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Technical Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. We regret that such queries cannot be answered over the telephone; they must be submitted in writing and accompanied by a stamped addressed envelope for reply.

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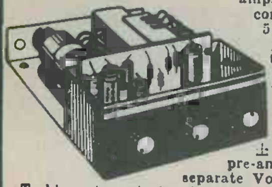
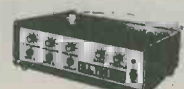
SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 Silicon transistors plus 2 power out-put transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz. 30KHz ±3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, escutcheon panel, input and output plugs. Overall size 3" high × 6" wide × 7½" deep. AC 200/250V. PRICE £15.00. P. & P. £1.20.

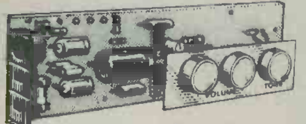
HARVERSONIC MODEL P.A. TWO ZERO



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 pre-amp). 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. x 5" h. x 7¼" d.

Special introductory price £28.00 + £2.50 carr & pkg.

HARVERSONIC STEREO 44



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 and 5 pin din tape rec./play socket are mounted on the printed circuit panel, size approx. 9½" × 2½" × 1" max. depth. Supplied brand new and tested, with knobs, brushed anodised aluminium 2 way escutcheon (to allow the amplifier to be mounted horizontally or vertically), at only £9·00 plus 50p P. & P. Mains transformer with an output of 17V a/c at 500 m/a can be supplied at £1·50 plus 40p P. & P. if required. Full connection details supplied.

BRAND NEW MULTI-RATIO MAINS TRANSFORMERS. Giving 13 alternatives. Primary: 0–210–240v. Secondary combinations 0-5-10-15-20-25-30-35-40-60v. half wave at 1 amp. or 10-0-10, 20-0-20, 30-0-30v. at 2 amps. full wave. Size 3in. long × 3½in. wide × 3in. deep. Price £3.00 P. & P. £1.20.

MAINS TRANSFORMER. For power supplies.
Pri. 200/240v. Sec. 9-0-9 at 500 mA. £1.60 P. & P. 65p.
Pri. 200/240v. Sec. 12-0-12 at 1 amp. £1.85 P. & P. 65p.
Pri. 200/240v. Sec. 10-0-10 at 2 amp. £2.50. P. & P. 90p.
Pri. 200/240v. Sec. 23v. at 1·5 amp, 6v at ·6 amp, 8v. at 50 mA. £2.2 + 65p P. & P.

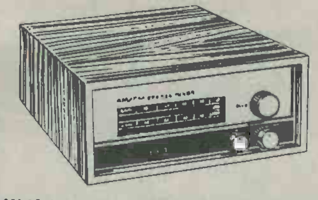
ALL PURPOSE POWER SUPPLY UNIT 200/240v. A.C. input. Four switched fully smoothed D.C. outputs giving 6v. and 7½v. and 9v. and 12v. at 1 amp on load. Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case overall size 6" × 3½" × 2½". Ready built and tested. Price £6.75. P. & P. 95p

STEREO-DECODER SIZE 2"×3"×½"

Ready built. Pre-aligned and tested. Sens. 20-560mV 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.

QUALITY RECORD PLAYER AMPLIFIER MK. II A top quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in wide × 3in deep × 6in high. Ready built and tested. PRICE £7·00. P. & P. £1.25
ALSO AVAILABLE mounted on board with output transformer and speaker. PRICE £8·00. P. & P. £1.30.

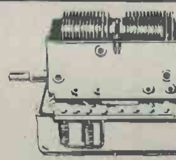
MAINS OPERATED SOLID STATE AM/FM STEREO TUNER



200/240V Mains operated Solid State A/M F/M Stereo Tuner. Covering M.W. A.M. 540-1605 KHZ, VHF/FM 88-108 MHZ. Built-in Ferrite rod aerial for M.W. Full AFC and AGC on AM and FM. Stereo Beacon Lamp Indicator. Built-in Pre-amps with variable output voltage adjustable by pre-set control. Max o/p Voltage 600 m/v RMS into 20K. Simulated teak finish cabinet. Will match almost any amplifier. Size 8½" w. × 4" h. × 9½" d. approx. LIMITED NUMBER ONLY at £28.00 + £1.50 P. & P.

SPECIAL OFFERS

Mullard LP1159 RF-IF Double Tuned Amplifier Module for nominal 470kHz. Size approx. 2⅜" × 1¼" × ⅜" 7·6V + earth. Brand new pre-aligned. Full specification and connection details supplied. £2·25 + P. & P. 20p.



Pye VHF/FM Tuner Head covering 88-108M/Hz. 10·7M/Hz IF output 7-8V + earth. Supplied pre-aligned, with full circuit diagram. Connection details supplied. Beautifully made with precision-geared FM Gang and 323 Pf + 323 Pf AM Tuning Gang only £3·15 + P. & P. 35p.

PRECISION MADE
Push Button Switch bank. 8 Buttons giving 16 S/P C/O interlocked switches plus 1 Cancel Button Plus 3 d/p c/o. Overall size 5" × 2½" × 1". Supplied complete with chrome finished switch buttons 2 for £1.80 + 20p, P. & P.

HI-FI LOUDSPEAKER SYSTEM MkII

Beautifully made simulated teak finish enclosure now with most attractive slatted front. Size 16½" high × 10½" wide × 9" deep (approx.). Fitted with E.M.I. Ceramic Magnet 13" × 8" bass unit, H.F. tweeter unit and crossover. AVAILABLE IN NOMINAL 4 ohm, 8 ohm or 16 ohm impedance (state which). Handling power 10 watts R.M.S.

OUR PRICE £14.00 each. Carr. £3

Cabinet Available Separately £8.00 each. Carr. £2.00
Also available in 8 ohms with EMI 13" × 8" bass speaker with parasitic tweeter £12.50 each. Carr. £3.00

LOUDSPEAKER BARGAINS
5in. 3 ohm £2·00, P. & P. 35p. 7 × 4in. 3 ohm £2·35, P. & P. 48p. 10 × 6in. 3 or 15 ohm £3·20. P. & P. 75p. 8 × 5in. 3 ohm with high flux magnet £3·00, P. & P. 60p. Tweeter. Approx. 3½". Available 3 or 8 or 15 ohms. £2.00 + 30p P. & P.

2" PLASTIC CONE HF TWEETER 4 ohm, £3·50 per matched pair + 50p P. & P.

HIGH POWER HI-FI 8 ohm Domic Tweeter. 1" voice coil. Magnet size 3" dia. Suitable for use in up to 50 watt systems. £4·50 each + 60p P. & P.

VYNAIR & REXINE SPEAKERS & CABINET FABRICS app. 54 in. wide. Our price £2.00 yd. length. P. & P. 50p per yd. (min, 1 yd.). S.A.E. for samples.

"POLY PLANAR" WAFER-TYPE, WIDE RANGE ELECTRO-DYNAMIC SPEAKER
Size 11¾" × 14¹¹⁄₁₆" × 1³⁄₁₆" deep. Weight 19oz. Power handling 20W r.m.s. (40W peak). Impedance 8 ohm only. Response 40Hz–20kHz. Can be mounted on ceilings, walls, etc. and used with or without baffle. Send S.A.E. for details. Only £8·40 each. P. & P. 90p for one, £1.10 for two.

Now available in either 8" round version or 4½" x 8½" rectangular. 10 watts R.M.S. 60Hz-20KHz £5.25 + P. & P. (one 65p, two 75p).

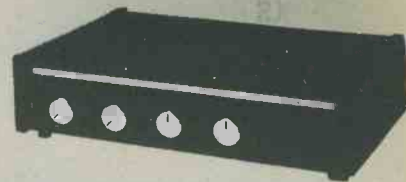
SONOTONE 9TAHC COMPATIBLE STEREO CARTRIDGE T/O stylus Diamond Stereo LP and Sapphire 78. ONLY £2.50 P. & P. 20p. Also available fitted with twin Diamond T/O stylus for Stereo LP. £3.00 P. & P. 20p.

LATEST CRYSTAL T/O STEREO/COMPATIBLE CARTRIDGE for EP/LP/Stereo 78. £2.00 P. & P. 20p

LATEST T/O MONO COMPATIBLE CARTRIDGE for playing EP/LP/78 mono or stereo records on mono equipment. Only £2.00 P. & P. 20p

MAINS TRANSFORMER. PR1.0.110 and 240 sec. 28V at 1.8 amps. Also tapped at 12V. 3 amp. Size 2¼"h x 3¼"w x 2¼"d. £2.50 + £1 P. & P.

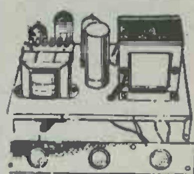
HARVERSONIC SUPER SOUND 10 + 10 STEREO AMPLIFIER KIT



A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 8 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board with component identification clearly marked, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specifications: Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ± 3dB 12–30,000 Hz Sensitivity: better than 80mV into 1MΩ. Full power bandwidth: ±3dB 12–15,000 Hz. Bass, boost approx. to ±12dB. Treble cut approx. to —16dB. Negative feedback 18dB over main amp. Power requirements 35v. at 1·0 amp.
Overall Size 12"w. × 8"d. × 2¾"h.
Fully detailed 7 page construction manual and parts list free with kit or send 25p plus large S.A.E.

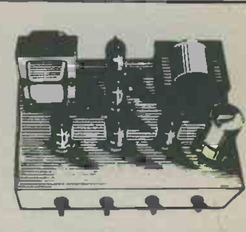
AMPLIFIER KIT	£13·50	P. & P. 80p
(Magnetic input components 33p extra)		
POWER PACK KIT	£5·50	P. & P. 95p
CABINET	£5·50	P. & P. 95p

Special offer—only £23.75 if all 3 units ordered at one time plus £1.25 P. & P.
Full after sales service
Also available ready built and tested £31·25. P. & P. £1.50.



3-VALVE AUDIO AMPLIFIER HA34 MK II. Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7¾"w. × 4"d. × 4¾"h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £8.50. P. & P. £1.40.

HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. £8.00. P. & P. £1.40.



10/14 WATT HI-FI AMPLIFIER KIT A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3–15 Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 25p × SAE (Free with parts). All parts sold separately. ONLY £13.50. P. & P. £1.40. Also available ready built and tested £18.00. P. & P. £1.40.

SPECIAL LINES OFFERED SUBJECT TO STOCK AVAILABILITY

Limited number of British Manufacturer's Surplus professional 100 watt RMS Slave amplifiers. Special features: 2 separate power modules, 1 for Bass response, and 1 for mid. range/tweeter. 5 stage LED display for power o/p indication. A/c mains i/p switchable for 110 or 240V. Can easily be converted to stereo.

AVAILABLE TO PERSONAL CALLERS ONLY—PLEASE PHONE TO CONFIRM AVAILABILITY.
Brand new and tested only £33·75.

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HARVERSON SURPLUS CO. LTD.

(Dept. REC) 170 MERTON HIGH ST., MERTON, LONDON, SW.19. Tel: 01-540 3985
A few minutes from South Wimbledon Tube Station
SEND SAE WITH ALL ENQUIRIES. FOR PERSONAL CALLERS ONLY: WE CAN NOW OFFER A FULL REPAIR SERVICE ON ALL HI-FI EQUIPMENT, DISCO, CASSETTES, CAR RADIO, ETC.

(Please write clearly)

PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. P. & P. ON OVERSEAS ORDERS CHARGED EXTRA.

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BOOKS BY BABANI

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BP2	Handbook of Radio, TV & Industrial & Transmitting Tube & Valve Equivalents	60p†
BP6	Engineers and Machinists Reference Tables	40p†
BP7	Radio & Electronic Colour Codes and Data	15p†
BP10	Modern Crystal and Transistor Set Circuits for beginners	95p†
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No. 229 Beginners Guide to Electronics	Price £2·25†
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No. 231 Beginners Guide to Transistors	Price £2·25†
No. 233 Beginners Guide to Radio	Price £2·75†
No. 234 Beginners Guide to Colour Television	Price £2·25†
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No. 236 Electronic Components	Price £1·08†
No. 237 Printed Circuit Assembly	Price £1·08†
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No. 239 30 Photoelectric Circuits & Systems	Price £1·80†

NUTS AND BOLTS

BA BOLTS – packs of BA threaded cadmium plated screws slotted cheese head.

Supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
1in 0BA	839	£1·20	½in 4BA	846	£0·32
½in 0BA	840	£0·75	¼in 4BA	847	£0·25
1in 2BA	842	£0·65	1in 6BA	848	£0·40
½in 2BA	843	£0·45	½in 6BA	849	£0·21
¼in 2BA	844	£0·52	¼in 6BA	850	£0·25
1in 4BA	845	£0·44			

BA NUTS – packs of cadmium plated full nuts in multiples of 50.

Type	No.	Price	Type	No.	Price
0BA	855	£0·72	4BA	857	£0·30
2BA	856	£0·48	6BA	858	£0·24

BA WASHERS – flat cadmium plated plain stamped washers supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
0BA	859	£0·14	4BA	861	£0·12
2BA	860	£0·12	6BA	862	£0·12

SOLDER TAGS – hot tinned-supplied in multiples of 50.

Type	No.	Price	Type	No.	Price
0BA	851	£0·40	4BA	853	£0·22
2BA	852	£0·28	6BA	854	£0·22

SWITCHES

Description	No.	Price
DPDT miniature slide	1973	£0·11*
DPDT standard slide	1974	£0·14*
Toggle switch SPST 1½ amp 250V a.c.	1975	£0·33*
Toggle switch DPDT 1 amp 250V a.c.	1976	£0·42*
Rotary on-off mains switch	1977	£0·50*
Push switch – Push to make	1978	£0·13*
Push switch – Push to break	1979	£0·18*

ROCKER SWITCH

A range of rocker switches SPST – moulded in high insulation. Material available in a choice of colours ideal for small apparatus.

Colour	No.	Price
RED	1980	£0·26*
BLACK	1981	£0·26*
WHITE	1982	£0·26*
BLUE	1983	£0·26*
YELLOW	1984	£0·26*
LUMINOUS	1985	£0·26*

Description	No.	Price
Miniature SPST toggle, 2 amp 250V a.c.	1958	£0·50*
Miniature SPST toggle, 2 amp 250V a.c.	1959	£0·55*
Miniature DPDT toggle, 2 amp 250V a.c.	1960	£0·70*
Miniature DPDT toggle, centre off, 2 amp 250V a.c.	1961	£0·85*
Push button SPST, 2 amp 250V a.c.	1962	£0·78*
Push button SPST, 2 amp 250V a.c.	1963	£0·83*
Push button DPDT, 2 amp 250V a.c.	1964	£0·98*

MIDGET WAFER SWITCHES

Single-bank wafer type – suitable for switching at 250V a.c. 100mA or 150V d.c. in non-reactiver loads make-before-break contacts. These switches have a spindle 0·25in dia. and 30° indexing.

Description	Order No.	Price
1 pole 12 way	1965	£0·48*
2 pole 6 way	1966	£0·48*
3 pole 4 way	1967	£0·48*
4 pole 3 way	1968	£0·48*

MICRO SWITCHES

	Order No.	Price
Plastic button gives simple 1 pole change over action. Rating 10 amp 250V a.c.	1970	£0·25

FUSE HOLDERS AND FUSES

Description	Order No.	Price
20mm x 5mm chassis mounting	506	£0·07*
1¼in x ¼in chassis mounting	507	£0·12*
1¼in car inline type	508	£0·15*
Panel mounting 20mm	509	£0·20
Panel mounting 1¼in	510	£0·30

QUICK BLOW 20mm

Type	No.	Type	No.	Type	No.
150mA	611	1A	615	3A	619
250mA	612	1.5A	616	4A	620
550mA	613	2A	617	5A	621
800mA	614	2·5A	618		

All 5p each excepting 616 which is 7p.

ANTI-SURGE 20mm

Type	No.	Type	No.	Type	No.
100mA	622	1A	625	2·5A	628
250mA	623	2A	626	3·15A	629
500mA	624	1·6A	627	5A	630

All 7p each

QUICK BLOW 1¼in

Type	No.	Type	No.	Type	No.
250mA	631	500mA	632	800mA	634

All 7p each

Type	No.	Type	No.	Type	No.
1A	635	2·5A	638	4A	641
1·6A	636	3A	639	5A	642
2A	637				

All 6p each

CASES AND BOXES

INSTRUMENT CASES. In two sections vinyl covered top and sides, aluminium bottom, front and back.

No.	Length	Width	Height	Price
155	8in	5¼in	2in	£1·52
156	11in	6in	3in	£2·12
157	6in	4¾in	1¾in	£1·30
158	9in	5¼in	2½in	£1·76

ALUMINIUM BOXES. Made from bright ali., folded construction each box complete with half inch deep lid and screws.

No.	Length	Width	Height	Price
159	5½in	2½in	1½in	62p
160	4in	4in.	1½in	62p
161	4in	2½in	1½in	62p
162	5½in	4in	1½in	73p
163	4in	2½in	2in	64p
164	3in	2in	1in	44p
165	7in	5in	2½in	£1·04
166	8in	6in	3in	£1·32
167	6in	4in	2in	86p

P.C.B. BOARDS

C26 4 pieces 8" x 3½" (approx.) Single-sided fibreglass 80p

C27 3 pieces 7" x 3½" (approx.) Double-sided fibreglass 60p

TRANSFORMERS

MINIATURE MAINS Primary 240V

No.	Secondary	Price
2021	6V-0-6V 100mA	90p*
2022	9V-0-9V 100mA	90p*
2023	12V-0-12V 100mA	95p*

MINIATURE MAINS Primary 240V with two independent secondary windings

No.	Type	Price
2024	MT280-0-6V, 0-6V RMS	£1·50*
2025	MT150-0-12V, 0-12V RMS	£1·50*

1 AMP MAINS Primary 240V

No.	Secondary	Price	
2026	6V-0-6V 1 amp	£2·50*	P. & P. 45p
2027	9V-0-9V 1 amp	£2·00*	P. & P. 45p
2028	12V-0-12V 1 amp	£2·60*	P. & P. 55p
2029	15V-0-15V 1 amp	£2·75*	P. & P. 66p
2030	30V-0-30V 1 amp	£3·45*	P. & P. 86p

STANDARD MAINS Primary 240V

Multi-tapped secondary mains transformers available in ½ amp, 1 amp and 2 amp current rating. Secondary taps are 0-19-25-33-40-50V.

Voltages available by use of taps:
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No.	Rating	Price	
2031	½ amp	£5·50*	P. & P. 86p
2032	1 amp	£6·60*	P. & P. 86p
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AUDIO LEADS

107	FM Indoor Ribbon Aerial	£0·60*
113	3.5mm Jack plug to 3.5mm jack plug. Length 1.5m	£0·75*
114	5 pin DIN plug to 3.5mm. Jack connected to pins 3&5. Length 1.5m	£0·85*
115	5 pin DIN plug to 3.5mm. Jack connected to pins 1&4. Length 1.5m	£0·85*
116	Car aerial extension. Screened insulated lead. Fitted plug & skt.	£1·10*
117	AC mains connecting lead for cassette recorders & radios. 2 metres	£0·68*
118	5 pin DIN phono plug to stereo headphone jack socket	£1·05*
119	2+2 pin DIN plugs to stereo jack socket with attenuation network for stereo headphones. Length 0.2m	£0·90*
120	Car stereo connector. Variable geometry plug to fit most car cassette, 8 track cartridge & combination units. Supplied with inline fused power lead and instructions.	£0·60*
123	6.6m Coiled Guitar Lead Mono Jack Plug to Mono Jack Plug BLACK	£1·50*
124	3 pin DIN plug to 3 pin DIN plug. Length 1.5m	£0·75*
125	5 pin DIN plug to 5 pin DIN plug. Length 1.5m	£0·75*
126	5 pin DIN plug to Tinned open end. Length 1.5m	£0·75*
127	5 pin Din plug to 4 Phono Plugs. All colour coded. Length 1.5m	£1·30*
128	5 pin DIN plug to 5 pin DIN socket. Length 1.5m	£0·80*
129	5 pin DIN plug to 5 pin DIN plug mirror image. Length 1.5m	£1·05*
130	2 pin DIN plug to 2 pin DIN inline socket. Length 5m	£0·68*
131	5 pin DIN plug to 3 pin DIN plug. 1&4 and 3&5. Length 1.5m	£0·83*
132	2 pin DIN plug to 2 pin DIN socket. Length 10m	£0·98*
133	5 pin DIN plug to 2 phono plugs. Connected pins 3&5. Length 1.5m	£0·75*
134	5 pin DIN plug to 2 phono sockets. Connected pins 3&5. Length 23cm	£0·68*
135	5 pin DIN socket to 2 phono plugs. Connected pins 3&5. Length 23cm	£0·68*
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Mullard C280 series. 250V PC mounting
0.01, 0.015, 0.022, 0.033, 0.047, **4p**; 0.068, 0.1, **4½p**; 0.15, 0.22, **6p**; 0.33, 0.47, **9p**; 0.68, **12p**; 1.0, **15p**; 2.2uF, **24p.**

Electrolytic Capacitors

Axial leads

25V	25V	25V	63V	63V	63V
10	22	100	1.0	4.7	22
	47		2.2	10	47
5p	**5p**	**7p**	**5p**	**5p**	**7p**

220/25V **10p**; 470/25V **14p**; 1000/25V **23p**; 2200/25V **32p.**

DIL Sockets

8 pin	11p
14 pin	12p
16 pin	13p
24 pin	30p

Tantalum Bead Capacitors

0.1, 0.22, 0.33, 0.47, 1.0, 2.2, @ 35V **11p**
4.7 @ 25V, 6.8 @ 25V, 10 @ 25V **12p**
22 @ 16V, 47 @ 6V, 68 @ 3V, 100 @ 3V **14p**

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All the following are Class 1 displays

	Red	Green	Yellow	Clip
0.125"	TIL209	TIL211	TIL213	3p
0.2"	FLV117	FLV310	FLV410	3p
	8p	16p	19p	

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DL707 0.3in. single **90p**
DL727 0.5in. double **180p**
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7401	12p	7446	70p	74118	82p	74173	120p
7402	10p	7447	55p	74119	130p	74174	90p
7403	12p	7448	50p	74120	82p	74175	70p
7404	10p	7450	13p	74121	25p	74176	90p
7405	13p	7451	13p	74122	40p	74177	90p
7406	29p	7452	13p	74123	40p	74178	120p
7407	29p	7454	13p	74125	45p	74179	110p
7408	14p	7460	13p	74126	46p	74180	70p
7409	14p	7470	28p	74128	62p	74181	195p
7410	10p	7472	22p	74132	70p	74182	75p
7411	18p	7473	22p	74141	45p	74184	120p
7412	21p	7474	20p	74142	202p	74185	120p
7413	25p	7475	28p	74143	202p	74186	720p
7414	45p	7476	20p	74144	202p	74188	540p
7416	27p	7483	75p	74145	65p	74190	70p
7417	27p	7484	90p	74147	135p	74191	100p
7420	10p	7485	90p	74148	120p	74192	70p
7421	28p	7486	26p	74150	62p	74193	70p
7422	17p	7489	150p	74151	48p	74194	92p
7423	25p	7490	24p	74153	60p	74195	70p
7425	22p	7491	65p	74154	106p	74196	70p
7426	25p	7492	45p	74155	48p	74197	92p
7427	25p	7493	24p	74156	63p	74198	150p
7428	34p	7494	80p	74157	40p	74199	150p
7430	10p	7495	55p	74159	170p		
7432	24p	7496	48p	74160	60p		
7433	32p	7497	240p	74161	80p		
7437	24p	74100	95p	74163	80p		
7438	24p	74105	40p	74164	60p		
7440	13p	74107	28p	74165	90p		
7441	52p	74109	45p	74166	100p		
7442	40p	74110	46p	74167	270p		
7444	90p	74111	70p	74170	170p		

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Discount 25+ 10% 100+ 15% any mix

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4001	12p	4021	85p	4049	28p	4081	16p
4002	16p	4022	85p	4050	45p	4082	16p
4006	95p	4023	15p	4051	88p	4502	90p
4007	16p	4024	68p	4052	88p	4507	52p
4008	94p	4025	15p	4053	88p	4508	230p
4009	46p	4026	135p	4055	100p	4510	110p
4010	50p	4027	35p	4060	100p	4511	70p
4011	12p	4028	70p	4066	35p	4512	95p
4012	16p	4029	90p	4068	16p	4516	70p
4013	35p	4030	50p	4069	16p	4518	65p
4014	85p	4033	130p	4070	16p	4520	110p
4015	80p	4035	110p	4071	16p		
4016	45p	4040	90p	4072	20p		
4017	55p	4041	80p	4073	20p		
4018	90p	4042	75p	4075	20p		
4019	45p	4043	85p	4076	110p		

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AC127	17p	BC183L	10p	ZTX300	16p
AC128	16p	BC184	10p	ZTX301	16p
AC176	18p	BC184L	10p	ZTX302	23p
AC186	24p	BC212	10p	ZTX303	23p
AD161	38p	BC212L	10p	ZTX304	25p
AD162	38p	BC213	10p	2N696	32p
AF124	27p	BC213L	10p	2N697	12p
AF125	27p	BC214	10p	2N698	28p
AF126	27p	BC214L	10p	2N699	50p
AF127	27p	BC477	19p	2N706	13p
AF139	36p	BC478	18p	2N706A	13p
AF239	40p	BC479	18p	2N2926G	10p
BC107	8p	BC547	11p	2N2926R	8p
BC107B	10p	BC548	10p	2N3053	18p
BC108	8p	BC549	11p	2N3054	50p
BC108B	8p	BC550	14p	2N3055	50p
BC108C	10p	BC558	12p	2N3702	8p
BC109	8p	BC559	13p	2N3703	8p
BC109C	10p	BCY70	14p	2N3704	8p
BC147	7p	BCY71	14p	2N3705	9p
BC148	7p	BCY72	14p	2N3706	9p
BC149	8p	BD115	52p	2N3707	9p
BC157	9p	BD131	35p	2N3708	8p
BC158	9p	BD132	35p	2N3709	8p
BC159	9p	BD139	35p	2N3710	8p
BC167	8p	BD140	35p	2N3711	8p
BC168	8p	BF244B	36p	2N3903	8p
BC169	8p	BFY50	15p	2N3904	8p
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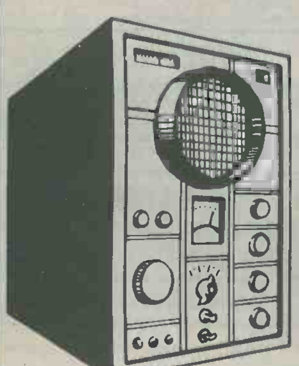

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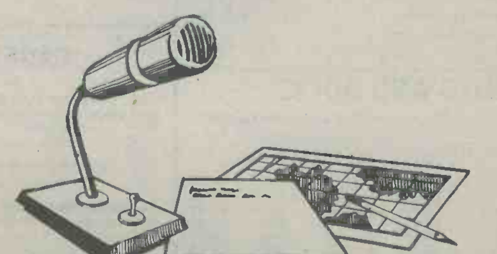

