in place with No. 6 self-tapping screws approximately 9mm long. The p.c.b. can then be mounted onto the pillars by lowering the push-button end so that the buttons line up with and project through the front panel holes. Then press the p.c.b. firmly onto the pillars. Check the action of the push-button switches, which must all be free to move without catching on the chassis. The use of a small file may prove helpful if problems exist but if the chassis has been made correctly, all should be well.

The other components can now be fitted to the chassis in the position shown in the drawings and photographs. Note that the volume, balance and tone controls are assembled onto their mounting bracket (Fig. 15), before the whole assembly is fitted to the chassis.

Control Spindles

First cut the control spindles to a length of 22mm. Do not strain the control when doing this. Clamp the unwanted part of the spindle in a vice and hold the potentiometer end to steady it, while cutting the spindle with a small hacksaw. Then remove any burrs.

Assemble the controls into their respective positions on the mounting bracket and tighten all nuts firmly but do not overtighten. The bracket is fixed to the chassis front with countersunk 6BA screws, approximately 12mm long, and spaced from it with two 6BA nuts. Finally it is held in place with another 6BA nut and lock washer.

When fitting the socket for the headphones, the tags come up either side of the phone/speaker switch and should be bent slightly outwards.

When the heat sinks are satisfactory, they should be painted *matt* black and left to dry thoroughly before using.

Finally, make up the chassis base plate and the control mounting bracket as shown in Figs. 10 and 12.

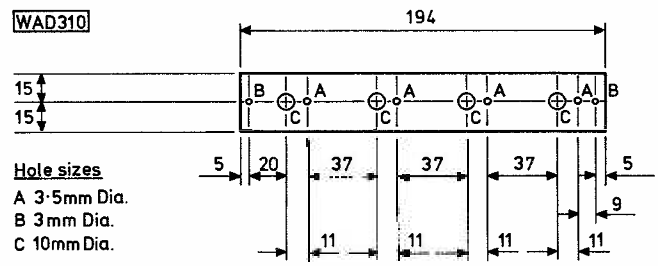
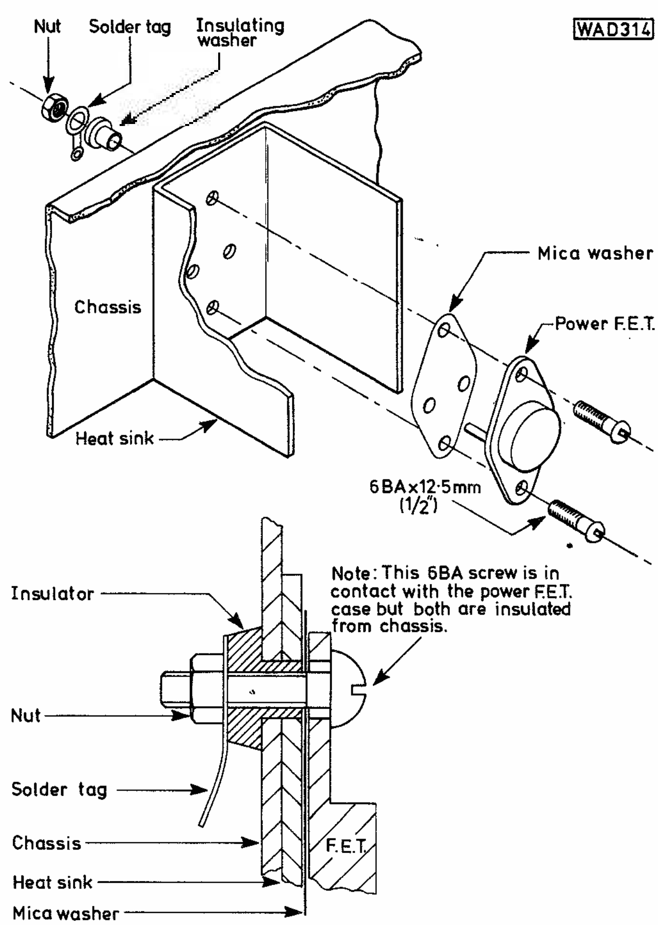


Fig. 12: Above, details of the control mounting bracket which is made from 1·2mm thick aluminium

Fig. 13: Below, the mounting details of the power f.e.t.s and heat sinks



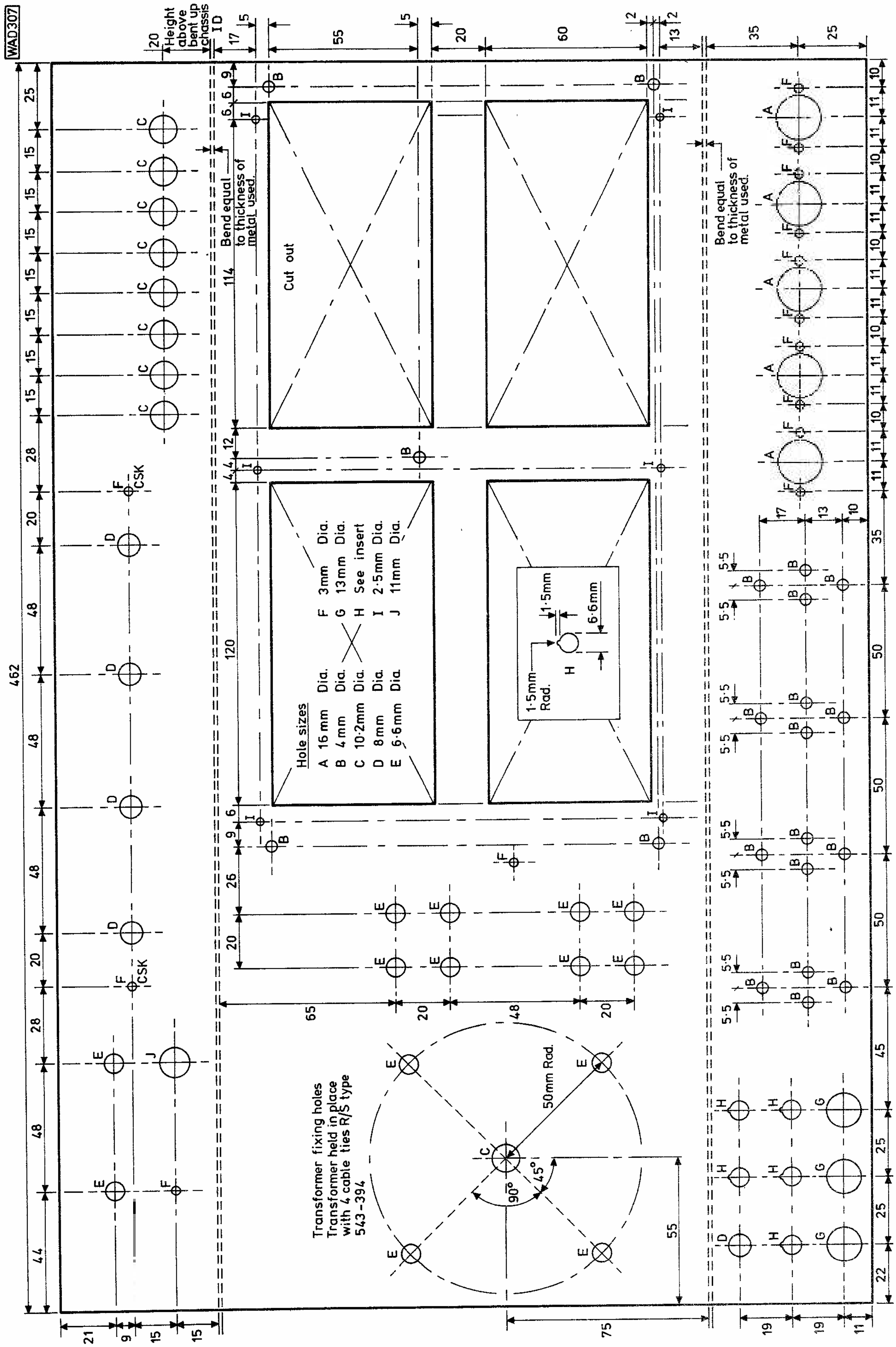


Fig. 14: Marking out details for the aluminium chassis which is made from 1·2mm thick sheet

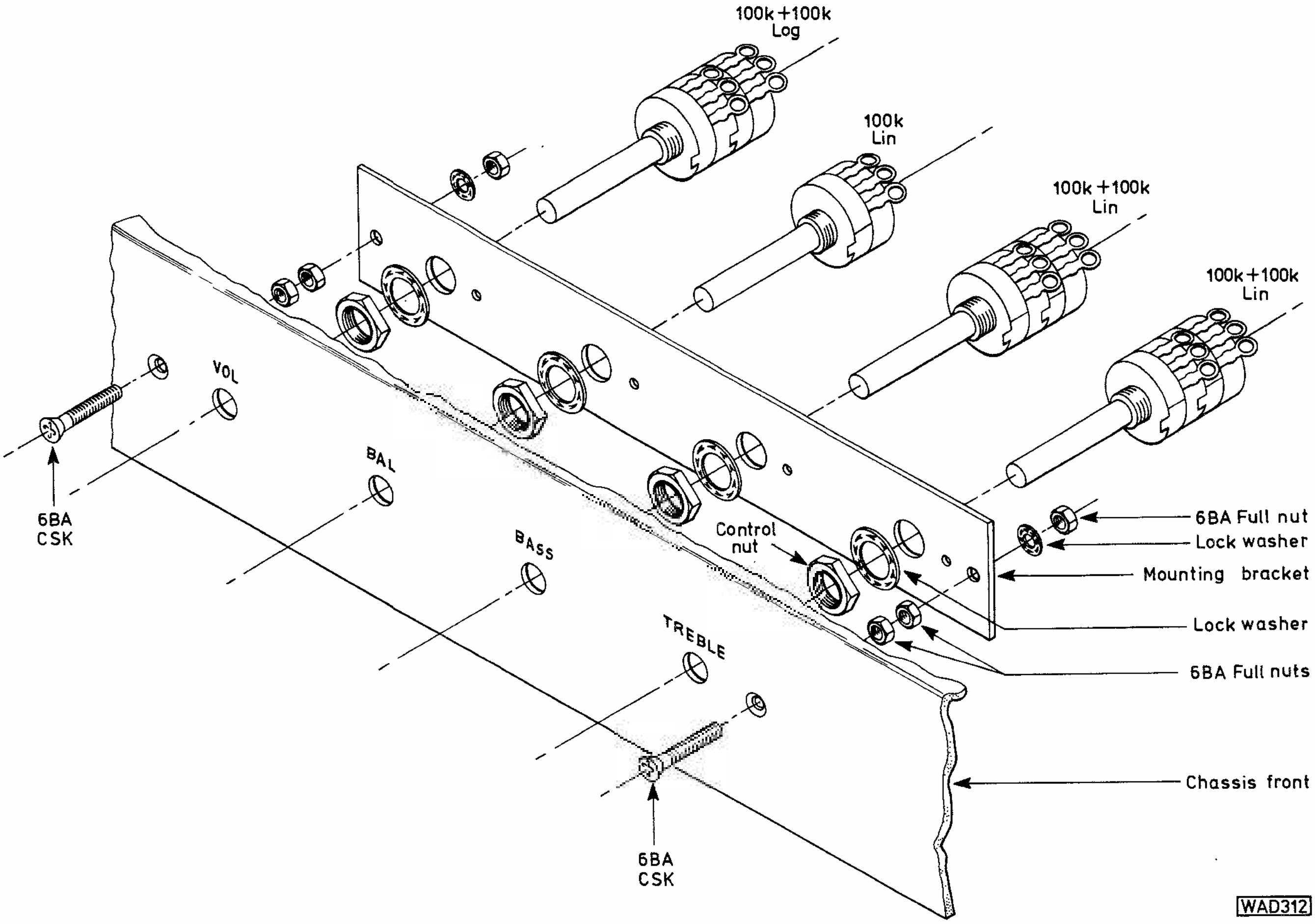


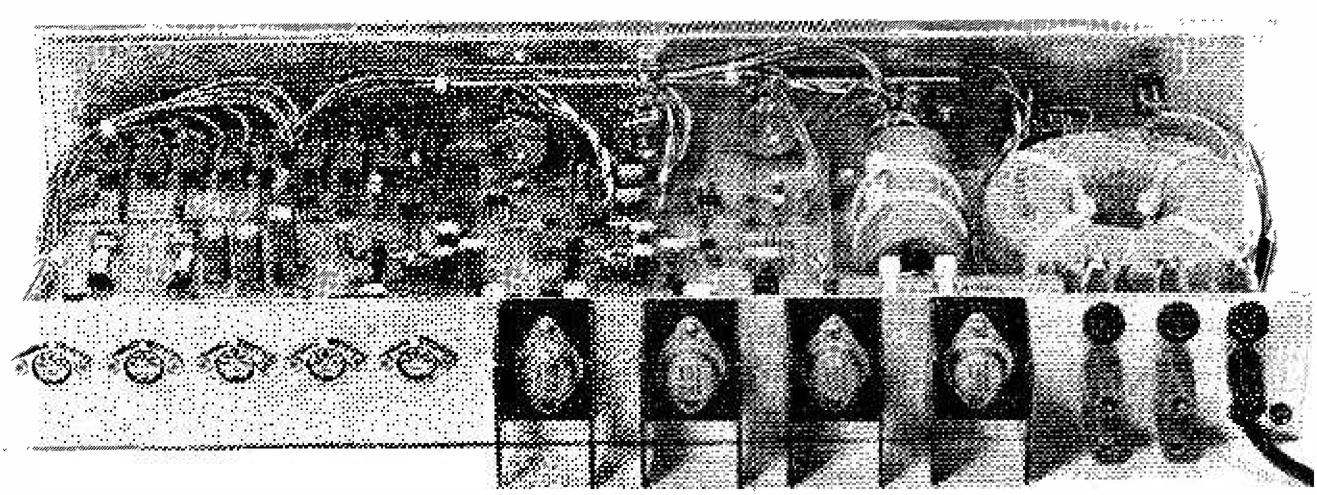
Fig. 15: Method of mounting the control potentiometers using the pot mounting bracket

The black earth terminal on the rear of the chassis is mounted without its rear insulating washer to ensure a good electrical contact with the chassis (Fig. 11).

The output power f.e.t.s should be assembled onto the heat sinks and chassis as shown in Fig. 13, but it is very important to make sure that the pins do not touch the sides of the holes, and that the mica washers are not damaged. The use of a heat sink compound helps here. After assembly, a multimeter may be used to check for shorts between pins and chassis.

Both the 4700µF reservoir capacitors are held in place with plastic cable ties. Four large plastic cable ties are used to hold the special toroidal mains transformer and should be firm but not over tightened, otherwise they may distort the chassis. A piece of foam is placed between the transformer and chassis to reduce vibration. This method of fastening the transformer to the chassis has been used instead of the bolt and plastic centre method as it has proved to be considerably cheaper and is just as easy and reliable. Do not be tempted to use metal ties, wire, or a bolt and clamp bar through the centre of the transformer, any of these methods can create a shorted turn, overloading the transformer. The l.e.d. used as an "on" indicator is a firm push fit into the hole provided.

Next month finishes the wiring of the amplifier and covers testing and setting-up procedures



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4v	7 amp	TM 32	**£2·70**	**60p**
6v	½ amp	TM 3	**85p**	**40p**
6·5v	½ amp	TM 37	**85p**	**40p**
6·5v	200 mA	TM 21	**£1·62**	**40p**
6·5v-0-6·5v	100 mA	TM 21	**£1·62**	**40p**
6·5v-0-6·5v	750 mA	TM 7	**£2·16**	**45p**
6·3-0-6·3v	100 mA	TM 33	**£1·62**	**40p**
6·3v	2 amp	TM 4	**£1·89**	**50p**
8·5v	1 amp	TM 12	**£1·62**	**40p**
8·5+8·5v sep. winding	½ amp	TM 12	**£1·62**	**40p**
9v	1 amp	TM 5	**£1·62**	**45p**
9v	3½ amp	TM 11	**£2·70**	**50p**
9v	5 amp	TM 38	**£3·24**	**60p**
10v	25 amp	TM 15	**£4·86**	**£1·25**
10v-0-10v	4 amp	TM 50	**£3·78**	**£1·25**
10v-0-10v	12½ amp	TM 15	**£4·86**	**£1·25**
12v	½ amp	TM 9	**£1·05**	**50p**
13v	100 mA	TM 21	**£1·62**	**40p**
13v	¾ amp	TM 7	**£2·16**	**50p**
12v	1 amp	TM 10	**£1·89**	**50p**
12v-0-12v	50 mA	TM 19	**£1·62**	**40p**
12v-0-12v	1 amp	TM 41	**£3·24**	**50p**
15v tapped 9v	2 amp	TM 11	**£2·70**	**50p**
17v	½ amp	TM 12	**£1·62**	**50p**
18v	¾ amp	TM 13	**£1·90**	**50p**
20v	½ amp	TM 14	**£1·62**	**50p**
20v (with 6v ½ amp)	2 amp	TM 50	**£3·78**	**£1·25**
20v	6 amp	TM 46	**£4·32**	**£1·25**
20v	12½ amp	TM 15	**£4·86**	**£1·25**
20v-0-20v	6 amp	TM 15	**£4·86**	**£1·25**
24v	1½ amp	TM 16	**£2·12**	**60p**
24v	2 amp	TM 17	**£2·70**	**60p**
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40v	5 amp	TM 48	**£5·02**	**£1·25**
40v	6 amp	TM 15	**£4·86**	**£1·25**
40v-0-40v	2½ amp	TM 48	**£5·02**	**£1·25**
50v & 6·3v	2 amp	TM 22	**£4·86**	**£1·25**
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75v	4½ amp	TM 24	**£7·02**	**£2·50**
80v tapped 70v & 75v	4 amp	TM 24	**£7·02**	**£2·50**
80v centre tapped	2½ amp	TM 48	**£5·02**	**£1·25**
100v	1 amp	TM 25	**£7·02**	**£1·75**
100v-0-100v	½ amp	TM 25	**£7·02**	**£1·75**
200v	½ amp	TM 25	**£7·02**	**£1·75**
250v-0-250v & 6·3v	50 mA	TM 36	**£3·78**	**£1·00**
000v	100 mA	TM 36	**£3·78**	**£1·00**
500v	50 mA	TM 36	**£3·78**	**£1·00**
260v	60 mA	TM 26	**£3·24**	**£1·00**
1000v	60 mA	TM 43	**£6·50**	**£2·00**
4 kv	5 mA	TM 49	**£4·05**	**70p**
5 kv	5 mA	TM 30	**£7·02**	**£1·00**
8 kv	5 mA	TM 45	**£4·05**	**£1·00**
8·5 kv	10 mA	TM 31	**£10·26**	**£2·00**

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FX 2243	4·5 cm	3·0 cm	81	
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Quantity discounts apply.

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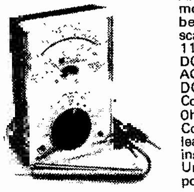

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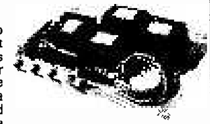

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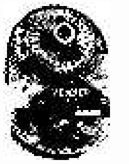

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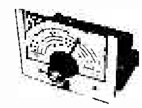

Although this uses no battery it gives really amazing results. You will receive an amazing assortment of stations over the 19, 25, 29, 31 metre bands. Kit contains chassis front panel and all the parts **£1·94**—crystal earphone **55p** including VAT and postage.

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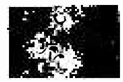

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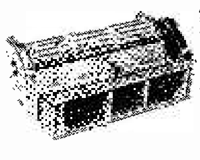

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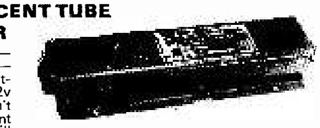

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Light Dimmer, our timer module with small mods makes an excellent light dimmer. Contains a 4 amp 400V SCR so it should be suitable for loads approaching 1KW. Price of module and instructions **£2·25.**

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Flashing Lights, chasing lights, random finishes, strobe effects etc., etc., can easily be achieved using our disco switches. These switches are ex-equipment but guaranteed perfect and supplied suitable for mains working. To get some idea of loading number, each switch is 10 amp. For the light pipe or Catherine Wheel effect order the 12 switch model with light pipe data model, interconnecting the switches to give fastest speed. 6 Switch model **£5.** 9 Switch model **£9·75.** 12 Switch model **£6·20.**

Reed Switches, standard 60 watt glass type. Normal open contacts glass lengths 2″ diameter 3/16″. 10 for **£1,** 100 for **£6,** 1000 for **£70.**

Flat Reed Switches, for stacking, greater quantity in confined space. Price **£50p.**

Ceramic Magnets, suitable for operating Reed switches, central fixing hole, 10 for **£1.**

Music Centre Transformer 12-0·12 at 1 amp and 9 volt at ½ amp. Normal primary, uprighting, impregnated and varnished for quiet operation. Price **£3·50.**

'W' Shaped Fluorescent Tubes for porch light, box signs or where you want light evenly spaced over a confined area of approx. 10″ +10″, 30 watts made by Philips, price **£2·24.**

Extension Speakers, 8 ohm 4-5 watts handling power. We have 5 or 6 different models in stock, cheapest being the Partytime at **£3·95** each, again only really a bargain for callers as postage is £1·50 per speaker.

Auto Transformers for working American tools and equipment, completely enclosed in sheet metal case with American type flat output socket made for computer so obviously first class 500 watts. With cang handle, offered at about half price only **£15.** These may be a bit soiled but are fully guaranteed. Similar but 1000 watt for **£29·50.**

Car Starter Charge Kit. New version. We supply two 10 amp rectifiers. 250v transformer and the start charge switch with instructions, price **£9·75.** This is probably one of the most useful pieces of equipment you can have in your garage. Sooner or later you or someone will leave something on and you will have a flat battery, this starter will get you away usually in less than 5 minutes.

Resetter Counter, by Veedroot Company, 230/240V mains operated, intended for surface mounting has a fixing flange at the bottom. Price **£2·16.**

12V Drip proof Relay. Specially designed for going under the bonnet of a car, made by one of our big manufacturers, this really has a removable semi-hard rubber cover. Contacts look suitable for up to 10 amps so this could be the right one. If you are thinking about making an anti-thief device. Price **£1**+8p.

High Speed Uniselector. As many customers know, we have a very comprehensive stock of uniselectors as used in automatic telephone exchanges, light flashing device etc., etc. Just arrived however is a high speed model made by famous Plessey, this is 2 pole 32 way with make before break wipers, overall size approx. 4″ × 3″ × 2½″, price **£3·50** +28p.

Pneumatic Ram for lifting, thrusting, pulling etc., has 2¾″ travel, looks large enough to open doors, lift, staircase, ventilators, etc. Price **£7·00.**

Solder Gun Bargain. The ETP, this is 100 watt solder gun, a very well made tool with lamp to illuminate work has double insulated mains transformer and is built into the shock proof thermoplastic case. Comes complete with spare tips. Mains operated of course. Price **£4·50.**

Interested in Tape Control. American made tape punches, really beautiful units made of sophisticated parts, designed we believe to automatically operate typewriters and they can of course be used to operate other punch tape controlled machines. Reference number is NCR Class 461-2 reference 205 H8 R56. We believe these are 8 bit paper tape punches, powered from 115V 50HZ in very good condition with tape **£16·00,** carriage is £3·20.

Resettable Fuses (thermal trips). Two new types have come in, one made by ETA is a 6 amp model which is mounted through a single hole rather like a volume control. This is suitable for 250 volts AC or 24 volts DC. Price **54p. 4·5 Amp Model** made by AEG is held by two screws thus a bank of these could be mounted between metal straps. Price **54p.**

Disc Motor, mains operated. This is very thin in fact less than ½″ thick and only approx 2″ dia. Spindle revolves at 250 rpm and the spindle which is approx. 1/32″ dia. pushes through so motor could be used to drive clockwise or anti-clockwise. The spindle being a friction fit can be pushed completely out and replaced by your own spindle, a knitting needle for instance. Price only **38p.**

75 rpm Mains Induction Motor with gearbox. This motor is quite powerful and has 1½″ stack and the final 75 rpm drive shaft is 1½″ long by ⅜″ dia. The motor also has a spindle coming from the opposite end to which could be fitted another pulley. Overall size approx. 3″ × 5″ × 2½″ + spindles. Price **£3·35.**

24 Hour Motor, beautifully made by Sangamo. This is 200-240v mains driven motor with gearbox together in one housing, size approx. 1¾″ dia. by 1¾″ deep. If you are contemplating making a 24 hour switch with a lot of on/offs, then this is obviously the motor. Price **£1·89.**

PRODUCTION LINES

alan martin

If you please

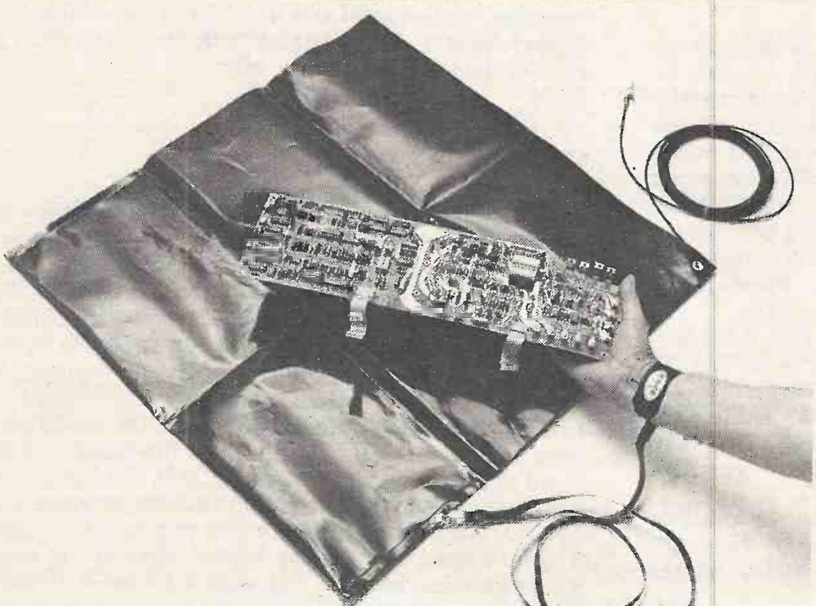
Would readers kindly mention "Production Lines", when applying to manufacturers or suppliers featured on this page.

Pattle's panels

We all know the problems of making a really good front panel for our projects. Dymo tape and typed sticky labels are no substitute for a photographically reproduced anodised aluminium panel. Several of our recent projects have featured front panels professionally made by D. J. Pattle to our designs. These panels are available to readers and come in a variety of styles, colours and thicknesses.

The thin type is available, self-adhesive backed, ready to be cut out and mounted on to a sub-panel. A full thickness aluminium version is available which also acts as the front panel.

If you want to add a touch of class to your shack, then the aluminium RSGB badge with your callsign across the centre, is available to order from Pattle. Full details and prices from: *D. J. Pattle, Juniper, Hillbury Road, Alderholt, Dorset. Tel: Fordingbridge 52081.*



Grounded

A portable field service kit which can prevent electrostatic charge from damaging sensitive electronic components during construction or servicing operations is now available from 3M UK Ltd.

This is the "Velostat" 8005 Field Service Grounding Kit, which provides an effective method of draining electrostatic charge from the individual to ground before it can damage or destroy sophisticated components, such as MOS, bi-polar devices and microprocessors.

Research has shown that thousands of volts of electrostatic charge can be generated and stored in a technician's body by simply walking across floors and sliding on and off stools. When the individual then handles a p.c.b., the electrostatic charge flows from him through the circuitry, literally blowing components.

The kit consists of a "Velostat" Table Top (614mm square), a conductive wrist strap and a ground cord. The Table Top has convenient storage pockets and can be rolled or folded to fit neatly in tool cases.

For details of price and availability contact: *3M United Kingdom Ltd., 380–384 Harrow Road, London W9 2HU. Tel: 01-286 6044.*

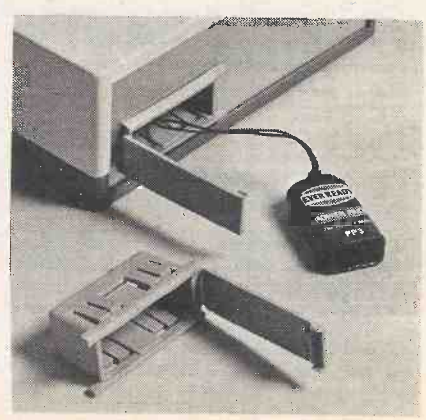
Battery holder

Most small equipment enclosures on the market today make no provision for battery housing and dismantling a complete instrument in order to replace an exhausted battery is both tedious and time consuming.

Vero Electronics Ltd. now make available an injection-moulded battery housing of simple clip-in design offering access for battery changing from outside the instrument.

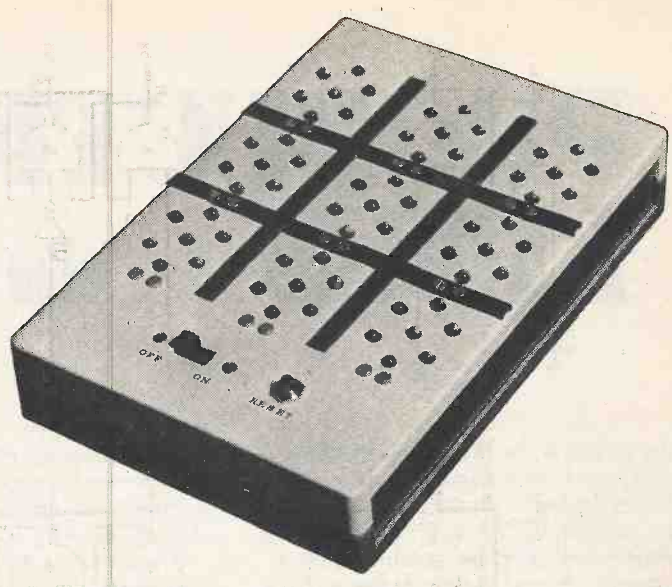
The holder accepts a 9V battery and may be easily fitted to a panel or enclosure with a thickness of 1·5 to 3mm. All that is required for fitting is a rectangular cut-out into which the holder is pressed home.

Supplied as a kit, the battery holder comes complete with connector and lead for less than £1. Further details from: *Vero Electronics Ltd., Industrial Estate, Chandler's Ford, Eastleigh, Hants SO5 3ZR. Tel: (042 15) 69911.*



LOGICAL NOUGHTS & CROSSES

J.D. MITCHELL PART 1



The game of Noughts and Crosses presented here is a less ambitious development than the automated opponents currently advertised, but has proved itself a source of great interest to friends and offspring alike. Babysitters particularly appreciate trying to beat the "computer" after the television closedown.

The game uses TTL integrated circuits, directly driven l.e.d. displays, and inputs are made by touch-switches or alternatively with a simple prod. The circuit automatically remembers the first input and sets its program for the remainder of the game. With the advantage of first move, the player may win 126 or 16 of the 945 different possible games as explained later. This facility was added at the cost of a few extra gates. The programming could have been wired to win or draw only, but there is little interest in competing against an infallible opponent. Mis-switches cannot override previously lit noughts and crosses.

Identifying the board squares as in Fig. 1(a), if the first input is to any outer square the reply is to 5. Should the first move be to square 5, the reply is to 1. The first reply is directly gated, but this is not possible for subsequent replies and a 9-bit event latch is used to set a program. The programs set by the first input made in each game are identified as in Fig. 1(b).

Figure 2 details the event latch, gating for the first reply, input latches which store the momentary Logic *0*'s from the touch-switches or probe, and display latches which directly drive the l.e.d. displays.

Six input latches are contained in IC13, type SN74118. The other three are cross-coupled 2-input NAND gates type SN7400. Capacitor C1 connected to the reset input prevents the discrete latches setting in the opposite polarity to those in IC13 on powering the circuit. All other capacitors shown are for decoupling.

Display latches

The display latches operate differently to the usual set-reset of the input latches. Initially, both inputs are at Logic *0*. When one input is switched to Logic *1*, both inputs to one gate are then at *1* and its output is at *0*. The display in that square is thus lit.

Display gating for squares 2, 4, 6 and 8, Fig. 2(b) are modified forms of the above latches. If a nought or cross input is made first, the display will be lit accordingly. If the third (inhibit) input is made first, a nought cannot then be displayed although a subsequent cross can. Five 3-input NAND gates are also used in the gating. Outputs from these are connected to the inhibit inputs of the latches. Two are spare type SN7410 as used in the 3-input display latches. The other three are type SN7412 (o/c collector) so that two may be connected as a wired-OR to the inhibit input of display latch 4. These latches with their associated gates prevent replies being made after the player has won a game.

Wired-OR gates

The 9-bit event latch comprises IC10 and square 5's input and display latches. IC10 is a dual 4-bit latch with clear inputs, type SN74116. Each 4-bit latch also has two enable inputs, which are connected as two pairs on PCB 1. All outputs from IC10 are connected as a wired-OR gate into one pair of enable inputs. The other enable inputs are connected to the $\overline{Q}$ output from square 5's input latch. When either pair of enable inputs is switched from Logic *0* to *1*, all eight latch outputs are held in the condition they were in previous to the switch. If the first input switched is 5, all outputs from IC10 are held at *0*. Display latch output 5x is enabled, and inverted to enable program E. Output E is inverted again to enable display latch ouput Io. The inverters buffer display latch 5. Should any other input be switched first (say 3x), output 3 from IC10 switches to Logic *1* and enables program C. The other programs remain disabled by the output of the wired-OR gate, whilst display latch output 50 is enabled.

The nine outputs from the event latch circuit are taken to PCB 2 where they are connected with eight of the Input latch $\overline{Q}$ outputs in a gated matrix. Input latch 5 is not re-

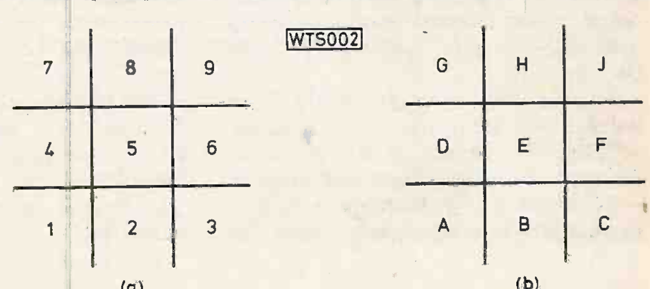


Fig. 1: The identification of the squares on the board

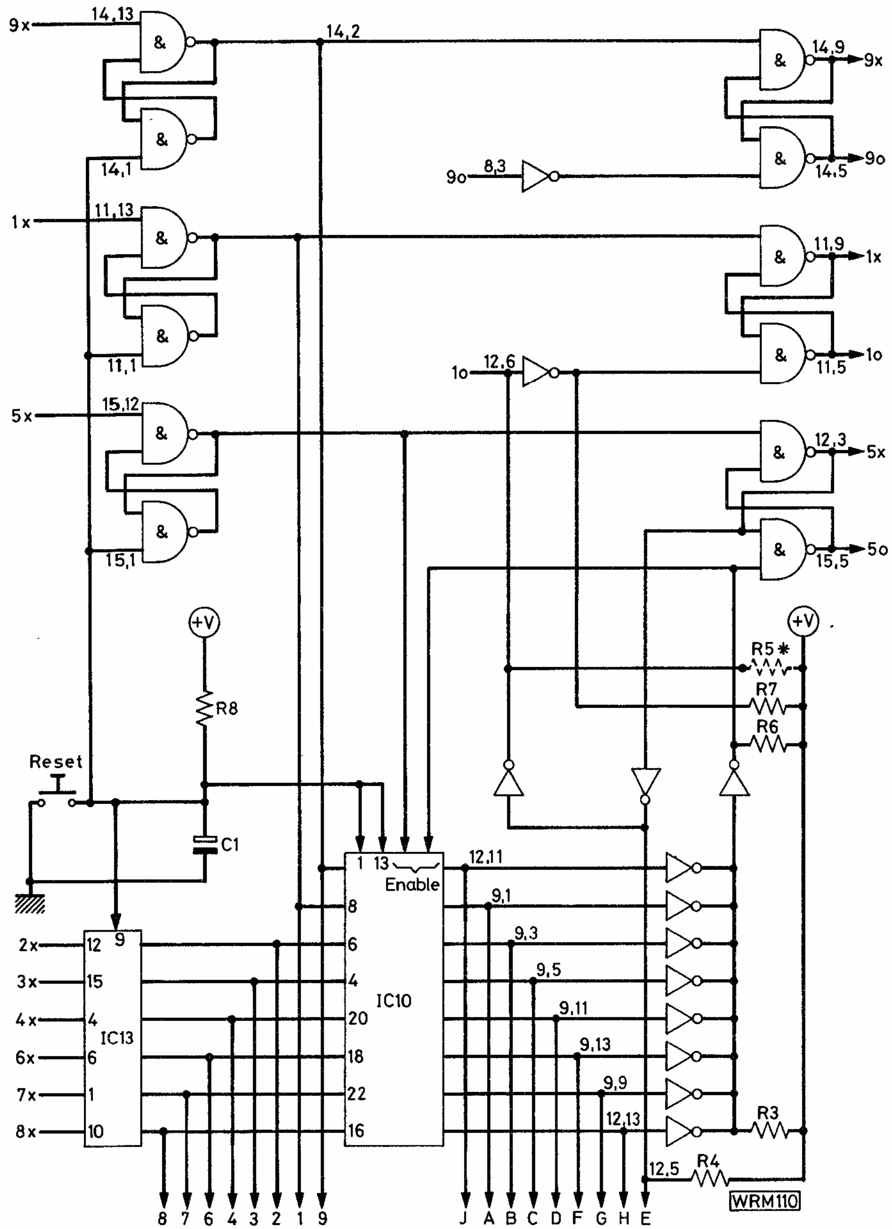


Fig. 2(a): The input latches are contained in IC13, an SN74118. The 9-bit event latch is made up from IC10 (SN74116) and square 5 input and display latches. C1 is to prevent the discrete latches from setting in the opposite polarity to those in IC13 when power is applied

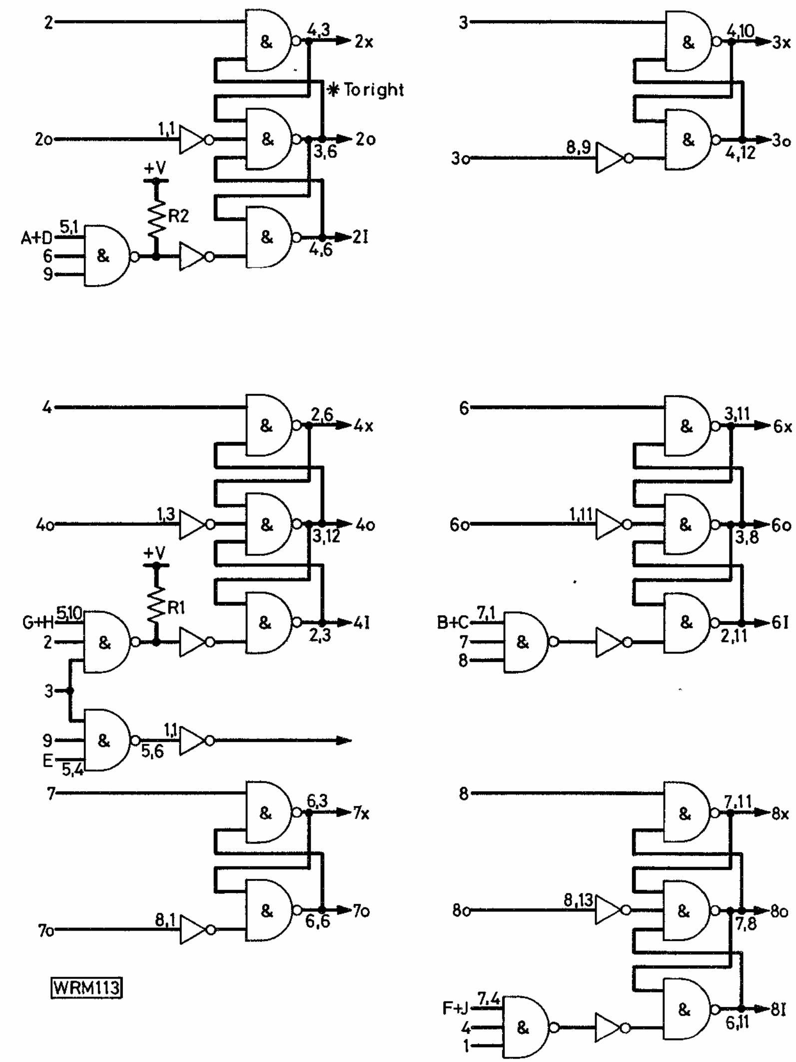
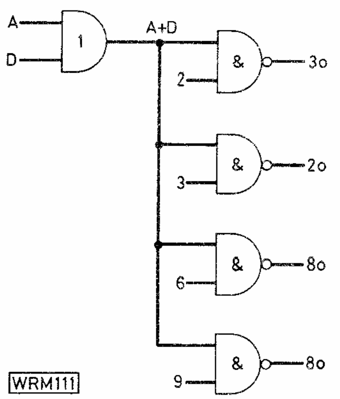


Fig. 2(b): The display gating for squares 2, 4, 6 and 8 are shown in this drawing. These gates ensure that the correct symbol is displayed in the appropriate square



Wired prog. o/p connections to nought display latches													
Inputs	A	B	C	D	E	F	G	H	J	A+D	B+C	G+H	F+J
1	–	3	2	7	–	–	–	–	–	–	–	4	2
2	–	–	1	–	8	1	–	–	4	3	–	6	–
3	–	1	–	–	7	9	–	–	6	2	–	6	–
4	7	7	8	–	6	–	–	–	–	–	–	1	2
5	–	–	–	–	–	–	–	–	–	–	–	–	–
6	–	–	–	–	4	–	2	3	3	8	9	–	–
7	4	–	–	1	3	–	–	9	–	–	4	–	8
8	6	–	–	9	2	–	9	–	–	–	4	–	7
9	–	–	–	–	7	3	8	7	–	8	6	–	–

Fig. 3: Circuit board 2 connects the nine event latches to eight of the input latch $\overline{Q}$ outputs in a gated matrix. All outputs with the same numbers are 'wired-OR' connected to the appropriate resistor on Board 2 and then to Nought inputs of display latches on Board 1

★ components

Resistors

½W 2% metal oxide

270Ω	9	Display
1kΩ	10	R8 and input switching
1·2kΩ	2	R3, 9
1·5kΩ	1	R14
1·6kΩ	5	R10, 11, 12, 13, 15
2kΩ	1	R16
2·2kΩ	9	Input switching
4·7kΩ	2	R1, 4
7·5kΩ	1	R6
9·1kΩ	3	R2, 5, 7

Capacitors

Disc Ceramic

0·01µF	7	Decoupling

Tantalum bead

22µF 6V	1	C1

Semiconductors

Diodes

1N4001	1	D1
Red l.e.d.	63	Display

Transistors

BC108C	18	

Integrated circuits

SN7400	6	IC2, 4, 6, 11, 14, 15
SN7403	12	IC17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28
SN7404	2	IC1, 8
SN7405	2	IC9, 12
SN7410	2	IC3, 7
SN7412	1	IC5
SN7432	1	IC16
SN74116	1	IC10
SN74118	1	IC13

Miscellaneous

Push-to-make switch (1), miniature slide switch (1), Battery holder B203 (1), Verocase 205 x 140 x 40mm (1), Veropins, nuts, bolts, washers, printed circuit boards (set of 4).