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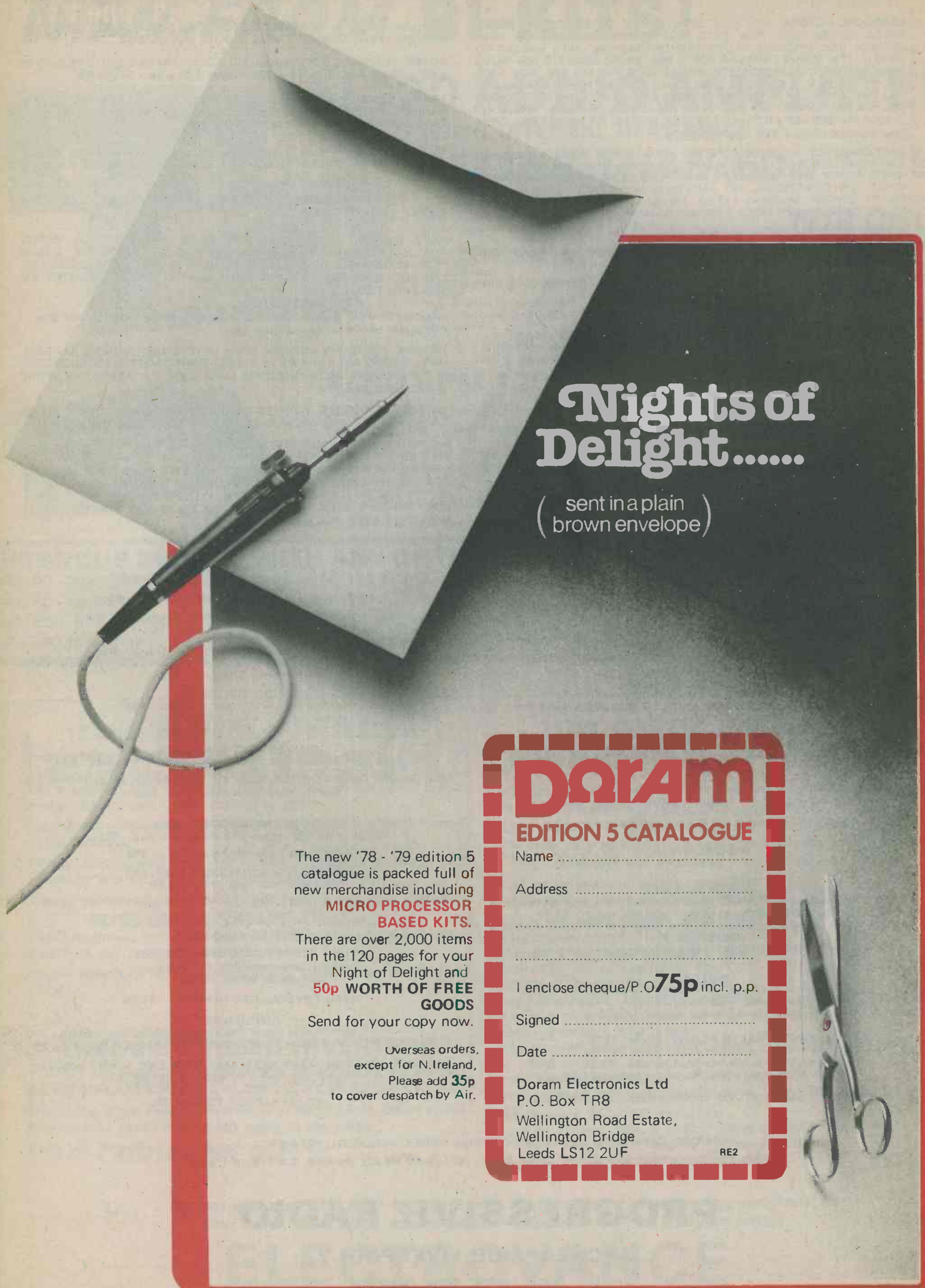
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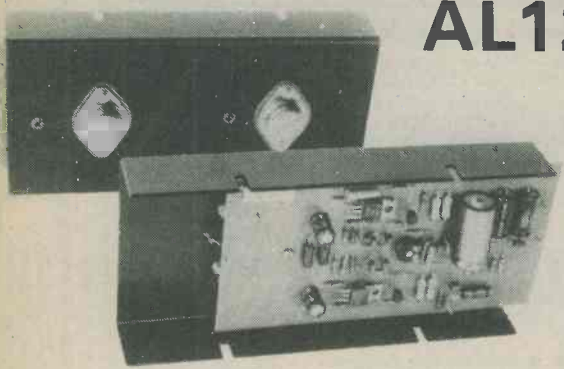

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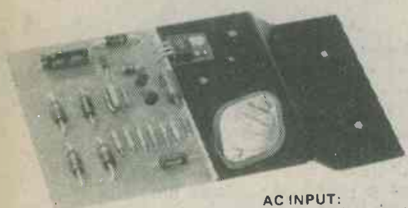

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SPM 120/45 Two AL60's up to 25w per channel simultaneously **£4.95** + 12½% VAT
SPM 120/55 Two AL80's up to 35w per channel simultaneously **£4.95** + 12½ VAT
SPM 120/65 Two AL120's up to 50w per channel simultaneously **£5.95** + 12½ VAT
SPM 120/65 One AL250 up to 125w **£5.95** + 12½% VAT Please add 25p P&P to all orders

AC INPUT:
AL120/45 40-48v ● AL120/55 50-55v ● AL120/65 60-65v ● OUTPUT CURRENT 2.5A ● RIPPLE @ 1A 100mV ● 2A 150mV

USE YOUR SPM 120 WITH ANY OF THESE!

AL 60. 25w (RMS) AMPLIFIER £4.55 + 12½% VAT. 25p p&p
AL 80. 35w (RMS) AMPLIFIER £7.15 + 8% VAT. 25p p&p
AL 250. 125w (RMS) AMPLIFIER £17.25 + 8% VAT. 40p p&p
PA 200. Pre-amplifier for use with all the above modules £16.30 + 12½% VAT. 40p p&p

BI-PAK

DEPT. RC8, P.O. Box 6, Ware, Herts

COMPONENTS SHOP: 18 BALDOCK STREET, WARE, HERTS.

ELIIO DIGITAL VOLTMETER

Assembled in Britain, Ranges 1v-10v-100v-1000v AC or DC Large .43 inch red L.E.D. display 3½ digits on front panel with the range select button switches, DC/AC switch, power on/off switch and probe sockets.

Auto Zereo — Accuracy 0.06B+ one digit Display flashing over-range indication.

Red or white cased units size approx 5" x 2½" x 6" tough ABS plastic with a semi-clear front display/control panel.

Circuit assembled on printed circuit boards with five integrated circuit type packages, guaranteed two years.

ELIIO (mains operated) **£44.50.** ELIIOB (mains or internal nickel cadmium cell powered) **£48.50.**

Please telephone or write for picture or further information of the DVM.

TRANSISTORISED INVERTERS

12v DC input-output 200/240v AC at 40 watts **£8.80 (kit £6.80)** 100w **£14.80 (kit £12.80)** 150w **£18.80 (kit £16.80).**

Frequency is not fixed & normally is at 44 to 65Hz, prices above include fully cased and tested ready to use units.

Sent via Roadline so please add £1.50.

LOW COST COMPONENTS

Nickel Cadmium Cells (new) — 6 x 1.2v (7.2v) 250ma/hr **£2.50**
5 x 1.2v (6v) 50ma/hr **£1.60.**

Seven segment economy quality common anode displays, left hand d.p. red, yellow or green **65p each** (new).

Bridge rectifier 18v 2 amp (new) **12p**
Solar cells, selenium, ex-equip used, rated approx 400mv 500ua **18p**

Small edgwise level meters (new) **60p**
Small edgwise batt/tune meters (new) **60p**

L.E.D.'s red, green, orange, small (new) **7p**
White rocker switch 240v 10A (new) **14p**
.68uf small polyester capacitors (new) **2p**
.68uf 200v capacitors (new) **4p**
2,200pf 400v capacitors (new) **4p**
Mixed electrolytic capacitors unmarked but new, **ten for 10p**
Extension type black rubber 13 amp sockets (new) **40p each**
Battery croc/clips **15p a pair**
Vinyl covered metal instrument cases (new) approx 5" x 2½" x 2½". **45p**
Unmarked values, volume controls (new) **10p**
Small push to lock switches 2pr cons (new) **8p.**

Transformers 240v AC Primaries:
Sec 12v 200ma **70p.** 8-0-8v 400ma **£1.20.**
12v lamp **£1.50.** 4-6-9v 150ma **£0.80**
Magnetic soiled but new earpieces **10p.**

Do not add any VAT P&P included with components. Callers by appointment. Mail order, Free Lists, advice please telephone: 01-736 0685 or write:

ELECTROVANCE

125 Hazlebury Road, London, SW6 2LX

TRADE COMPONENTS

NO LISTS: TOO MANY ITEMS. PAY A VISIT — THOUSANDS MORE ITEMS BELOW WHOLESALE PRICE. CALLERS PAY LESS AS PRICES INCLUDE POSTAGE AND VAT AND ADDITIONAL DISCOUNT IN LIEU OF GUARANTEE. MINIMUM ORDER £3 OTHERWISE ADD 50% FOR SMALL ORDER HANDLING COSTS.

GOODS SENT AT CUSTOMERS RISKS UNLESS SUFFICIENT ADDED FOR REGISTRATION OR COMPENSATION FEE POST.

VALVE BASE

Printed circuit B7G ... ... **5p•**
Chassis B7-B7G **11p**
Shrouded Chassis B7G-B8A **12p**
B12A tube. Chassis B9A **12p**

Speaker 6" x 4" 5 ohm ideal for car radio **£1.55**
4¾" diam. 30 Ω **£1.75**
2½" diam. 32 or 8Ω **£1.07**

TAG STRIP–6 way 4p 9 way **6p** Single **1½p**

5 x 50pF or 2 x 220pF trimmers **20p**

Car type panel lock and key **65p**

Transformer 9V 4A **£3.78**

Aluminium Knobs for ¼" shaft. Approx. ⅝" x ⅞" with indicator Pack of 5 **70p**

BOXES — Grey polystyrene 61 x 112 x 31mm, top secured by 4 self tapping screws **57p** clear perspex sliding lid, 46 x 39 x 24 mm **15p.**

ABS, ribbed inside 5mm centres for P.C.B., brass corner inserts, screw down lid, 50 x 100 x 25mm orange **65p**; 80 x 150 x 50mm black **97p**; 109 x 185 x 60mm black **£1.52.**

DIECAST ALI superior heavy gauge with sealing gasket, approx 6½" x 2⅜" x 1⅜" **£1.50; 3¾" x 2⅜" x 1⅜" £1.25.**

Used 999 ALARM UNIT. 12 volt includes loop cassette tape player, 2 x d.p.t.d., 1 x 4 p.d.t. miniature relay. Reed relay, solenoid, 35 marked semiconductors, caps, resistors, pots, terminal strip etc. **£3.70**

SWITCHES

Pole	Way	Type	
1	2	Slide	15p
6	2	Slide	24p
2	1	Rotary Mains	24p
2	Alternating	Micro with roller ...	30p
2	3	Miniature Slide ...	20p
1	2	Toggle	15p
1	2	Sub-Min Toggle ...	75p
2	Alternating	2A Mains Push (⅜" hole)	43p

S.P.S.T. 10 amp 240v. white rocker switch with neon. 1" square flush panel fitting **38p;** S.P.S.T. dot 13 amp, oblong, push-fit, rocker **20p** Sidleen/AFA Very High Security barrel Key Switch, 2 tubular keys ... ... **£2.95** Standard thumb-wheel switch 0-9 in 2p 10w, 10p 2c, 1248N or B or Comp. 1242 also 2p co **£1.20**

AUDIO LEADS

3 pin din to open end, 1½yd, twin screened **45p**
3 pole jack both ends 4ft **£1**
3 pole jack plug to tag ends, 4ft **45p**

COMPUTER & AUDIO BOARDS/ASSEMBLIES VARYING CONTENTS INCLUDE ZENER, GOLD BOND, SILICON, GERMANIUM, LOW AND HIGH POWER TRANSISTORS AND DIODES, HI STAB: RESISTORS, CAPACITORS, ELECTROLYTICS, TRIMPOTS, POT CORES, CHOKES ETC.

3lb for **£2** 7lb for **£3.70**

1k horizontal preset with knob 10 for **40p**

3" Tape Spools **5p**
1" Terry Clips ... **5p**
12 Volt Solenoid **40p**

ENM Ltd. cased 7-digit counter 2¼ x 1⅜ x 1¼" approx. 12V d.c. (48 a.c.) or mains **£1.10**

Auto charger for 12v Nicads, ex-new equipment **£5.19**

RESISTORS

⅛-¼-½ watt ... **1½p**
1 watt **3p**
Up to 15w w/wound **10p**
1 or 2% 5 times price

Cinch 8 way std 0.15 pitch edge connector **25p**

RELAYS

P.O. 3000 type, 1,000 OHM coil. 4 pole c/o **75p**
12v d.p.c.o. heavy duty octal **£1**
700 ohm 11-31 volt miniature sealed d.p.c.o. ...**£1**
185 ohm 6/12V miniature sealed 4 p.c.o. ... **£1.45**

POTS

Wirewound **38p**
Log. or Lin., carbon rotary or slide. Single **30p** With switch **40p** Dual **45p** Dual switch **55p** 1.5m Edgetype 10 for **40p**

Skeleton Presets
Slider, horizontal or vertical standard or submin **8p**

THERMISTORS and V.D.R's

CZ1/2/6/11/14, KR22, KT150, VA1005/6/8/1010/1033/4/7/8/9 1040/1053/5 /1066/7/1074/6/7 / 1082/6/1091/6/7/8 / 1100/3/8/8602. Rod with spot blue/fawn/green.
E299DDP120 / 218 / 224 / 338 / 340 / 350 / 352 · VF020 · E220ZZ002 · KR150 ... All **22p**
E23 glass bead **85p**
YG150-S534 bead, KB13, E299 DHP230, 116-121 401 (TH7, VA1104, OD10) **35p**

Miniature 0 to 5mA d.c. meter approx ⅞" diameter ... **£1.25**
RS Yellow Wander Plug Box of 12 ... ... **40p**
18 SWG multicore solder ... ... **3½p foot**
RS 20 way miniature ribbon cable, 25 metre roll (normal trade £19.60 exc post & VAT) **£8.50**

JAP 4 gang min. sealed tuning condensers **40p**

ELECTROLYTICS Many others in stock

Up to MFD	10V	25V	50V	63–75V	100V	200–250V	300–350 V	450–500V
10	6p	7p	7p	10p	13p	15p	26p	32p
25	6p	7p	7p	10p	13p	18p	32p	37p
50	6p	7p	7p	12p	16p	23p	32p	37p
100	7p	7p	13p	15p	24p	26p	–	–
250	12p	13p	15p	22p	36p	–	£1.10	£1.30
500	13p	15p	22p	30p	55p	–	–	£1.60
1000	16p	27p	50p	60p	–	£1.05	–	–
2000	28p	47p	55p	87p	–	–	–	–

As total values are too numerous to list, use this price guide to work out your actual requirements 8/20, 10/20, 12/20, 22/50, 47/25. Tub. Tant **24p** each 16-32/275V, 100-150V, 100-100/275V **40p** 50-50-50/385V, 12,000/12V, 32-32-50/300V, 20-20-20/350V 80p 700mfd/200V, 100-200-60/300V £1.30 100-100-100-150-150/320V. £2.60 100-300-100-16/300V £1.85

RS 100-0-100 micro amp null indicator Approx. 2" x ¾" x ¾" **£1.85**

INDICATORS

Bulgin D676 red, takes M.E.S. bulb....................**38p**
12 volt, or Mains neon, red pushfit....................**23p**
R.S. Scale Print, pressure transfer sheet............**12p**

CAPACITOR GUIDE — maximum 500V

Up to .01 ceramic **4½p.** Up to .01 poly **6p** .013 up to .1 poly etc. **7p.** .12 up to .68 poly etc. **8p.** Silver mica up to 360pF **10p,** then to 2,200pF **11p,** then to .01 mfd **21p.** **13p.** .1/750: **15p.** .01/1000, 8/20. .1/900 .22/900, 4.16. .25/250 AC (600vDC): **50p.** 5/150, 10/150, 40/150.
Many others and high voltage in stock.

FORDYCE DELAY UNIT

240 volt A.C./D.C. Will hold relay, etc., for approx. 15 secs after power off. Ideal for alarm circuits, etc. **£1.35**

CONNECTOR STRIP

Belling Lee L1469, 4 way polythene. **9p each**

1¼ glass fuses 250 m/a or 3 amp (box of 12) **20p**
Bulgin 5mm Jack plug and switched socket (pair) **40p**

Reed Switch 28mm, body length **11p**

Aluminium circuit tape, ⅛ x 36 yards—self adhesive. For window alarms, circuits, etc. **95p**

TV MAINS DROPPERS

5 assorted multiple units for.................................**75p**

100pF air-spaced tuning capacitor...................**£1.30**
5¼" x 2¼" Speaker, ex-equipment 3 ohm **65p**
2 Amp Suppression Choke....................................**10p**
3 x 2½ x 1/16" } PAXOLINE 5 for **35p**
4⅝ x ½ x ⅛" } 10 for **15p**
PVC or metal clip on MES bulb Holder 5 for **30p**
VALVE RETAINER CLIP, adjustable 5 for **15p**

OUTPUT TRANSFORMERS

Sub-miniature Transistor Type **35p**
Valve type **90p**

PAT CORES with adjuster
LA2508-519 **43p per pair**

GRUNDIG REGULATED TAPE MOTOR
6V nominal approx. 3 x 1½". Incl. shock absorbing carrier **£1.05**

3.5mm metal stereo plug **30p**

Ferric Chloride, Anhydrous mil spec 1lb bag **97p**

RS neg. volt regulator 103, 306-099 (equiv. MPC900) 10A, 100 watt 4-30 volt. Adjustable short circuit protection. Normally £12.50+. **£6.65**

Digital count unit. Counts in steps of 1, 2, 5 or 10 with total limit switch (2 x D.I.L. BCD), reed relay remote output. Mains power supply, relay and delay unit. UNUSED. **£5.40** Displays on 2 Minitron. 7 segments sold separately.

Burglar alarm, cord-powered for windows, doors, luggage and personal attack. Battery powered **86p**

DEAC rechargeable NICAD 450K. Capacity 6V 450 m.a.h. at 10 hour rate. Ex-new equipment **£4.11. P&P 30p**

Crouzet 30-minute timer-programmer. multi-variable contacts **£7.56**

ACOS DUST JOCKEY Automatic record cleaner **£1.30**

Wood cased 8-12V buzzer **£2.50**

McMurdo 4 or 8 way plug and socket ex-equipment **50p**

"Makeswitch" 1-pole 10-way wafer **15p**

2.5A r.f. thermo-couple and meter 2¼" square **£3.80**

BRIAN J. REED

161 ST. JOHNS HILL, BATTERSEA, LONDON SW11 1TQ
Open 10 a.m. till 7 p.m. Tuesday to Saturday. VAT receipts on request.
Terms: Payment with order Telephone: 01-223 5016

Lamp control panels with 5A mains triac, heat sink, 2 Multi-turn trimpots, cermet pot. 4 x 1A diodes, 9 x 1N914 neon indicator, 11 popular transistors, Hi-stab resistors, capacitors, etc. £1.60

C90 Cassette Tape 62p

Mullard 12-0-12V, 1.4A stabilized, regulated, power supply. Approx. 8½" x 4¾" x 3½" with handbook £14.50

27V 5A Double section bobbin transformer £4.32

Greenpar 50 ohm BNC line plug, round or flanged chassis socket or t.n.c. or u.h.f. plug, all 60p each

UK & EIRE — Postal Orders for same day service. Cheques require 8 days from a Tuesday banking to ensure clearance: export — banker's draft (sterling) same day service. Foreign currency money orders etc. can lose value and take 4-6 weeks to clear.

250 Ω 50 watt + Resistor 40p

SEMICONDUCTORS Full spec. by Mullard etc. Many others in stock

AC128/176	17p
ACY29	22p
AD161/2 match pr.	85p
AF116	20p
AF124/6/7	28p
AF139	23p
AF178/80/81	35p
AF239	35p
ASY27/73	35p
AU110/113	£2.50
BC107/8/9 + A/B/C	8p
BC147/8/9 + A/B/C	8p
BC157/8/9 + A/B/C	8p
BC178A/B 179B	14p
BC184C/LC	11p
BC186/7	23p
BC213L/214B	13p*
BC261B	10p
BC327/8 337/8	10p
BC547/8 + A/B/C	13p
BC556/7/7B/8/9	11p
BCX32/36	15p
BCY31	90p
BCY70/1/2	14p
BCZ11	32p
BD113	57p
BD115	35p
BD116(BRC116T)	£1.15
BD131/2/3	40p
BD135/6/7/8/9	35p
BD137/138 match pr	82p
BD140/142	35p
BD201/2/3/4	92p
BD232/3/4/5/8	55p
BDX77	£1.15
BD437	58p
BD115/167/173	18p
BF178/9	23p
BF180/1/2/3/4/5	18p
BF194/5/6/7	8p
BF194A, 195C	8p
BF200 258 324	23p
BF262/3	35p
BF336	31p
BFS28 Dual Mosfet	£1.15
BFW10/11 F.E.T.	46p
BFW30	£1.15
BFW57/58	21p
BFX12/29/30	23p
BFX84/88.89	20p
BFY51/52	16p
BFY90	57p
BR101	34p
BRY39/56	29p
BSV64	36p
BSV79/80 F.E.T.s	90p
BSV81 Mosfet	£1.00
BSX20/21	16p
BSY40	30p
BSY95A	14p
BU204 + Mount Kit	£1.85
BU208	£2.26
CV7042 (OC41/44 ASY63)	12p
GET111	45p
MD700 Dual	£2.26
OC45(ME2)	13p
ON222	23p
R2008B/2010B	£2.30
TIP/30	50p
TIS88A F.E.T.	28p
uA7805	£1.85
ZT1486	£1.15
ZTX300/341	9p
2N393 (MA393)	35p
2N456A	57p
2N706A	18p
2N929	16p
2N987	45p
2N1484	£1.15
2N1507/2219	18p
2N2401	35p
2N2412	80p
2N2483	28p
2N2904/5/6/7/7A	18p
2N305	16p
2N3055 R.C.A.	60p
2N3704	10p
2N3133	24p
2N3553	56p
2N4037	39p
2N5484 FET	39p
2SA141/2/360	36p
2SB135/6/457	24p
40250 (2N3045)	35p

OTHER DIODES

1N916	8p
1N3716 Tunnel	45p
1N4148	4p
BA145	17p
Centercel	29p
BZY61/BA148/OA81	12p
BB103/110 Varicap	24p
BB113 Triple Varicap	43p
BA182	15p
OA5/7/10	17p
BZY88 Up to 33 volt	10p
BZX61 11 volt	17p
BR100 Diac.	17p
BZY96C 10V	34p
BZY95C 33V	34p

NEW B.A. VALVES

EB91	40p
ECL80	67p
PCC84	59p
6SN7/6K7	89p
6AT6	89p
EZ81	59p

RS *Irravin* high temperature wire, 19/0.16, minus 55° to 105°C, 600V 3A, white, black or red. Half trade price at 54p 10M coil.

TRANSFORMER

Ferromag C core. Screen 95-105-115-125-200-220-240v input output 17v ½A x 2·2 24-0-24v 104A+20v 1mA. These current ratings can be safely exceeded by 50%. £4.90

PVC QUALITY TAPE

Lasso 10m x 15mm grey 38p
33m x 33mm green £1.13p

BRIDGE RECTIFIERS

Amp	Volt		
½	1,600	BYX10	34p
1	140	OSH01-200	30p
1.4	42	BY164	47p
0.6	110	EC433	20p
5	400	Texas	£1.10
2½	100	I.R.	48p

Cassette Dynamic Microphone with switch and twin plug £1.80
Telephone Pickup, sucker with lead and 3.5 plug. 70p.

ENAM. COPPER WIRE

SWG. PER YD.
24 to 42 4p

GARRARD

GCS23T Crystal Stereo Cartridge £1.20
Mono (Stereo compatible) Ceramic or crystal £1

RECTIFIERS

	Amp	Volt	
M1	½	68	5p
1N4005/6	1	6/800	6p
1N4007/BYX94	1	1250	8p
BY103	1	1,500	21p
SR100	1.5	100	9p
SR400	1.5	400	10p
REC53A	1.5	1,250	16p
LT102	2	30	15p
BYX22-200	1½	300	25p
BYX38-300R	2.5	300	48p
BYX38-600	2.5	600	52p
BYX38-900	2.5	900	60p
BYX38-1200	2.5	1,200	65p
BYX48-300R	2.5	300	30p
BYX49-600	3	600	42p
BYX49-900	3	900	47p
BYX49-1200	3	1,200	60p
BYX48-300R	6	300	47p
BYX48-600	6	600	60p
BYX48-900	6	900	70p
BYX48-1200R	6	1,200	92p
BYX72-150R	10	150	42p
BYX72-300R	10	300	52p
BYX72-500R	10	500	65p
BYX42-300	10	300	36p
1N5401	3	100	16p
1N5402	3	200	18p
MR856	3	600	24p
BYX42-900	10	900	92p
BYX42-1200	10	1,200	£1.07
BYX46-300R*	15	300	£1.19
BYX46-400R*	15	400	£1.75
BYX46-500R*	15	500	£2.00
BYX46-600*	15	600	£2.30
BYX20-200	25	200	72p
BYX52-300	40	300	£2.05
BYX52-1200	40	1,200	£2.90
RAS310AF*	1.25	1,250	48p

*Avalanche type

OPTO ELECTRONICS

Diodes

TIL209 Red	14p
BPX40	57p
BPX42	92p
BPY10	92p

(VOLTIAC)

BPY68	
BPY69	92p
BPY77	

Photo transistor

BPX29	92p
OCP71	75p

BIG L.E.D. 0.2" 2v 50m/A max.
RED 16p
Wire end neons 9p

PHOTO SILICON CONTROLLED SWITCH
BPX66 PNPN 10 amp £1.15

THYRISTORS

Amp	Volt		
1	240	BTX18-200	.35p
1	400	BTX18-300	.41p
1	240	BTX30-200	.35p
15	500	BT107	£1.14
6.5	500	BT101-500R	£1.05
6.5	500	BT109-500R	£1.14
20	600	BTW92-600RM	£3.40
15	800	BTX95-800R Pulse Modulated	£8.75
30	1000	28T10 (Less Nut)	£3.40

3" red 7 segment L.E.D. 14 D.I.L. 0-9 + D.P. display 1.9v 19m/a segment, common anode .95p
RS 0.6in. green £2.25
Minitron 0.3in 3015F filament £1.25
CQY11B L.E.D. Infra red transmitter £1.15
One fifth of trade
Plastic Transistor or Diode Holder 1½p
Transistor or Diode Pad 1½p
Holders or pads 65p per 100

PAPER BLOCK CONDENSER

0.25MFD	800 volt	87p
1MFD	250 volt	54p
1MFD	400 volt	65p

TV KNOB

Dark grey plastic for recessed shaft (quarter inch) with free shaft extension 8p

CHASSIS SOCKETS

Car Aerial 11p, Coax 8p, 5 pin 180° 11p, 5 or 6 pin 240° din 8p, speaker din switched 13p, 3.5 mm switched 7p, stereo ¼" jack enclosed 20p.