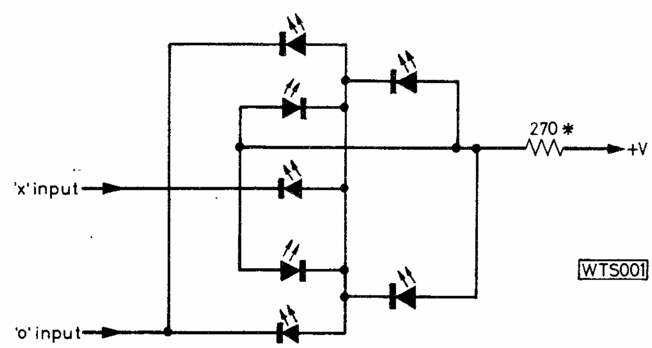


Fig. 4: Circuit diagram of one l.e.d. display. This forms the display for one square and nine of these are required for the complete game. The 270Ω resistor is the approximate value needed to limit total current to 10mA

quired because of the direct gating used for the first reply. 2-input o/c collector NAND gates type SN7403 are used for the matrix, their outputs connected as wired-OR gates—see Fig. 3. To reduce the number of gates in the matrix, four 2-input-OR gates type SN7432 are used to provide outputs A + D, B + C, F + J and G + H. The NAND gate outputs are connected back to inverters on PCB 1 and then to the nought inputs of the display latches.

Outputs

Outputs from the display latches are connected directly to the display l.e.d.s, which are interconnected and positioned as shown in Fig. 4. Initially, both outputs of a latch are at Logic *1*. If the "X" input to a display is switched to 0V, current flow is from the positive rail via the four corner-mounted l.e.d.s, through the centre l.e.d. into the gate, displaying a cross in the appropriate square. If a "O" input to a display is switched low, current flow is via the corner l.e.d.s and through the top and bottom l.e.d.s to show a nought. The resistor is selected to limit current to 10–15mA.

PART 2 will cover the construction of this interesting project together with the circuit diagrams and printed circuit board layouts

HOTLINES

A REVIEW OF RECENT DEVELOPMENTS
In general, the author does not have any more information on products than appears in the article.

Lasers Again

Readers may remember the fuss over using lasers as part of London's Christmas decorations last year. Apparently some thought the beams would constitute a hazard.

In the American town of Atlanta they've been using lasers for some time to control traffic lights. Before anyone sees "red", the health hazard is virtually nil and the system has been given a fond, approving kiss by the US Bureau of Radiological Health Standards as being "safe for eyes".

Previously, the digital computer that controls the city's traffic lights was coupled to the lights via telephone lines, or by dedicated cables. The system can control up to 500 separate road junctions. At each set of lights is an optical transceiver that faces its neighbour at another junction.

Sensors, in the road, monitor the traffic density and this information is fed back along the laser chain to the computer. The digital computer "computes" all this information and, having computed sends a master command signal to the relevant traffic lights.

Tests on the laser's range showed reliable operation at distances of well over $\frac{1}{4}$ mile even in the very worst weather conditions (such as heavy fog, etc). In a good, clear, typical English summer's day (singular!) type weather, the range approaches 10 miles.

Peak power outputs of the GaAs laser diodes used are around 10W, and these are pulsed at 2kHz.

A shining example to traffic light manufacturers everywhere.

Thermometers

For those with an interest in electronic thermometers, keep an eye open for the magic number AD590. It's a completely self-contained temperature transducer with an accuracy of $\pm 0{\cdot}5°C$ over the temperature range $-55°C$ to $+150°C$. And it's only "transistor size" being housed in a standard TO-52 can. Better still, there are only two leadout wires.

During manufacture, the resistive elements are precision laser trimmed to precise values. The result is a sensor that is linear over the range. So much so that you can plug in different ones without any need to recalibrate. For the technical buffs, the output is 298·2µA at 298·2K (that's 25°C) and any temperature change up or down gives a 1µA/K variation.

The cheapest version costs barely the equivalent of a single British quid. A miniature, ceramic flat pack version is also available. Note that these are the prices for 100 off, though!

Stronger yet Faster

High gain-bandwidth product and high collector-emitter breakdown voltage are two conflicting ideals according to many bipolar transistors. These comments are particularly pertinent in the field of switching applications.

The Japanese think they've found an answer, and it's quite a clever one. They've combined a field-effect transistor gate structure with a standard bipolar transistor. One of the beneficial effects observed is that, assuming the same base width, where a particular conventional transistor had a breakdown voltage of say 20V, the new hybrid would make this figure 200V.

Not only does the new structure give a ten times increase in breakdown voltage, but it also offers a four times increase in gain-bandwidth product. One set of figures quotes 80MHz/500V.

Midget Supplies

Ever since the advent of switching power supplies, these items seem to have shrunk ever smaller. An American company began one power supply development programme by asking itself a question. "As digital panel meters get smaller and smaller, how will they be able to keep the useful feature of being operable from d.c. supplies and mains?" Pointless to have a beautiful, small d.p.m. only to find a dirty great power supply (by comparison) is required to power it.

Since many miniature d.p.m.s use c.m.o.s. and require only small currents and voltages, their power needs are not great, never-the-less with mains one side and a d.c. voltage the other, something very small has to go in the middle.

The result is the µS-A series power supplies. They measure only 12·5mm cube and will supply from 1·5 to 15V d.c. from a 120 or 240V a.c. mains supply. They don't mind if the frequency of that supply is anywhere between 47Hz and 440Hz. The one-off price in the US is about the equivalent of £4 sterling. But the 100 off price plummets to just over £1.

Tiny Switch

Always well worth watching is the International Electron Devices Meeting. Among the many fascinating papers that caught my eye was one which described a small electromechanical switch. And when I say small, I really do mean small with a very little "s". This intriguing device is built using semiconductor technology. The switching cantilever is just 76 micrometres long. It is fabricated from a very thin layer of metal coated on a membrane of silicon dioxide. The membrane itself certainly isn't very thick, either; only 3500 Ångströms! Switching takes place by electrostatic action on the membrane. Switching time is around 40 millionths of a second using a "switching" voltage of 60V. The author claims the higher voltages give even shorter switching time—but one then starts to get contact bounce.

An important aspect of this new device is that the switch (or switches) could be fabricated on the same chip as the active devices.

A parting shot. It is thought that, after development, these tiny switches could be made to function at switching times to the order of 10µs using 30V max. and with a current carrying capability exceeding 100mA.

Although obviously in its infancy, the idea seems to be promising when one examines the prototype test figures. Some of the switches under test in the laboratory have exhibited lifetimes of over 2 million switching operations while switching current densities of 5×10^4 amperes per square centimetre.

It might be as well for readers who are avid constructors to purchase a powerful watchmakers glass as a precautionary aid to future projects!

Ginsberg

STEREO DECODERS
DEVICES & CIRCUITS
PART 1

M. J. DARBY

In previous articles we have seen how a basic f.m. receiver functions, and have also considered front-end devices and circuits in detail.

However, many f.m. transmissions carry stereo information, and this part of the series deals with the essentials of the stereo decoder.

The Multiplex Signal

The audio output from the demodulator of a stereo receiver consists of both audio frequencies and ultrasonic frequencies which carry the required information for both the left and right hand channels. These two channels are said to be "multiplexed' so that they can be present as a single signal. It would obviously be very uneconomical to employ two separate transmitters for the left and right hand signals.

The multiplex signal from the output of the receiver demodulator circuit contains a number of parts which are illustrated in Fig. 1 and listed below.

1. The audio frequency band from about 30Hz up to 15kHz contains the required audio signal and constitutes the sum of the signals in the left and right hand channels. In a monaural receiver, only this part of the signal will provide the output in the loudspeaker.

The transmitted signal is thus "compatible", which means that the one signal can be used to operate both monaural and stereo radio receivers.

2. A 19kHz pilot tone which is transmitted at a relatively low signal level. This pilot tone is required for the operation of the stereo decoder circuit; if the tone is not present in any signal (or not present at an adequate amplitude), the stereo decoder circuit will switch to the monaural mode and the same signal (left-plus-right) will be fed to the two speakers.

3. A left-minus-right signal which is modulated onto a 38kHz sub-carrier signal. The sub-carrier itself is suppressed so that there is a small gap of about 60Hz in width at 38kHz. The left-minus-right signal covers a frequency band of about 30Hz to 15kHz. The sub-carrier modulation process generates signals of 38kHz ± (left-minus-right frequency); this means that the lower sideband of the sub-carrier extends from 38 – 15 = 23kHz up to within 30Hz of the 38kHz frequency, whilst the upper sideband extends from 30Hz above 38kHz up to 38 + 15 = 53kHz. The upper and lower sidebands are shown in Fig. 1. The 38kHz sub-carrier itself has an amplitude which does not normally exceed 1% of the total signal amplitude.

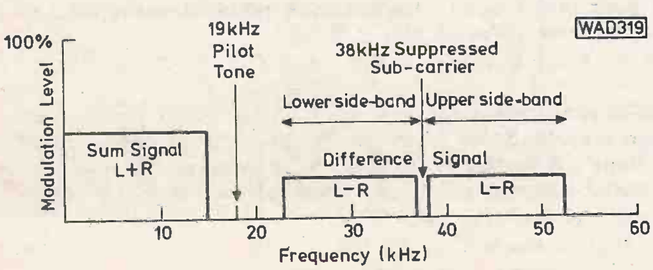


Fig. 1: Spectrum of the stereo multiplexed signal

It is obvious from Fig. 1 that the stereo multiplex signal has a much wider bandwidth than the monaural signal which extends up to only 15kHz. This wide bandwidth inevitably results in more noise being present in a stereo signal than in the same signal in the monaural mode. In practice the degradation in signal-to-noise ratio is some 20dB, so a much better aerial is required for good, low noise stereo reception than is necessary for good reception of the same signal in the monaural mode.

When a broadcast is to be monaural for a period of more than a few minutes, the pilot tone at the 19kHz frequency may be switched off so that stereo receivers are switched to the monaural mode. This automatically ensures that the optimum signal-to-noise ratio is obtained when only a monaural signal is being transmitted. Similarly, if the signal level falls below that required for good quality stereo reception, most stereo decoders will automatically switch to the monaural mode so that a better signal-to-noise ratio is automatically obtained without the listener having to take any action.

Decoder Types

Some of the earlier forms of stereo decoder circuits are of the so-called switching type. In such circuits the 19kHz pilot tone is extracted from the multiplexed signal using a tuned circuit and is doubled in frequency to re-generate the 38kHz sub-carrier frequency. This latter signal is used to switch the multiplexed input to the decoder between the left and right hand channels.

Switching circuits of this type are not at all easy to set up and to align. In addition, they have the disadvantage that they do not provide the optimum separation between the left and right hand channel signals and require ferrite cored inductors (which are always difficult to design effectively.

All modern circuits employ phase-locked loops in the stereo decoder circuit. The frequency of oscillation of the voltage controlled oscillator of the phase-locked loop automatically locks on to a harmonic of the pilot tone frequency and the loop will remain locked to this latter frequency until the pilot tone is switched off. Any normal

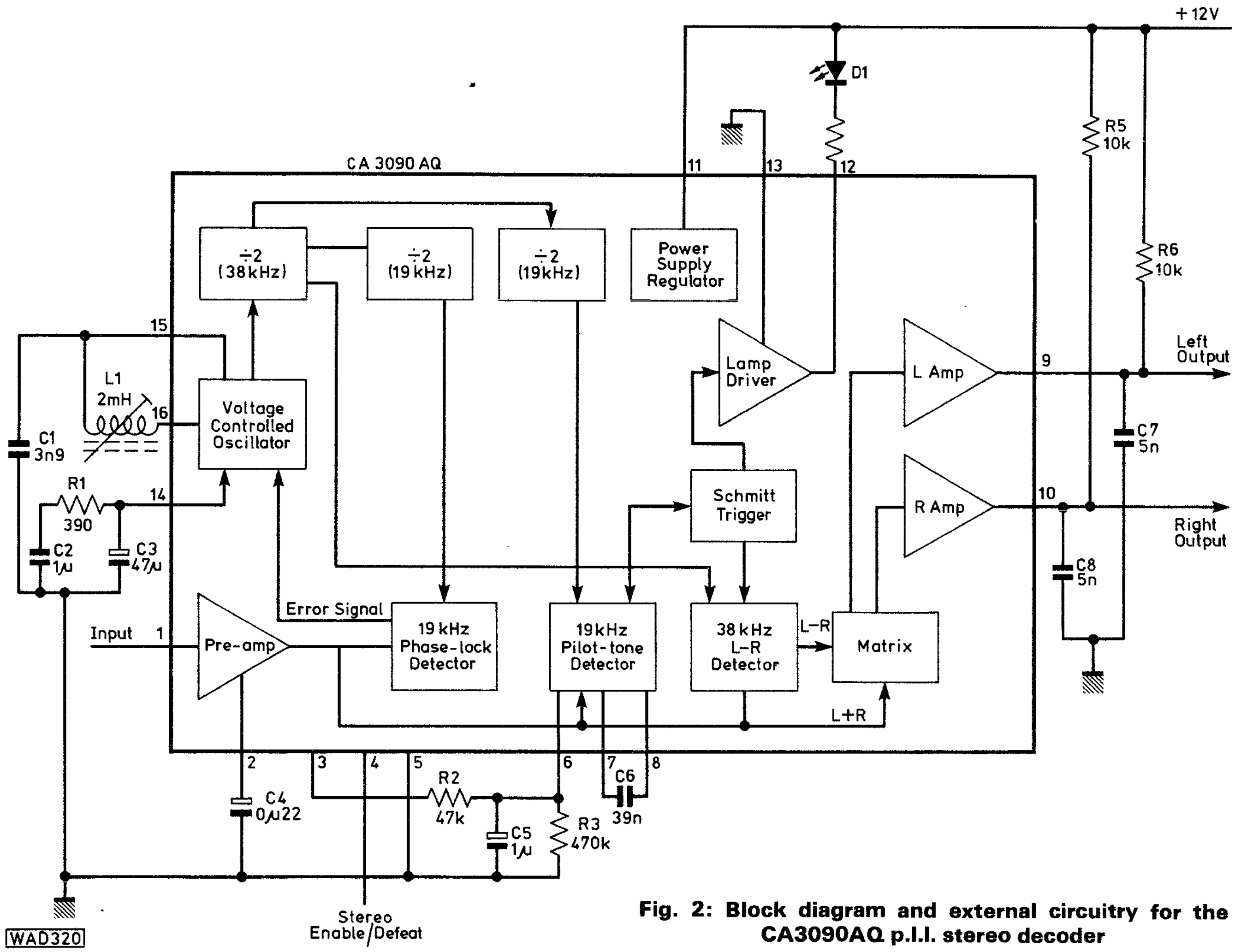


Fig. 2: Block diagram and external circuitry for the CA3090AQ p.l.l. stereo decoder

variation of the component values with temperature or normal ageing will not affect the performance of the circuit, so no critical component values are required in phase-locked loop decoders. In addition, this type of decoder is easy to set up, a simple adjustment of the loop free-running frequency being all that is required. Circuits employing a phase-locked loop for stereo decoding can provide excellent separation of the two channels, the interference between the channels normally being at least 40dB below the signal level.

Special integrated circuits for the phase-locked loop decoding of stereo signals are readily available. We will now discuss the principles of operation of a phase-locked loop stereo decoder and look at some typical circuits. It is much simpler to use a monolithic device than to try to make a stereo decoder from discrete components.

The RCA CA3090AQ

The first integrated circuit phase-locked loop stereo decoder to become available was the RCA Type CA3090Q in 1971, but this has been replaced by the CA3090AQ which is an improved version of the device, and provides an excellent performance. It has the disadvantage that the phase-locked loop is tuned by means of an inductor, whereas the other devices are tuned by a variable resistor; however, the thermal stability of the CA3090AQ is reputed to be better than that of other devices.

The internal circuit of the CA3090AQ is shown in block form in Fig. 2 together with a typical external circuit. This device is encapsulated in a 16 pin dual-in-line package and requires a supply of around 21mA from a +12V line. It can be seen that the internal circuit of the device is relatively complex, but the external circuit is quite simple and easy to construct.

A demodulated multiplexed stereo signal with a frequency spectrum like that shown in Fig. 1 is applied to pin 1 of the CA3090AQ; the input impedance at this pin is fairly high (about 50kΩ), so there is very little loading on the demodulator circuit which feeds pin 1. The signal is first amplified by a low-distortion pre-amplifier circuit inside the CA3090AQ and is then fed to both a 19kHz phase-locked detector and to a 38kHz detector of a similar type. In addition, the amplified signal is fed to a 19kHz pilot tone detector, the output of which determines the state of a Schmitt trigger circuit which controls the mode of operation (monaural or stereo).

The voltage controlled oscillator in the CA3090AQ operates at the fourth harmonic of the pilot tone frequency, namely 4 × 19 = 76kHz, this 76kHz signal being locked in frequency to the harmonic of the pilot tone. However, the 2mH external inductance connected to pin 16 must be adjusted so that the free-running frequency of this voltage controlled oscillator is fairly close to 76kHz; when the pilot tone is applied with the signal to pin 1, locking is then automatic.

The 76kHz voltage controlled oscillator signal is divided in frequency by a factor of two to produce a

38kHz signal exactly at the frequency of the suppressed sub-carrier; this 38kHz signal is fed to the L–R (left-minus-right) signal detector. The 76kHz signal is also divided in frequency by other circuits which produce two 19kHz signals in phase quadrature (that is, 90° out of phase with one another. One of these 19kHz signals is passed to the 19kHz phase-lock detector which generates the error signal which keeps the loop in lock, whilst the other 19kHz signal is required by the pilot tone detector.

The amplified multiplex signal and the output from the 38kHz L–R detector are applied to a matrix circuit which produces the left and right hand audio signals. These signals are amplified internally before appearing at pins 9 and 10. The 5nF capacitor and the 10kΩ resistor in each of these output circuits provide the required de-emphasis time constant.

If the pilot tone is absent or at such a low amplitude that the signal could not provide good stereo reception, the pilot tone detector does not switch the Schmitt trigger circuit to the stereo mode. The circuit therefore, operates in the monaural mode and the left-plus-right sum signal appears at both of the outputs so that both speakers produce a monaural output.

The signal from the Schmitt trigger also operates a lamp driver circuit. The latter causes the light emitting diode D1 to glow when the circuit is operating in the stereo mode. If no 19kHz pilot tone is present at the input or if the pilot tone is too weak to cause the circuit to operate in the stereo mode, the light emitting diode does not glow. A light emitting diode consumes less current than a tungsten filament lamp and also has the advantage that it is more reliable (since filaments tend to break after much use!). Nevertheless, the light emitting diode and its series resistor R4 in Fig. 2 can be replaced by a suitable small tungsten filament lamp which requires not more than about 100mA.

The Coil

The Toko coil type YXNS 30450NK has been especially designed for use with the CA3090AQ device; it has 270 turns on a ferrite core and a blue colour coded core adjuster. The use of this miniature coil (available from Ambit International) is much more convenient than trying to wind a suitable coil oneself.

In order to adjust the core, a stereo signal should be fed to the circuit of Fig. 2. The core of the coil should be rotated first in one direction and then in the other to find the points at which the circuit switches from the stereo to the monaural mode (as indicated by the light emitting diode, D1). The core should be set about half way between these two points. The centre frequency of the voltage controlled oscillator is then quite close to 76kHz, but the setting is not very critical, as the capture range of the phase-locked loop circuit is some ±10% of the centre frequency.

The mode of operation (stereo or monaural) can be controlled by the application of a suitable potential to pin 4 of Fig. 2. At potentials of more than about +1·2V, the circuit is switched to the stereo mode, whilst at voltages of less than about +1V the circuit operates monaurally. If this mode switching facility is not required, pin 4 should be directly grounded.

The CA3090AQ provides a channel separation better than 25dB, the typical value being about 40dB. The 2nd harmonic distortion in each of the outputs is some 0·2% typical, but higher order harmonics are less than 0·1% of the output amplitude.

The CA3090AQ is readily available from Arrow Electronics Ltd., Coptfold Road, Brentwood CM14 4BN, the current price being £2·96 including VAT, but 25p is required for p&p on orders under £5.

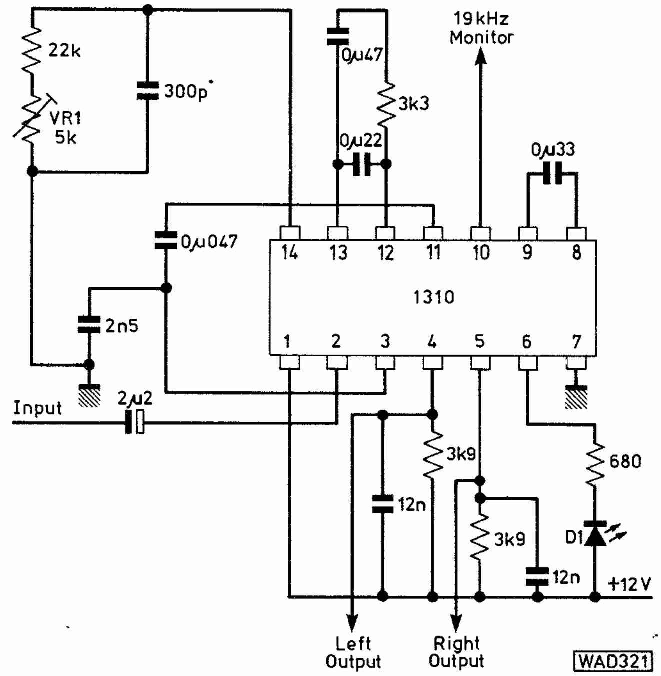


Fig. 3: External circuitry required for the MC1310

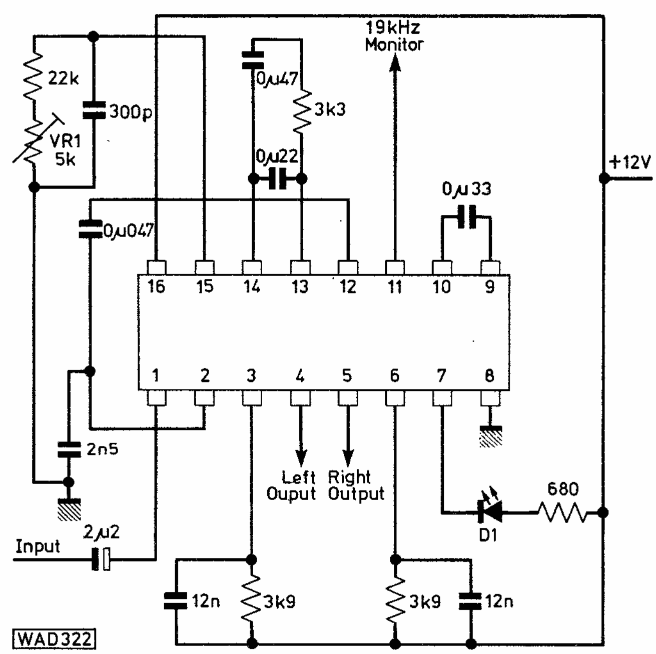


Fig. 4: External circuitry for the National LM1310E

The 1310 Types

The Motorola MC1310P first appeared on the market in 1972, but is now an "industry standard" type of device which is second sourced by many other manufacturers. For example, National Semiconductor market it as their LM1310, Signetics as the MC1310, RCA as their CA1310E, Texas Instruments as their SN76115N, Sprague as their ULN-2210 and Exar as their XR1310.

All of these devices can be used in the circuit shown in Fig. 3, although there may be minor differences between the various types, such as the exact supply voltage range over which they operate satisfactorily.

The circuit of Fig. 3 operates on very similar principles to that of Fig. 2, but the free-running frequency of the voltage controlled oscillator is set by the adjustment of VR1 instead of by the adjustment of the core of a coil. The adjustment can be made by connecting pin 10 to a frequency counter and adjusting VR1 with no input signal until the frequency at pin 10 is 19kHz. The amplitude of the signal at pin 10 is about 3V peak. However, it is usually far easier to adjust VR1 with a small stereo input signal so that it is set at about the centre of the range over which the light emitting diode D1 remains illuminated.

The value of the capacitor employed between pins 8 and 9 determines the stereo-monaural mode switching delay. The time constant for this switching is equal to the value of this capacitor multiplied by about 53kΩ. If pin 8 is connected to ground, the circuit will operate only in the monaural mode.

The capture range in the circuit of Fig. 3 is less than that in the case of the CA3090AQ, being typically about ±3%. However, it can be increased by reducing the capacitance between pin 14 and ground and increasing the resistors in parallel with this capacitor in proportion; nevertheless, care must be taken to ensure these changes do not result in increased beat note distortion at high signal levels due to oscillator phase jitter.

The MC1310P is available from Arrow Electronics Ltd., at £3·14 including VAT.

Emitter Follower Outputs

A number of other devices, such as the National Semiconductor LM1310E, are available in 16 pin dual-in-line packages. They are similar to the MC1310P, but include an emitter follower in each output circuit to provide low impedance outputs. A circuit for the use of the LM1310E is shown in Fig. 4. It can be seen that the de-emphasis components in the pin 3 and pin 6 circuits are not connected to the output pins themselves, but rather in the base circuits of the internal emitter followers. In general the remarks made about the MC1310P also apply to the versions with emitter followers (with a change of pin number), but the emitter follower device circuits will not be discussed further, as they have been largely replaced by a rather better device.

The industry standard Types LM1800, CA758E, SN76116N, MC1311, μA758 and ULN-2244 are similar to the LM1310E, but in addition to their emitter follower outputs, they incorporate a circuit which provides some 45dB of power supply ripple rejection. In other words, they can give the lowest possible hum level. These devices are encapsulated in 16 pin dual-in-line packages and can be used in the circuit of Fig. 4. They are adjusted in the way already described and the remarks about the 1310 type of device also apply to these devices except for pin number changes.

It should be noted that the total harmonic distortion from devices of this type increases with increasing input signal level, as shown in Fig. 5. However, a low signal level will give rise to a poor signal-to-noise ratio. A suitable compromise between distortion level and signal-to-noise ratio must therefore be reached. The output typically consists of the wanted signal plus a second harmonic component at −52dB down together with a 19kHz pilot tone at −37dB down, the 38kHz suppressed carrier at −40dB down and the sidebands of this sub-carrier at about −28dB down. The channel separation in dB at various levels is shown in Fig. 6 for a typical device of this type.

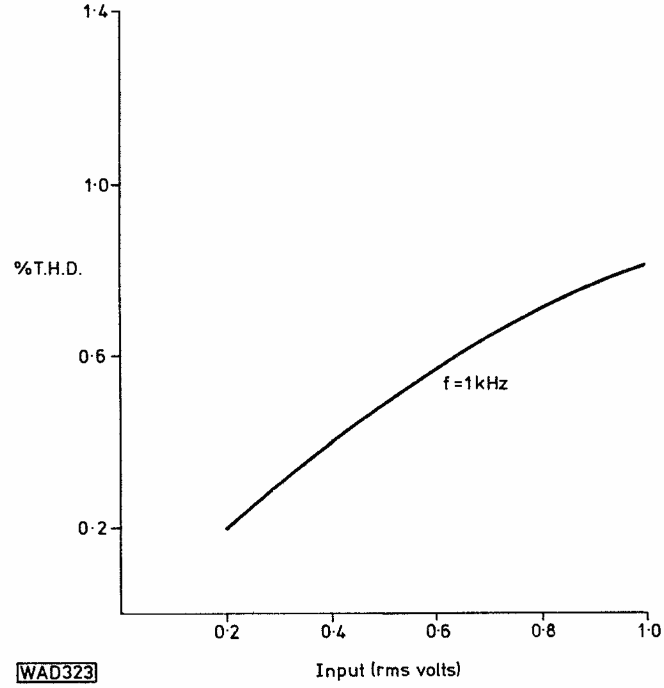


Fig. 5: Relationship between total harmonic distortion and input signal level

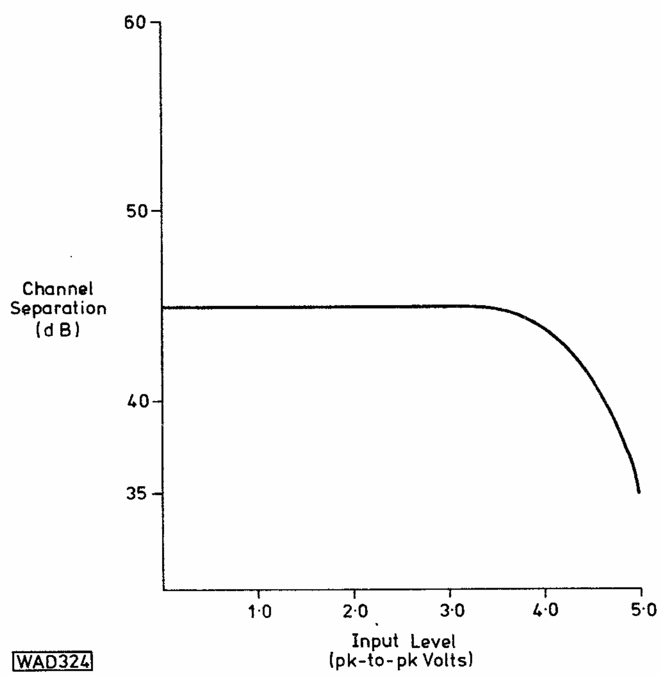


Fig. 6: Channel separation plotted against input signal level

The Sprague ULN-2244 device is available from Phoenix Electronics Ltd., 139 Havant Road, Drayton, Portsmouth PO6 2AA at £3·38 (including VAT) plus 20p p&p at the time of writing.

The TDA1005

The Mullard/Signetics TDA1005 phase-locked loop stereo decoder device has been designed so that it can provide an output which is very low in unwanted signal levels. The device was originally designed for use with an

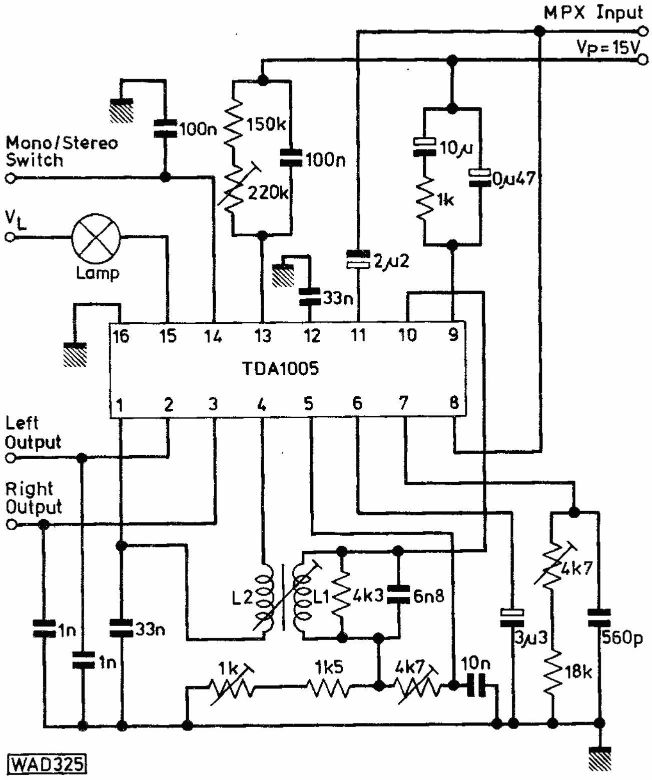


Fig. 7: External circuitry for the TDA1005 in the frequency multiplex mode

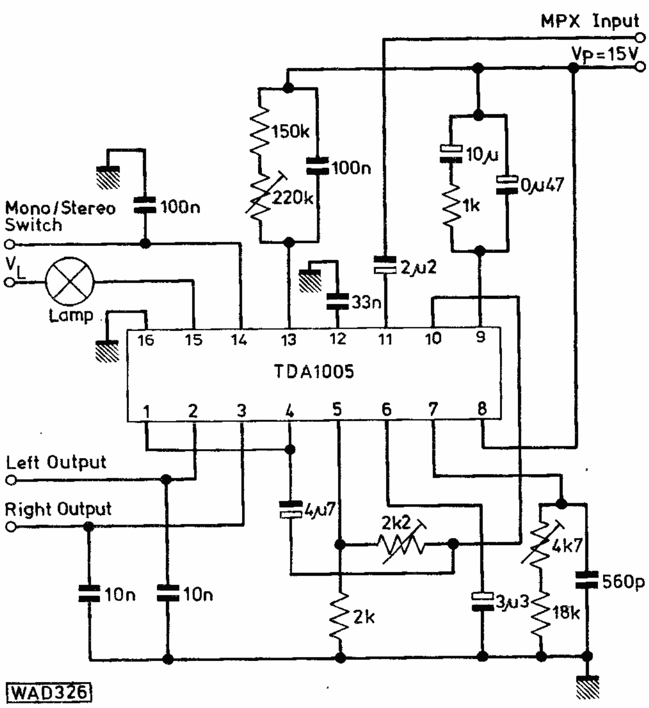


Fig. 8: External circuitry for the TDA1005 operating in the time multiplex mode

inductor in a frequency multiplex decoder, but can also be used without any inductor in the so-called time multiplex circuit. Typical circuits of these types are shown in Figs. 7 and 8 respectively.

CONTINUED NEXT MONTH

WIRELESS WENT TO WAR

continued from page 41

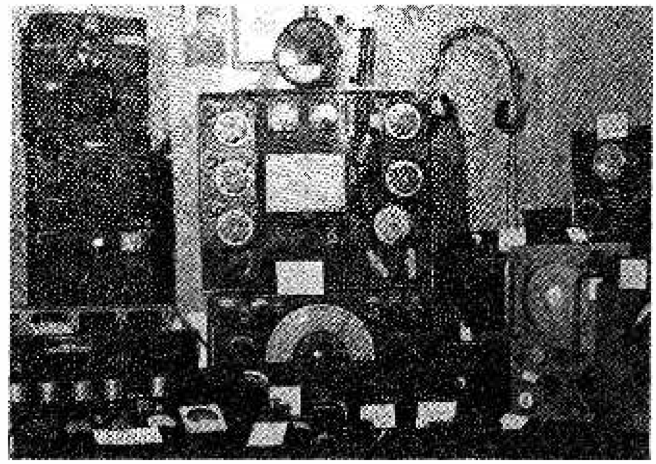


Fig. 5: Now museum pieces, the R1155/T1154 stands proudly in the centre with three sets from the Heinkel 111 on the left and a piece of wartime RADAR on the right

called the National Wireless Register, and readers were invited to complete the form so that they might be classified into technical groups which would be useful to the authorities, and avoid the real danger that the ability of wireless men might be lost through individuals being hastily drafted into non-wireless categories.

The form itself states: "During the Great War the needs of the Services for operators were largely met, especially during the early stages, by the voluntary enlistment of trained Post Office operators, but as Morse is no longer used in the Post Office, this possible source of supply is rapidly dwindling. It is therefore imperative that all our readers who have at least a good working knowledge of Morse, or have other qualifications such as ability to service and repair wireless and electrical apparatus, should apply to help fill the vacancies which now exist in the RNV(W)R, the Royal Corps of Signals, TA, and the RAFCWR."

Less than a year later, Great Britain was at war and in the early days a party of 55 ex-Civilian Wireless Reservists went to the Maginot Line and were christened the "Early Birds" by the amateur radio fraternity. According to the RSGB journal, September, 1942, some 2500 of their members had joined the forces. By the end of the war, thousands of people from the radio fraternity had served their Country in one of the many branches of radio communications in the armed forces. Ex-service personnel still talk with affection about such famous pieces of equipment as the Army's Wireless Sets, Nos 18, 19, 38 and 46, the Navy's CR100, the RAF's R1155/T1154 combination, the AR88 and the B2 and MCR-1 Clandestine sets, all of which are now collectors' items and stand silent in various museums representing a period of time when Wireless and thousands of its enthusiasts went to war. ●

ACKNOWLEDGMENTS

We are indebted to the Editor of *Wireless World* for permission to reproduce Fig. 4 and other extracts from that journal, and to the RSGB for permission to quote from the *T & R Bulletin*.

The sets in the photographs are from the author's collection and are on display at The Chalk, Pits Museum, Houghton, Sussex.

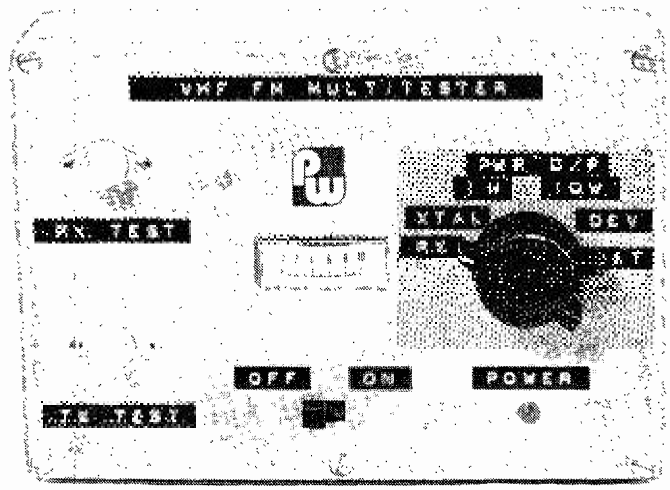
FM MULTITESTER

D.WHITFIELD & M.TOOLEY

This multitester was originally evolved as a constructional project for members of the UK F.M. Group in London, where several such instruments were very successfully built. Together with a suitable wavemeter, it forms the basic test equipment necessary to carry out performance checks on frequency-modulated v.h.f. equipment and meets Home Office requirements in this respect.

The majority of people owning commercial apparatus will possess basic test equipment but are unlikely to have the sophistication of r.f. power meters, deviation meters and so on. The unit to be described was developed as a means of carrying out rapid assessments of performance and offers an accuracy, after initial calibration, which is quite adequate for amateur use.

Receiver check, crystal test, power output (1W and 10W) and frequency deviation are the four functions provided, together with a battery status indication. The instrument and battery pack is built into a small, diecast box, which makes it rugged and readily portable.



Functions

Function 1 selects the crystal oscillator, which puts out a low-level signal on a pre-determined frequency within the 2m band. The choice of crystal is left to the constructor but perhaps the most useful channel to use would be S20 (145·500MHz), the UK calling frequency.

The oscillator operates at the fundamental frequency of the crystal — which falls in the 8MHz range — the output frequency being achieved by a stage of multiplication. The facility may be used for checking receiver gain, S-meter calibration and alignment.

Function 2 provides a crystal test, and devices within the range 4–24MHz may be checked for performance. The internal crystal is removed and that to be tested plugged into its socket. If the constructor foresees regular use of this facility, it may be worthwhile bringing the socket to the outside of the unit — possibly putting several different types in parallel.

The measurement of r.f. power, to a maximum of 1 watt, may be carried out using Function 3 and the internal 50Ω dummy load, at a typical v.s.w.r. of 1·1 : 1. Although the power scales are non-linear, it is possible to draw up a calibration chart for the instrument by reference to a commercial power meter.

Measurements of up to 10 watts may be made by selecting Function 4. The internal dummy load will handle these levels only for a short period however — typically 30 seconds.

Function 5 measures the deviation of an f.m. signal on a pre-calibrated scale of 0–10kHz. The signal applied should be at a power level of between 500mW and 10W and must be of the same frequency as that used for the receiver check (Function 1).