INTEGRATED CIRCUITS

TBA920	£3.00
TAA700	£2.40
TBA800	£1.24
741 dil. op amp	28p
uA702 op amp	53p
723	58p
(72) 709	52p
SN76013N/ND	£1.40
SN76228N	£2.03
SN76131N	£1.55
SN74017N	38p
TAD100 AMRF	£1.22
CA3001 R.F. Amp	58p
CA3132	£2.22
CD4013 CMOS	41p
CD4069	24p
TAA300 1 wt Amp	£1.15
TAA550 Y or G	26p
TAA263 Amp	75p
7400/7401	16p
7402/4/10/20/30	16p
7414	64p
7438/74	27p
7414	64p
7483	79p
7493	41p
LM300 2/20V reg	£1.15
LM1303N	£1.15
74154	£1.02
TBA5500	£1.80
ZN414 Radio Chip	£1.40

TRIACS

Amp	Volt		
8	400	Plastic RCA	£1.40
25	900	BTX94-900	£4.50
25	1200	BTX49-1200	£6.75

RS 2mm Terminals Blue & Black 5 for 50p
Chrome Car Radio facia 28p
Rubber Car Radio gasket 10p
DLI Pal Delayline 90p
Relay Socket miniature 2PCO 20p
28 pin d.i.l. socket low profile 38p
Colour EHT Tray 3000/3500 £5.50
Nylon self-locking, 3½" tie clips 3p
750uh choke 12p
0-30, or 0-15, black pvc, 360° dial, silver digits, self adhesive 4½" dia. 13p
Mullard Semiconductor, Valve & Component Data Book 1976-78 50p

McMurdo PP108 8 way edge plug 12p
Multicore Solder ½kg. 16 or 18 or 20 s.w.g. £5.00
3 inch 8 Ω speaker £1.15

New unmarked, or marked ample lead ex new equipment

ACY17-20	10p
ASZ20	10p
ASZ21	35p
BC186	13p
BCY30-34	24p
BCY70/1/2	10p
BY126/7	5p
HG1005	12p
HG5009	4p
HG5079	4p
L78/9	4p
M3	12p
OA81	4p
OA47	4p
OA200-2	4p
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7427	27p	29p	74100	119p		74163	92p	165p			
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4043	85p	4511	163p	4560	218p
4044	80p	4512	116p	4561	65p
4045	150p	4514	325p	4562	530p
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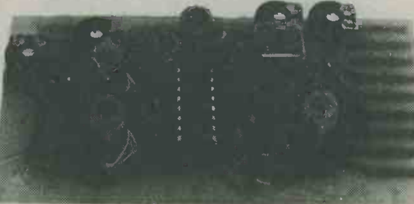

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VERSATILE NICAD BATTERY CHARGER

by A. P. Roberts

CHARGING UNIT WITH FOUR SWITCHED CONSTANT CURRENT OUTPUTS

Nickel cadmium (NiCad) rechargeable cells and batteries are very popular these days, especially in applications where a fairly high current is required for lengthy periods. Typical examples are given with electronic calculators, digital multimeters, electronic flashguns, portable communications equipment and cassette recorders. Ordinary dry cells tend to have rather short lives when used in such equipment and so, although they are relatively cheap in the short term, the comparatively high initial cost of nickel cadmium cells is easily justified in the long term.

The author has accumulated a number of NiCad batteries of various types, with a different charger being used for each particular type. The reason for using a different charger for each size of battery is that different cells have their own particular recommended charging current, and a purpose-made charger was obtained each time a new size of cell was acquired. The charger which forms the subject of this article was designed to rationalise matters by providing a single charging source for any of the NiCad batteries used by the author, and it has four switched output currents. These are 9, 15, 50 and 100mA, which are suitable for the nickel cadmium versions of PP3, HP16, HP7 and PP9 size cells respectively.

Equivalent cells made by different manufacturers do not always have quite the same recommended charging currents, but the nominal charge current is not very critical. In any case, it is an easy matter to change the charging currents provided by the present unit, if preferred, as is described later.

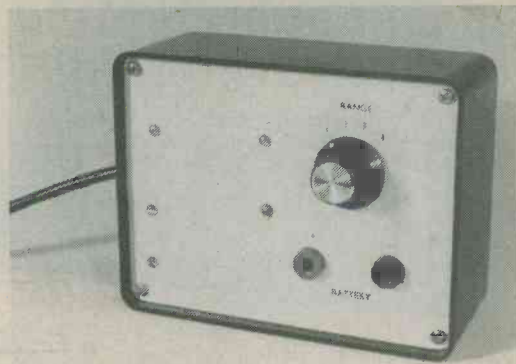
The unit can be used to charge a single PP3 or PP9 size battery, or up to six HP16 or HP7 size cells connected in series. As the maximum output current of the charger is 100mA it cannot be used to charge HP11 or HP2 size cells, which have recommended charging currents of 200 and 400mA respectively. We are referring here to nickel cadmium cells and batteries in terms of primary zinc-carbon cells and batteries of equivalent size, and it is most important to point out that on no account should any attempt be made to charge a primary cell with the charger, as this is dangerous and could cause an explosion to occur. The only cells and batteries which should be charged are those which are reliably identified as being nickle cadmium rechargeable types.

CONSTANT CURRENT

Nickle cadmium cells and batteries have a very low internal resistance. This is often an advantage but it slightly complicates the process of recharging as, without current limiting of some sort, the charger would only need to have an output voltage slightly higher than the cell or battery voltage to cause an excessively high charging current to flow. This could easily result in the cell or battery being damaged. The charger must therefore incorporate a current limiting circuit to ensure that a safe charge current is always supplied.

One simple method of doing this is to have a high voltage source connected to the battery via a current limiting resistor. Whilst this obviously has the advantage of extreme simplicity, it has the disadvantage of requiring a mains transformer having

The only control on the front panel of the NiCad battery charger is the current selector switch. The two output sockets are below this



a high secondary voltage, which makes it bulky and expensive.

A better method, and the one adopted here, is to use a fairly low source voltage and an electronic constant current generator to set the charge current at the required level. The circuit is based on the 723C voltage regulator i.c., and it is probably not generally realised that this type of device can be employed as a constant current generator. The basic arrangement of its current regulator section is shown in Fig. 1.

The output voltage in Fig. 1 with respect to ground is determined by the reference voltage which is fed to the non-inverting input of the operational amplifier and the potential divider which connects the output to the inverting input of this amplifier. In the present application it is not of great importance what the output potential is actually set at, provided it is somewhat higher than the maximum output voltage which will ever be required.

Current limiting circuitry is incorporated in the 723C i.c., and it ensures that the output current is limited to a pre-set level. A constant current effect is thus given. Just two components provide the current limiting, these being an internal transistor and a discrete external resistor, RCL. The resistor is connected in series with the output and also connects across the base-emitter junction of the current limit transistor. The output of the circuit is obtained from the output of the operational amplifier via a unity gain buffer stage, this being needed to provide a low output impedance. The collector of the current limiter transistor connects to the output of the operational amplifier.

When a load is connected between the output of the circuit and ground a current will flow through RCL and a voltage will be developed across it in consequence. If the current flow is sufficient to produce about 0.65 volt across RCL the current limit transistor will be turned on, resulting in a current being drawn from the output of the operational amplifier and taken to ground via the current limit transistor and the output load. This results in the output potential of the operational amplifier being pulled down towards ground potential. The main output current is still provided by the buffer stage, its output voltage being controlled by that at the output of the operational amplifier.

In this way the output current is limited to a level which causes a little over 0.65 volt to be developed across RCL. Even a short-circuit on the output does not cause a current in excess of this level to flow, as the output of the operational amplifier would be similarly taken to ground through the current limit transistor. The required limit current is set by the value given to RCL, and the value of this resistance in ohms is approximately equal to 650 divided by the required limit current in milliamps.

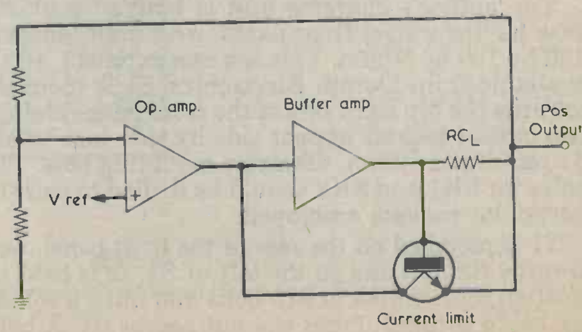


Fig. 1. The current limit section of the 723C regulator. Negative input and output are assumed here to be at ground potential and the unregulated positive input (not shown) feeds the operational and buffer amplifiers

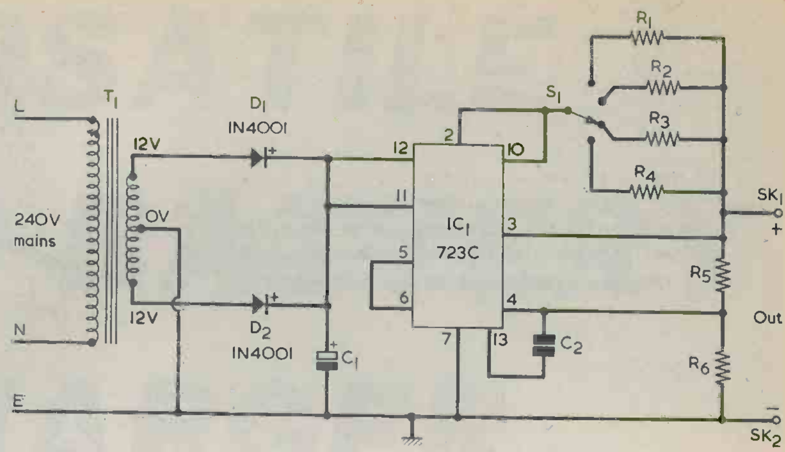


Fig. 2. The circuit of the NiCad battery charger. Constant current outputs are selected by S1

THE CIRCUIT

Fig. 2 shows the complete circuit of the charger. The mains supply is connected direct to the primary of T1 without an on-off switch, as it is assumed that the unit will simply be unplugged from the mains when it is not in use. The output from the secondary of T1 is full-wave rectified by D1 and D2, and the rectified voltage is then smoothed by C1.

Pin 5 of the i.c. is the non-inverting input of the operational amplifier and this connects to the internal 7 volt reference source which is available at pin 6. R5 and R6 provide the negative feedback loop between the output of the circuit and the inverting input of the operational amplifier at pin 4, and these set the quiescent output voltage of the circuit. This voltage is approximately equal to 7 times the sum of R5 and R6 divided by R6, or about 13 volts with the specified component values. C2 is a compensation capacitor which is needed in order to prevent the voltage stabilizer circuit from becoming unstable.

R1 to R4 are the current limiting resistors, with the required resistor being selected by S1. These resistors provide output currents of approximately 100mA, 50mA, 15mA and 9mA respectively. The precise calculated values required do not coincide with preferred values, and so a near value in the E24 series is used for each resistor. The currents are also affected by component tolerances. The output currents obtained from the prototype charger were all about 5% or so on the low side, which is quite close enough in practice.

CONSTRUCTION

The author's charging unit is built in a plastic case having a steel front panel, with dimensions of 130 by 100 by 50mm. This is a case type M3, and is available from Doram Electronics. S1 is mounted towards the top right side of the front panel and the two output sockets appear side by side just below. S1 requires a 10mm. diameter mounting hole. The holes for SK1 and SK2 should be drilled to suit the particular sockets employed.

T1 is mounted on the rear of the front panel, well towards the top and to the left of S1. It is held in position by two 6BA or M3 bolts and nuts, a solder tag being secured under the nut nearer S1. A hole for the mains lead is drilled in the left hand side panel of the case, and a grommet is fitted in this hole.

Many of the components are assembled on a Veroboard panel of 0.1in. matrix which has 11 copper strips by 21 holes. Details of this panel are

COMPONENTS

Resistors
(All ¼ watt 5%)
- R1 6.8 Ω (see text)
- R2 13 Ω (see text)
- R3 47 Ω (see text)
- R4 75 Ω (see text)
- R5 33k Ω
- R6 39k Ω

Capacitors
- C1 100μF electrolytic, 25V Wkg.
- C2 100pF ceramic plate

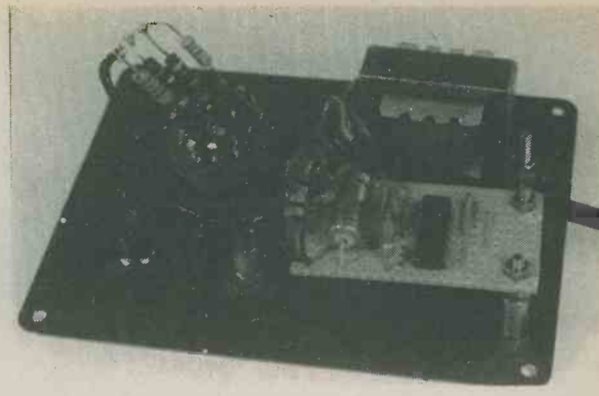
Transformer
- T1 miniature mains transformer, secondary 12-0-12V at 100mA

Semiconductors
- D1 1N4001
- D2 1N4001
- IC1 723C (14 pin d.i.l.)

Switch
- S1 3-pole 4-way rotary

Sockets
- SK1 insulated wander socket, red
- SK2 insulated wander socket, black

Miscellaneous
- Case (see text)
- Control knob
- Veroboard, 0.1in. matrix
- 2-way connector block (see text)
- 3-core mains lead
- Bolts, nuts, wire, etc.



All the parts are mounted on the rear of the front panel

provided in Fig. 3, which also illustrates the other wiring of the unit. Start construction of the component panel by cutting out a board of the required size with a hacksaw. Then drill the two mounting holes clearance size for 6BA or M3, and make the 15 breaks in the copper strips. The components and the 7 link wires are then soldered into position. The i.c. can be fitted in a 14 pin d.i.l. holder if desired, but this is not really necessary and was not done with the prototype unit.

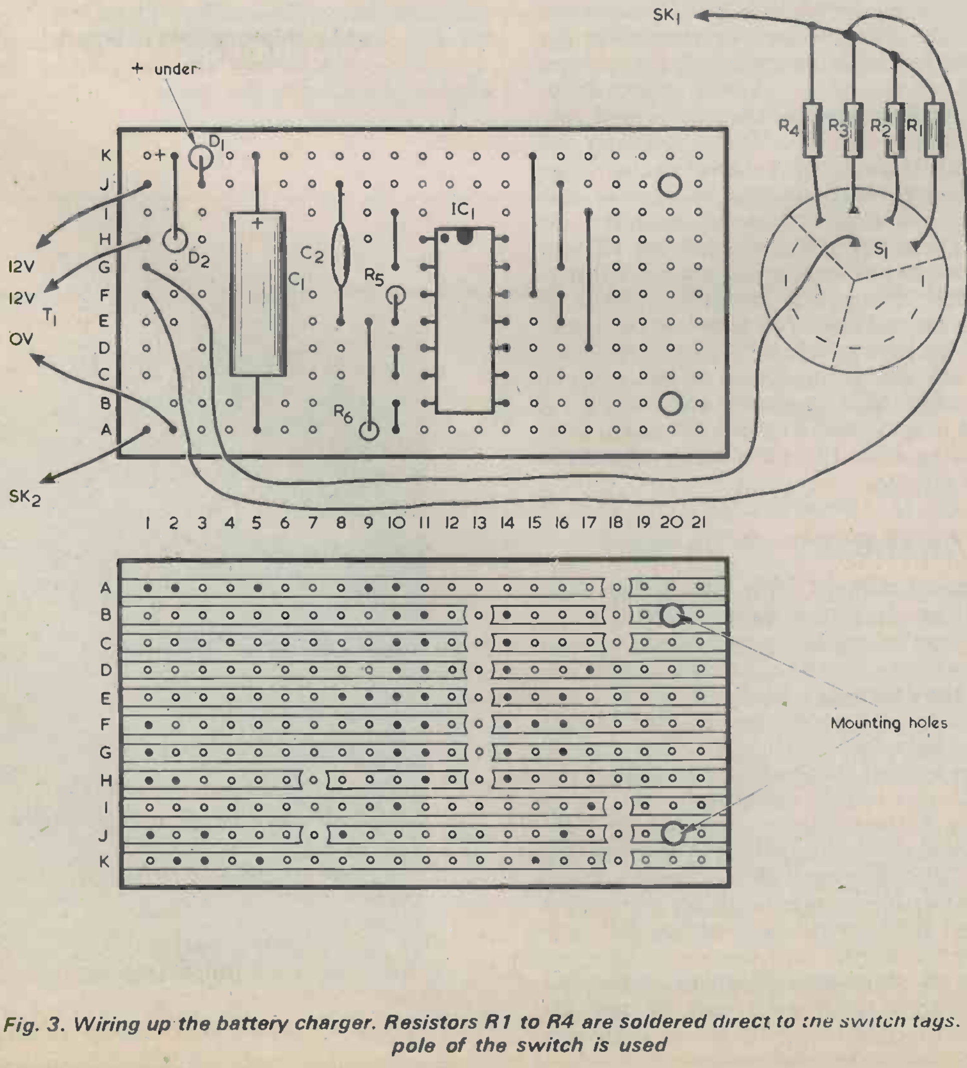
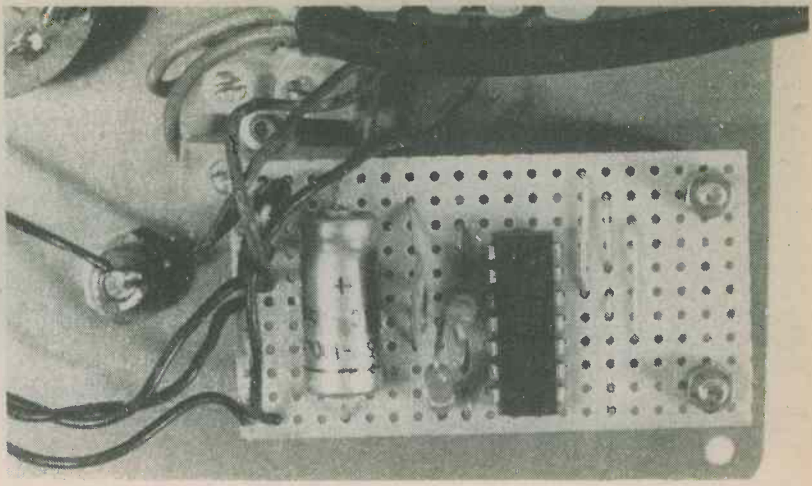


Fig. 3. Wiring up the battery charger. Resistors R1 to R4 are soldered direct to the switch tags. Only one pole of the switch is used



A close-up of the Veroboard component module

The completed board is wired up to the rest of the unit as shown in Fig. 3 before it is mounted on the rear of the front panel below T1. Spacers are fitted over the mounting bolts to ensure that the underside of the board is spaced well away from the front panel.

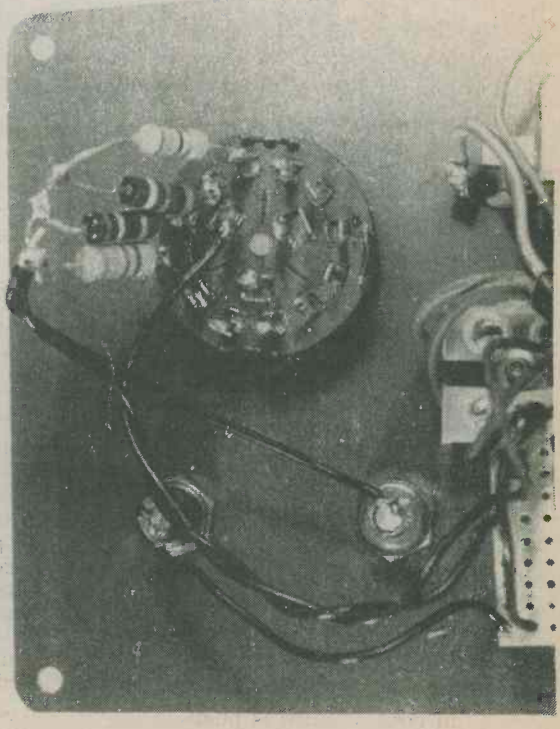
The live and neutral wires of the mains lead connect to the primary of T1. Since virtually all miniature mains transformers have flying leads this connection is best made by way of a 2-way connector block of the type which is intended for mains wiring. These are normally sold in 12-way lengths and it is an easy matter to cut off a 2-way section by means of a sharp knife. The block is mounted on the rear of the front panel in the space between T1, S1 and the component panel by a 6BA or M3 bolt and nut. The mains earth wire is soldered to the tag under the mounting nut of T1. The mains lead is anchored to the front panel near the point of entry into the case by a plastic or plastic covered clamp.

USING THE CHARGER

When recharging PP3 or PP9 size nickel cadmium batteries the connection between the battery and the charger can be made by way of a twin lead terminated in wander plugs at one end and suitable battery clips at the other end. Make absolutely certain that the battery is connected to the charger with the correct polarity.

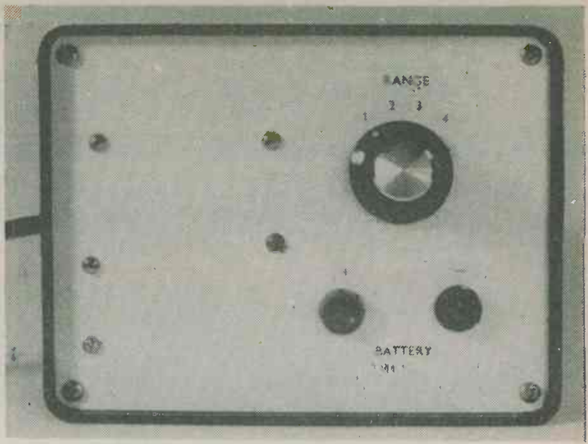
The most convenient method of connecting the charger to HP7 size nickle cadmium cells is to mount these in a battery holder intended for HP7 cells, and then make the connection in the manner just described. This is possible as these battery holders are fitted with connectors which are similar to those used on PP3 batteries. Holders for four cells are readily available, and these can be used with fewer cells by short-circuiting across unused positions. More than four cells can be accommodated by two holders wired in series, with any unused positions short-circuited.

Making the connection to HP16 size NiCad cells may not be as easy and will probably call for a certain amount of ingenuity. There was no problem for the author here as the HP16 size cells were



The four current limit resistors are wired direct to the switch tags

A direct view of the front panel. The positive output socket is on the left



fitted in an electronic calculator which permitted connection to the battery cells via a 3.5mm. jack socket without the need to remove them from the calculator.

Whatever method of connection is employed, make quite sure that the polarity is correct and that the charger is switched to the correct output current. It is also advisable to use a multimeter to check that the output currents are approximately correct. Care should be taken not to charge cells for very much longer than is absolutely necessary. Remember that the charger will continue to supply current to the battery or cells even after they have become fully charged.

As mentioned earlier some cell and battery manufacturers recommend slightly different charging currents to those specified in this article. Results should be perfectly satisfactory using the charging currents given here but, if preferred, alternative resistor values may be employed in one or more of the R1 to R4 positions. The values may be calculated in the manner described earlier. The maximum output current available is 100mA, whereupon resistors having values lower than 6.8 Ω must not be fitted. ■

BOOK REVIEW

THE RADIO AMATEUR'S HANDBOOK. 55th edition, 1978. 704 pages 6½ x 9in., (163mm x 233mm). Published by the A.R.R.L.

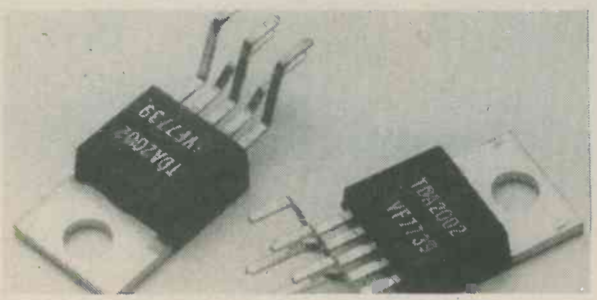
This new 1978 edition of the well known "Radio Amateur's Handbook" is a completely revised successor to the previous series of 54 editions, of which four million copies have been sold since the first edition appeared in 1926. Over the years it has established itself as the standard manual of amateur radio, as well as having been widely adopted as a practical reference book for radio technicians the world over and as a textbook for radio study in many schools. The basic purpose of the book is to present a complete treatment of every phase of modern amateur radio practice from elementary theory through to advanced practical application, with emphasis on ideas and methods that have shown their worth.

A feature of the "Handbook" has always been its practical designs for receivers, transmitters, antennas, test equipment and much else needed by the progressive radio amateur. There are many new designs and ideas to be found in this edition; too many to detail in a short review. Suffice is to say that if you are a newcomer to amateur radio, this book is a 'must' for your bookshelf, and if you are an 'old-timer', you will find much of interest which is likely to be new to you, in this edition.

It is obtainable from The Modern Book Co., 19-21 Praed Street, (Dept. RC), London W2 1NP. Price £7.50.

NEWS . . . AND

8-WATT MONOLITHIC AUDIO POWER AMPLIFIER — TDA2002



This monolithic integrated circuit is designed for Class B audio power amplifier applications using low impedance loads, down to 1.6 ohms if required. Its construction makes use of Fairchild's patented Planar epitaxial process. Output is typically 8 W at a supply voltage of 14.4 V and a load of 2 ohms, falling to 6.5 W at 16 V, 4 ohms.

Designed with a thermal shutdown feature, the device can withstand excessive ambient temperatures (below 150°C) and temporary or permanent overloads on the output. Heatsink safety margins can also be reduced, an increase in junction temperature (below 150°C) only resulting in a reduction in output power and supply current.

A part number TDA2002A is also available. This is the same electrically as the TDA2002 except that it does not include an overvoltage protection circuit.

Both versions are provided in a 5-pin power package, with two possible pin configurations designed to ease either horizontal or vertical mounting on the printed circuit board. A wide supply voltage range (+8 V to +18 V) can be accepted. A typical application would be use in car radio systems.

Supplied by Fairchild Instrument Co. Ltd., 230 High Street, Potters Bar, Herts. EN6 5BU.

IBA TUNES TO EUROPE'S SPACE SATELLITE

This magazine has frequently reported on the Amateur Satellite programmes and helped to foster an interest in this branch of amateur radio. In this issue, for example, there is an account of the successful launching of OSCAR 8 (Orbital satellite carrying Amateur Radio).

We have therefore been particularly interested to learn of the research by the Independent Broadcasting Authority in preparation for Eurovision programme exchange in the early 1980's and, in the longer term, for possible direct broadcasting to homes from space satellites.

IBA engineers at Crawley Court, Winchester are now receiving super-high-frequency (SHF) beacon transmissions from the new European Orbital Test Satellite.

The Orbital Test Satellite (OTS) of the European Space Agency was successfully launched from Florida on May 11, 1978 and has now been manoeuvred into position at approximately 11° East.

The special £75,000 IBA satellite receiving station with a compact 3-metre dish aerial was built last summer in readiness for OTS. When the first launch failed, the aerial was directed towards an Italian experimental satellite SIRIO positioned at 15° West and many propagation measurements have been made on the beacon transmissions from this satellite.

In the course of a special joint experiment, colour television pictures were received through SIRIO by means of the large 25-metre dish aerial of the Chilbolton Observatory of The Appleton Laboratory (Science Research Council) using the IBA's 12 GHz low-noise receiver. The Italian broadcasting organisation, RAI, relayed a lunchtime news bulletin in 625-line PAL colour.

This is believed to have been the first time that high-quality colour television pictures have been transmitted between different countries in Europe through a satellite at frequencies as high as 11.6 GHz.

AMATEUR RADIO EXHIBITIONS

THE RSGB AMATEUR RADIO EXHIBITION 1978

This year's exhibition was held at the Alexandra Palace, London, on May 5th, and 6th, which proved again to be a very successful venue. The layout and spaciousness was used to good advantage and there was ample to space to see all the exhibits comfortably.

AMSAT-UK, The Amateur Radio Mobile Society, the British Amateur Television Group, the British Amateur and Radio Teleprinter Group, and Raynet were among several groups who had stands. They, together with the Royal Corps of Signals and the Post Office, had much of interest to show.

Several items of new equipment were to be seen on the Trade stands and the component and surplus dealers had much to offer to keep the bargain hunters happy.

THE BAEC AMATEUR ELECTRONICS EXHIBITION 1978

Although much smaller than the RSGB exhibition readers who can get to the British Amateur Electronics Club exhibition to be held at the Shelter, Centre of the Esplanade, Penarth, South Glamorgan, from 15th to 22nd July, inclusive, will find much of interest to constructors judging by previous exhibitions.

The exhibition will open each evening from 7.00 p.m., except on 15th and 20th July. It will also be open in the afternoons on 15th, 16th and 20th July.

Again all proceeds will go to the Cancer Research Campaign to whom substantial sums have been donated in previous years.

. . . COMMENT

PORTABLE LANGUAGE LABORATORY

MANY PEOPLE learn foreign languages in a language laboratory — a classroom fitted with tape recorders, microphones, headsets and so on. But up till now this has meant setting aside a special room and installing expensive equipment. The result is that the room is then useful for nothing except language teaching — not a wise use of valuable teaching space in schools with limited facilities. BBC World Service has reported on a language laboratory that does not waste any space.

It is a completely portable language laboratory. Built to high specifications, using modern electronics, it is robust enough to withstand the rigours of heavy-handed teachers and pupils. The master control unit allows the teacher to control fast forward wind; rewind of the instructional tape; playback of the tape, without the students being able to interfere. Without 'clearance' from the teacher's console, no student can operate any of the recorder functions.