A check on the carrier frequency is also possible using Function 5. If the internal oscillator is accurately adjusted by means of a frequency meter or against a communications receiver with crystal calibrator, the meter will

Table 1

Voltages
(Multitester switched to range 2, Cystal Check)

Tr1 (with crystal fitted)	c	12V
	b	5·1V
	e	8·5V
Tr1 (crystal removed)	c	12V
	b	5·8V
	e	5·2V
Tr2 (with crystal fitted)	c	12V
	b	1·7V
	e	2·5V
Tr2 (crystal removed)	c	12V
	b	0V
	e	0V
IC1	pin 2	6V
	pin 3	6V
	pin 6	6V
	pin 7	12V

The above voltages were measured with a 10MΩ resistance d.c. voltmeter and a 1MΩ probe.

The r.f. voltages at various points are:

Tr1	emitter	1·5V r.m.s.
Tr2	base	1·4V r.m.s.
Tr2	collector	0·15V r.m.s.
D6	cathode	0·05V r.m.s.

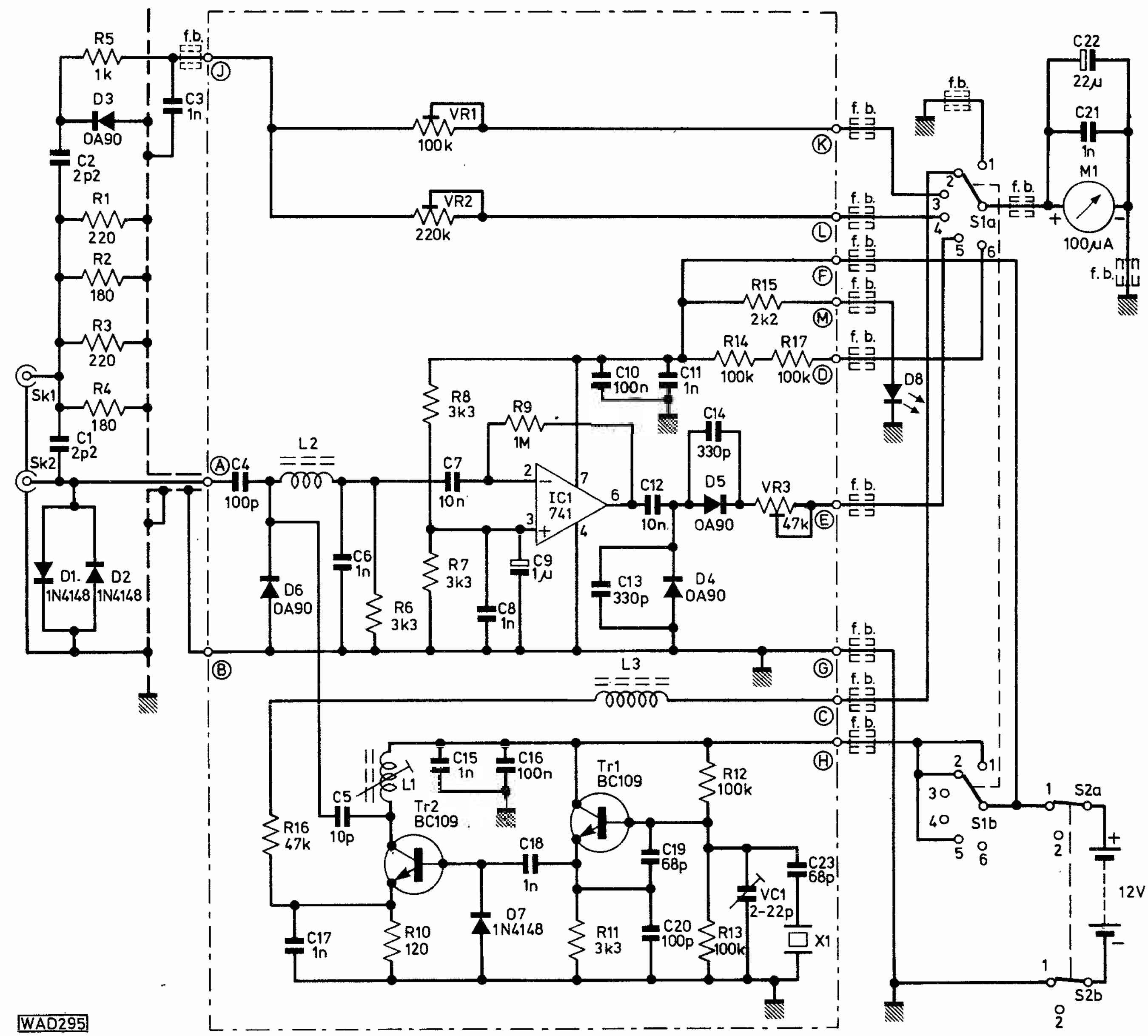
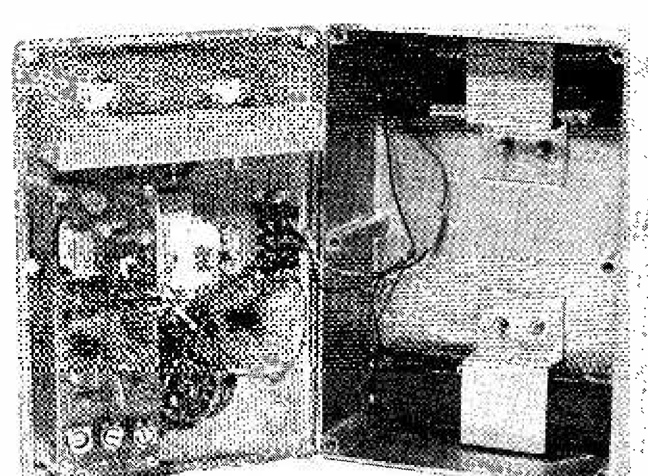


Fig. 1: Circuit of the Multitester

indicate a standing reading corresponding to the error, in kilohertz. For example, a reading of 4 in the absence of modulation would indicate that the transmitter is 4kHz off channel. Hence, the instrument can be used for checking both the receive and transmit frequencies once correctly calibrated.

The final function serves to test the internal batteries. Here the meter operates as a voltmeter with a full-scale deflection of 20 volts.



Circuit Description

Transistor Tr1 functions as a conventional Colpitt's oscillator, the frequency being adjusted by trimmer TC1, whilst Tr2 acts as a multiplier and amplifier, the diode D7 improving the harmonic content of the signal at its base.

With suitable crystals, Tr1 will readily oscillate at any frequency between 4 and 24MHz. However, the circuit is optimised for operation at 8MHz and when a crystal for

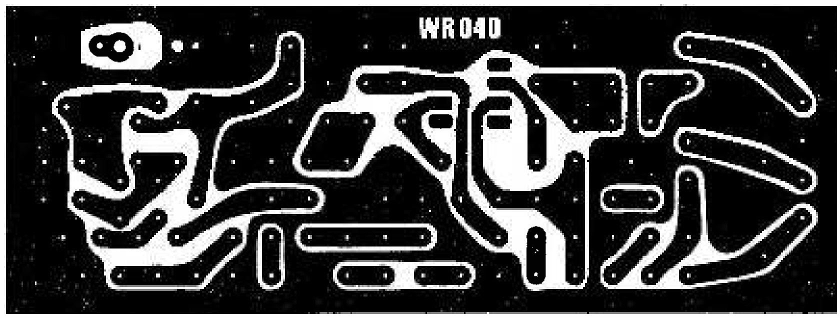


Fig. 2: Layout of the p.c.b. (shown full-size)

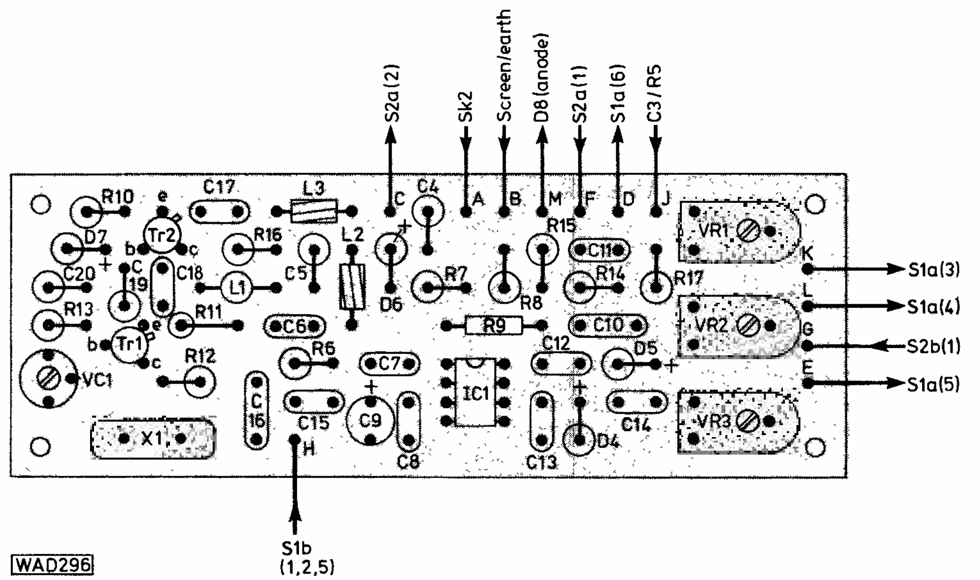


Fig. 3: Component layout

this frequency is used (8·08333MHz for 145·5MHz, for instance), Tr2 multiplies 18 times, L1, together with the stray and internal capacitance of Tr2, resonating at approximately 145·000MHz.

The integrated circuit IC1 is arranged to operate as a very high gain audio-frequency amplifier and requires only a very small input voltage to achieve full limiting of its output. This means that a small sine-wave input is converted to a 6 volt peak square-wave output of the same frequency. Diodes D4 and D5, together with C12, form a charge-pump arrangement. Thus, the current through VR3 and the meter will depend on the frequency of the signal applied to IC1 and not on its amplitude. The relationship between the input signal frequency at C7 and the meter current is substantially linear.

Potentiometer VR3 is used to calibrate the instrument. Diode D6 acts as a simple, but effective, mixer, the output of which passes through an r.f. filter formed by L2 and C6 and is the frequency difference between the output signal at Tr2 and the input from SK1. This is subsequently passed to IC1 and the circuit previously described. The diodes D1 and D2 form a limiting circuit to prevent the input to the mixer diode (D6) from exceeding 1·2 volts peak-to-peak whilst D3 is used to sense the r.f. at SK1 for the power ranges, the calibration being by adjustment of VR1 and VR2.

Construction

In order to ensure the circuit operates satisfactorily, it is essential to closely follow the recommended layout. Newcomers to the construction of v.h.f. and u.h.f. equipment take heed that conventional wiring techniques will introduce stray reactance which will adversely affect the ultimate performance. Hence component leads must be as short as possible, the neatness of the wiring being a secondary consideration.

Most of the devices are mounted on a p.c.b., the remainder being fixed on the lid of the box. Ferrite beads provide the necessary r.f. decoupling, and these may be rigidly mounted by the application of a small amount of adhesive.

The dummy load resistors (R1–R4) are positioned on the screen and as close to SK1 as possible. In use, these are likely to become fairly warm, so the screen will also double as a heatsink. The free length of the resistor leads should not exceed 5mm for minimum v.s.w.r.

The full circuit of the multitester is shown in Fig. 1 and the p.c.b. details and component layout in Figs. 2 and 3. It should be noted that many devices are vertically mounted and this should be borne in mind when shopping!

The inductor L1 consists of $3\frac{1}{2}$ turns of 20 s.w.g. enamelled copper wire, wound on a 4mm diameter ferrite-dust core. It is self-supporting and after initial adjustment should be secured with wax. Chokes L2 and L3 are each made from 6 turns of 36 s.w.g. enamelled copper wire, wound on a ferrite bead. Note the capacitor C23, which is mounted below the p.c.b. between the "hot" end of crystal X1 and the junction of R12 and R13.

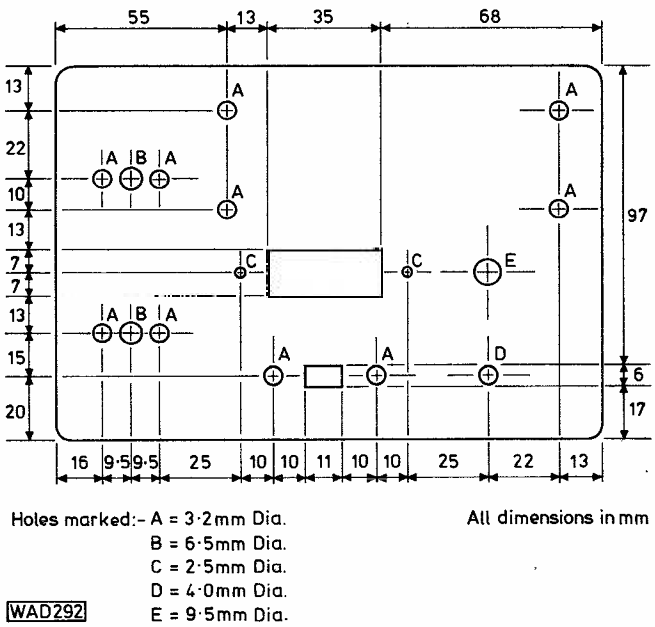


Fig. 4: Drilling details for the box lid

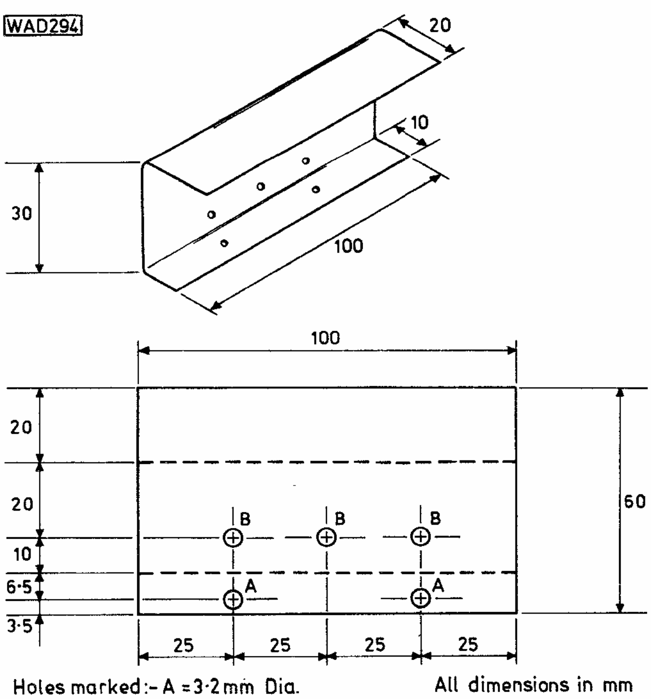
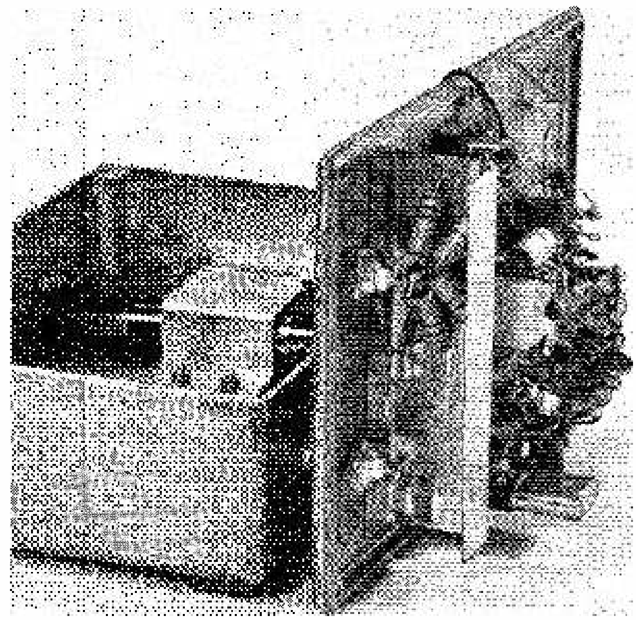


Fig. 5: Construction of the tinplate screen

Testing and Calibration

Make a thorough visual examination of the p.c.b. when the assembly has been completed, paying particular attention to the polarity of components and soldering. Assuming all seems correct, connect the batteries and switch on, setting the function switch to "Battery Check". The meter should indicate "6" — corresponding to 12 volts — and the l.e.d. should illuminate.

Now set the function switch to "Crystal Test" and observe the meter reading: if the oscillator is working then some indication should be present. Adjust VC1 for max-



Internal view of the unit, showing arrangement of dummy load resistors

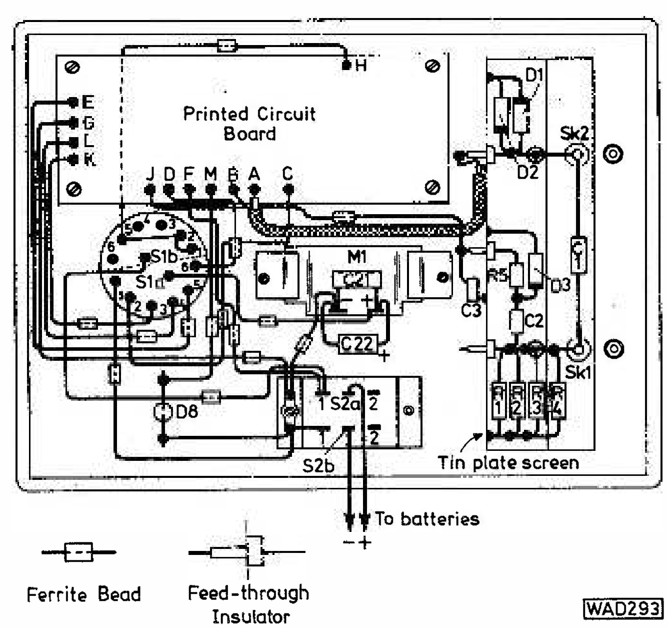


Fig. 6: Wiring diagram

★ components

Resistors
¼W 5% Carbon film

120Ω	1	R10
1kΩ	1	R5
2·2kΩ	1	R15
3·3kΩ	4	R6, 7, 8, 11
47kΩ	1	R16
100kΩ	4	R12, 13, 14, 17
1MΩ	1	R9

2W High stab. carbon

180Ω	2	R2, 4
220Ω	2	R1, 3

Semiconductors
Transistors

BC109	2	Tr1, 2

Integrated circuit

741	1	IC1 (Mini-dip type)

Diodes

1N4148	3	D1, 2, 7
OA90	4	D3, 4, 5, 6
LED	1	D8 (Red)

Crystal
Within 8MHz range (see text), HC25 series 8·08333MHz for S20 (145·500MHz) from P. R. Golledge Electronics, Merriott, Somerset TA16 5NS

Sockets

50Ω BNC	2	SK1, 2
HC25	1	SK3 Crystal Holder (P. R. Golledge Electronics)

Switches

S1	1	2-pole, 6-way rotary
S2	1	2-pole, 2-way slide

Potentiometers
Miniature skeleton pre-set, horizontal mtg.

47kΩ	1	VR3
100kΩ	1	VR1
220kΩ	1	VR2

Capacitors
Silver Mica

2·2pF	2	C1, 2
10pF	1	C5

Polystyrene

68pF	2	C19, 23
100pF	2	C4, 20
330pF	2	C13, 14

Miniature disc ceramic

1nF	8	C3, 6, 8, 11, 15, 17, 18, 21
10nF	2	C7, 12
100nF	2	C10, 16

Electrolytic 16V axial leads

1μF	1	C9
22μF	1	C22

Trimmer. Single turn miniature ceramic

2–22pF	1	VC1

Miscellaneous
100μA meter, edgewise-reading. RS type 259-561. Diecast box 171 × 121 × 55mm. Ferrite beads (14 off). Battery cradle (2) to accommodate 4 × HP7-type cells. Pointer knob (Sifam). Feed-through insulators (3). 25mm stand-off pillars for mounting p.c.b. (4). Piece of tinplate approx. 100 × 60mm × 20 s.w.g. Printed circuit board.

imum deflection. Connect a receiver (or transceiver) to SK2 "Receiver Test" and tune to the test channel frequency. Peak L1, with reference to the meter, adjusting VC1 also to obtain the best indication possible. If you are fortunate enough to have access to a reliable digital frequency meter, swing VC1 to the correct fundamental frequency, as measured at the emitter of Tr2. This completes the oscillator and multiplier alignment for functions 1 and 2.

Switch to the 1 watt r.f. function and set VR1 and VR2 to mid-position. Using a variable power supply, inject 4·6 volts at point "J" on the p.c.b. and adjust VR1 for a full-scale deflection on the meter. Now select the 10 watt r.f. power function and inject 14·6 volts at point "J"; adjust VR2 for a full-scale reading. If a commercial power meter, such as the Antenna Specialists or Bird Through-line, is available, then the meter calibration may be very accurately carried out and a chart drawn up.

Finally, select the deviation function and apply a signal of between 0·5 and 1 volt r.m.s. at a frequency of 10kHz (sine or square wave) to pin 2 of IC1, via a 10nF capacitor. Adjust VR3 for full-scale deflection of the meter.