A single master console can accommodate up to 36 students and they can be working on any four programmes simultaneously, so slow learners can spend more time on the first lesson while the average learner plods on, and bright pupils race ahead.

The entire 36-student laboratory can be set up or dismantled in minutes. All connections are by plugs and sockets, and all you need to move the complete assembly of 36 student units are two small trolleys. For longer distances the whole assembly can be packed in lightweight cartons, ideal for road or air transport, and the makers claim that the whole laboratory can be operated after only half an hour of study of a comprehensive instruction book.

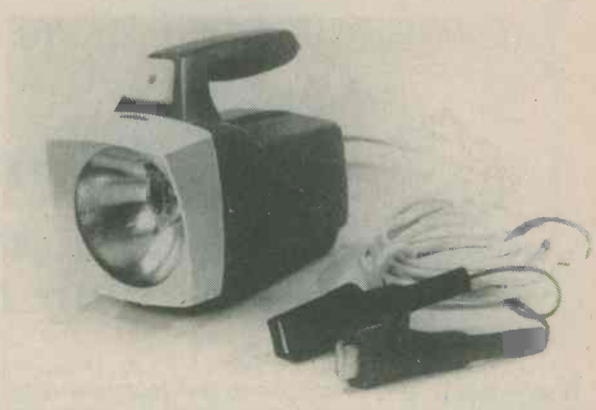
PEAK PROGRAMME METERS FOR PICCADILLY RADIO

Peak programme meters from the standard range manufactured at the High Wycombe factory of Ernest Turner Instruments, a member of the Hawker Siddeley Group, have been used in a new custom-built studio production control desk for Piccadilly Radio, the independent local radio station serving the Greater Manchester area. The desk was designed and built by electronic studio equipment specialists, Tweed Audio.

The new Tweed control desk was specifically designed to meet Piccadilly Radio's own special requirements for the production of radio commercials. It combines complex multi-channel control, monitoring and metering facilities using the latest solid-state circuitry throughout. A comprehensive jackfield is also provided to permit insertions in all incoming and outgoing lines.

Piccadilly Radio has six operational studios and is on the air continuously day and night with a full service. The station broadcasts on medium wave for mono reception and in the VHF-FM waveband for stereo.

DORAM RANGE OF CONSTRUCTIONAL KITS



Among the many kits available from Doram Electronics Ltd., is the Xenon ignition timing light kit shown in the photo above.

The Xenon ignition timing light kit features a flash brilliant enough to be used even in sunlight. A useful asset to any motoring enthusiast, the kit incorporates automatic polarity selection and inductive pick-up making it suitable for use with any 12v car electrical system. When not in use as a timing light the unit, which is housed in an attractive impact and oil resistant torch-like case, can be used to "freeze" movement using the unique Doram strobe control.

For further details of the range of Doram kits readers should write to Doram Electronics Ltd., PO Box TR8, Leeds LS12 2UF.

MICROVISION SCORES IN THE STATES

Sales of the Sinclair Microvision pocket television continue to boom in the USA. On average, over 80% of all production is airfreighted to the major cities in the States. The picture below shows the Microvision being used by spectators at American football, to watch close-ups and action replays of the live broadcast of the game.

As the set only weighs 26½ oz., it is very convenient to use on holiday where, whether at home or abroad, users can watch local or international events even when sitting on the beach, for example.

PHOTOCELL PROPERTY PROTECTOR

by D. Snaith

A Light-triggered device which gives warning of intruders.

Regrettably, we become more and more security-conscious these days, and considerably increasing interest is being shown in simple devices which are capable of giving warning of burglars and thieves. The circuit which forms the subject of this article is intended to give an audible warning of the presence of intruders. It is a light-operated device and is designed for use during the night, when its photocell can be situated in a position of complete or almost complete darkness. If any light falls onto the photocell, say from a torch or the striking of a match nearby, the circuit triggers to the alarm condition and stays in this state until switched off. When triggered, the device can cause an electric bell to ring, or it can actuate any other warning system.

DESIGN APPROACH

In the design of a protection device of this nature two considerations have to be given prior attention. The first of these is that the device should be battery operated, thereby conferring independence from the mains supply. Secondly, the current consumed from the battery when the circuit is in the stand-by condition should be very small as, otherwise, expenditure on batteries will be high. It is acceptable that a relatively high current is drawn from the battery after the device has been triggered and the alarm is being given.

The photocell employed in the circuit is the ORP12. This is a 2-terminal component which is also referred to as a "photoconductive cell" or as a "light dependent resistor". When brightly illuminated it offers a low resistance of 300Ω or less, whilst in total darkness it exhibits a resistance in excess of 10MΩ. It is a little sluggish in reaching high resistance values under conditions of total or near darkness, but such sluggishness is not apparent when its resistance falls again on being illuminated.

The circuit of the protection device appears in the accompanying diagram. The ORP12 is shown as PC1 and, in the stand-by condition, this exhibits a high resistance of the order of a megohm or more. It is connected in a potential divider in company with VR1, and a pre-set voltage is tapped off by VR1 slider and is applied to the base of TR2 via current limiting resistor R1.

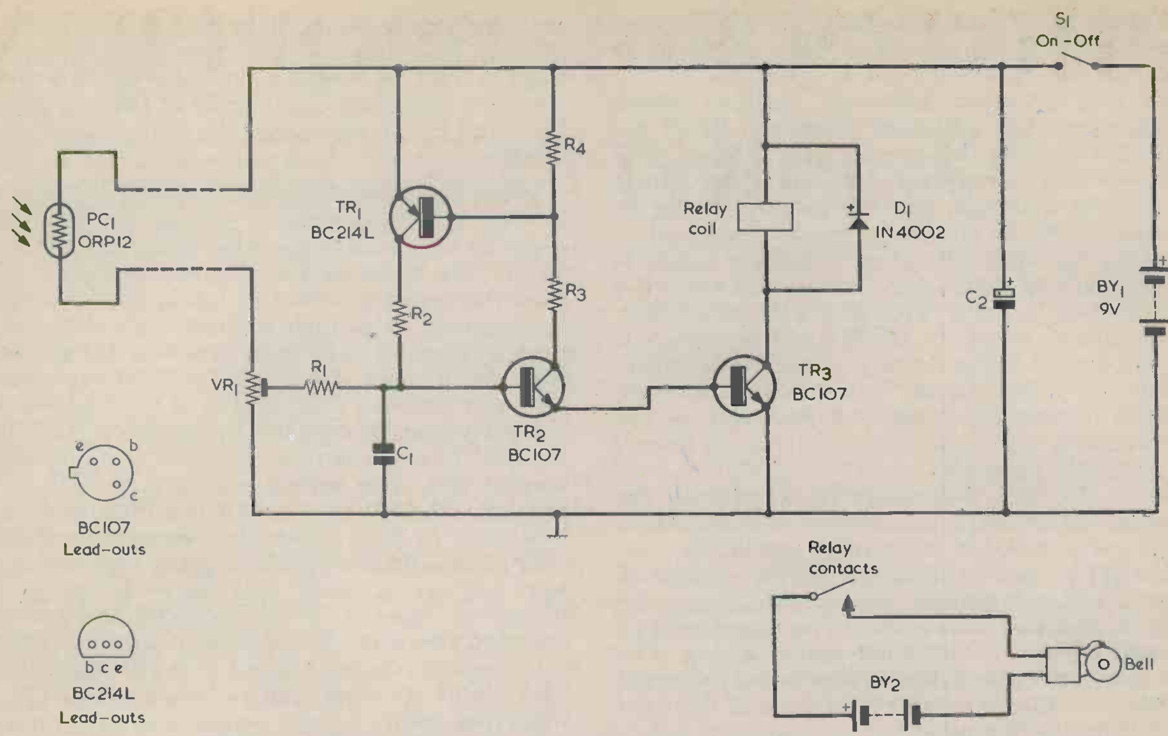
TR2 cannot pass collector current until the voltage on its base is about 1.2 volts positive of the negative rail. This voltage is needed since TR2 base has to be some 0.6 volt positive of its emitter, and there is a further 0.6 volt delay in the base-emitter junction of TR3. VR1 is set up such that, when the ORP12 exhibits its high resistance, the voltage applied to TR2 base is below the 1.2 volt level.

Since TR2 is not then conducting, negligible current flows through R4 and R3, or through the base-emitter junction of TR3. In consequence both TR1 and TR3 are also cut off. The only current drawn from the 9 volt battery, BY1, by the transistors is therefore leakage current, and is in the order of microamps. Current is also drawn by the ORP12 and VR1 but, with the ORP12 exhibiting a resistance of around 1MΩ, the current will be below 5μA. Under stand-by conditions there is in consequence, virtually zero current drawn from BY1.

If the ORP12 is illuminated its resistance drops and the voltage applied to the base of TR2 increases. When this voltage reaches about 1.2 volts positive of the negative rail, TR2 passes a collector current through R3, causing base current to flow into TR1. This in turn passes collector current via R2 into the base of TR2. A regenerative loop is set up which results in both TR1 and TR2 being turned hard on. Due to the relatively low value of R2, the circuit stays locked in this state even if the positive voltage at the slider of VR1 returns to its previous lower level. Thus, only a momentary illumination of the ORP12 is required to cause TR2 and TR1 to be turned hard on and to remain in this condition.

A current of slightly less than 2mA flows in the base-emitter junction of TR2 by way of R2 and, since this junction is forward biased, into the base-emitter junction of TR3 as well. TR3 can, as a result, pass sufficient collector current to energise the relay. The normally-open contacts of the relay close and complete the warning circuit which, in the diagram, is represented by a battery and bell.

To reiterate on current consumption, the current drawn from BY1 is negligibly low until the protection device is actuated by illuminating the ORP12. It then rises to the current needed to energise the relay plus abut 2mA in R2 and the transistors. In



The circuit of the property protection device. The transistors are normally cut off, and they latch on to the conducting state if the photocell is momentarily illuminated

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)
R1 100k Ω
R2 4.7kΩ
R3 100kΩ
R4 470kΩ
VR1 1m Ω pre-set potentiometer, 0.25 watt skeleton

Capacitors
C1 0.1μF polyester
C2 100μF electrolytic, 10 V. Wkg.

Semiconductors
TR1 BC214L
TR2 BC107
TR3 BC107
D1 1N4002

Photocell
PC1 ORP12

Switch
S1 s.p.s.t. toggle (see text)

Batteries
BY1 9 volt
BY2 voltage to suit bell

Miscellaneous
Relay (see text)
Bell
Metal case (see text)
Wire, solder, etc.

practice, there is a very narrow range of adjustment in VR1 which can cause TR2 to pass a current of up to some 30μA in R3 before TR1 turns on, but the appropriate settings of the potentiometer are then on the verge of causing TR2 and TR1 to turn on in the stand-by condition. These settings will be automatically avoided during the normal adjustment of the device.

If a warning bell is employed, this is operated by the second battery, BY2, the latter having a voltage suitable for the particular bell used. It is desirable to keep the bell and battery separate from the main circuit, as high bell transient currents and voltages could otherwise affect the operation of the electronics.

The function of capacitor C1 is to prevent any r.f., mains hum or static voltages picked up on the wiring to the ORP12 being passed to the base of TR2 and thereby causing false triggering of the protection device. D1 is the usual reverse-connected diode which prevents the formation of a high back-e.m.f. across the relay coil when the relay de-energises on switching off.

PRACTICAL POINTS

The circuit can be assembled in any metal case which will take the components and batteries. This box is made common with the negative supply rail. S1 may be a standard toggle switch or a key-operated switch such as is listed by Home Radio (Components) Ltd. The relay can be any type having a coil resistance of 250Ω or more which operates reliably at coil voltages around 7 volts. An excellent choice here is the 410Ω "Open Relay" with changeover contacts which is available from Maplin Electronic Supplies. The coil of this relay will draw about 22mA from the 9 volt supply, and it has a coil voltage operating range of 4.8 to 35 volts.

VR1 is a standard 0.25 watt skeleton potentiometer, and it is adjusted before the lid of the metal case housing the components is fitted. The sensitivity of the circuit will decrease as the voltage of BY1 falls with age, and the battery should be discarded when the voltage is about 7.5 volts when energising the relay. The effect of battery ageing is not very acute: if the battery can provide about 8.5 volts off load to allow TR2 and TR1 to initially start to turn on when the ORP12 is illuminated, it does not matter if the battery voltage falls subsequently due to the current in the relay coil. Since the latter is inductive it will not draw current instantaneously, and a reserve of current is in any case available from C2.

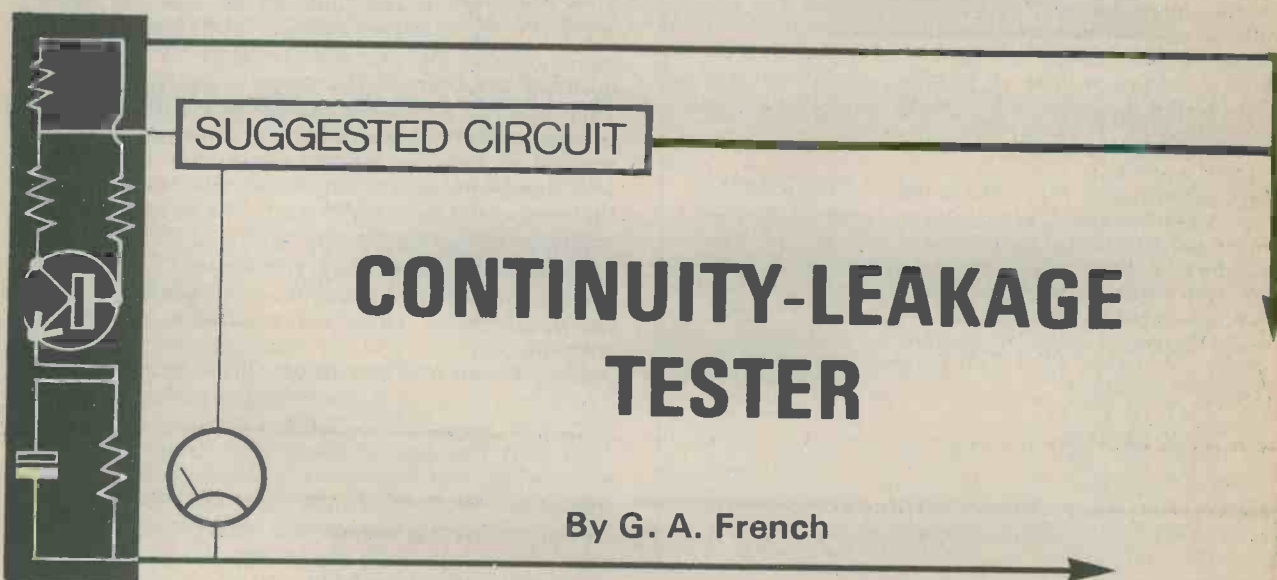
Due to the high resistances in the circuit, the device should be employed indoors in a dry situation. It is not suitable for outdoor operation.

The ORP12 can be mounted on the surface of the metal box or it may be connected to the box by way of up to 3 feet of twin flex. The flex should be kept well clear of unscreened mains wiring. The cell is mounted close to the objects being protected since there is then a greater likelihood of the light from a torch falling upon it.

The value chosen for VR1 is that which suits total or nearly total darkness for the ORP12 when it is in the stand-by condition. The circuit can be checked after it has been constructed under normal ambient lighting conditions, but it will be found difficult if not impossible to obtain satisfactory settings in VR1. It is only when the ORP12 is able to exhibit a resistance of the order of 1MΩ or more in the stand-by condition that the circuit is at its most effective.

When the device has been installed a period of a few seconds is allowed to enable the ORP12 to reach its high resistance value under the dark condition. The slider of VR1 is then advanced, away from the negative end of its track, until the device is triggered. S1 is then opened, VR1 slider is set back by about 5 to 10 degrees of rotation and S1 is then closed again. A few experimental adjustments will soon enable a final setting to be obtained, and sensitivity can be checked by shining a torch near the ORP12 or by striking matches at a distance of several feet. The setting required in VR1 is not critical, although adjusting it is a little fiddling as this has to be done in the dark! Remember that the ORP12 is a little sluggish in going high resistance but not, as is important here, in going low resistance. Also, it is not necessary to have VR1 adjusted very close to the position at which the circuit triggers; adequate sensitivity will be given with VR1 slider set back quite considerably from the triggering point.

If the ORP12 is in total or almost total darkness it may be possible to set VR1 slider fully to the positive end of its track, and this will be found to be a satisfactory setting in practice. ■



CONTINUITY-LEAKAGE TESTER

By G. A. French

Simple robust items of test equipment can be of considerable use to the amateur constructor, particularly if they are also inexpensive and can be made compact enough to fit into a pocket. The continuity-leakage tester to be described here requires less than a dozen low-cost components and can be readily assembled in a small plastic case.

CIRCUIT DIAGRAM

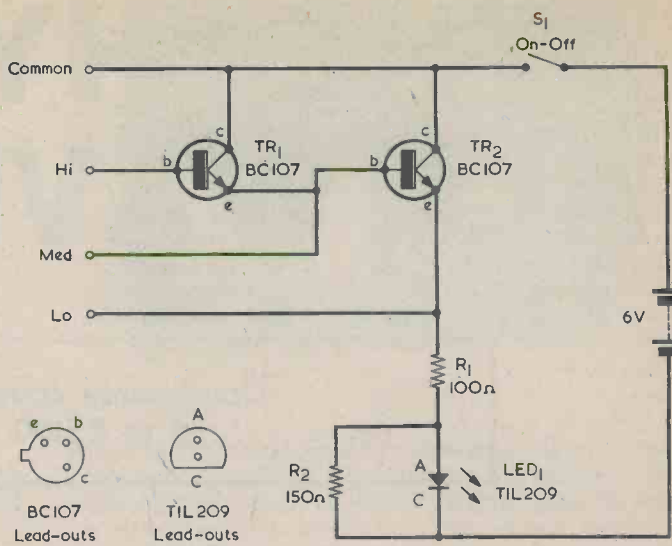
The circuit of the continuity-leakage tester is given in the accompanying diagram and it will be seen that it has four test terminals, these being designated "COMMON", "HI", "MED" and "LO". For checking continuity, connection is made between the "COMMON" and "LO" terminals, and the l.e.d. lights up when these two terminals are bridged. The l.e.d. lights up when the "COMMON" and "MED" terminals are bridged by resistances up to some 30kΩ and when the "COMMON" and "HI" terminals are bridged by resistances up to about 1.5M Ω.

The functioning of the circuit is very simple. When the "COMMON" and "LO" terminals are connected together, current flows from the 6 volt battery through R1 and then through R2 and LED1, causing the l.e.d. to be illuminated. Connecting together the "COMMON" and "MED" terminals causes current to flow into the base of TR2. This then functions as an emitter follower and the supply voltage, less 0.6 volt dropped in the base-emitter junction of TR2, is once more applied to R1, R2 and LED1. Because of the current amplification offered by TR2 the l.e.d. will light when a relatively low current flows into the base of TR2, whereupon it becomes possible to cause the l.e.d. to be illuminated with fairly high values of resistance between the "COMMON" and "MED" terminals.

If connection is made between the "COMMON" and "HI" terminals, the current gain offered by TR1 is added to that given by TR2, and the l.e.d. will light for high values of resistance between the two terminals. In this instance the voltage at the upper end of R1 is 1.2 volt less than the supply voltage because of the extra 0.6 volt dropped in the base-emitter junction of TR1. The "COMMON" and "HI" terminals may be used for leakage tests.

The presence of R2 across the l.e.d. limits its sensitivity, this being particularly desirable when employing the circuit for continuity testing. The l.e.d. will not light until a voltage of about 2 volts appears across it, whereupon it is necessary for the upper end of R1 to be 3.3 volts positive of the negative rail to cause the l.e.d. to be illuminated. With a battery voltage of 6 volts, continuity will only be indicated by resistances of less than 200 Ω.

The increase in sensitivity at the "HI" and "MED" terminals depends on the current gain of the two transistors, and is best checked empirically. With the prototype circuit the l.e.d. was illuminated at the two resistance values just mentioned. Constructors requiring a high degree of sensitivity may employ BC107C's for TR1 and TR2.



The circuit of the continuity-leakage tester. Sensitivity is governed by choosing the appropriate test terminals

BATTERY VOLTAGE

A simple circuit of this nature will inevitably have limitations, and it will be found that sensitivity falls with battery voltage as the battery ages. However, satisfactory results for all three levels of sensitivity will be obtained for battery voltages down to about 5 volts, at which point the battery will have offered much of its useful life.

The maximum current drawn from the battery is 40mA when the "COMMON" and "LO" terminals are connected together. Of this current about 13mA flows through R2 and 27mA through the l.e.d. The current drain when none of the test terminals are bridged consists of leakage current in the transistors, and is a matter of microamps only. The battery can be made up of four HP7 1.5 volt cells connected in series, or of any other series combination of four 1.5 volt cells.

The l.e.d. is shown as a TIL209, but any other small red l.e.d. may be employed instead. R1 and R2 are $\frac{1}{4}$ watt 5% components, and S1 is a small toggle switch.

The circuit can be assembled in a small plastic case with the switch, the l.e.d. and the four terminals mounted on the front panel. It will be found convenient to use insulated wander plug sockets for the terminals. Two test leads are also required, these being terminated in matching wander plugs. The remaining end of one test lead can then be fitted with a crocodile clip, and the remaining end of the other lead fitted with a test prod. ■

Mail Order Protection Scheme

The publishers of this magazine have given to the Director General of Fair Trading an undertaking to refund money sent by readers in response to mail order advertisements placed in this magazine by mail order traders who fail to supply goods or refund money and who have become the subject of liquidation or bankruptcy proceedings. These refunds are made voluntarily and are subject to proof that payment was made to the advertiser for goods ordered through an advertisement in this magazine. The arrangement does not apply to any failure to supply goods advertised in a catalogue or direct mail solicitation.

If a mail order trader fails, readers are advised to lodge a claim with the Advertisement Manager of this magazine within 3 months of the appearance of the advertisement.

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

"Direct response advertisements, display or postal bargains where cash has to be sent in advance of goods being delivered."

Classified and catalogue mail order advertising are excluded.

THE "HYBRID" ALL WAVE RADIO

Continuous coverage from 16 to 2,000 metres

This receiver uses three transistors and one valve. It is mains operated, the direct supply voltage appearing in the circuit being approximately 14 volts. It should be mentioned, for the benefit of prospective constructors who have been brought up in the all-semiconductor era, that the inclusion of a valve in this design gives very real benefits, and that construction and operation are not complicated in any way thereby.

Coverage is from just below the 16 metre short wave band to the top of the long wave band and it is continuous; there are no gaps. Four Denco plug-in coils are used to achieve this range. Amplified a.g.c. is employed and the output from the speaker is ample for a large room. A short indoor aerial is required, and a few yards of wire across the ceiling will do nicely. The earth connection is automatically provided by way of the mains.

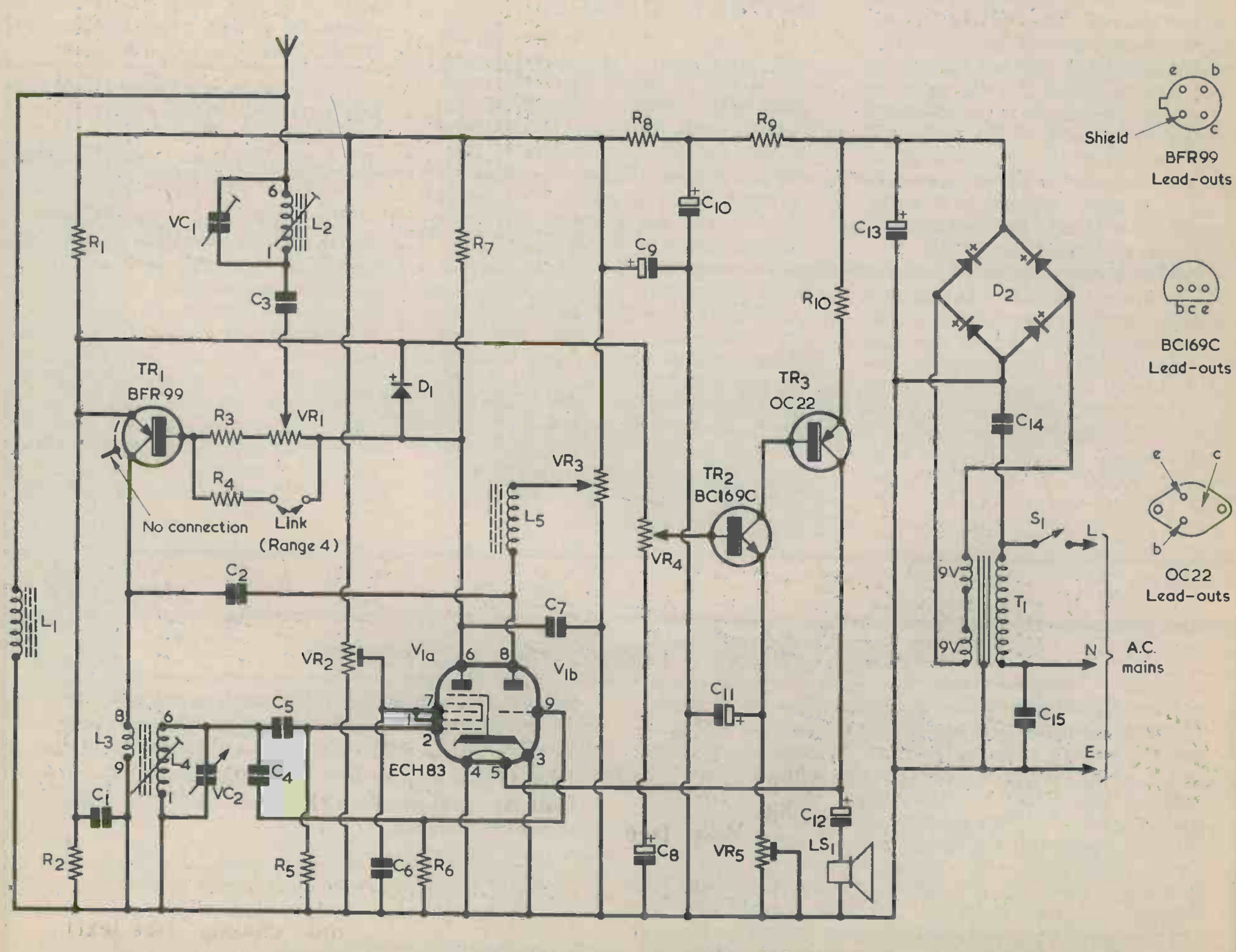
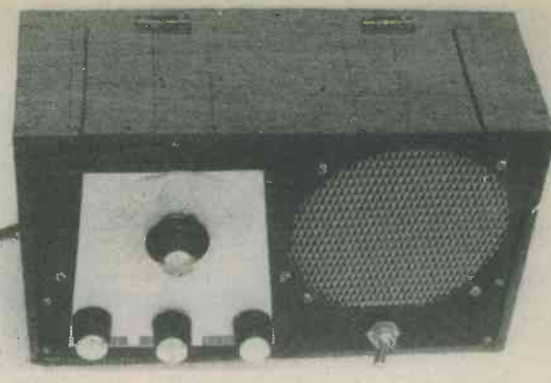


Fig. 1. The circuit of the receiver. This has a number of unusual features, including reflex operation at TR1 and the use of the valve heater as the output transistor d.c. load

Part 1 (2 parts)

By

Sir Douglas Hall, K.C.M.G.



CIRCUIT OPERATION

The receiver circuit is shown in Fig. 1. The aerial signal is applied to the main circuit via VC1 and L2, which constitute a wave trap. This may not always be necessary but in many areas, including that in which the author's house is situated, there is a strong local medium wave station which can break through and interfere with reception of other transmissions. L2 is a medium wave plug-in coil with the mica trimmer VC1 in parallel with its tuned winding. VC1 requires a maximum value of about 140pF if the wavelength of the offending station is between 200 and 300 metres, or about 500pF if the wavelength is greater than 300 metres. An in-

COMPONENTS

Resistors

(All fixed values 10% ¼ watt unless otherwise stated)

R1 3.3kΩ
R2 3.3kΩ
R3 390Ω
R4 390Ω
R5 220kΩ
R6 68kΩ
R7 100kΩ
R8 47Ω
R9 47Ω
R10 10Ω 2 watts
VR1 10kΩ potentiometer, log
VR2 22kΩ or 25kΩ pre-set potentiometer, skeleton horizontal
VR3 22kΩ or 25kΩ potentiometer, linear, "moulded carbon" or wire-wound
VR4 10kΩ potentiometer, log
VR5 22kΩ or 25kΩ pre-set potentiometer, skeleton horizontal

Capacitors

C1 0.1μF polyester
C2 0.1μF polyester
C3 220pF silvered mica or ceramic
C4 220pF silvered mica or ceramic
C5 10pF silvered mica or ceramic
C6 0.01μF polyester
C7 3,300pF silvered mica or ceramic
C8 4.7μF or 5μF electrolytic, 10V. Wkg.
C9 1,000μF electrolytic, 25V. Wkg.
C10 1,000μF electrolytic, 25V. Wkg.
C11 100μF electrolytic, 10V. Wkg.
C12 1,000μF electrolytic, 10V. Wkg.
C13 2,000μF electrolytic, 25V. Wkg.
C14 0.02μF or 0.022μF, 250V. A.C. Wkg. (see text)
C15 0.02μF or 0.022μF, 250V. A.C. Wkg. (see text)
VC1 mica trimmer (see text)
VC2 365pF variable, type "01" (Jackson)

Inductors

L1 10mH r.f. choke (Repanco or equivalent)
L2 Miniature Dual Purpose Coil, Yellow, valve usage, Range 2 (Denco)
L3, L4 Miniature Dual Purpose Coils, Yellow, valve usage, Ranges 1, 2, 3 and 4 (Denco)
L5 1.5mH r.f. choke (Repanco or equivalent)
T1 Mains transformer, secondaries 9v+9v, 330mA, type MT235CS (Douglas)

Semiconductors

TR1 BFR99
TR2 BC169C
TR3 OC22 (see text)
D1 1S44 (see text)
D2 Silicon bridge rectifier, 50 p.i.v. 1 amp minimum

Valve

V1 ECH83

Speaker

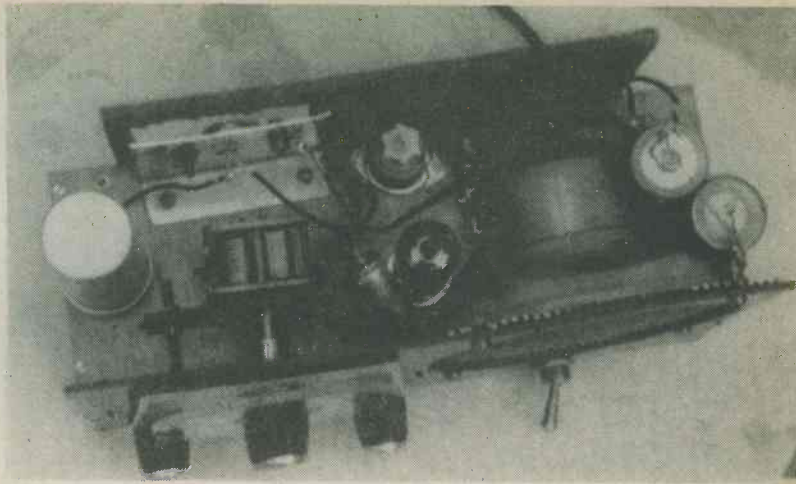
LS1 15Ω moving-coil, 5in. round

Switch

S1 s.p.s.t. toggle

Miscellaneous

18-way group panel (see text)
Ball drive type 4511/F (Jackson)
4 control knobs
3 B9A valveholders
Wander plug socket (for aerial)
3-core mains lead
Materials for case and "chassis" (see text)



Layout of components above the "chassis" deck

terfering station with a wavelength in the order of 200 metres will require a 20pF trimmer, and the dust core of the coil will need to be fully screwed out. The wave trap is adjusted for maximum rejection of the local station and is then left alone. L1 is merely a bypass r.f. choke and it prevents any hum picked up on the aerial being passed to the receiver input.

The aerial signal is next applied via C3 to the slider of VR1, which controls input level. This potentiometer provides a very useful variable selectivity control and it can be adjusted with minimal effect on tuning except at the highest frequencies available, where the reaction setting may be somewhat affected. R3 ensures that the aerial input cannot be applied direct to the base of TR1, a circuit condition which would result in spurious oscillation in some circumstances. R4 is brought into circuit on the highest frequency range by means of a wire link added across two unused pins of the appropriate coil. The consequent reduction in impedance at TR1 base results in a smoother control of tuning and reaction over the range concerned.

TR1 is a silicon p.n.p. transistor having a very good high frequency performance and it amplifies the aerial signal in the common emitter mode. The transistor specified has a lead-out connecting to its shield and case, but no connection is made to this lead-out. The output at its collector is applied to the coupling winding, L3, of whichever of the four Denco coils is plugged in. The coils employed are intended for inter-stage use with valves, and the tuned winding, L4, with VC2 in parallel, is applied via C5 to the control grid of V1(a). This is a heptode connected to function as a pentode and the relevant component values are such that it acts as a leaky-grid detector — the most sensitive form of a.m. detector there is. A considerably amplified signal, now at audio frequency, is built up across R7 and is applied to the base of TR1 via VR1 and R3 (and R4 when this is brought into circuit). TR1 acts as an emitter follower at a.f., presenting a high input impedance to the audio signal across R7 and producing an output at a much lower impedance across R1. This output is applied to volume control VR4.

As well as being applied to the control grid of V1(a), the r.f. signal from L4 and VC2 is also fed, via C4, to the grid of V1(b). This triode acts as a Q multiplier since it provides regeneration via C2 and L3 to the tuned winding, the regeneration level being controlled by VR3 which varies the anode voltage available for the triode. The connections to L3 are opposite to those given in the manufacturer's instructions for the coil, the reversed connection providing the correct phase relationship for regeneration.

Since V1(a) is a leaky-grid detector its anode current decreases on reception of a signal, the reduction in current being proportional to the strength of the signal. The lower anode current in R7 causes the anode to go positive which, in turn, reduces the base bias current for TR1 and thereby lowers its gain. The overall result is an automatic gain control loop. The a.g.c. effect is enhanced by the use of the potential divider, R1 and R2, to supply TR1 emitter. These two resistors keep the emitter at a nearly constant potential as its base bias varies.

Returning to the a.f. signal at the volume control, VR4, the slider of this component connects directly to the base of TR2. This is a high gain transistor connected in the common emitter configuration and its collector is directly coupled to the base of the output transistor, TR3. This again, is in the common emitter mode, but with very heavy negative feedback provided by R10. Bias is arranged so that TR3 passes a collector current of 300mA, and this passes through the heater of V1(a) (b), which is rated at this current. Thus. the valve heater provides the resistive load for TR3 collector, the latter being coupled to the speaker by way of C12. The arrangement is extremely unorthodox but it works excellently, the power lost because of the shunting of the speech coil by the heater being compensated for by the useful damping effect and the lack of direct current flowing through the speaker. It may be observed that the alternating signal current is superimposed on the direct current flowing through the heater, whereupon excess heater current could be passed. In practice, there is a small increase in current due to the output signal and at full output about 2 volts r.m.s. can appear across the heater. But the effect is reduced by the fact that maximum loading of TR3 reduces the direct current it passes. The valve is a type originally developed for use in car radios, which means that its heater can withstand voltages above its nominal 6.3 volts up to more than 7 volts.

In the present circuit the valve heater is subject to the same range of voltages as would be encountered in its intended function, and the valve suffers no harm.

There are two pre-set potentiometers for setting bias requirements. Of these, VR5 is adjusted so that the collector current passed by TR2, which is the base current of TR3, is such as to cause TR3 collector current to be 300mA. VR2 sets the screen grid potential of V1(a) and hence its anode current, and is adjusted such that, under no-signal conditions, V1(a) anode voltage provides a base bias for TR1 which allows it to pass a collector current of about 500μA.

The function of D1 is to prevent a high reverse voltage being applied across the base-emitter junction of TR1 when the receiver is switched on and the valve has not warmed up. Under this condition V1(a) passes no anode current and, without D1, R7 could take TR1 base considerably positive of its emitter. With D1 in circuit, however, the base cannot go positive of the emitter by more than 0.6 volt. When V1(a) commences to pass anode current the situation reverses with the base of TR1 being taken about 0.6 volt negative of its emitter. D1 is then reversed biased and has no further effect on circuit performance.

C14 and C15 prevent mains modulation hum. These two capacitors require a working voltage of 250 volts a.c. or more. Suitable mixed dielectric capacitors rated at 300 volts a.c. are available from Maplin Electronic Supplies.

The BFR99 listed for TR1 is available from Doram Electronics Ltd. Diode D1 can be any small silicon diode, such as the 1S44 listed. The mains transformer is a Douglas type MT235CS and can be obtained from Douglas stockists or direct from Douglas Electronic Industries Ltd., Eastfield Road, Louth, Lincolnshire, LN11 7AL. The tuning slow motion drive is fitted with a flange to take a pointer and is a Jackson type 4511/F. This is available from Home Radio (Components) Ltd. A number of tagstrips are required, and these may be cut out from a "standard" 18-way group panel as provided by Doram Electronics. Doram Electronics can also supply the 15Ω 5in. speaker which is required. Although most, if not all, speakers of the type specified have approximately the same dimensions this point cannot be guaranteed and

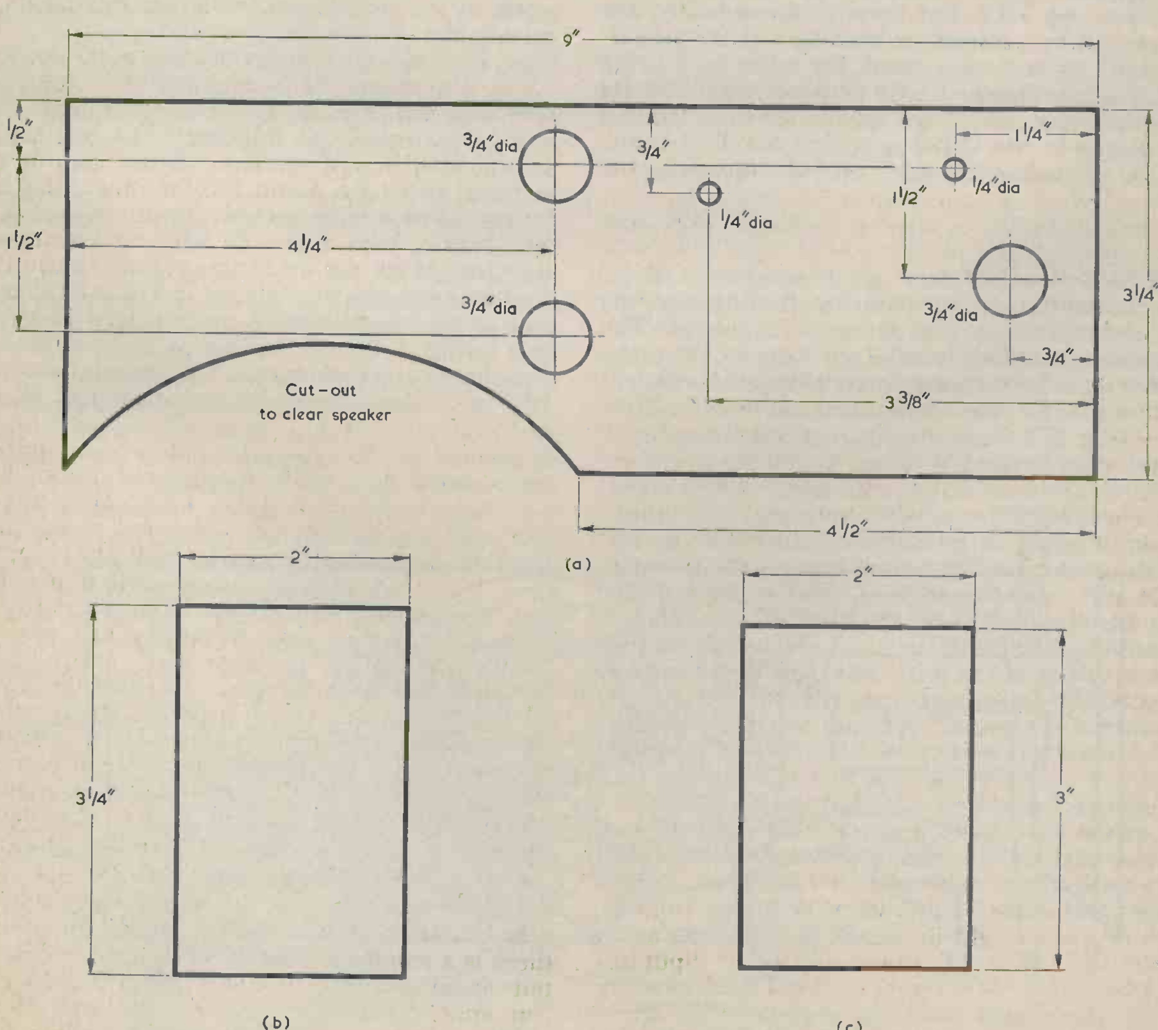
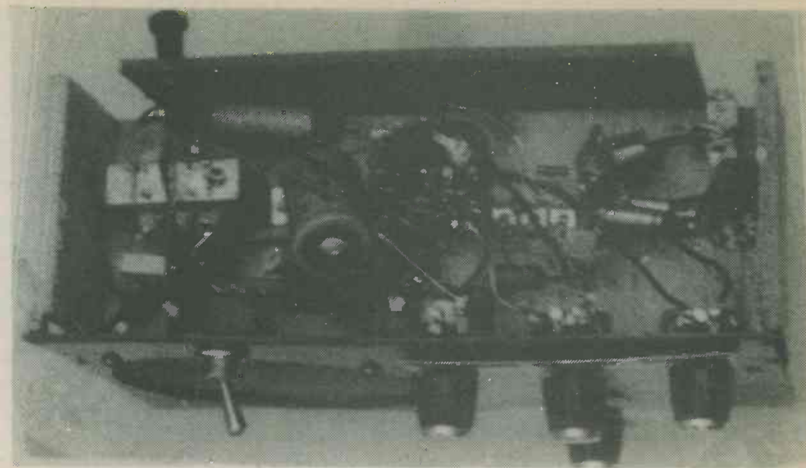


Fig. 2. Underside view of the "chassis" deck (a) after cutting out and dimensions of the two side supports, (b) and (c). The material is ¼in. plywood



The parts which are assembled on the underside of the receiver

constructors are advised to obtain the speaker before cutting out the plywood and other items on which the receiver parts are assembled. If any amendments to the cutting dimensions are required to suit the particular speaker to be employed they may then be made during this part of the construction.

A further point concerns the potentiometer employed for VR3. For maximum noise-free life this should be a miniature wire-wound or "moulded track" carbon component, the latter type being available from Home Radio (Components) Ltd. Its body diameter should not be greater than 1in. An alternative to the OC22 specified for TR3 is the 2N2147. This has the same lead-out layout as the OC22.

CONSTRUCTION

Construction commences by cutting out the item shown in Fig. 2(a) from $\frac{1}{4}$in. plywood. The dimensions needed for the cut-out to clear the speaker will become apparent shortly. Next drill the two $\frac{1}{4}$in. diameter holes and cut out the three $\frac{3}{4}$in. diameter holes for the valveholders. Drill out two 6BA clear mounting holes for each valveholder so that, when these are later mounted, their pins will take up the orientation shown in the wiring diagram of Fig. 3. Both Fig. 2(a) and Fig. 3 show the underside of the piece of plywood. Note that L2 will be fitted in a screening can; this is the can in which it is supplied, the can lid having a $\frac{3}{4}$in. hole made at its centre and being secured under the valveholder. Follow this by cutting out the items of Figs. 2(b) and 2(c), again using $\frac{1}{4}$in. plywood.

Fig. 4(a) shows the front panel as seen from the rear with the three potentiometers and the on-off switch mounted in position. The material is s.r.b.p., hardboard or any similar non-metallic material about $\frac{1}{8}$in. thick. Drill the mounting holes for the three potentiometers, the on-off switch and the speaker, then make the large circular speaker aperture. Mark out the centre only of the $\frac{3}{4}$in. hole then make up the item shown in Fig. 4(b). The $\frac{3}{8}$in. hole in this piece will be concentric with the $\frac{3}{4}$in. hole in Fig. 4(a), and the item is made of the same material as the front panel. Using the piece of Fig. 4(b) as a template, mark out and drill the cor-

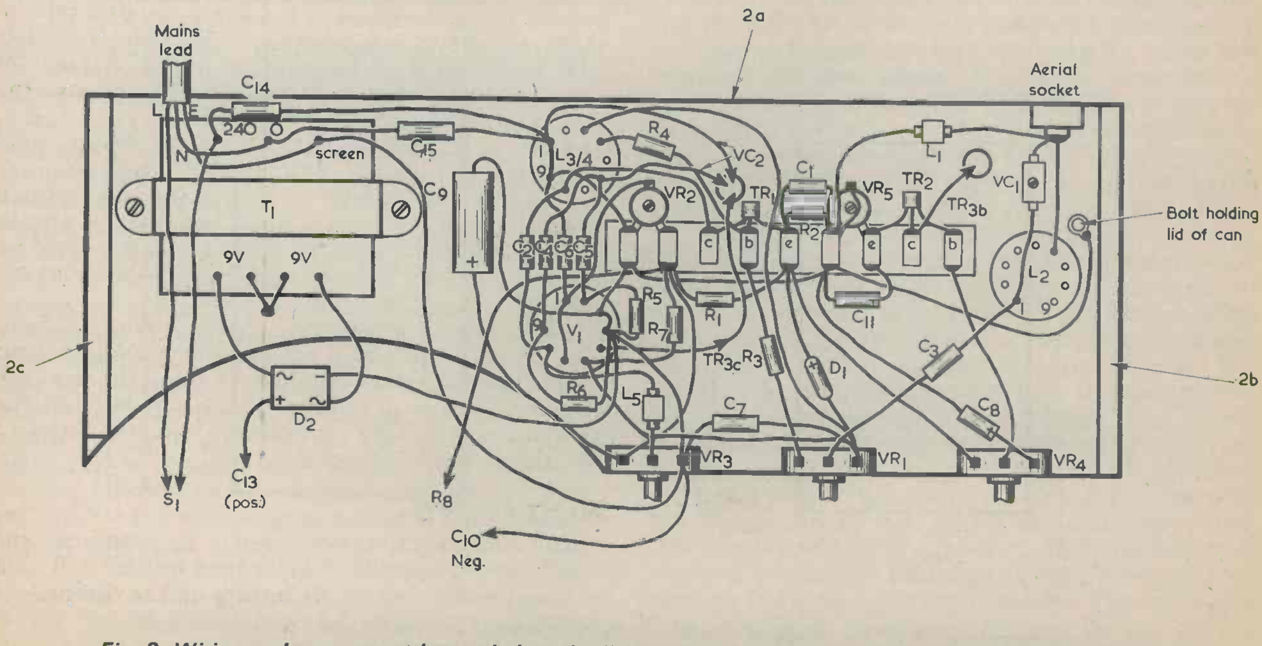


Fig. 3. Wiring and component layout below the "chassis" deck. The wiring should not be started until some constructional work, to be described next month, has been completed

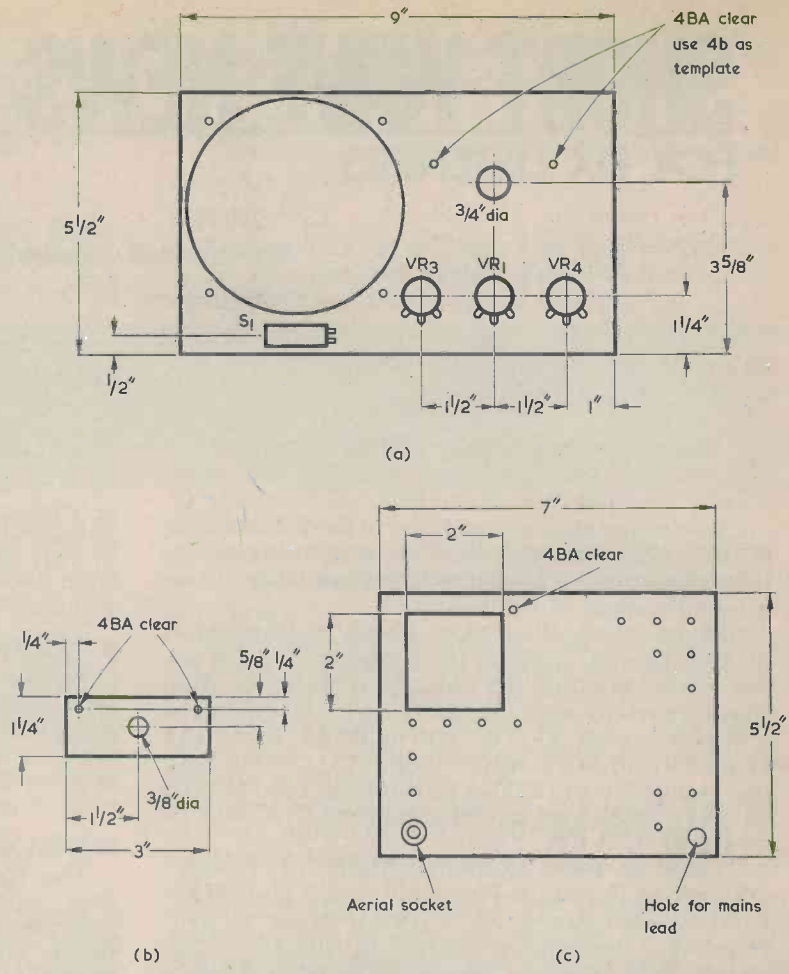


Fig. 4. (a) The front panel, as seen from the rear. (b) The item on which VC2 is mounted. (c) The rear panel. This is made from peg board

responding 4 BA clear holes in the front panel. These last two holes should be lightly countersunk at the front. Then cut out the $\frac{3}{4}$in. hole on the centre which has already been marked up. The hole should, in practice, be slightly larger than $\frac{3}{4}$in. as it takes the flange of the tuning drive.

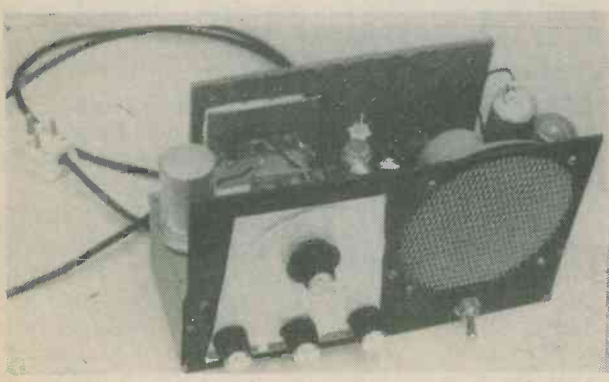
The items of Fig. 2(b) and Fig. 2(c) are now screwed to the ends of the piece of Fig. 2(a) on its underside so that the item of Fig. 2(a), when correct way up, is raised 2in. above any surface on which it is placed. Fig. 3 shows the positioning. Note that the piece of Fig. 2(c) does not quite reach the front, to leave space for the speaker frame.

When the parts are assembled the "chassis" consisting of Figs. 2(a), (b) and (c) is offered to the rear of the front panel of Fig. 4(a), the lower edges of the "chassis" and the front panel being at the same level. Using the speaker as a guide, the cut-out to clear it shown in Fig. 2(a) can next be made. The front panel is secured by woodscrews to the items of Figs. 2(a), (b) and (c), a $\frac{1}{4}$in. spacing washer being employed between the panel and Fig. 2(c).

The components so far discussed may now be assembled or mounted as applicable. If desired, the front panel can be covered with Fablon or left plain, according to the material used. A piece of gauze is interposed between the speaker and the front panel.

Cut out a 9-way tagstrip from the group panel and secure it to the underside of the "chassis" deck, as in Fig. 3, after first covering the plywood with a strip of p.v.c. insulating tape over the area to be covered by the tagstrip. The strip is mounted by means of small woodscrews passed through the central holes in the end tags.

Finally, cut out the piece shown in Fig. 4(c) from peg board. Drill out the holes for the mains lead and the aerial socket but do not cut out the two inch square aperture yet. This item is the back of the receiver and will be mounted to the rear edges of the three items of Fig. 2.



A view of the receiver removed from its case

NEXT MONTH

In next month's issue we shall complete the constructional details for this receiver and will then proceed to the process of setting up the two pre-set potentiometers.

(To be concluded)

SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT *Frequencies* = kHz

Clandestine stations continue to hold the interest of the writer and other short wave enthusiasts, the information below being the latest available on this piratical aspect of the hobby.

"Bizim Radyo" ("Our Radio") broadcasts programmes in Turkish, the contents of which are pro-communist and are thought to emanate from transmitters in East Germany and Romania. The schedule is from 0500 to 1550 on **9585**; from 1015 to 1045 on **9500**; from 1050 to 1115, 1740 to 1810 and from 1910 to 1925 on **9585**; from 2000 to 2100 on **5915** from 2005 to 2020 and from 2120 to 2155 on **6200**.

"Voice of the Communist Party of Turkey" ("Tuerkiye Komunist Partisinin Sesi") also broadcasts programmes in Turkish from a pro-communist transmitter located in Romania. This station may be heard from 0400 to 0430, 1640 to 1705 and from 1815 to 1900 on **9585**; from 0810 to 0840, from 2030 to 2100 and from 2200 to 2245 on **6200**.

Then we have the "Voice of Palestine, Voice of the Palestine Revolution" transmitting from Algeria in Arabic from 1603 to 1700 on **7195, 9685, 9705, 11740, 11810** and on **15160**, presented by the Palestine Liberation Organisation.

There is also "Voice of the Free Sahara", also based in Algeria, radiating in Arabic, Spanish or French from 2000 to 2100 on 11740, 11810 and on **15160**, organised by the Popular Front for the Liberation of the Sahara and Rio de Oro (the Polisario Front).

Or why not try **6160** or **7230** from 2303 to 2330 when you may log "Voice of the Chilean Resistance" in Spanish to Chile, the transmitter also being based in Algiers.

CURRENT SCHEDULES

The schedules published here are correct at the time of writing but some may be subject to changes at short notice.

● MEXICO

"Radio Mexico", Mexico City, radiates programmes in Spanish from 2155 to 0335 daily on **5985, 9705** and on **15385**.

● FINLAND

"Yleisradio", Helsinki, currently lists programmes in English to Europe as follows — from 0930 to 0955 (Saturdays and Sundays only) on **9550, 11755** and on **15270**; from 1300 to 1325 daily on **11755, 15105** and on **15260**; from 1325 to 1455 (Sundays only) on **11755** and on **15105**; from 1900 to 1925 daily on **9550** and on **11755** and from 2030 to 2055 daily on **6120** and on **9550**.

● YUGOSLAVIA

"Radio Yugoslavia", Belgrade, broadcasts programmes in English to Europe from 1530 to 1600 on **9620, 11735** and on **15240**; from 1830 to 1900 on **6100, 7240** and on **9620**; from 2000 to 2030 on **6100, 7240** and on **9620** and from 2200 to 2215 on **6100, 7240** and on **9620**.

● UGANDA

The Uganda Broadcasting Corporation, Kampala, operates an External Service in which programmes in English are intended for the areas shown via 250kW transmitters at Soroti. From 0900 to 1100 and from 1300 to 1417 in both English and vernaculars to East and Central Africa (relay of the domestic service Red Channel) on **6030**; from 1500 to 1530 to East and Central Africa on **6030**; from 1608 to 1650 to Southern Africa on **9515**; from 1700 to 1730 to East and Central Africa on **6030**; from 1805 to 1830 (Sundays, Tuesdays, Thursdays and Saturdays only) to West Africa on **15325** and from 2030 to 2100 (Sundays, Mondays, Wednesdays and Fridays only) to North Africa on **9730**.