The alignment and calibration is now complete. Typical voltages are given in Table 1 to facilitate troubleshooting should problems subsequently arise, but in practice, little difficulty should be experienced with the instrument. ●

LETTERS

continued from page 29

Sir: I agree entirely with Mr Goodier's letter. A lot of what people consider to be progress in this world is anything but. I think it must be because people don't hear what they don't like!

G. M. Pheasant
Great Wyrley
Walsall

Sir: I am an ardent supporter of CB, and unlike the majority of its critics, I have had five years of operating on a Citizen's Band in a more enlightened country, where I learned the true value of low-power radio communications for the general public.

I wonder why Mr Goodier singles out hikers and climbers? There are numerous situations where two-way radio could be a lifesaver. Yes, hikers would benefit—how many times do we hear of mountain and moorland rescue teams being called out each winter? But what about the owners of small boats that do not warrant a marine-band ship-to-shore radio? I think it fair to say that the lifeboat service would have been spared many hours of searching if small fishing boats and yachts had the right to carry a CB radio. What about the everyday motorist, broken down on the motorway or involved in an accident—both situations where CB would be of immense value? There are, of course, emergency telephones to cover these eventualities, but how often does one find these out of order due to vandalism? I think these points must surely form the basis of a good argument in favour of a UK Citizen's Band.

I am not so naive as to believe the band would be full of do-gooders permanently listening and waiting for emergencies. I am sure it would suffer misuse and abuse, but I think you will agree that there are very few aspects of modern life that are not abused by someone, somewhere. I can say in all honesty, that during my five years of operating CB, I encountered only a very small number of cases of illegal operating, such as the use of high-power r.f. amplifiers and v.f.o.s, etc.

I will agree with those who say the 27MHz band is in some ways unsuitable due to the ease of DXing when conditions open up. Although this would contravene the terms of the licence, I feel it much less likely to offend the listener than the fiasco on GB3LO and other repeaters. I would like to see a portion of the v.h.f. spectrum opened up to CB, but to be practical I think the 27MHz band would have to be accepted, as there is an unlimited amount of good-quality equipment already available at very modest prices.

I believe many people, especially some of my fellow amateurs, are being very guarded about this issue, but this is hardly surprising when Mr Goodier suggests using part of the amateur 2m band. There is no connection between CB and amateur radio—they are worlds apart and will always remain that way.

The suggestion of a novices' band is excellent. I have spent many enjoyable hours working slow c.w. and giving American novices some overseas contacts, and it is towards the United States that we must look when considering such a band.

I rather suspect Mr Goodier's motives to be somewhat personal, and I see them as an attempt to use 2 metres without taking the RAE. When his proposals are carefully studied, I believe they would benefit neither amateur radio nor a Citizen's Band service.

John M. Southall G4DMT
Somersham
Suffolk

Sir: Contrary to Mr Goodier's suggestion, 144·5–145·0MHz is not "A dead part of the 2 metre band". Many local nets use this section of the band, including the Norfolk-Lincolnshire nets, also it contains various beacons and the Dutch National (similar to RAYNET) frequencies. Why should the small amateur frequency allocations be cut up for a Citizen's Band, albeit in the guise of a novices' band?

It is quite simple these days to obtain an amateur licence without having to study Morse. Also to allow a free-for-all with 10 watts is just inviting interference problems. One watt would be more than adequate in any novices' band, but let it not be in the amateur frequency allocations, please.

D. G. Blake G3MWV
Cromer
Norfolk

New publication

Sir: I intend launching a new publication called *Innovation News,* initially as a newsletter, devoted to new designs, ideas, inventions, etc.

If anyone is interested in this idea, either as a subscriber or contributor, would they please contact me at the address below. An s.a.e. would be appreciated.

B. McAleer
59 Castledine Street
Loughborough
Leicestershire
LE11 2DX

Information Please

Sir: I would be glad to hear from readers with any knowledge of pulsed High Frequency as used in Medicine.

G. H. Anthony
17 Ledbury Road
Hereford
HR1 2SY

ON THE AIR

by Eric Dowdeswell G4AR

Letters from readers on aerial matters are very common, but reveal a certain misunderstanding on the results to be expected with simple half-wave dipoles. Such an aerial is usually cut to length using the formula 468/frequency (MHz) giving the answer in feet. It is sufficient to take the middle of the band concerned rather than a specific frequency. On 20m for example, take 14 200kHz, giving $468/14{\cdot}2 = 33$ft approximately.

This length of wire is then cut in half and fed in the centre with low-impedance feeder, preferably 75 ohm, which is led to the receiver. Some readers seem to think that this aerial will virtually eliminate all signals except those on 20m! Such an aerial is similar in electrical characteristics to a simple tuned circuit which has quite a broad selectivity curve, so it will still work, albeit with decreasing efficiency, from 10m to 160m, peaking on 20m. On the transmitting side one would not use a half-wave dipole on other than its design frequency, except perhaps on its third harmonic (a 7MHz aerial on 21MHz) but that is another matter.

I feel that it is rather pointless using an aerial designed for one band with a multi-band receiver. Much better to use a dipole, say 66ft, centre-fed with open wire tuned feeder and an a.t.u. to give optimum performance on all bands. Details with possible feeder lengths can be found in most aerial handbooks. The end-fed version, known as the "Zepp", was one of the first aerials ever designed and can be very useful in certain locations.

I am surprised that readers do not progress to simple wire element beams from end-fed wires, as they need not cost anything but can be made from copper wire obtained from old transformers, with bits of plastic strip for insulators. It seems to be thought that such beams will not work well unless the elements are nice and straight, precisely vertical or horizontal, as they appear in the books.

Nothing could be further from the truth, as the ends of elements may be drooped down and attached to such sundry supports as are available. Simple V-beams are very useful provided the legs are each at least a wavelength long, which is easily obtainable for say the 10 and 15m bands. An a.t.u. will permit operation on other bands and still retain some gain. The legs of the "V" can even go from the top of a pole down to ground level if no distant supports are available.

The thing is to try out various designs and to experiment, but always use an a.t.u. to bring the whole system to resonance. The experience obtained will come in very useful indeed when a transmitting licence is eventually obtained.

On the Bands

In spite of finding it a problem to stay awake **Ian Marquis** A9140 of Leigh-on-Sea, Essex, has managed to cover all bands and it is very obvious that the 80m band is really waking up now with prefixes like EP2, JA, TU, ZL showing up in Ian's log, caught on his FRG-7 and "multi-band Slim Jim". A new one on me and I await details with great curiosity! On 20m Ian found a nice one in VK9XW on Christmas Island, very appropriate!

A pleasant letter from G4HLN, **Lawrence Bennett** of Bristol, who finds working DX a lot less easy than just listening to it! He has a Heathkit HW32A on 20m s.s.b. but is very keen on c.w. and would like to see some c.w. logs in this column. I agree, being a code nut, and as there must be plenty of readers studying code for their "A" licence how about some c.w. logs for a change?

Regular **Bill Rendell** from Truro, Cornwall, got very excited when he heard the "long path effect" on some OH stations on 20m and even went to the trouble of calculating the distances involved, having done some navigation in the past. However, I feel that there was probably an intense aurora borealis at the time, reflecting signals from the Scandinavian area. The effect is better known on the v.h.f. bands, when best results are obtained if all concerned turn their beams to the north. On 80m Bill logged CT2, KG4, TF, W0 and ZL4 for his first look at this band this season.

David Parker BRS40420 got his hands on some shiny new sets at the Leicester, show but didn't feel too jealous when he got back to his HQ120X. I'd plump for that set any day OM! David found Jan Mayen on 20m in the form of JX9WI for a rare one, plus ZD7SD on St. Helena.

General Notes

From Stokenchurch, Bucks, **Peter Recklin** BRS40425 found the *PW* series on the RAE to be easy reading compared to other books on the subject. Having organised the series, I feel rather good about his remarks. He, like many others, comments on the lack of interest shown by the RSGB in the "very beginners" and adds: "after all, that is where the new generation of radio amateurs will come from". Precisely! Peter had a go at an RAE course but found the pace too hot for the time he had available, but I'm sure it was good experience. Peter has an FRG-7 modified with a Toko MFL455 filter, as per *Radio Communication,* August '78. Naturally enough, he finds reception of s.s.b. signals greatly improved.

Greg Duffy of East Kilbride, Glasgow, has been using a 15m dipole on several bands and still managed to copy things like HR3, 9N1 and YN1 on 20m on his FR50B. You may be interested in my opening few paragraphs, OM. From 23 Palace Avenue, Paignton, Devon, **Tom Hillier** writes to ask for advice on improving his ex-naval B40 receiver. There are plenty still around so if you think that you can help Tom, drop him a line direct.

With little time for DXing **Dave Wyatt** in Oswestry, Salop, found ZD9GH on Tristan da Cunha, with his BC348 and 90ft long wire on 20m. Good luck with the exams OM. Another seeking information is **Jim Clow** of 7 Montagu Road, Datchet, Berks, who has a Collins TCS10 set and no manual. "Complete stranger" **Colin Price** of Leuven in Belgium hails from Cambridge and is keen on taking the RAE with a view to getting an ON ticket, to keep in touch with home. Having just finished a post-graduate course, Colin acquired a Marconi Electra set plus an old 19 set and an a.t.u., so he's well on the way.

Through the kindness of a reader, **Chris Mortlock** of Brackley, Northants, acquired an R107 and, with the help of G3YMQ, is getting it up to scratch. Chris has been playing around with pins in maps to see what his aerial is doing on 80m as far as directivity is concerned. A good idea but a world map must be one of the great circle type that gives true direction and distance. Other maps are useless for this purpose.

Newcomers

Following my odd notes offering guidance to those newly acquainted with amateur radio, I have heard from a couple of dozen readers who were obviously standing on the sidelines, just looking in, but a bit shy to write in case they should be thought to be "slow". As I've said before, we all have to start somewhere, whatever the hobby, and it is only commonsense to seek advice and no-one will think less of us for that. **John Bull** (Laughton-en-le-Morthen [lovely!] South Yorks) wanted the aerial chart to go with his new SRX30 (Lowe Electronics).

George Grzebieniak, London W4, is 14 and collects old radios but now favours amateur radio. He has a Realistic DX160 and inside long wire. **Ian Scrimshaw** of Grimsby has an AR88 now and wonders about an aerial for 160m. Well, other than a specialised one, a long wire around 132ft and a.t.u. is probably the best answer, with a good earth connection if at all possible.

Glasgow University lecturer in biochemistry **Barry Clark** BSc, PhD, AIMLS, did not hesitate to write in, having been interested in crystal sets and simple valve sets a few years ago, at school. He is about to buy a receiver and intends to go on for his ticket. London W3 is the QTH of **Peter Smith** who has a National DR2800 but didn't have much luck with an a.t.u. I don't know this set but it sounds as if the "very long wire" is the trouble, already causing intermodulation problems on strong signals, compounded by the a.t.u.

David Allsop started recently with a CR100 in Abingdon, Oxon, and logged ZD7SS on St Helena. An FR50B has been added, greatly improving reception, with a 60ft wire. Heart attack victim **Len Wilson** of Scarborough wanted the aerial chart to go with his DX160 receiver and 60ft of wire in his bungalow loft. He, quite rightly, reckons amateur radio is for him now that he has to take things easy. Raised in the RAF on the R1155, AR88 and the R1475, **Jim Bence,** now of Hamilton, Lanarkshire, has returned to radio with an Elizabethan Pathfinder set with 12 bands running from long waves to 470MHz, after 27 years, so not quite a newcomer!

Electronics technician **Eric Hayes** (Freckleton, Lancs) specialises in the repair of hi-fi gear but got the bug when a friend brought in a Trio QR666, and finished up buying the set! He's tried a 60ft wire and a vertical in the loft but wants something better. He intends to go for the RAE in the near future and I don't imagine you will have much difficulty OM.

In Stanford-le-Hope, Essex, **Alan Taylor** has "hung up his football boots" and with family ties having cut out sailing, gliding and skiing, he has turned to amateur radio, realising that it will keep him at home! Having been a 25 w.p.m. operator in the RAF he is well on the way to his G4 ticket. Alan, you almost had me in tears! Lastly, but certainly not the least, 13-year-old **Paul Burgess** of Lowestoft, Suffolk, has started off with a Heathkit AR3 valve set, but is concerned that it does not have a variable b.f.o. as he is keen on c.w. Hooray. If anyone can help with a manual or info write to Paul at 3 Andrew Way. With letters from 15 "newcomers" this month it ought to produce a couple of new licences at least, in due course!

Club News

Stevenage and District ARS meet first and third Thursdays at British Aerospace, Gunnels Wood Road, Stevenage, Herts, at 8pm. Programme arranged to August which gives us poor reporters a chance to get items in print in due time. Wish other clubs would do likewise! April 5 sees G3AGP talking on the problems of mobile operators, with a junk sale on the 19th. Newcomers, don't despise a junk sale, you'll never get better bargains anywhere! Sec. **Trevor Tugwell** G8KMV at 11 The Dell, Stevenage, for more info.

Southdown ARS meets on first Monday of the month (ex-Bank Holidays) at Chaseley Home for Disabled, Bolsover Road, South Cliff, Eastbourne at 1930 hours. Cyril Minns G3YSZ has ascended to the presidency and Dave Morgan G4FDW now handles the society's Newsletter. Copy please! Cyril Collins G8SC, prog. sec. would like to hear from anyone able to give talks, lectures, etc. Contact **Dick Jeffries** G8KQN, 16 James Avenue, Herstmonceux, East Sussex.

West Kent ARS have G4BWH talking on the engineering involved in the recent BBC programme changes, on March 16. On the 30th Tony Tory lectures on microprocessors in amateur radio. Meetings at the Adult Education Centre, Monson Road, Tunbridge Wells at 8pm, plus alternate Tuesdays at 8pm, at the Drill Hall, Victoria Road. More info from **Brian Castle** G4DYF, 6 Pinewood Avenue, Sevenoaks, Kent.

Wessex AR Group (sec. ed. **Geoff Cole** G4EMN, 3a Cavendish Road, Bournemouth) has a very special meeting at the lecture theatre, Bournemouth School, East Way, at 7.30pm on Friday March 16, when L. Moxon G6XN, aerial expert par excellence, will talk on Aerials and Propagation, Multi-banding of Aerials and Miniaturised Beams. Next day, on to skittles and social evening at the Moose Centre, Malmesbury Park Road, Bournemouth with special prizes for the ladies. Info on this from **Archie Hoggan** G8ASX on Bournemouth 427582.

Thames Valley ARTS are in for a treat when Dr. A. McGregor talks to them about Radio Astronomy on March 6 at usual meeting place, Giggs Hill Green Library, Thames Ditton. Meetings there first Tuesday every month. Contact **R. Blasdell** G3ZNW, 92 Bridge Road, Chessington, Surrey.

Remember, logs, letters by 15th of the month and allow for strikes, delays and other tribulations!

Log Extracts

W. Rendell:—80m CT2QN KG4W TF1AW W0MC ZL4KE **20m** C5ABK EA8LS FK8CU (New Caledonia) JY5MC P29JS VK9XW 8P6IB 9Y4OV **15m** C5ABK KZ5AS OX3WO 9J2TJ

L. Bennett G4HLN (worked):—**20m** C31OZ CT2AO FP0EE HC1BU J28BA OY81 PJ8CO YI1BGO

G. Duffy:—20m HR3JJ YN1CR 9N1MM **15m** FY7AWZ KZ5RO OX3GW SU1CR TI2JV VP9JO YS1FAF ZL1BD 8P6FX 9L1AB 6W8AR

R. Bell:—20m ZL4HB ZL4LZ

I. Marquis:—160m (c.w.) K1PBW W1BB/1 **80m** CN8DO D4CBK EP2SL JA4BCW TU2FH ZL4KE 5B4HD **20m** JY9DI VK9XW **15m** VS6HG XT2AV **10m** FR7ZL HZ1SH SU1DP TR8GDC

All s.s.b. except where stated otherwise.

BROADCAST BANDS

MEDIUM WAVE DX

by Charles Molloy G8BUS

A DXer in the Shetland Islands, **Arthur Tate,** writes to say that he has modified his m.w. loop to work on the long waves simply by fitting a fixed capacitor (no value given) in parallel with the loop's tuning capacitor. Arthur asks for comments about this arrangement which works very well with BBC Radio 4 on 200kHz. Radio 4 incidentally, appears to have become semi-DX in the Shetlands since the great change around last November.

Modifying a Loop for the Long waves

The disadvantage of Arthur's method is the very restricted tuning range that is obtained. With my 40 inch loop, a parallel capacitor of 2000pF tunes it to 300kHz, but the tuning capacitor would only adjust the frequency through a range of about 20kHz! At the l.f. end of the band the situation is worse. A fixed capacitor of 6700pF tuned the loop to 155kHz, but this time the tuning control had little effect.

To cover the band, a capacitance range of 2500pF to 7200pF is required which is obviously impracticable. None-the-less, this method is of value if you want to tune the loop to a single frequency as Arthur did. Fitting "in parallel" means joining one wire of the fixed capacitor to one terminal of the tuning capacitor on the loop and joining the other end to the other terminal. No need to disconnect anything, you just bridge the fixed capacitor across the variable one.

A better method is to insert a fixed inductor in series with the loop's main winding. Disconnect one of the two wires to the tuning capacitor. Connect this wire to one end of the inductor and run a wire from the other end of the inductor to the tuning capacitor in place of the disconnected wire. You may have to put the inductor inside a metal box, which should be earthed, in order to prevent it acting as an aerial. The inductor should have a value of about 2000μH, i.e. 2 millihenries, and the loop should now tune over the long-wave band. The secondary winding of a long-wave tuning coil would have about the right value of inductance. If the loop will not tune to a low enough frequency then more inductance is required. If it will not tune high enough, then remove some turns from the inductor or use one of a lower value.

Long-wave Loops

Both of these methods of modifying a m.w. loop are at best a makeshift, but they do enable the DXer to try out the long waves without too much effort. Anyone seriously interested in DXing on this band should construct a l.w. loop. It will certainly have greater pick-up than a modified m.w. loop. Pick-up is proportional to the number of turns and to the size of the loop. A 40 inch l.w. loop will have about $3\frac{1}{2}$ times the number of turns of a 40 inch m.w. loop, and therefore will have $3\frac{1}{2}$ times the pick-up.

It is difficult to specify the exact number of turns that are required as the self-capacitance of such a winding will be high. For a 40 inch loop the number should lie between 22 and 28, and if you start with the higher figure you can remove turns one at a time until the desired range is achieved. The type of wire to use is not important so long as it is insulated and rigid when wound. A 500pF tuning capacitor or thereabouts, should be adequate as the frequency ratio (highest to lowest) on the l.w.s is approx 2:1 instead of 3:1 on the m.w.s.

Readers' Letters

An interesting letter from **N. Soar,** who lives near Sheffield, and is the author of *50 Circuits using Germanium, Silicon and Zener Diodes* published by Babani. He describes how to boost the performance of a transistor portable, by placing it close to a crystal set tuning coil which in turn is connected to an aerial. If the receiver is tuned to a weak signal and the crystal set coil is tuned to the same frequency, then the coil will feed extra signal to the receiver by induction which greatly improves reception. With this set-up he was able to pick up Radios Manchester, Blackburn and Nottingham. Reception was good enough to listen to the programmes.

This method will be of interest to DXers who use a transistor portable that does not have an aerial socket, and it works on the same principle as mounting the receiver on a shelf fixed to a m.w. loop as described in this column in the December 1978 issue. You can also boost the signal by wrapping the aerial lead round the receiver two or three times, but you will boost all stations not just the one you are tuned to and this may cause overloading. It does help on some occasions though.

The well-known R1155 receiver is in use by **Chris Marcroft** at Ramsbottom, who obtained one for £3 and modified it along the lines described in an article I wrote for the March 1967 issue of *PW*. When connected to a 130ft long wire and a.t.u., this rig pulled in WINS on 1010kHz, WNEW on 1130 and VOCM 690, CJYQ 930 which are located in New York City and St John's in Newfoundland. Chris prefers his long wire to a m.w. loop as the pick-up is much greater, which is what one would expect. If you have a long wire and a loop, then it is worthwhile fixing a switch so that you can try each aerial in turn, to see which gives the best results with any particular station.

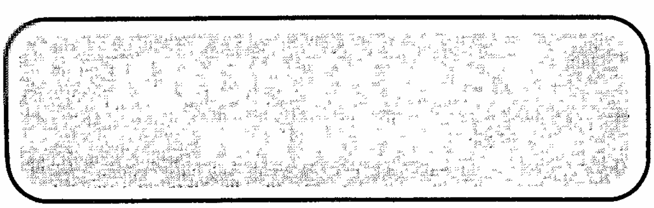
Reader **Andrew Roger** is puzzled by the number of layers in the ionosphere and how they affect DXing. So far as the medium and long waves are concerned, only the bottom two layers, the D and the E are of interest. The D layer, which absorbs l.f. signals, is maintained by the sun and disappears after dark to allow DX to be heard. The E layer, which also is created by the sun, does not disappear entirely after dark and this is the layer that reflects the DX on the medium and long waves. In mid-winter the D layer may only appear around mid-day and consequently some DX can be heard at times during daylight hours of winter mornings and afternoons.