● SEYCHELLES

"Far East Broadcasting Association", Mahe, offers programmes in English from 0400 to 0445 to East Africa (not Saturdays and Sundays) on **11800**; from 0700 to 0800 to South Asia (not Saturdays or Sundays) on **15160** and from 1530 to 1630 (not Saturdays or Sundays) South Asia on **9545** and on **11865**.

● ALGERIA

"Radio of the Democratic Peoples's Republic of Algeria", Algiers, has a programme in English for Europe from 1800 to 1900 on **7060** and on **7145**.

● EGYPT

"Radio Cairo" has an External Service in which programmes in English are presented as follows — from 1215 to 1330 to South and South East Asia on **17920**; from 1630 to 1830 to East, Central and South Africa ("Voice of Africa") on **15255**; from 2030 to 2200 to West Africa ("Voice of Africa") on **15375**; from 2215 to 2345 to Europe on **9805** and to the Americas from 0200 to 0330 on **6230** and on **9475**.

● **THAILAND**
"Radio Thailand", Bangkok, directs programmes in English to both Europe and Asia from 0415 to 0515 on **9655** and on **11905**; from 1055 to 1155 and from 2330 to 0155 on the same channels.

● **ETHIOPIA**
The "Voice of Revolutionary Ethiopia", Addis Ababa, has an International Service in which a programme in English is listed from 1700 to 1800 on **7155** and on **9595**.

● **JORDAN**
"The Broadcasting Service of the Hashemite Kingdom of Jordan", Amman, currently operates an English Service from 0500 to 0540 and from 1500 to 1730 on **9560**. Programmes in Arabic may be heard from 0330 to 0730 on **7155** and on **11920**; from 0730 to 0930 on **11920**; from 0930 to 1245 on **9530** and on **11920**; from 1400 to 1500 on **11920**; from 1500 to 1915 on **9530**; from 1915 to 2310 on **7155** and on **9530**.

● **KUWAIT**
"Radio Kuwait" has an English Service which is also intended for listeners overseas, from 0500 to 0800 to East and South East Asia on **9650** and on **15345** and from 1700 to 2000 to Europe on **9650** and on **12085**.

AROUND THE DIAL

● **ECUADOR**
Radio Nacional Progresso, Loja, on **5060** at 0442, OM announcer, songs in Spanish, guitar music. The schedule is from 1030 to 0415 (varies at sign-off) and the power is 5kW. This one quite often puts in a good signal to the U.K.

La Voz de los Caras, Bahia de Caraquez, on **4795** at 0445, OM with full and clear identification followed by local pop song in Spanish. The schedule is from 1300 to 0400 (Sundays to 0520) and the power is 3kW.

Radio Popular, Cuenca, on **4801** measured (**4800** nominal) at 0422, YL with songs in Spanish, local-style dance music. This one can often be heard after Radio Lara signs off at 0400. The schedule of Radio Popular is on a 24-hour basis and the power is 2kW. Sometimes identifies as "Radio Amiga Popular de Cuenca".

● **NEW CALEDONIA**
Radio Noumea on **11710** at 0803, OM with a newscast in French — just barely audible at that!

● **ICELAND**
Reykjavik on **12175** at 1836, identification by OM and station announcements, all in English.

● **AUSTRALIA**
Melbourne on **9570** at 0834, OM with a local newscast in English.

● **NORWAY**
Oslo on **15175** at 0524, OM in Norwegian to North America, the Middle East and South Asia, scheduled from 0500 to 0630 daily.

● **KUWAIT**
Radio Kuwait on **15345** at 0530, full identification and a world newscast in English by YL.

● **CHILE**
Santiago on **15150** at 2200, local music then OM with identification and news in German. The "Voice of Chile" also heard in parallel on **15115**.

● **PAKISTAN**
Radio Pakistan on **15115** at 1105, OM with the local news, slow-speed dictation, all in English.

● **CHINA**
Radio Peking on **17680** at 1110, Chinese music YL with programme for Kampuchea (Cambodia), schedule on this channel from 1030 to 1130.

Radio Peking on **17635** at 1117, local-style music then YL with the programme for Indonesia scheduled from 1030 to 1130.

Radio Peking on **15045** at 1332, Chinese classical music then YL with the programme intended for Malaysia, scheduled here from 1300 to 1400.

Radio Peking on **7485** at 1545, Chinese classical music in the programme beamed to Iran and Afghanistan scheduled from 1530 to 1600.

Radio Peking on **7315** at 1548, OM with the programme in English intended for South Asia, scheduled from 1500 to 1600 on this channel.

Radio Peking on **9900** at 1745, YL with songs in the Hakka programme for South East Africa and South East Asia, scheduled from 1700 to 1800.

Urumchi on **5060** at 1732, sign-off with choral 'Internationale'.

● **UGANDA**
Kampala on a measured **5026** at 1925, local music, OM with identification "Home Service from Kampala" and a newscast in English at 1930.

NOW HEAR THIS

La Voz de la Selva, Iquitos, Peru, on **4825** at 0355, local-style dance music then OM with identification in Spanish.

NEW 1978 CATALOGUE

The new 1978 catalogue of A. Marshall (Lon.) Ltd., 40-42 Cricklewood Broadway, London, NW2, is now available at 45p post paid or 35p to callers. In addition to the Cricklewood Broadway address, Marshall's have retail premises at 325 Edgware Road, W2, 85 West Regent Street, Glasgow, and 1 Straits Parade, Fishponds Road, Bristol.

The catalogue has 40 large pages listing over 8,500 line items, including products from National, Texas, Siemens, Sescosem, Vero, Antex, Electrolube, Sifam and Arrow Hart. For all these companies Marshall's are officially appointed distributors.

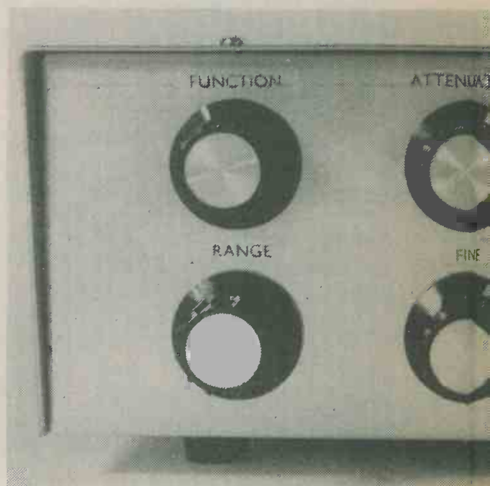
As well as listing a wide range of components the catalogue is particularly strong in semiconductor devices, these extending from diodes to microprocessor integrated circuits. A helpful feature is that pinout diagrams are given for many of the integrated circuits and for all the discrete devices. The catalogue has a large number of clear illustrations and an index assists in rapidly locating any individual item. All prices quoted are VAT inclusive.

VARIABLE-C A

Part 1 (2 parts)

* SINE AND SQUARE WAVE OUTPUTS

* LONG-LIFE VARIABLE



There can be little doubt that an a.f. signal generator is one of the most useful pieces of test gear for checking and evaluating audio equipment. It is used in the measurement of frequency response, distortion, transient response and other parameters. Units of this type are easily produced by the home-constructor, and a simple a.f. signal generator forms the subject of this article.

It has four frequency ranges which are approximately as follows: Range 1, 20 to 400Hz; Range 2, 200Hz to 4kHz; Range 3, 2kHz to 40kHz; Range 4, 20kHz to 400kHz. These are very slightly lower than the calculated theoretical ranges, incidentally, due to the shunting effects of stray circuit capacitances on the frequency selective components. The first three ranges cover more than the entire audio frequency spectrum and Range 4 could therefore be omitted, if desired. However, it is normal practice for equipment of this type to have a coverage which extends to 100kHz or more. Both sine wave and square wave outputs are available.

The generator is completely self-contained, with power being provided by an internal 9 volt PP6 battery. The current consumption is about 10mA in the sine wave mode and approximately 1mA higher in the square wave mode. The maximum output amplitude is about 1 volt r.m.s. sine wave or 1.3 volts peak-to-peak square wave. A switched attenuator can reduce this by 20dB (10 times) or 40dB (100 times) and a volume control type of attenuator provides a continuously variable output level from zero to the level selected by the switched attenuator. The circuit is very simple and uses only three active devices including two CMOS operational amplifiers, but both the sine and square output waveforms are of high quality.

WIEN NETWORK

Some a.f. signal generators these days employ shaping techniques to produce the required waveforms but, although these have certain advantages over the popular alternative technique of a Wien bridge oscillator and squaring circuit, in general the quality of the shaped sine wave output is considerably inferior to that produced by the latter. Therefore, this design is based on a Wien bridge oscillator which produces a high quality sine wave. A high gain amplifier converts the sine wave to a square wave so that either type of waveform can be selected.

The circuit configuration of a Wien frequency selective network is shown in Fig. 1(a). The circuit is normally designed so that Ra equals Rb and Ca equals Cb, whereupon the frequency of operation, at which the output is in phase with the input, is given by the equation

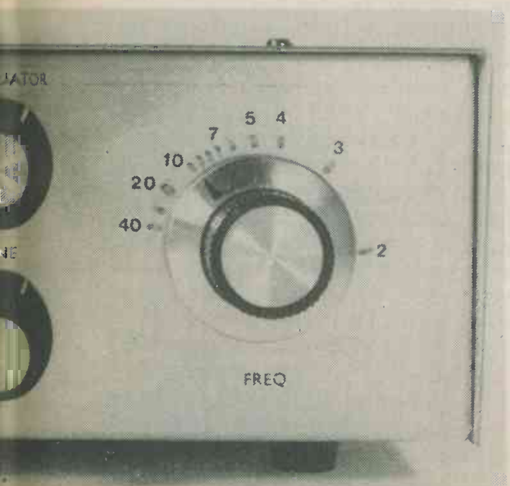
$$f_o = 1/2\pi R.C.$$

.F. GENERATOR

By P. R. Arthur

S * 20Hz TO 400kHz IN 4 RANGES

E CAPACITOR TUNING



The important feature of the Wein network is that it provides zero phase shift at its operating frequency, together with some degree of phase shift at other frequencies.

The Wein network can be used in the oscillator circuit shown in Fig. 1(b), where it is connected between the output and non-inverting input of an operational amplifier. In consequence, positive feedback is applied to the amplifier at the operating frequency of the Wein network, and the circuit will oscillate provided the gain of the amplifier at least compensates for the losses in the network.

In order to obtain a good sine wave output having a low harmonic distortion content it is necessary for the gain of the operational amplifier to be no more than is absolutely necessary to produce oscillation. There is then only sufficient gain to provide oscillation at the Wein operating frequency, and the circuit is prevented from oscillating at frequencies close to the operating frequency or from oscillating so violently that clipping of the output occurs. The closed loop gain of the amplifier is controlled by the potential divider given by Rc and Rd, which provides negative feedback between the output of the amplifier and its inverting input. The amplifier needs to have a voltage gain of approximately 3 times to cause the circuit to gently oscillate, but the exact voltage gain which is required in practice varies slightly with changes in the values of the frequency selective components.

In a conventional circuit the operating frequency of the oscillator is normally varied by making Ra and Rb variable resistors, whilst Ca and Cb are switched capacitors. In this way several tuneable ranges are provided and the circuit can be made to cover the entire audio frequency spectrum. The

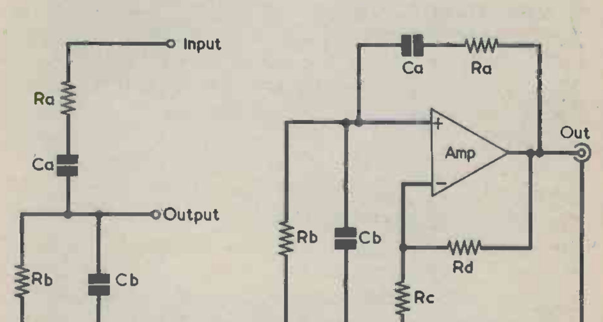


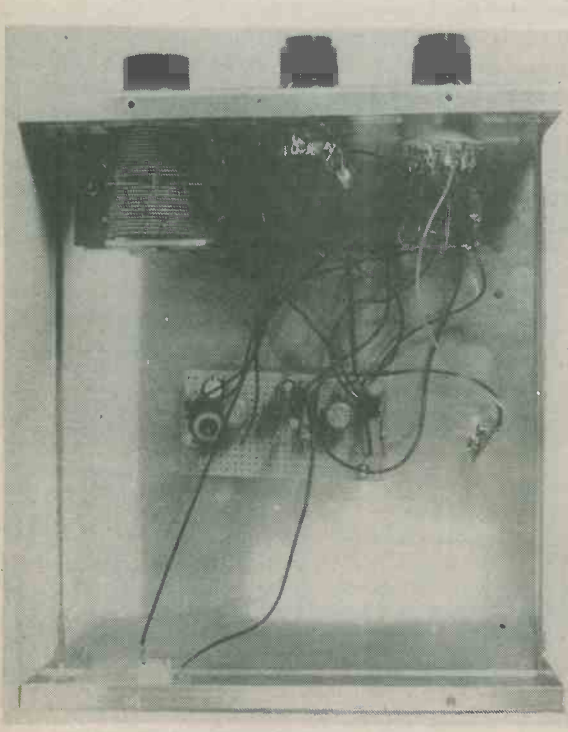
Fig. 1(a). Frequency selective components in a Wien network. (b) Coupling the Wien network to an operational amplifier variation in the Wien network resistors makes it impracticable for Rc and Rd to be pre-set for the desired degree of gain, since this varies at the different frequencies of oscillation. Either Rc or Rd could be made variable so that the gain of the amplifier can be adjusted manually to the appropriate level for any frequency selected, but it is more usual to employ some form of automatic gain control. This is obviously more convenient in use and it also provides more consistent results, particularly with regard to the output amplitude, which is effectively stabilized by the a.g.c. circuitry.

As just stated, it is normal for the resistive part of the Wien network to be variable and the capacitive part to consist of switched fixed values. However, there is no reason why a dual-gang variable capacitor and fixed value resistors should not be used instead, the only problem with this arrangement being that the amplifier needs to have an extremely high input impedance since it must place very little loading on the Wien network. The input impedance of the amplifier must, in fact, be very high in comparison with the impedances in the network. Variable capacitors having a maximum capacitance of more than a few hundred picafarads are not readily available, and this makes it necessary to use high value resistors in order to obtain operation at low audio frequencies. The capacitive reactances will then be at a similarly high order.

With modern components a very high amplifier input impedance can easily be achieved, and a CMOS CA3130T op-amp is used in the present design. This device has a typical input impedance of 1.5 million megohms. Its input impedance falls at high frequencies due to its small but inevitable input capacitance, but this does not matter as the impedances in the Wien network also fall at high frequencies.

Apart from the interest value, there is a practical advantage in using a variable capacitor and fixed resistors. The fixed value components normally have close tolerances so that one frequency scale can be used for all the ranges. Close tolerance resistors (for at least the lower values) are far cheaper than close tolerance capacitors, and this more than offsets the additional cost of a dual-gang variable capacitor in comparison with a dual-gang variable resistor. Also, in the author's experience the tuning potentiometer of an a.f. signal generator tends to wear out rather quickly if the unit is used a great deal. Variable capacitors are considerably more hard-wearing, and seem to last indefinitely.

This circuit, then, uses a variable capacitor and switched fixed resistors in the Wien network. As with the version having variable resistance it still, of course, requires an a.g.c. circuit to control amplifier voltage gain.



The Veroboard panel is located centrally on the bottom of the instrument case. The dual-gang variable capacitor is mounted on an s.r.b.p. panel

THE CIRCUIT

Fig. 2 gives the complete circuit of the a.f. signal generator. IC1 is the Wien bridge oscillator amplifier, and VC1-2 is the variable capacitor. R4 to R11 are the fixed resistors in the Wien network, and the two resistors required for each range are selected by switch S1(a) (b). The non-inverting input of the i.c. is biased to about half the supply potential by R2 and R3, the bias voltage being passed to the non-inverting input via whichever resistor is switched into circuit by S1(a). C3 provides decoupling for the bias voltage.

A thermistor with a negative temperature coefficient, TH1, is connected between the output of IC1 and its inverting input, and the a.c. voltage gain of the i.c. is equal to the resistance of the thermistor divided by the value of R1. C2 provides d.c. blocking. TH1 is not the usual type of thermistor which is designed to sense ambient temperature; in fact just the opposite is the case. It is mounted in an evacuated glass encapsulation on thin leads so that to a large extent it is isolated from the outside temperature. Also, whereas most thermistors are designed so that the current passing through them has very little heating effect, this particular device is designed so that very little current needs to flow through it in order to produce a significant increase in its temperature. Being a negative coefficient type, its resistance falls with increasing temperature.

When the circuit is initially switched on, TH1 is cold and has a high resistance. This causes the circuit to oscillate violently and a fairly high current to pass through the thermistor, which results in its temperature rising. Its consequently falling resistance, in turn, causes the gain of the circuit to be reduced and the amplitude of the oscillations to drop to a low level which produces only moderate heating of the thermistor. If adjusting VC1-2 should result in the circuit oscillating more violently, then the thermistor will become more heated, its resistance will fall, and the gain of the circuit will be reduced to a level which brings the output amplitude back to virtually its previous level. If, on the other hand, adjusting VC1-2 should result in reduced output amplitude, or even in oscillation ceasing altogether, the thermistor will sense the

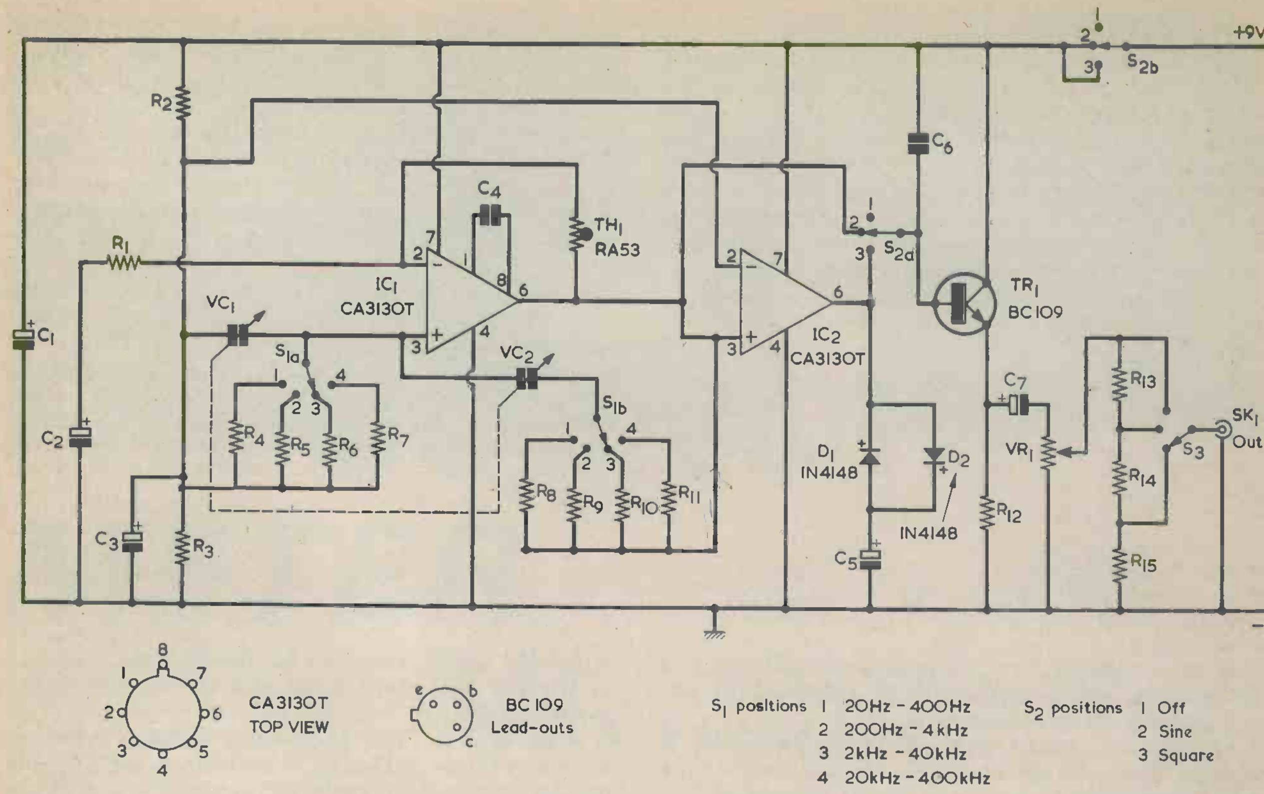


Fig. 2. The circuit of the a.f. signal generator. An unusual feature for a design of this nature is that frequency is selected by a dual-gang variable capacitor

COMPONENTS

Resistors
(All fixed values ¼ watt 5%)
R1 470Ω
R2 2.7kΩ
R3 2.7kΩ
R4 20MΩ (see text)
R5 2MΩ (see text)
R6 200kΩ (see text)
R7 20kΩ (see text)
R8 20MΩ (see text)
R9 2MΩ (see text)
R10 200kΩ (see text)
R11 20kΩ (see text)
R12 680Ω
R13 3.6kΩ
R14 360Ω
R15 39Ω
VR1 1kΩ potentiometer, linear

Capacitors
C1 100μF electrolytic, 10 V. Wkg.
C2 100μF electrolytic, 10 V Wkg.
C3 10μF electrolytic, 10 V. Wkg.
C4 68pF ceramic plate
C5 100μF electrolytic, 10 V. Wkg.
C6 33pF ceramic plate
C7 100μF electrolytic, 10 V. Wkg.
VC1-2 365 + 365pF 2-gang variable, type "02" (Jackson)

Semiconductors
IC1 CA3130T
IC2 CA3130T
TR1 BC109
D1 1N4148
D2 1N4148

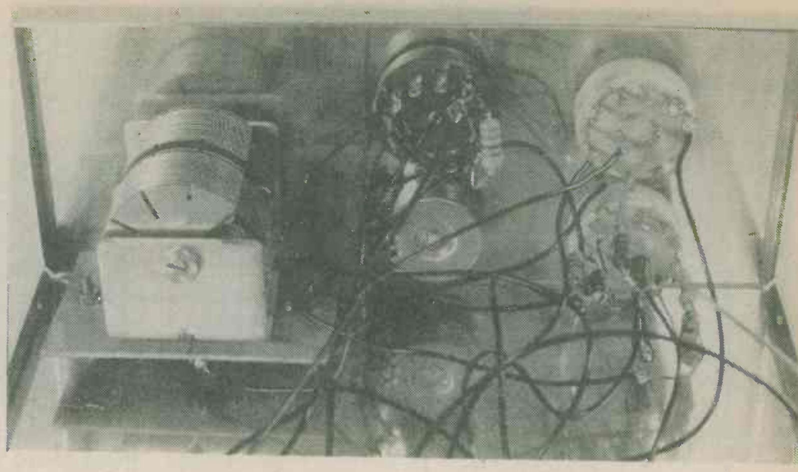
Thermistor
TH1 RA53

Switches
S1(a) (b) 2-pole 4-way rotary (see text)
S2(a) (b) 2-pole 3-way rotary (see text)
S3 1-pole 3-way rotary (see text)

Socket
SK1 3.5mm jack socket (see text)

Miscellaneous
Metal case (see text)
Veroboard, 0.1in. matrix
S.R.B.P. panel
5 control knobs
9-volt battery type PP6 (Ever Ready)
Battery connector
Bolts, nuts, wire, etc.

The Wien network and attenuator resistors are soldered direct to the tags of the associated switches



decreased current flow, its resistance will rise and the output signal level will be returned to approximately its previous level.

This system works very efficiently and there is no significant change in output amplitude over the entire frequency range of the signal generator. The thermistor is a rather expensive component, but it is much simpler to use than other control elements and it also introduces less distortion than alternative techniques using Jugfets or MOSFETs. The distortion factor of the prototype was measured as 0.3% at 1kHz, but the performance of individual units built up to the circuit may vary somewhat from this figure. (The distortion factor is the total noise and distortion remaining in the output after the fundamental signal has been filtered out).

SQUARING

IC2, a second CA3130T operational amplifier, provides the squaring action. It is used here as a comparator. The inverting input is connected to the bias voltage at the junction of R2 and R3, and the non-inverting input is connected to the sine wave output of IC1. If no connection were made to it, the output of IC2 would be low (virtually equal to the negative supply rail potential) when the non-inverting input is negative of the inverting input, and high (virtually equal to the positive supply rail potential) when the non-inverting input is positive of the inverting input.

On positive-going half-cycles from IC1 the non-inverting input of IC2 is taken positive of the inverting input, and on negative-going output excursions it is taken negative of the inverting input. Thus, the output of IC2 will go high on positive input signals and low on negative ones, with a square wave of 1:1 mark-space ratio being produced in consequence.

The peak-to-peak amplitude of this square wave will be virtually equal to the supply rail potential, and this is more than is really required. D1 and D2 are therefore included in the circuit to clip the square wave signal at about plus and minus 0.65 volt, giving an output amplitude of about 1.3 volts peak-to-peak. This clipping circuit also slightly improves the output waveshape. C5 couples the lower ends of D1 and D2 to chassis and provides d.c. blocking. The output current from IC2 flowing into either D1 or D2 is limited by the current capability of the i.c. and there is no risk of damage to the diodes or the i.c.

After IC2 is TR1, an emitter follower which is used to provide buffering at the output. S2(a) (b) is the function switch, with S2(a) providing either a sine or a square wave output depending upon which i.c. output it connects to TR1 base. S2(b) provides on-off switching. C7 couples the output from TR1 to the variable output attenuator, VR1. R13 to R15 form the coarse output attenuator, with the desired output being selected by the attenuator switch, S3.

C1 is the supply decoupling capacitor, and C4 and C6 are needed to prevent instability.

The components employed should not be difficult to obtain. Both S1 and S2 are 2-pole 6-way rotary switches with adjustable end stops. S1 is set for 4-way operation and S2 for 3-way operation. S3 is a single pole 12-way type with an adjustable end stop set for 3-way working. The thermistor, TH1, is available from Maplin Electronic Supplies. D1 and D2 should be high speed types, as specified; other types may cause the appearance of an overshoot "whisker" at the leading edge of each square wave half-cycle.

The two 20M resistors, R4 and R8, are not readily available as such, and each can consist of two 10MΩ resistors in series. Similarly, R5 and R9 can consist of two 1MΩ resistors in series. The Wien network resistors, R4 to R11, can be 5% types without introducing any serious scale inaccuracies. If a very high degree of scale accuracy is required, R6, R7, R10 and R11 can be 2% or even 1% types, with R5 and R9 each consisting of two 2% or 1% 1M Ω resistors in series. It will be difficult to obtain close tolerance resistors for R4 and R8 and so the 20 to 400Hz range may have a lower scale accuracy than the others. In general, 5% resistors in the Wien network will be more than adequate for nearly all the possible uses to which the signal generator will be put. The attenuator resistors, R13 to R15, will also be satisfactory at 5%.

Constructional details will be given next month.

(To be concluded)

CMOS DIGITAL FREQUENCY METER

Part 2 (Conclusion)

By R. A. Penfold

The concluding article describing this attractive item of test equipment.

In last month's issue we described the method of operation of the frequency meter then proceeded to the input and prescaler stages, and to their assembly on their printed circuit board. We next discussed the circuit of the counter/divider section of the unit. We now proceed to the construction of this section.

COUNTER BOARD

The component layout and copper pattern of the counter/divider board are reproduced full size in Fig. 6. No attempt has been made to cram the components into the smallest possible space, in fact the design approach is just the opposite. By leaving the i.c.'s reasonably well spaced out, home production of the board should not be too difficult for any reasonably experienced constructor.

The holes for trimmer C11 and the crystal socket may vary in position with some components from those shown in the diagram. These two pairs of holes should therefore be marked out and drilled with the aid of the components themselves. The leads emanating from the 4026 i.c.'s and identified as "A" to "G" will connect to the appropriate segments of the displays. The three mounting holes are 6BA clearance size.