DX Heard

Our long-wave DXer Andrew Roger of Bristol reports hearing the USSR 1st programme on 173kHz, Tebessa Algeria on 251kHz, Lahti in Finland on 254, an unidentified station behind Czechoslovakia on 271 (Novosibirsk Siberia?) and Minsk on 281. Reception was during the evening, using a Vega Spidola with internal aerial, and Andrew draws attention to the English programme from Tebessa which is on 251kHz daily from 2000 to 2030.

Some Spanish DX comes from **Bob Bell** (Blyth) who used his Yaesu Musen FRG-7 and 20 inch mini-loop to pull in Seville on 683kHz, Malaga 729, San Sebastian 774, Seville? on 792, Murcia 1179 and La Linea on 1314. Spanish stations have been conspicuous since last November, but there has been quite a shuffling about of frequencies and you have to listen for the identification to be certain.

Chris Mancroft asks about Radio Beacons on the medium waves and he reports hearing "MW" in Morse on 1008kHz and "RO" on 1012, which appear to be at their strongest when DX conditions to North America are good. The medium waves are supposed to be used exclusively for broadcasting, though in practice some radio beacons are to be found within the band below 800kHz. It has also been the practice in some countries to leave their m.w. transmitters on the air after the programmes finish and to key the transmitter with some sort of identification. Sottens in Switzerland, now on 765kHz, used to transmit "SOT" during the night, though whether this was for navigation purposes or just to keep the frequency occupied and deter intruders, was not clear. Morse signals on the medium waves are very likely the harmonics of long-wave radio beacons. Such beacons would be of considerable value to the DXer if their locations were known as they could be used as a guide to propagation. Unfortunately it is not too easy to track down many of them.



SHORT-WAVE BROADCASTS

by Charles Molloy G8BUS

Readers often comment on the current state of the short-wave bands which are dominated by high-power broadcasts of political propaganda and jamming. **T. W. G. Eltenham** complains that smaller countries do not get a look-in, while **George Rose** comments on the increasing number of harmonics observed on the higher frequencies, caused no doubt by a combination of super-power transmitters and beam antennas. In my opinion it is an absolute waste of time to write to the offenders, who have no interest in DXers or in the hobbyist s.w. listener, but there are several things that can be done to get round the problem. After all, if DXing were all that easy then it would cease to be attractive!

When to Listen

Not every band is dominated by high-power broadcasts all of the time. Generally speaking the higher frequencies are in use during the day and lower ones at night, but there is DX to be found when the bands are quiet. Latin Americans for example, are on the 19m and 25m bands during the late evening as the path to that area is still open then. Mixed paths of daylight and darkness can also produce signals on unexpected frequencies, usually at the middle of the spectrum. Low frequencies can yield interesting catches during the day.

Out of Band Stations

As a result of overcrowding there is an unofficial spreadout, up to 100kHz beyond the limits of each s.w. band. Some of the late arrivals to international broadcasting are to be found here. Typical is Kuwait on 12 085kHz which is outside the h.f. limit of the 25m band. This station has European-style programming and is widely reported. Countries to be found around the edges of the 49m, 41m, 31m, 25m and 19m bands are Israel, Andorra, Egypt, Iran, Pakistan, Vietnam, Saudi Arabia, India, Bangladesh, Austria and Guinea, so that it is always worthwhile tuning near the upper and lower limits of each band and investigating weak signals.

Another area where interesting DX is to be found is in the spaces between the international bands, though telegraph QRM can be troublesome. Israel broadcasts its domestic service on approx 9020kHz, which is well away from the 31m band. Out-of-band transmissions appear to be used mainly for domestic broadcasting, particularly by China but also by India, Iran, Israel, Mongolia, Korea, Turkey and on the l.f. side of the 49m band by Peru, Indonesia, Bolivia and Honduras. Always check a weak signal as real DX seldom comes roaring in.

The B40 Receiver

Many thanks to *PW* readers **G. A. Cartwright, John Markey, D. Porter** and **Bill Hentall,** for responding to Roderick William's request in the January issue for suggestions for a suitable replacement for the output valve in his B40 wartime communications receiver. The B40 was used by the Navy and although bulky and heavy it is quite presentable in appearance. It has its own speaker and can be plugged straight into the mains and used without modification. It is the only set I have come across that has an anti-crossmodulation control which works by adjusting the bias to the control grid of the first r.f. valve. There were a number of variants of the B40 indicated by a suffix letter. There was also the B41, a low frequency version covering 15kHz to 720kHz in five bands—not much use for broadcast band DX as it stands.

A number of readers have referred to the B40 recently. **Robert Round** remarks wryly: "My first receiver was a B40, and to be honest I think I was a fool to get rid of it." I can sympathise Robert, I feel the same way about my old much-modified CR100 which was disposed of some time ago. **G. Stainton** is desperate for a manual for his B40. Try Brooks, Farrant House, Winstanley Road, London SW11 2EJ who supply reprints of many manuals. John Markey would like to fit an antenna trimmer to his B40. Connect a small variable capacitor of about 50pF in parallel with the first r.f. section of the main tuning capacitor, if you can locate it. John would like to contact readers who have done any "mods" to the B40, replies direct to John please at 4 Harrison Way, Lydney Gdns, Gloucester GL4 5BN. Perhaps someone will start a club for B40 owners!

11 Metre Band

This band (25 605–26 095kHz) is gradually opening up now that increasing solar activity is bringing higher frequencies into use. **Harold Brodribb** of St. Leonards-on-Sea (AR88) reports hearing Radio RSA on 25 790kHz (also announcing 21 535 and 15 220) and Radio France on 25 630, both stations logged during the afternoon. **K. H. Smith** of Ross-on-Wye picked up the Voice of America in the early evening on his home-brew receiver on 26 040 and **Mark Hallam** of Hereford (Realistic DX160 plus long wire) logged Radio RSA on 25 790 from 1100–1200 and again between 1300 and 1530 with a very strong signal and English programming.

Other stations reported recently were Radio Liberty on 25 690 and IBA Jerusalem on 25 605kHz. 11 metres is a daytime band and worldwide reception is possible when it is open. Broadcasters will be tempted onto 11 metres to escape from the congestion on lower bands, even though it is outside the range of many domestic receivers. If your receiver will tune as high as 11 metres then it is worth giving the band a try.

Tropical Bands

The main tropical band is 60 metres which extends from 4750 to 5060kHz. Unlike the main s.w. bands, 60m is shared with commercial users and is only reserved for broadcasting in tropical areas and parts of Asia. As a result there is a lot of telegraph QRM on 60m and the newcomer to the band, especially if he listens at the wrong time of day, may not hear any broadcasting stations at all. A path of darkness between Tx and Rx is required before reception is possible, so it is a waste of time looking for DX on 60m in the middle of the day. A good outdoor aerial is an advantage, though many of the better portables will deliver DX with their internal aerial.

A good log of 60m DX comes from **Bob Bell** who lives in Blyth and uses an FRG-7. He reports hearing Radio Universo in Venezuela on 4800kHz at 0200, Benin on 4870 at 1825, Radio Casa Ecuador on 4930 at 0215, Radio Ecos Venezuela on 4980 at 0225 and two out-of-band catches, one in Chinese on 4380 at 1750 and an unidentified station in English on 4385 at 1805. **L. Lewis** (Pensilva in Cornwall) used his Realistic DX160, long wire and a.t.u. to pull in Radio Guatapuri in Colombia on 4817kHz at 0535, and Radio Garoua in Cameroon on 5010, with a programme in English at 1830. **Mark Hattam** picked up Radio ELWA Liberia on 4779 at 2200 and Radio Nigeria on 4990 at 1800 both in English.

DX Reported

A Trio 9R59D plus Joystick are in use at Mackworth near Derby by **Roy Patrick** who reports hearing Kabul, Afghanistan on 11 805 with a programme in English at 1900, Radio Nacional Chile on 11 720 at 2205, Radio Australia on 11 870 (replacing 11 855) from 1500 to 1700. Roy mentions that Radio Monitors International DX programme from SLBC Sri Lanka is on the air on Sundays at 1100 on 11 835, 15 120, 17 850 and again at 1900 on 9720, 11 870, 15 115 and 17 850.

From RSA-land comes a log from **David Webb** who lives in Sunnyside, Pretoria and who uses an old domestic receiver of unknown origin together with a wire put round the picture rail. With this set-up he has managed to pull in Tirana on 9500 at 1930, Australia on 9570, 11 940 at 1500, Algiers on 9500 at 1915 in English and Radio Sweden on 15 240 at 1845. A Racal 117E and 80ft long wire are in use by **V. Frankl** of Rotherham, who reports hearing out-of-band Pyongyang on 6576kHz at 2000, South Korea on 7550 at 1615 and Radio Athens on 9930 at 1920. **Andrew Rogers** of Bristol (Vega Spidola and whip) heard Amman in Jordan on 9560 at 1500 and Riyadh, Saudi Arabia on 6075 at 2110. **Roger Shepherd** of Whitstable has had his National Panasonic RF1105 for only two months, and during this time he has heard programmes in English from Turkey on 9515 at 0105, Israel on 9435 at 2005 and Spain on 9505 at 2030. **J. Pritchard** (Warsop) now has an ITT Touring CD108 with digital readout which picked up Pakistan on 17 665 at 1104 and the Voice of Nigeria on 15 185 at 1849.

Reports on the various bands are welcome and should be sent direct, by the 15th of the month, to:

AMATEUR BANDS Eric Dowdeswell G4AR, Silver Firs, Leatherhead Road, Ashtead, Surrey KT21 2TW. Logs by bands, each in alphabetical order.

MEDIUM and SW BANDS Charles Molloy G8BUS, 132 Segars Lane, Southport PR8 3JG. Reports for both bands **must** be kept separate.

VHF BANDS Ron Ham BRS15744, Faraday, Greyfriars, Storrington, Sussex RH20 4HE.

by Ron Ham BRS15744

One of the most exciting things about the radio frequency spectrum above 30MHz is that unexpected natural disturbance which can suddenly occur and take the most experienced v.h.f. enthusiast by surprise and, as my readers have shown, 1979 began in just that way.

Solar

Early in 1978, we observers of the sun were confidently expecting the then high level of sunspot activity to continue throughout the year, but, how wrong we were. Having recorded radio noise from the "active" sun on 108 out of the first 212 days (compared with 106 days for all of 1977), the count fell drastically to only 24 "active" days from the remaining 153, which means that, in future, we should consider sunspot activity on a day-to-day basis. At 1036 on December 31, **John Branegan** GM8OXQ, Saline, Fife, heard a strong burst of solar noise covering a wide frequency range, and **Cmdr Henry Hatfield,** Sevenoaks, Kent, and myself, recorded several individual bursts of solar noise, at 136 and 146MHz, on January 3 and 4, and

10 to 16, inclusive. These bursts were associated with about eight groups of sunspots, some with four and six spots, seen by Henry with his spectrohelioscope. On the 6th he saw five plages, on the 11th a small flare, and a bright active area was visible on the 12th and 13th.

Aurora

Considering this solar activity, it was not surprising that ionospheric disturbances were reported by the BBC World Service on January 5 and 6, and John Branegan noted auroral events on the 4th and 7th. Between 1810 and 1817 on the 4th, John heard tone "A" signals from the 2m beacons in Wrotham, GB3VHF and Kiel, DL0PR, and although the auroral signals faded out on 2m around 1820 they persisted on Band I TV until 1907. During the event, several of John's fellow GMs worked London stations on 2m. Following an auroral alert from **John Matthews** G3WZT, near Horsham, Sussex, around 1900 on the 7th, **John Cooper** G8NGO, Cowfold, Sussex, heard a French station working a GM on 2m s.s.b. and, in turn, phoned **Alan Baker** G4GNX, Newhaven, who heard some weak s.s.b. signals bouncing off the auroral display, while in nearby Lancing, **Roy Bannister** G4GPX, heard GM4DSZ. Alan also confirmed a report from **Cecil Sadler** G3JEO, Brighton, that signals in the 40m band were being influenced by the aurora. Between 1500 and 2000 on the 7th, John Branegan received auroral signals from European TV in Band I, f.m. broadcast stations in Band II, strong 2m signals from stations in DL, EI, G, GI, GM, GW, LA and SM and from beacons around the UK, in Cornwall, GB3CTC, Northern Ireland, GB3GI, Lerwick, GB3LER and Kent, GB3VHF. John also had three contacts through OSCAR-8J during the event and was told by SM5FUR that, the aurora was affecting all Sweden.

The 10 Metre Band

Mark Hattam, Hereford, using his Realistic DX-160 receiver and a long wire aerial, says that signals from Radio South Africa and Voice of America, in the 11m band, were "pounding in" on January 9, and in the 10m band he heard UN3CEY in QSO with an American station, and a harmonic of a Radio Moscow transmission around 28·750MHz. **Michael Mrzyglod,** Wallingford, Oxford, who is in the process of joining the RSGB, reports hearing several European and Russian amateurs on 10m around noon on December 26. From December 15 to January 17 I received signals, almost daily, from the International Beacon Project stations in Bahrain, A9XC, Germany, DL0IGI and Cyprus, 5B4CY and less frequently from Bermuda, VP9BA and Florida, N4RD. The majority of these signals were received on my FR101 with a long wire aerial and averaged around 539.

DX Television

At 0910 on December 19 I heard strong television sync pulses on 49·75MHz with my R216, fed by a dipole aerial, which alerted me to switch on my JVC3060, also fed by a dipole, and there on Ch. R1, for a short while was a test card from YLE-HK1, Finland. Between 0800 and 0920 on the 20th both **Ian Rennison,** Horsham, using a JVC3040, and myself, received a very strong test card from Poland (Fig. 1), on R1, accompanied by the sound, which I received on the R216, on 56·25MHz. From 0745 until about 0930 on January 4, Ian and myself received strong pictures from both Poland and Hungary on R1 (Fig. 2), and at times both signals were fighting for predominance on our receivers.

During the afternoon of the 7th, John Branegan, using his Eddystone 770R, heard video signals on 48·25, 49·75 and 61·8MHz and TV sound, in Spanish, on 53·75 and 60·75MHz. John reports that the m.u.f. was up around 44MHz to the USA on January 5, 6 and 7 and, at 1450 on the 6th, he received French TV sound on 41·25MHz and, "strangely enough," says John, "the aerial seemed to peak around 270°".

Tropospheric

Despite the poor conditions on December 26, Roy Bannister heard signals from the new Norfolk repeater, GB3FR, on R7 when the London repeater, GB3LO, was quiet, and, during a spell of good conditions on December 18, signals from the Burnley repeater, GB3RF, also on R7, were received by **Don Campbell** G5SD, in Clymping, on the Sussex coast. A mild tropospheric opening occurred on January 6 when the atmospheric pressure, which had reached 30·4in, began to fall. Throughout the day, I received strong signals from more than a dozen Continental f.m. stations in Band II and during the evening, Ian Rennison received a strong picture from the French TV station at Lille.

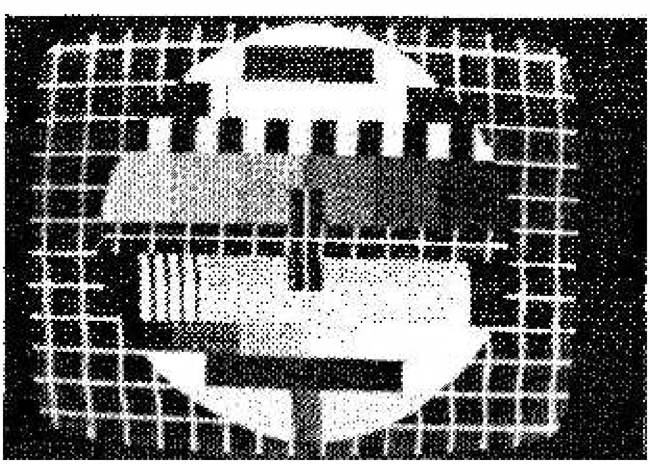


Fig. 1: Test card from Poland on 49·75MHz, received in Sussex on 20 December 1978

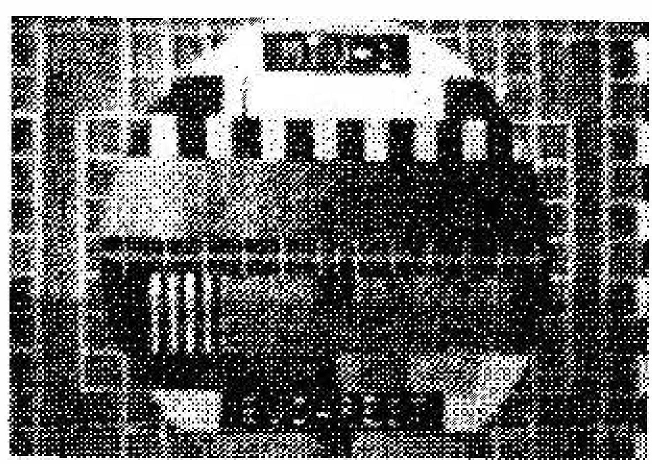


Fig. 2: Test card from Hungarian Television on 49·75MHz, received in Sussex on January 4

Around 1300, while I was receiving strong pictures from the IBA transmitter at Lichfield, Ch. 8, 189MHz, Alan Baker worked F1BBQ on 2m c.w. and later had QSOs through the French repeater, FZ2THF, on R9. During another pressure drop, at 2030 on the 3rd, **Fleming Jul-Christensen** G8RMA (ex OZ1EVA), Eastbourne, using a TS700-S, heard OE5KEJ on 2m s.s.b.

Microwaves

John Tye G4BYV, Dereham, Norfolk, is active on both 13 and 23cm with home-brew equipment into a 4ft dish aerial on both bands. During the second half of 1978 he had 10 QSOs with G stations, 11 with PA0 and 1 DK on 13cm, and 33 with G, 40 with PA0, 22 in Germany, 3 ON and 1 GW on 23cm which is a fine effort. John has now built a converter for 9cm and is waiting for the right conditions to use it.

Satellites

To celebrate the new year, John Branegan had Hogmanay QSOs with WB2OXJ and WB2SBW, both in New Jersey, just a few minutes before midnight on OSCAR-8J. All-told, John worked 16 stations in 8 countries, DB, G, GM, HB, I, PE, SM and W via 8J on New Year's Eve, and with only 4 days operating during December he had 60 QSOs on 8J, 7 of them transatlantic, including W2GEZ and WB2SBW which are new ones for him. John now has a QSL card confirming his 8J contact with C31QO, Andorra and has now worked CN8AK, Morocco on OSCAR-8A.

Tail-piece

Congratulations to **Ern Hoare** G8BDJ, Brighton and **Alec Painter** G8EAQ, Worthing, on passing their Morse tests. They will, no doubt, soon be sporting their new callsigns.

I received a Christmas card from **Frank Luman** who, while on holiday with his parents in Denver, Colorado, is studying the DX-TV situation over there.

While on a round trip to Birmingham on January 10, Alan Baker worked through eight of the 2m repeaters, GB3BC, BM, LO, MH, PI, SN, SR, and WH, showing that mobile operators need never be alone on their journeys through and around the UK.

What do the VHFs have to offer? Part 3

No one should harbour the idea that the v.h.f. bands have little excitement to offer the radio enthusiast. In fact, there is still so much to learn about the behaviour of radio waves between 1 and 10 metres that they are a haven for the DX hunter, experimenter and home constructor. To be successful in the world of v.h.f., one must pay great attention to detail, such as taking extra care when selecting components, keeping wiring as short as possible, soldering all joints, and making sure that aerials are securely mounted, and have a good-quality feeder. Remember, it is easy to ruin the performance of an expensive piece of v.h.f. gear with a poor aerial, badly-connected mains lead, loose loudspeaker, and microphone connections or an intermittent aerial plug.

The Home Station

Before equipping a v.h.f. station, the operator, whether a licensed amateur, broadcast or short-wave listener, radio-astronomer, satellite enthusiast or TV DXer, must decide first where to locate his shack and then where to put his aerials. These, ideally, should be as close to the shack as possible to avoid unnecessarily long and therefore lossy feeders. The choice and size of aerial depends upon the band being used and the space available, in some cases the consent of the local planning authority is required, it is best to play safe and get this point clarified.