Two important points should be carefully noted in connection with this assembly. First, as was mentioned last month, CMOS i.c.'s can be damaged by high static voltages at their inputs, and such voltages are not uncommon in a domestic environment. The particular CMOS i.c.'s used here are among the more expensive types and so they must be handled with due care.

Normally, CMOS i.c.'s are supplied in some form of protective packaging, such as a plastic tube, conductive foam or metal foil. Do not remove the i.c.'s from this packaging until they are to be connected into circuit, and then handle them as little as possible. Use i.c. sockets or Soldercon pins for the CMOS i.c.'s and do not connect the i.c.'s into circuit until all the other components have been soldered into place on the board. Preferably they should be fitted after all external connections to the board have been completed.

The second point concerns switch S1(a)(b). For the reasons given last month, this must be a break-before-make type.

POWER SUPPLY

The circuit of the power supply is shown in Fig. 7, in which the mains is applied to the primary of transformer T1 via S3(a)(b). The transformer has two 15 volt 200mA secondary windings and these are connected in parallel to give what is effectively a single 15 volt 400mA secondary. Parallel connection of the secondary windings is permissable with the particular transformer specified, but may not be so for other similar types, and this point should be checked before any substitute transformer is employed. The reason for this statement is that some transformers may not have accurately matched secondary windings, with the result that one winding produces a slightly higher voltage than the other. Parallel connection would then result in internal current flow from the first winding into the second, with consequent overheating and the

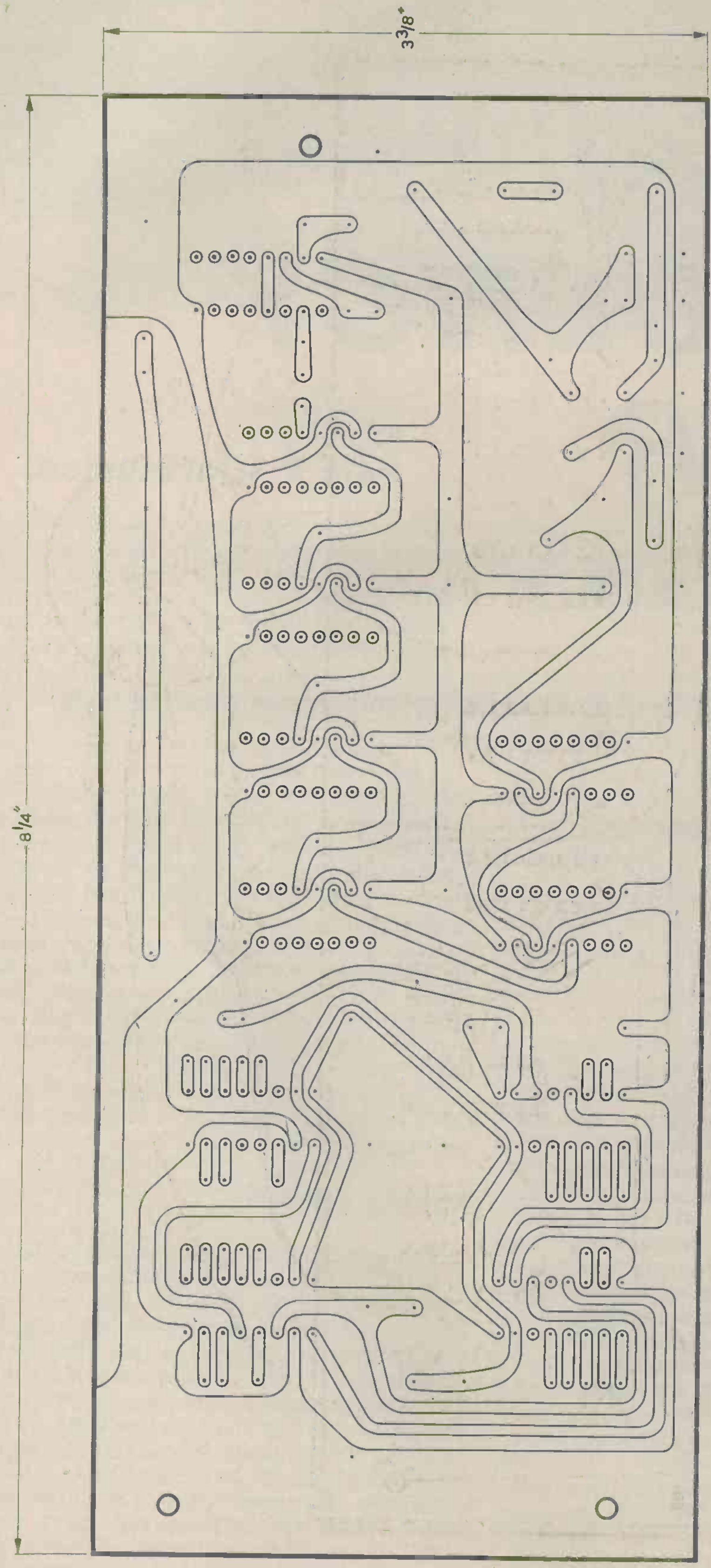
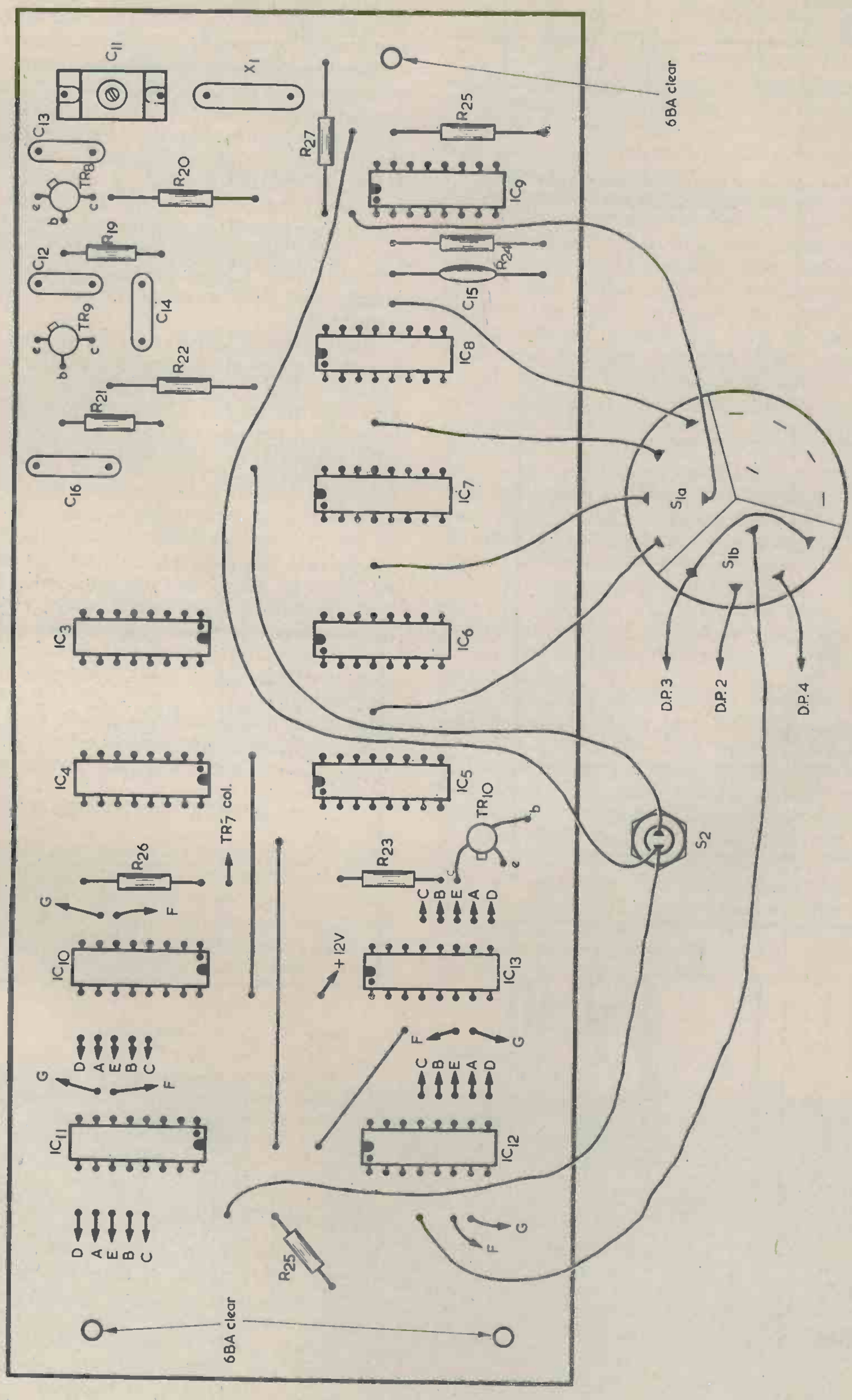


Fig. 8. The copper and component sides of the main module in the digital frequency meter. This is reproduced full size


C11
X1
C13
6BA clear
R27
R25
TR8
R20
IC9
R19
C12
R24
C15
C14
TR9
R22
IC8
R21
IC7
C16
S1a
S1b
IC3
IC6
D.P.3
D.P.2
D.P.4
IC4
TR7 col.
IC5
TR10
S2
R26
R23
+12V
IC10
IC13
IC11
IC12
R25
6BA clear
G
F
D A E B C

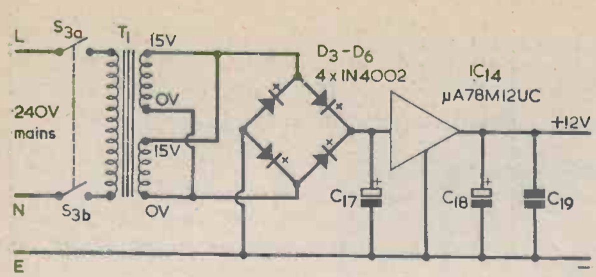


Fig. 7. The circuit of the power supply section of the frequency meter

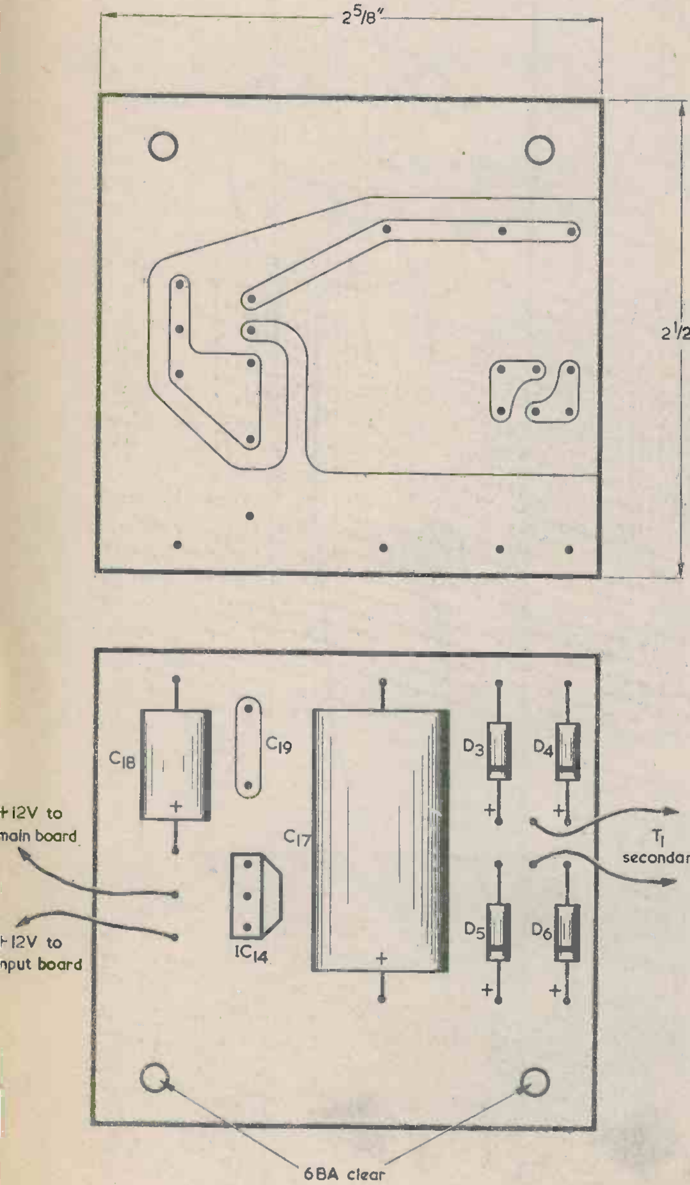


Fig. 8. The power supply printed circuit board, again reproduced full size

possibility of the transformer burning out. Of course, a transformer having a single 15 volt secondary rated at 400mA or more could be used, provided it is physically small enough to fit into the available space.

Full-wave rectification is given by D3 to D6, and the resultant d.c. output is smoothed by C17. It is preferable to have a regulated supply in order to obtain the best possible accuracy from the frequency meter, and it is also necessary to ensure that the supply potential does not rise above 15 volts, which is the absolute maximum supply voltage rating for the CMOS i.c.'s. A monolithic i.c. voltage regulator, IC14, is therefore used to stabilize the output voltage of the power supply to 12 volts. This is the maximum recommended supply voltage for CMOS i.c.'s of the type which are normally supplied to the amateur user. C18 provides final smoothing at the output and C19 prevents instability in the voltage regulator.

Apart from S3(a)(b) and T1, all the power supply components are assembled on the printed board shown in Fig. 8. This is again reproduced full size and the mounting holes are clearance for 6BA bolts. The voltage regulator i.c. will be fitted later with a heat sink. This will be on the side of IC14 which is nearer C17.

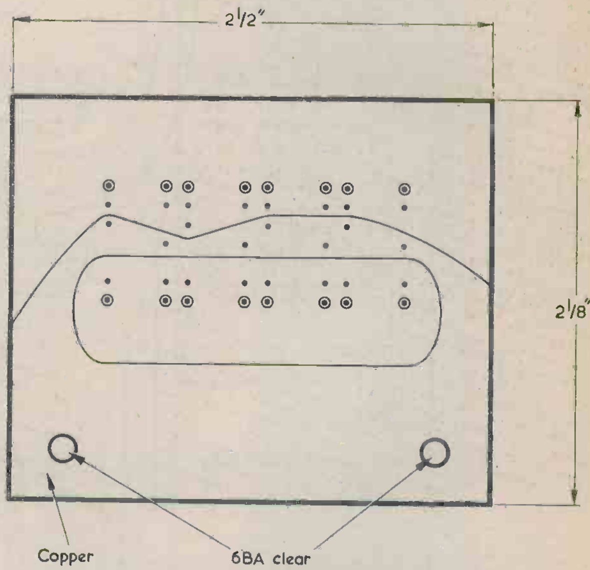


Fig. 9. The copper side of the display board. There is no necessity to show the component side as the display pins can only be inserted into the holes with the displays correctly oriented

DISPLAY BOARD

Details of the display printed circuit board are given in Fig. 9, and the board is really little more than a convenient means of mounting the four l.e.d. displays. When the displays have been soldered into place, a right angle bracket with the same width as the board is made up from 18 s.w.g. aluminium sheet and is secured to the two 6BA clear holes in the board and to the chassis by two further 6BA bolts and nuts. The bracket holds the displays in position behind the cut-out in the front panel. The basic scheme can be seen in the photographs of the unit. The bracket also provides

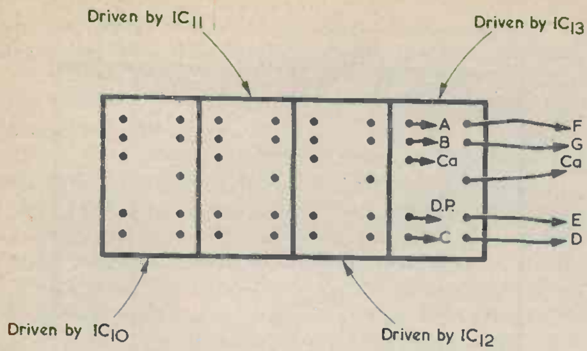


Fig. 10. Connections to the display assembly. This is a rear view with the display pins pointing towards the reader

the negative supply connection to the display common cathodes (on pins 4 and 12) by way of the copper of the board.

It was originally intended that the connections to the displays would be made by way of 14 pin d.i.l. sockets, into which the displays will plug. This did not work out very well in practice, however, due to the fact that many d.i.l. holders seem to be of rather flimsy construction, and they tended to break up. In consequence the leads have to be soldered direct to the display pins. This is slightly harder from the constructional point of view, since many connections have to be made in a very confined area, but fortunately it is not quite as difficult as it may at first appear. Connection details are given in Fig. 10, and this diagram shows the wiring when the displays are viewed from the rear, i.e. looking on to the lead-out wires.

MECHANICAL CONSTRUCTION

The prototype instrument is housed in a Veropak case type 49-1470L, which has dimensions of 11 by 4.4 by 8.6in. These cases are made of p.v.c. clad steel with a 16 s.w.g. anodised aluminium front panel. A flat sheet of 18 s.w.g. aluminium with its front edge bent up for bolting to the front panel forms a simple chassis, and it is secured to the panel by a pair of short M3 panhead screws with nuts. As can be seen from the photographs, the chassis is large enough to take the three printed boards and the mains transformer comfortably. A hole fitted with a grommet is needed in the back of the case to take the mains lead, and this lead is secured to the chassis with a suitable plastic covered clamp. The mains earth lead connects to a solder tag under one of the securing nuts for the mains transformer. The heads of the bolts which secure the transformer, as well as those which secure the printed boards, are all below the chassis.

The mechanical construction is not very critical, and it is not necessary to closely copy the prototype in this respect. Virtually any metal case of adequate size should be satisfactory, and it is essential that a flat metal chassis be employed. This is because the negative supply connection is carried to the printed boards by way of their mounting bolts and spacing washers. The latter must be metal and they raise the underside of each board sufficiently high above the chassis surface to ensure that there is no risk of connections under the board short-circuiting to the chassis. Constructors who prefer additional safeguards may cut out and drill mounting holes in thin s.r.b.p. sheets to the same dimensions as the boards. These may then be secured below the boards immediately above the chassis surface.

IC14 requires a small heat sink and details of this are given in Fig. 11. It is made from sheet aluminium, which should not be thinner than 18 s.w.g., and it is secured to the i.c. with a 6BA bolt and nut.

On the front panel of the prototype, the rotary on-off switch is to the left with range switch S1(a)(b) to its right. The ranges increase in terms of frequency as the knob of this switch is rotated clockwise. The next control is the reset push-button, and below this is the input coaxial socket. This is a flush mounting type and it connects to the input circuit and prescaler board by a short length of screened cable. The latter should be reasonably short in order that it introduces as little extra input capacitance as possible. With the prototype, a small section of the bent-up front of the chassis is cut away to give clearance for this socket.

The power supply section. As can be seen here, a simple heat sink is secured to the 12 volt regulator i.c.

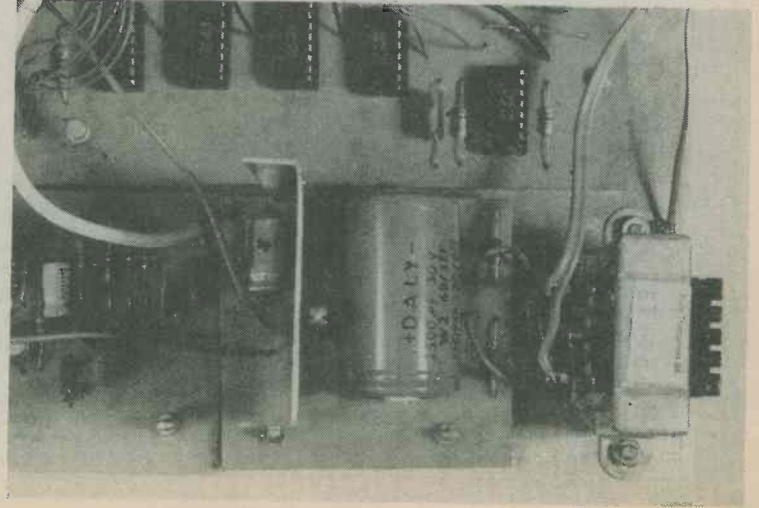
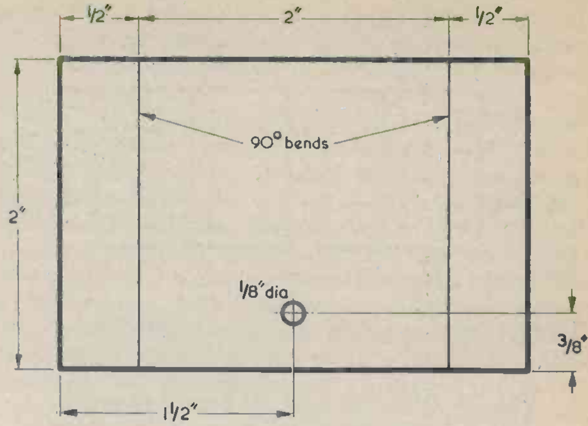


Fig. 11. The heat sink for IC14, before bending. This is made of 18 s.w.g., or thicker, aluminium sheet



Finally, to the right on the front panel is the rectangular cut-out which forms a window for the displays. This should measure about $1\frac{5}{8}$in. by $\frac{1}{2}$in., and can be cut out either by using a fretsaw or a miniature round file. A better appearance is given if the outer edges of the cut-out are slightly bevelled. A display filter is glued in position behind the cut-out in order to provide improved presentation together with a more easily read display. The author used an untinted circularly polarised filter type PNF21, which can be obtained from Electrovalue, Ltd. Other display filters should be equally suitable provided, of course, they are intended for use with red displays.

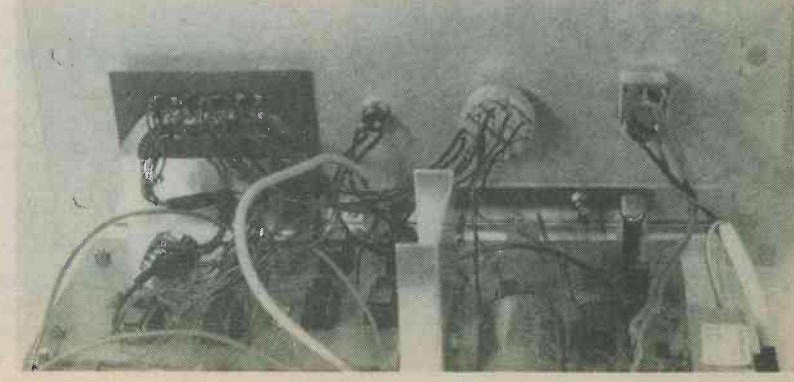
ADJUSTMENT

Two components must be set up before the instrument is ready for use. C11 must be adjusted to trim the crystal oscillator as accurately as possible to its nominal 1MHz operating frequency, and R9 must be adjusted to optimise the very high frequency sensitivity of the unit.

Probably the easiest way of setting up C11 is to beat an output from the oscillator divider chain with the BBC long wave transmission on 1,500 metres (200kHz). An insulated lead a few feet long can be temporarily connected to one of the unused outputs of IC3, say at pin 1. There will be a 100kHz pulsed output here which will be rich in harmonics. If a radio receiver tuned to the BBC 1,500 metre signal is placed near the lead, the 200kHz second harmonic will produce a beat note with the 200kHz carrier.

The crystal should not be far off frequency and the beat note will probably be at around 2Hz or

Looking at the rear of the front panel. This shows the wiring to the controls and to the pins of the l.e.d. displays



less. By adjusting C11 it should be possible to reduce the beat note to only about one beat of every 5 to 10 seconds, giving a level of accuracy which is more than adequate for normal amateur requirements.

Once this adjustment has been completed the temporary insulated lead can be removed.

In order to adjust R9 an r.f. signal generator covering up to about 50MHz with an adjustable output level is required. This is coupled to the input socket of the frequency meter and adjusted for maximum output. It may be found that the meter will register the applied input frequency right up to about 40MHz or so, this occuring if R9 happens to be close to the final setting required and if the signal generator provides an adequate output amplitude.

Should this be the case, the output from the signal generator should be attenuated somewhat until the frequency meter fails to respond properly to the input signal. R9 is then adjusted to restore correct readings once again. The output is then further attenuated and R9 is again adjusted to restore readings. This procedure is repeated until further adjustment of R9 fails to enable accurate readings to be made. The output level from the signal generator is then slightly increased, and R9 is finally adjusted to produce accurate readings from the instrument once again.

If the instrument fails to provide readings at high frequencies, then the signal generator must be adjusted to a fairly low radio frequency, say about 1 to 2MHz, after which R9 is tried at various settings until readings are produced. It is then a matter of increasing input frequency until readings are lost, and then readjusting R9 to restore them once again. This is continued until no further improvement in performance can be obtained.

It is possible that the minimum 42MHz bandwidth of the instrument may not be realised when using a simple signal generator as a signal source. This is due to the fact that the sensitivity of the unit falls off somewhat at high frequencies, as does the output level of many simple r.f. signal generators. The lack of readings at high frequencies would therefore be due to an inadequate input signal level rather than a fault in the frequency meter.

USING THE UNIT

When using the unit it must be borne in mind that it places a certain amount of loading on the circuit under test. At audio frequencies this is not usually significant, but at radio frequencies the input impedance of the unit falls considerably due to the shunting effect of the input capacitance. It should also be remembered that this input capacitance can have a serious detuning effect if the input signal is taken from directly across a tuned circuit in the equipment under test. Connecting a resistor or low value capacitor in series with the input to the instrument will reduce such loading effects, but this will also reduce the input sensitivity. Of course, when measuring high level r.f. signals with an instrument such as this it is not normal practice to couple the output of a transmitter or similar high power equipment direct to the input of the meter. An r.f. pick-up loop should be used instead.

Although the unit has a four digit read-out, it is possible with higher frequencies to effectively obtain additional digits by a process known as overranging. A reading is initially taken in the normal way, and then the range switch is adjusted one step in an anti-clockwise direction and another reading is taken. This procedure is continued until a final reading on range 1 has been taken.

For instance, if readings of 15.76, 5.761, 761.3, and 61.35 are obtained on ranges 4, 3, 2, and 1 respectively, then the input frequency is 15.76135MHz. In this way it is possible to obtain a resolution of 10Hz on any frequency which falls within the scope of the instrument, in theory at any rate. In practice, the accuracy of the last digit may not be sufficiently high to make overranging down to range 1 worthwhile with input frequencies of many MHz.

A final look at the completed digital frequency meter. The legends on the front panel are taken from Panel-Signs Set No. 4.

Theoretically the unit should not produce false readings as the Schmitt trigger should fail to operate if the input level is inadequate. However, in practice it is possible for a barely adequate input signal to intermittently trigger the Schmitt circuit, and thus produce a false reading. This is due to the fact that a certain amount of hum and noise may be generated in the input circuitry. It is normally quite obvious if a false reading is being obtained as it will usually be ridiculously low, and a totally different reading will be produced each time a measurement is made. There is only a very limited range of input levels which will produce inaccurate readings, and so this is not a major problem.

Of course, if there is a lot of hum or noise present on the input signal this may also result in false readings being obtained, but this is not the fault of the equipment, and cannot be avoided unless the hum or noise can be filtered out.

In your work-shop

F.M. INTERMEDIATE FREQUENCY BREAKTHROUGH

Giggling to himself, Dick switched off the cassette recorder he had just successfully serviced and carried it over to the "Repaired" rack. With a wide grin he turned to the "For Repair" rack and selected a long, medium and v.h.f. portable radio receiver. Happily, he carried it over to his bench and switched it on, selecting first the medium wave band.

The receiver performed normally at all sections of the band. He next switched to long waves, to find that reception was perfectly adequate here as well. He pulled the telescopic aerial to its full length and then switched to f.m. The receiver tuning control happened to coincide with one of the local f.m. transmissions, and it reproduced this with good quality and volume. As Dick tuned through the signal the set behaved quite normally, having on either side of the correct central position a tuning position at which the signal could also be resolved. (Fig.1.)

Dick returned the set to the central tuning position and frowned down at it. Then, unexpectedly, he gave vent to a loud and raucous guffaw.

I.F. BREAKTHROUGH

There was a rattling sound from the other side of the Workshop as Smithy crashed his soldering iron down on its rest.