The Transmitting Amateur

The holder of a class B transmitting licence (G8-plus-3-letter callsign) may only use the 2m band within the v.h.f. spectrum, whereas the holders of a "full" licence (those who have passed the Morse test in addition to the RAE) may also use the 4m band. A typical aerial installation for the DX hunter is an 8-element Yagi for 2m and a 3-element Yagi for 4m, both horizontally polarised and mounted on an aerial rotator. The majority of amateurs are in favour of the VHF Band Plan, published by the RSGB, which recommends that c.w. contacts are made between 70·025 and 70·150MHz and 144·00 and 144·150MHz, and s.s.b. contacts on 70·200MHz and between 144·150 and 144·500MHz.

Operators soon learn the possible range of QSOs on each band from their location, under normal atmospheric conditions, but the real DX comes during the sporadic-E season on 4m and a tropospheric opening or aurora on 2m. Apart from the sheer thrill of working v.h.f. stations at almost impossible distances, it is advisable to exchange QSL cards to confirm contacts, because these cards are the evidence required by RSGB members who wish to claim the "Four Metres and Down" certificates offered by the Society for confirmed QSOs from: 3 Countries and 20 Counties on 4m; 5 Countries and 30 Counties on 2m. Senior awards are also offered.

Under abnormal conditions it is possible to work DX through the national and European 2m repeater network; these signals are frequency modulated and vertically polarised, so aerials such as dipoles, ground planes or crossed Yagis are normally used. Repeater contacts do not qualify for the RSGB certificates.

The Broadcast Listener

The v.h.f. hunting ground for the broadcast listener is the f.m. broadcast band, 88-108MHz, which is full of Continental broadcast stations during a tropospheric opening. East-European broadcast stations are often heard in the UK between 65 and 73MHz during the sporadic-E season. Many of my readers use a rotatable, multi-element Yagi for the broadcast DX in Band II, especially if they wish to resolve full stereo from the incoming signal.

The VHF Listener

The v.h.f. listener should make sure that his aerials are as efficient as those used by the transmitting amateurs. Listening on v.h.f. is very rewarding, especially during an atmospheric disturbance, when there is a host of DX signals about and a great opportunity to get a QSL card, from stations in rare Counties, which cannot be heard under normal conditions. To earn a QSL card, from either an amateur or a beacon keeper, the listener's report must be useful and contain such information as date, time, signal

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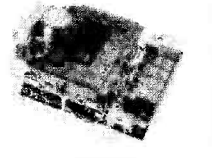

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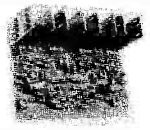

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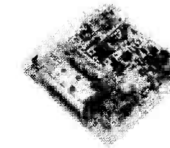

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7409	.17*	.19*	7473	.28*	.29*	74153	.67*	.48*	74221	—	.99*
7410	.15*	.19*	7474	.28*	.29*	74154	1.21*	1.25*	74240	—	2.25*
7411	.25*	.19*	7475	.44*	.43*	74155	.67*	.78*	74241	—	2.25*
7412	.18*	.19*	7476	.30*	.29*	74156	.67	.78*	74242	—	2.25*
7413	.27*	.40*	7478	—	.29*	74157	.67*	.55*	74243	—	2.25*
7414	.71*	.79*	7482	.73*	—	74158	—	.58*	74247	—	.95
7415	—*	.19*	7483	—	.75*	74160	1.21*	.99*	74248	—	.95*
7416	.25*	—	7485	1.18*	.88*	74161	1.21*	.65*	74249	—	.95*
7417	.34*	—	7486	.25*	.29*	74162	1.21*	1.25*	74251	—	.83*
7420	.16*	.19*	7489	2.60*	—	74163	1.21*	.65*	74253	—	.99*
7421	—*	.19*	7490	.34*	.62*	74164	1.02*	1.15*	74257	—	.99
7422	—*	.19*	7491	.73*	1.05*	74165	—	.78*	74258	—	.99
7423	.25*	—	7492	.46*	.75*	74166	1.02*	—	74259	—	1.50*
7425	.25*	—	7493	.34*	.65*	74168	—	1.85*	74266	—	.35*
7426	.25*	.19*	7495	.54*	.88*	74169	—	1.85*	74273	—	2.25*
7427	.39*	.19*	7496	.67*	1.25*	74170	1.85*	1.65*	74279	—	.48*
7428	.38*	.19*	74107	.27*	.35*	74173	1.41*	.88*	74283	—	.99*
7430	.16*	.19*	74109	.44*	.35*	74174	1.01*	1.05*	74290	—	.83*
7432	.25*	.25*	74112	—	.35*	74175	.81*	1.05*	74293	—	.83*
7433	—*	.19*	74113	—	.35*	74176	1.01*	—	74295	—	1.05*
7437	.25*	.25*	74114	—	.35*	74177	1.01*	—	74298	—	1.25*
7438	.25*	.25*	74121	.27*	—	74180	1.01*	—	74365	—	.51*
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7441	.70*	—	74123	.60*	.78*	74182	.81*	—	74367	—	.51*
7442	.50*	.55*	74124	—	1.25*	74184	1.81*	—	74368	—	.51*
7445	.60*	—	74125	.51*	.39*	74185	1.62*	—	74386	—	.39*
7446	.60*	—	74126	.51*	.39*	74188	2.97*	—	74670	—	1.85*
7447	.60*	.87*	74132	.72*	.65*	74189	3.17*	2.25*			
7448	.60*	.87*	74133	—	.19*	74190	1.21*	.75*			

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4013	.48*	4072	.21*
4014	.92*	4077	.21*
4015	.92*	4081	.21*
4016	.43*	4082	.21*
4017	.81*	4085	.92*
4018	.92*	4086	.92*
4019	.56*	4093	.81*
4020	.92*	4099	1.81*
4021	.92*	4502	.92*
4022	.92*	4508	2.46*
4023	.18*	4510	1.07*
4024	.65*	4511	.95*
4025	.18*	4514	2.70*
4026	1.84*	4515	2.70*
4027	.51*	4516	1.07*
4028	.70*	4517	4.10*
4029	1.18*	4518	.95*
4030	.56*	4521	2.54*
4032	1.08*	4522	1.89*
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4040	.92*	4534	7.12*
4042	.70*	4536	3.74*
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strength, any interference, beam headings, and mention the callsigns of other signals heard from the same area. Don't forget to enclose s.a.e.

Artificial Earth Satellites

A large cross-section of the v.h.f. fraternity are interested in receiving signals from both commercial and amateur radio satellites. A 10-element crossed Yagi with an alt/azm (altitude and azimuth) mount is ideal for listening to or working through the amateur satellites. Although this aerial is specifically designed for the 2m band it will suffice for receiving signals from the commercial birds in the 136/137MHz band. A permit from the Home Office is required to receive signals from commercial satellites. Both the AMSAT and Russian amateur radio satellites have uplink frequencies around 145·900MHz and downlinks around 28·400MHz. The latest information about these satellites can be obtained by listening to the AMSAT net at 1015 on Sunday on 3·780MHz.

Radio Astronomy

Briefly, a radiotelescope consists of a high-gain aerial directed toward the celestial source being observed, a sensitive receiver tuned to the observational frequency, and a recording instrument—usually a pen recorder. Radio waves from heavenly bodies are very similar to the background noise of a radio receiver, therefore the telescope must be able to distinguish between the two.

The usual practice is to connect a local noise source to the aerial socket and see how far it deflects the pen, then disconnect it, couple the aerial and measure the difference between the noise source and the incoming celestial waves. The sun, which affects our daily communications around the world, is a very powerful transmitter of radio waves when sunspots are present. For solar radio observers there is the day-to-day excitement of never knowing when this nuclear furnace, 93-million miles away, is going to send off a flare and emit radio waves between 100 and 200MHz. Radio astronomy presents a challenge to the home constructor who wishes to build v.h.f. aerials, low noise pre-amplifiers, converters and d.c. amplifiers to drive a pen recorder.

DX Television

It is well-known that the normal range of v.h.f. television signals is, subject to the terrain between the transmitter and receiver, about 50 miles. However, to receive signals at a greater distance, a large aerial system plus mast-head pre-amplifiers are required. Long-distance television reception is possible during an atmospheric disturbance which can affect both v.h.f. and u.h.f. signals over a wide area.

Within the UK, v.h.f. transmissions of the BBC are in Band I, 41–76MHz, and the IBA in Band III, 176–215MHz, both 405-line. Continental, African, Icelandic and Russian v.h.f. transmissions, which are the targets for the TV DXer, fall in two frequency ranges, 48–68MHz and 175–225MHz. The lower range is subject to sporadic-E and the higher range to tropospheric disturbances. Pictures from Russia can be received on Ch.R1, 49·75MHz and R2, 59·25MHz.

For super DX, which is not outside the bounds of possibility, there are American (525-line), Australian and New Zealand TV who also transmit between 46 and 68MHz. Detailed information about international television is published in *World Radio and TV Handbook*.

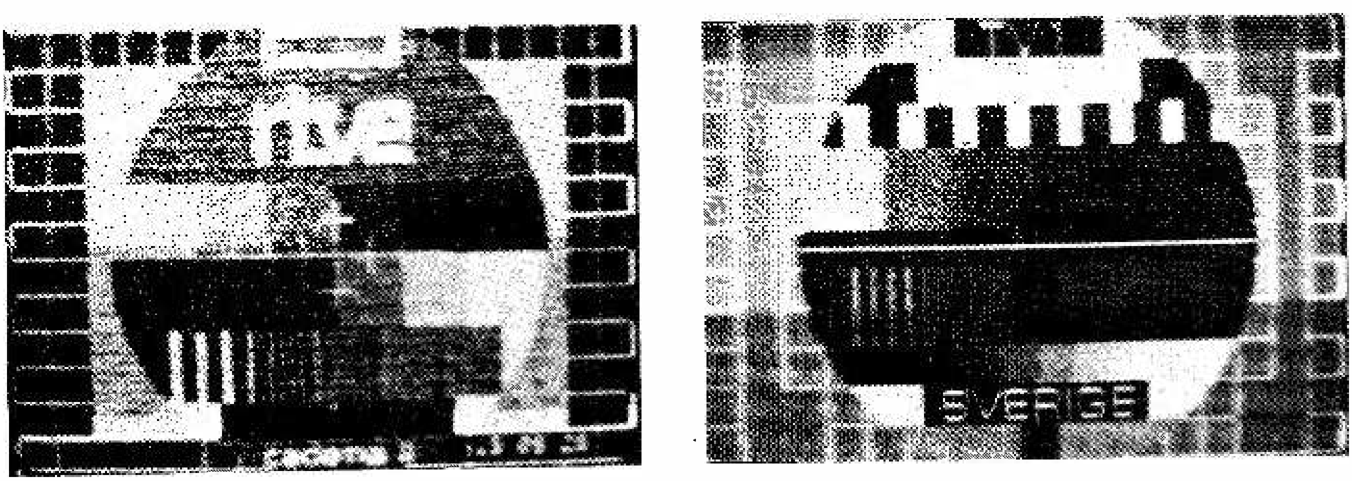

Fig. 3: Pictures from Spain and Sweden received by the author during the 1978 sporadic-E season with only a dipole aerial feeding a JVC 3060 receiver. Both stations can be received on Channels E2 (48·25MHz), E3 (55·25MHz), and E4 (62·25MHz). In each case the sound is 5·5MHz higher than the vision frequency

GUY STANBURY ***by RON HAM***

For Christmas, 1963, the 9-year-old Guy Stanbury received a Philips electronic kit. Soon after, he was borrowing copies of *Practical Wireless* from his local library, and in 1968 he became a regular reader.

Guy's interest in v.h.f. began in 1971, when he visited Bob Dewick, a keen Band II DXer at Bradwell-on-Sea, Essex, and saw Bob's Hacker receiver which could be fed from either a Rhombic aerial or four Jaybeam 4-element Yagis stacked vertically and horizontally. Very soon, Guy, at his home in Chelmsford, began experimenting with v.h.f. aerials, starting with an Antiference 4E, mounted on a cable-controlled rotating spindle, then a 6-over-6 array on a rotator followed by various long Yagis. His current installation is two Fuba UKa Stereo 8 aerials, stacked and phased according to the instructions and mounted on a Stolle rotator.

His receivers progressed from a Rigonda "Symphony" stereogram, to a PW "Sandown", which he constructed in 1975, and used for about a year until he purchased his present equipment, a tuner and i.f. modules from Ambit International. In his station, Guy has both reel-to-reel and cassette recording facilities, a frequency counter which he is trying out, an oscilloscope, and all the tools needed by the home constructor. Although he is a Band II specialist, with signals heard from stations in Greece, Italy, the low countries, Western Germany and Yugoslavia, via sporadic-E and tropospheric propagation, Guy plans to expand into the field of u.h.f. DX-TV, using a Wolseley Colour King or Colour Prince aerial.

Guy is currently on an HNC course in Electrical and Electronic Engineering, and enjoys corresponding with his fellow Band II enthusiasts, and his many friends in the world of v.h.f. radio.

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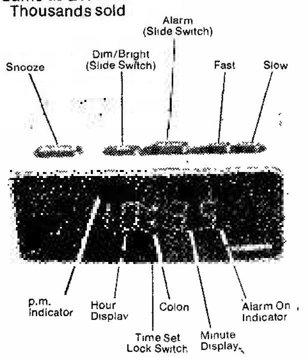

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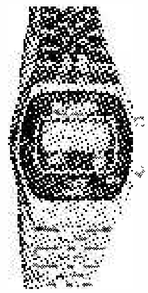

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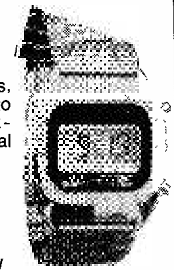

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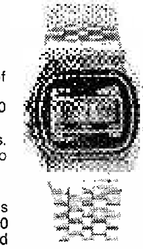

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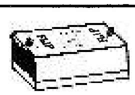

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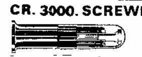

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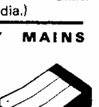

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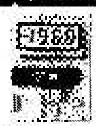

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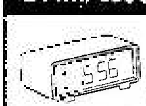

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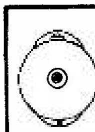

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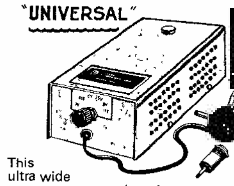
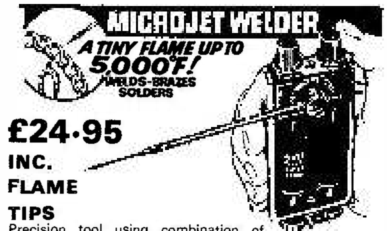


CHOICE OF 3-4½-6-7½-9-12 VOLTS DC

This ultra wide range power supply unit converts the usual domestic AC input 220/250 volts to a choice of DC outputs 3-4½-6-7½-9-12 volts DC, selected by a rotary switch. The output multiplug is polarity reversing and combines a 3·5mm Jack plug with 2·1mm and 2·5mm power plugs PLUS 2·5mm Jack plug (slips over the 3·5mm plug). Suitable wide range of different units. Earthed, ventilated metal case with pilot light and switch. Exceptional value. Only £9·95 + 95p P&P. Also single voltage 9v 150ma model suitable for nearly all T.V. Games. £5·45 + 55p P&P.

MICROJET WELDER

A TINY FLAME UP TO 5,000°F! WELDS-BRAZES SOLDERS



£24·95 INC. FLAME TIPS

Precision tool using combination of butane and compressed oxygen or micronox. A pencil lead thin flame size, adjustable to 5,000°F. Cuts metals, welds, brazes and solders gold, silver. Ideal modelling, electricians, opticians, dentists, silversmiths, jewellery, clockmakers, electronic and computer servicing. Up to 30 minutes use on fuel supplied. Replacement set of 2 micronox, 1 butane cylinder £2·30 + 25p p&p extra. Only £24·95 + £1·35 p&p. Access accepted.

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Rate
22p per word, minimum 12 words. Box No. **60p** extra.

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For the purpose of this scheme, mail order advertising is defined as:—

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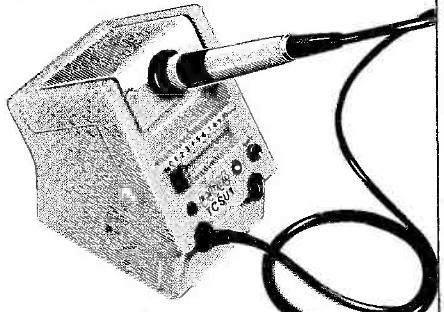
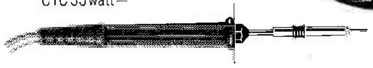
INDEX TO ADVERTISERS

PLEASE MENTION PRACTICAL WIRELESS WHEN REPLYING TO ADVERTISEMENTS

Model TCSU1 Soldering Station

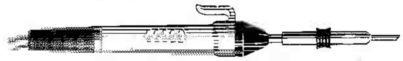


CTC 35watt—



The TCSU1 soldering station with either the XTC 50watt—24/26 volt soldering iron or the CTC 35watt—soldering iron for pin point precision and exceptionally fast recovery time. We have put at least twice as much power into irons which are already well known for good recovery time. The temperature control stops them from over heating; the "fail safe" electronic circuit provides protection even if the thermocouple fails. TCSU1 soldering station **£ 38.10** XTC and CTC irons **£14.85** inclusive of VAT and P.&P.

Model CX - 17 watts

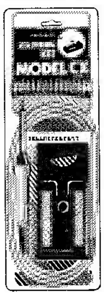


... a miniature iron with the element enclosed first in a ceramic shaft, then in a stainless steel. Virtually leak-free. Only 7½" long. Fitted with a **3/32"** bit. **£4·37** inclusive of VAT and P.&P. Range of 5 other bits available from ¼" down to 3/64".

Model X25 - 25 watts

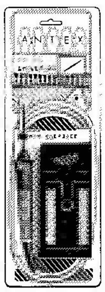
A general purpose iron also with a ceramic and steel shaft to give you toughness combined with near-perfect insulation. Fitted with 1/8" bit and priced at **£4·37** inclusive of VAT and P.&P. Range of 4 other bits available.

Model SK3 Kit



Contains both the model CX230 soldering iron and the stand ST3. Priced at **£6·21** inclusive of VAT and P.&P. It makes an excellent present for the radio amateur, modelmaker or hobbyist.

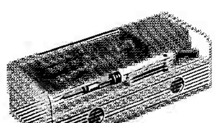
Model SK4 Kit



With the model X25/240 general purpose iron and the ST3 stand, this kit is a must for every toolkit in the home. Priced at **£6·21** inclusive of VAT and P.&P.

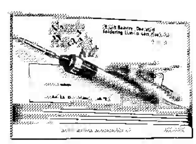
Model SK1 Kit

This kit contains a 15watt miniature soldering iron, complete with 2 spare bits, a coil of solder, a heat sink and a booklet 'How to solder'. Priced at **£6.48** inclusive of VAT and P.&P.



Model MLX Kit

The soldering iron in this kit can be operated from any ordinary car battery. It is fitted with 15 feet flexible cable and battery clips. Packed in a strong plastic envelope it can be left in a car, a boat or a caravan ready for soldering in the field. Price **£4.83** inclusive of VAT and P.&P.



Now heat to any level

between 145°-400°c

(with accuracy of 2%)

With the

Antex TCSC1 Soldering Station

All Antex soldering irons are made on the principle of putting the heating element inside a shaft, then the desired bit is eased over the shaft, giving maximum heat transference, this is why so often a small Antex iron can do the job of a larger conventional iron. The precision made slide on bits are slit to make them easily interchangeable.

The ANTEX multi purpose range of soldering equipment is fast becoming a must for every home. Built with precision for long life, each iron is fully tested and guaranteed.

ANTEX soldering irons are made in England to strict local and international standards of safety.

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ANTEX

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Plymouth, Devon.
Tel. 0752 67377/8
Telex. 45296

Please send me the Antex colour brochure ☐ I enclose cheque/P.O./Giro No. 258 1000 ☐

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A genuine 150W per channel stereo disco to build yourself. Full specification in our catalogue.

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Our catalogue describes a wide range of plugs and sockets, all at marvellous prices. See cat. pages 114 to 129 for details.

61-note touch-sensitive piano to build yourself. Full specification in our catalogue.

A very high quality 40W per channel stereo amplifier with a superb specification and lots of extras. Full construction details in our catalogue.

A digitally controlled stereo synthesiser the 5600S with more facilities than almost anything up to £3,000. Build it yourself for less than £700. Full specification in our catalogue.

A hi-fi stereo tuner with medium and long wave, FM stereo and UHF TV sound! Full construction details in our catalogue.

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Multimeters, analogue and digital, frequency counter, oscilloscopes, and lots, lots more at excellent prices. See cat. pages 106 and 183 to 188 for details.

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A massive new catalogue from Maplin that's even bigger and better than before. If you ever buy electronic components, this is the one catalogue you must not be without. Over 280 pages – some in full colour – it's a comprehensive guide to electronic components with hundreds of photographs and illustrations and page after page of invaluable data.

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A superb range of microphones and accessories at really low prices. Take a look in our catalogue—send the coupon now!

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