"Ye gods," he snorted in an exasperated tone, "what the devil is up with you this morning?"

Surprised, Dick turned round to face the irate Serviceman.

"What do you mean?"

"What do I mean?" repeated Smithy. "What I mean is all this chuckling and laughing you've been doing. You've only been in for an hour or so and for every minute of it you've been whinnying away to yourself like an old mare in heat."

"Have I been?" replied Dick. "Blimey, I'm sorry about that."

"Well, all right then," said Smithy, mollified, "but what's the joke?"

Struck by a sudden thought, he glanced down at himself anxiously.

"Is there," he queried belligerently, "something about *me* that you find particularly humorous?"

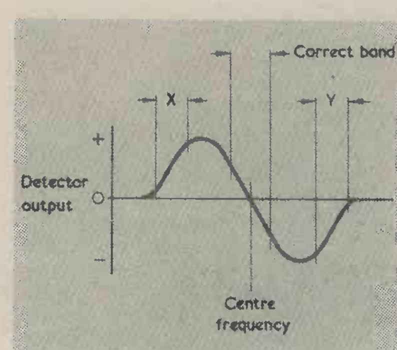


Fig. 1. The response of a balanced ratio f.m. detector. A properly tuned receiver presents the correct central band of intermediate frequencies to the detector. Detection (with distortion) is also possible if band X or band Y is presented to the detector

"Oh no," soothed the grinning Dick, "it's nothing to do with you at all. I've been thinking about old Joe."

"Joe?"

"You know, down at Joe's Caff. What I've been laughing about is something really hilarious which happened there last night."

"Well," said Smithy primly. "I don't approve of you laughing about things that happen outside the Workshop. Especially during working hours."

Dick was suddenly seized with a fit of giggles.

"If," he spluttered helplessly, "you'd only seen those ducks . . ."

"Please get on with your work," interrupted Smithy firmly. "For a start, what's the fault on that a.m.-f.m. set you've got on your bench?"

With an effort Dick wrenched his mind back to the mundane affairs of the present.

"So far as I can find out up to now," he replied, "there doesn't seem to be anything wrong with it at all. It tunes all right over all the medium and long wave bands and I've just checked it out on one station on the f.m. band."

"Try another station."

Obligingly, Dick adjusted the receiver tuning control. As the broadcast station receded into silence the receiver reproduced what sounded like an amalgam of morse transmissions of differing strengths and speeds. These disappeared as Dick tuned into the next station on the dial. Eventually he tuned successfully to all the local transmissions, the spaces on the dial between them being interrupted by the mysterious morse signals.

"That's queer," he remarked. "I've never heard a background noise like that on any f.m. set before. I know that when you tune up to the higher end of the band you're liable to get the police and taxi services and things like that, but I've never heard morse on a v.h.f. radio."

"What's probably happening," stated Smithy, walking over and looking down at the set critically, "is that the 10.7MHz rejector circuit's gone for a burton. You're almost certainly getting 10.7MHz breakthrough when there isn't a strong enough f.m. signal to give a full a.m. limiting action."

He stopped and pondered thoughtfully for a moment.

"Let me see now," he continued slowly. "10.7MHz is around 28 metres and that is the allocation, so far as I can remember, for general fixed communication services. With the wide i.f. bandwidth of an f.m. set I'm surprised that the breakthrough isn't worse. It may well be so in the evenings, which is probably why the set-owner brought the radio in."

"10.7MHz rejector circuit?" repeated Dick. "This is the first time I even knew that an f.m. set *had* a 10.7MHz rejector circuit."

"They're present on virtually all the f.m. radios you're likely to encounter," stated Smithy. "The f.m. front-ends of these a.m.-f.m. portables select the desired v.h.f. signal that's required, but without a 10.7MHz rejector circuit they're also liable to let signals around this frequency break through and get into the 10.7MHz i.f. amplifier. As it happens, these f.m. front-ends seem to be pretty standardised nowadays. The telescopic aerial couples into a tuned circuit which is broadly resonant at the middle of the f.m. band of 87.5 to 108MHz and which does not have any variable tuning. It then passes on to a grounded base transistor which acts as an r.f. amplifier, and then goes to a signal frequency tuned circuit which does have variable tuning. After this there's a second grounded base transistor, and this functions as a mixer-oscillator. The output from this is passed to the 10.7MHz i.f. amplifier stage. As you know, 10.7MHz is the standard intermediate frequency for v.h.f. f.m. receivers." (Fig.2.)

"What about this 10.7MHz rejector circuit?"

"That sits between the first and second transistors," explained Smithy. "It's a series tuned circuit, which means that it absorbs energy at its resonant frequency. You can usually spot it in the front-end because the capacitor in the tuned circuit has a value of around 200 to 700pF. All the other capacitors in the f.m. front-end are either in the signal frequency circuits and are less than 100pF, or they're bypass capacitors with values of 1,000pF or more."

A.M. STAGES

Dick absorbed this information.

"What happens after the first 10.7MHz i.f. transformer?"

"Usually," said Smithy, "the 10.7MHz i.f. signal goes into a 10.7MHz i.f. amplifier transistor. The output of this then couples to the combined f.m. and a.m. intermediate frequency amplifier which handles the 10.7MHz i.f. and the a.m. i.f. at 460kHz, or thereabouts." (Fig. 3.)

"Fair enough," commented Dick. "Why are grounded base transistors used for the r.f. and mixer-oscillator stages of the f.m. front-end?"

"Because," said Smithy, "a transistor in grounded base can amplify at much higher frequencies than it can in grounded emitter. In some sets you'll find f.e.t.'s in one or more of the front-end stages, but grounded base bipolar transistors still seem to be the most popular with the set-

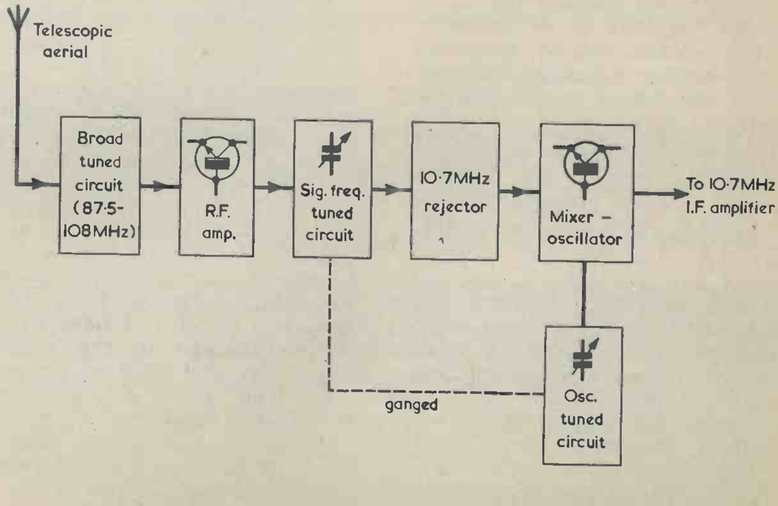


Fig. 2. Block diagram illustrating the stages in a standard f.m. front-end, as found in an a.m.-f.m. portable radio

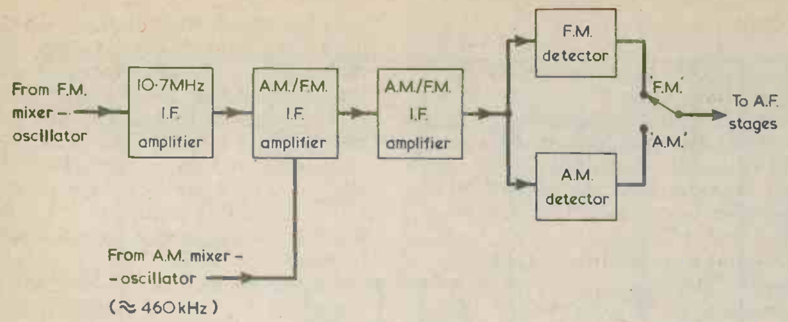


Fig. 3. Most a.m.-f.m. portables have the i.f. line-up shown here. The switch at the right is part of the wavechange switch. Another part of the wavechange switch (not shown) may apply power to the f.m. or the a.m. front-end as applicable

makers. Here, just a minute!"

"Yes?"

"What did you say just now about ducks down at Joe's Caff?"

A broad smile creased Dick's face.

"I thought you didn't want me to talk about it during working hours."

"I don't, really. But, dash it all, *ducks!* Where were they?"

"On the wallpaper."

"Smithy sighed wearily.

"I know," he moaned unhappily, "that I should stop right here, but now I'm hooked. What wallpaper?"

"Joe felt that his place was looking a bit more dreary than usual and so he's decided to redecorate it."

"Using wallpaper with ducks on it?"

"That's right. You know how mean he is. He managed to get a whole job-lot of wallpaper cheap which, I guess, was originally intended for papering kids' schoolrooms, or kindergartens, or something like that."

"Fair enough," said Smithy hastily. "You've now satisfied my curiosity. It's all clear to me: Joe wants to redecorate his Caff and it so happens that he uses wallpaper which was meant for children's classrooms or something like that and which has got ducks on it. Right, let's get straight back to this f.m. front-end. Why don't you get the service manual out so that we can look at it in more detail?"

"Okeydoke," responded Dick easily, rising to his feet and making for the filing cabinet. He soon found the appropriate service sheet and returned with it to Smithy's side. The latter opened it out at the receiver circuit diagram, in which the f.m. front-end stages appeared at the top left. (Fig.4)

"There you are," said Smithy. "Quite a nice straightforward front-end circuit. As so often happens in these sets, the positive supply rail is the one which connects to chassis instead of the negative rail. Now, the telescopic aerial connects via a 47pF capacitor to a coupling winding, and from this the aerial signal passes to a winding which is tuned by a 60pF and a 51pF capacitor in series. These provide a tap in the capacitive side of the tuned circuit which matches in to the fairly low input impedance of the r.f. transistor emitter. In some sets there'll be a single tuning capacitor across the coil and the tap will be into the coil. The transistor base is grounded, incidentally, by means of the 1,000pF capacitor which couples it to the positive rail."

"The collector," stated Dick in a perplexed tone, "connects first to a 270 Ω resistor. What's a 270 Ω resistor doing there?"

"You quite often bump into these low value resistors in series with the signal circuits of f.m. receivers," stated Smithy. "Their primary purpose is to reduce the effect of impulsive interference. They crop up in the i.f. stages, too, where they carry out the same function."

R.F. TUNED CIRCUIT

"Right," said Dick briskly. "After the 270 Ω resistor there is what must be a signal frequency tuned circuit. There's a coil and directly across it is a 20pF variable capacitor and a 5pF trimmer."

"Yes," agreed Smithy, "that is the signal frequency tuned circuit for the front-end. The 20pF variable capacitor is ganged with another 20pF variable capacitor in the oscillator section. It will also be ganged with the variable capacitors which tune the receiver a.m. mixer-oscillator. If the receiver were f.m. only you could well have varicap diodes instead of the variable capacitors, but most of the a.m.-f.m. jobs still stick to variable capacitors. There's a 27pF fixed capacitor across the tuned circuit as well, its function being merely to bring the tuning range over the correct band."

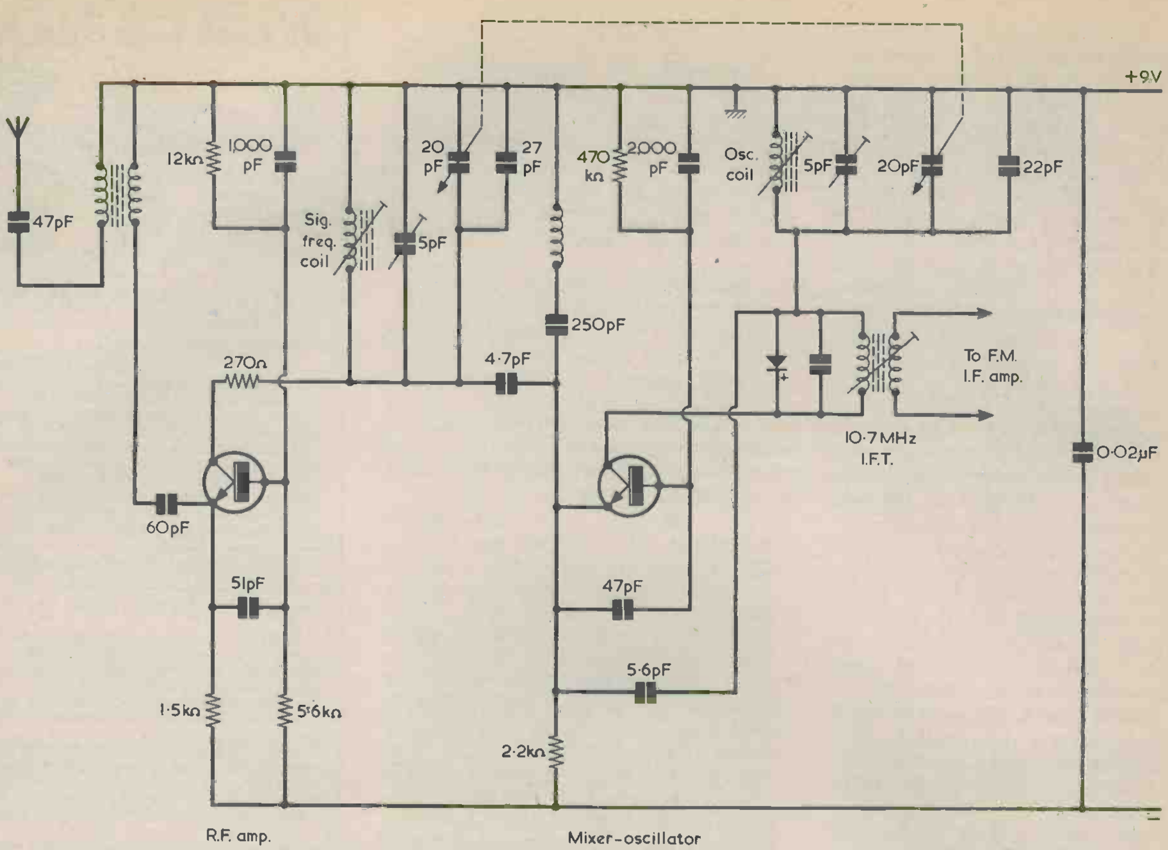


Fig. 4. Slightly simplified circuit illustrating commercial design for an f.m. front-end. As is frequent practice, it is the positive instead of the negative supply rail which connects to chassis. The two transistors are BF195 or similar, and the component values shown are representative. The 10.7MHz rejector coil is that in series with the 250pF capacitor

"Next," said Dick, "there's a 4.7pF capacitor, after which there's a 250pF capacitor and a coil in series, the coil connecting to chassis at the positive rail."

"And what," prompted Smithy gently, "might be the purpose of these two components?"

"Why of course!" exclaimed Dick excitedly. "They form the 10.7MHz rejector circuit."

"Right first time. In some sets you'll find the rejector circuit has the coil at the non-earthy end with the capacitor connecting to chassis. Or, again, the rejector circuit may connect to the negative supply rail instead of to the positive rail. These are minor variations on a basic theme, and basically they all come down to the same thing: a series tuned 10.7MHz rejector circuit."

"We then," said Dick, his interest rising, "arrive at the emitter of the second grounded base transistor; and this must be the mixer-oscillator transistor."

Smithy nodded in agreement.

"The base of this transistor," went on Dick, encouraged, "goes up to the positive rail by way of a 2,000pF capacitor, and so this base is well and truly grounded, too. Hello, there's a 47pF capacitor between the emitter of the transistor and its base! Won't that reduce the input signal level at the emitter?"

"It will, rather," agreed Smithy. "The signal across the signal frequency tuned circuit passes first through the series 4.7pF capacitor to the emitter of the second transistor and then encounters the relatively large 47pF capacitor connecting to the transistor base. The two capacitors provide a capacitive tap into the signal frequency tuned circuit but they also carry out a more important function. You see, the oscillator tuned circuit also couples to the emitter, whereupon the 4.7pF and 47pF capacitors loosen the coupling between the oscillator tuned circuit and the signal frequency tuned circuit. As a result, there is less chance of the signal frequency tuned circuit pulling the oscillator tuned circuit off its correct frequency."

"Gosh," breathed Dick. "That's crafty. Stap me, Smithy, there aren't half some odd little quirks to look out for in this circuit."

"And now," stated Smithy, "we can look at the oscillator part itself. The collector of the transistor connects to the primary of the first 10.7MHz i.f. transformer and, after this, to the non-earthy end of the oscillator tuned coil. The capacitor across the primary will have a low reactance at oscillator frequency. The coil is tuned by the remaining 20pF section of the 2-gang variable capacitor together with a 5pF trimmer and a 22pF fixed capacitor. Positive feedback, to produce oscillation, is given by coupling the non-earthy end of the oscillator coil back to the transistor emitter via a 5.6pF capacitor."

"Just like that?"

"Just like that," confirmed Smithy. "The emitter and collector of a grounded base transistor are in phase and so, to get it to oscillate, all you have to do is couple the collector tuned circuit back to the emitter via a low value capacitor. Simple, isn't it?"

"I'll say," agreed Dick enthusiastically.

LIMITER DIODE

Smithy paused for a moment and turned away from the circuit diagram. It was clear that some matter was troubling him.

"These ducks," he commenced hesitantly.

"On the wallpaper?"

"Er, yes. Was there anything peculiar about them?"

"Too true there was. Whoever designed that wallpaper must have had a fetish about ducks. There were big ducks, small ducks, yellow ducks, green ducks, red ducks, you never saw so many ducks. And all in a crazy pattern which repeated itself every two feet or so. But, the ducks were only part of it. Another bit was the paste which Joe was going to use to stick the paper to the wall."

"Wallpaper paste should be no problem at all, surely," protested Smithy. "You can get all sorts of modern pastes from do-it-yourself shops."

"Smithy, you don't know Joe. He's so tight that, when I come to think of it, he has a definite affinity with those ducks on the wallpaper. He reckons that since he considers himself to be in the catering trade he should take advantage of the products which that trade offers. So he made up the paste with flour and water."

"Was it successful?"

"Well, he got me and a couple of my mates in to give him a hand and *we* thought it was highly successful. First of all, he cut out a length of the paper and he slapped his paste all over it, then went up the ladder and stuck on the top bit. After that he went down the length of the paper smoothing it all down with a cloth. Real professional it looked."

Smithy frowned.

"So what was the difficulty?"

"Just when he'd smoothed all the paper right down to the bottom," chortled Dick, "the top started curling away from the wall. So he ran up the ladder and stuck the top bit back up again, after which he had to run down again to hold down the bottom bit, as this was starting to flap around. Then it happed all over again. It was poetry in motion watching him rush to the top of the ladder to push down the top bit of the wallpaper and then rush down the ladder to push down the bottom bit. Twenty minutes he was at it, going up and down."

"Just for the first piece of wallpaper?"

"Just for the first piece. In the end I had to get him out of his trouble."

"How'd you do that?"

"I got a hammer and *nailed* the paper to the wall at the top! Then we got some boxes and things and held the bottom tightly in place so that it should look all right if, eventually, that paste of his ever does set hard."

"Dear me," said Smithy, impressed, "that must have been quite a performance."

"That was only the beginning," laughed Dick. "I'll tell you about the rest in a minute. In the meantime, there's something in this f.m. front-end circuit which is puzzling me a bit."

"What's that?"

"There's a diode across the primary of the first 10.7MHz i.f. transformer. What's that supposed to do?"

"It's a limiting diode," explained Smithy. "Like those low value series resistors we talked about just now, you occasionally encounter these diodes across the primaries of the 10.7MHz i.f. transformers in a.m.-f.m. sets. They're germanium diodes and their purpose is to limit the i.f. signal if the receiver happens to be tuned to an extremely strong signal. Since they're germanium diodes they become conductive at quite a low forward voltage, whereupon they hold down the strong signal at around this voltage. If, by the way, one of these diodes is preceded by one of those low value series resistors, like that 270Ω one, the resistor will assist in the limiting process as well as reduce the effects of impulsive interference."

"That seems," remarked Dick cheerfully, "to have cleared up all I wanted to know about this f.m. front-end circuit. I suppose that, after the first i.f. transformer, there is a 10.7MHz amplifier stage before the f.m. and a.m. intermediate frequency signals are combined together in the common i.f. amplifier."

"That's pretty well what happens," agreed Smithy. "The usual form, as I said just now, is that the 10.7MHz i.f. signal goes through one more stage than does the a.m. intermediate frequency signal."

ENAMELLED WIRE

"I suppose," said Dick philosophically, as he proceeded to take the back off the receiver and examined its internals to see how best to remove the printed board, "that the next thing to do is to have a look at the 10.7MHz rejector circuit in this set."

"That would be a good idea."

Smithy watched as his assistant worked on the receiver.

"Did you only," he asked suddenly, "get one strip of wallpaper up last night?"

Dick chuckled.

"In the end we got three up," he said, exulting in the memory. "The second piece was pretty simple at the beginning. First of all, Joe got up the ladder and stuck on the top bit, then, as he worked his way down, I shot up above him and nailed it in place. Then, when he'd finished pressing down the bottom bit we got some more boxes and things and held *that* end in place."

"Humph," commented Smithy. "Pretty well all right, then."

Dick unfastened a screw holding the board in place.

"Not entirely," he replied. "What Joe had forgotten was that quite a few of the ducks overflowed over the edges of the paper, whereupon the second strip had to be aligned vertically with the first one so that, say, the front part of a duck on the first piece continued accurately to its rear part on the second piece."

"Didn't that happen?"

Dick grimaced happily.

"The pieces were miles out," he beamed. "Not only were the ducks all out of sync with each other but the wrong ducks got married up together on the two bits of paper. There was what could be politely described as an extremely unusual juxtapositioning between the two halves of the ducks which did join together."

"Dear me."

"When he saw this, Joe went beserk, and he put up the third piece in a great rush. This time, though, he got the paper up upside-down."

Dick's face lit up at the memory.

"Not only," he went on, "was the juxtapositioning between one duck and the next simply unusual, this time it was nothing short of *incredible.* Joe looked at it and was completely shattered. All he said was 'the man who thought of printing a duck on wallpaper like that must have been raving mad'. Then he went back to his counter all cheesed off and got his steam generator going so we could all have some tea after we'd cleared up the mess."

"What a funny thing to say about the wallpaper."

"Well, that's what we *thought* he said. Anyway, I've got this printed board out now, so shall we have a look at this 10.7MHz rejector circuit?"

Reluctantly, Smithy tore himself away from a vision of the dingy interior of Joe's Caff partly decorated by its strange duck-filled triptych of wallpaper strips. He turned his eyes onto the a.m.-f.m. receiver.

"There certainly isn't much to check here," he pronounced. "Only a coil and a capacitor in series. Now let's have a look. Ah, here's the coil. It isn't in a can and it hasn't got a core. It's just wound with enamelled wire on a simple moulded former with two tags at the bottom. I'll check it for continuity."

He pulled Dick's testmeter towards him and quickly applied its prods to the coil tags.

"Right first go!" he announced cheerfully. "The coil's open."

"Are you certain?" queried Dick. "There don't seem to be any visible breaks in it."

"Nevertheless," said Smithy, "I think we'll try a little re-soldering."

He picked up Dick's soldering iron, tinned its bit with a little cored solder and applied it to the solder joint between one coil end and its tag. The existing solder at the joint melted visibly and Smithy withdrew the iron. He then repeated the procedure at the other tag. (Fig.5).

"Is that all you're going to do?"

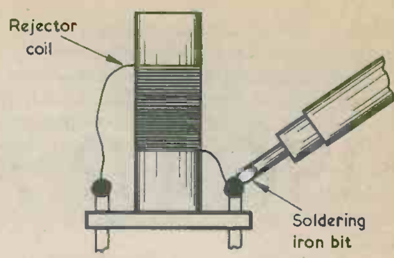


Fig. 5. Re-soldering a coil wire end to its tag. The wire is coated with solder-through enamel

"I hope so," replied Smithy. "Let's check the coil for continuity now."

Once more he applied the testmeter prods. This time the testmeter needle moved over rapidly to indicate zero resistance.

"Blow me," said Dick. "What happened there?"

"I just made one of those solder joints good again. Coils like this are usually wound with wire coated with solder-through enamel which melts at soldering temperature. At the factory they just put the wire through the tag hole without stripping off the enamel and then solder at the tag. The soldering iron only needs to be applied long enough to start melting the enamel and then you get a joint right through to the copper underneath. This particular joint must have been skimped a bit so that it became unsoldered again after the set left the factory. Well, let's see how this set works now."

Dick refitted the board in position and then switched the receiver on. It now behaved impeccably and, on the v.h.f. band, reproduced nothing other than the f.m. signals it was supposed to reproduce, with no alien signals in between or at any other part of the band.

DECORATING

Later, back at his own bench, Smithy mused momentarily over the disasters which had beset the ill-fated Joe in his Caff on the previous evening. He glanced around the Workshop. It was certainly in need of some redecoration itself and Smithy pondered on whether or not a little wallpaper might not be worth using here. A simple austere design would perhaps be suitable, as befitted an establishment engaged in electronic investigationary work. Or something a little lighter? Say, with brightly coloured patterns, or flowers or — inevitably the thought crept into Smithy's head — ducks?

Smithy shuddered.

Certainly not ducks. ■

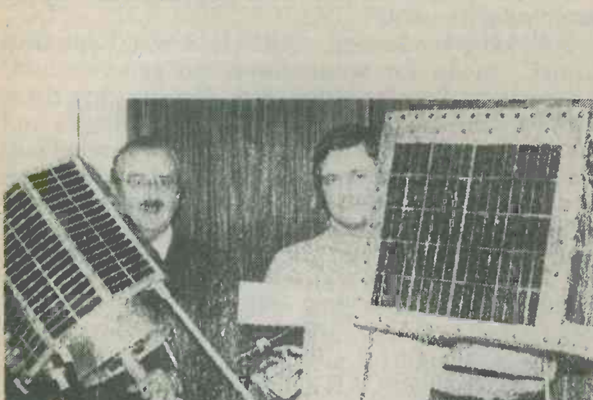
OSCAR 8 SUCCESSFULLY LAUNCHED

By Arthur C. Gee

Delta rocket 139 carrying Oscar 8 rises majestically into the sky on March 5 while radio amateurs around the world wait with baited breath. (NASA photo)

OSCAR 8 was successfully launched on Sunday, 5th March last, from the Vandenberg Air Force Base in California. It was a "textbook" launch. It was ejected from the second stage of the two-stage Thor-Delta 2910 rocket, along with a NASA Landsat-C Earth Resources Technology Satellite and a NASA PIX (Plasma Interaction Experiment).

OSCAR 8 has been built, over the past two years, by radio amateurs in the U.S.A., Canada, West Germany and Japan. Extensive use has been made in its construction, of parts left over from OSCAR 7 and the Phase III programmes. Its principal objective is to provide a low orbiting satellite for educational uses. It is to provide the means for the use of such a satellite, as an educational tool in schools and other such institutions, and also to provide a means for the continued communication by satellite for radio amateurs. Oscar 6 has now gone out of service and when Oscar 7 comes to the end of its life, Oscar 8 can carry on providing a similar service, until such time as the Phase III satellites come into use. Oscar 8 is a Phase II (low orbit) communications satellite. It has transponders for two modes of communication and a six channel telemetry beacon system.



Full sized models of Oscar 7 and Oscar 8 give a good impression of the size and configuration of these satellites. G3RWL (rt) holding Oscar 8 when giving a lecture to the Thames Valley Club recently. Photo: courtesy T.V.A.R.T.S.

The Mode A transponder has an uplink frequency of 145.9 MHz and a downlink frequency of 29.4 MHz and the Mode J transponder has 145.9 uplink and 435.1 MHz downlink. The telemetry beacon Mode A is on 29.402 MHz and on Mode J is 435.095 MHz. The telemetry system is a six channel Morse Code system similar to that on Oscar 6 and 7. Telemetry is sent at twenty words a minute as three digit numbers in Morse Code. Channel 1 gives total Solar Array current; Channel 2 Battery Charge/Discharge current; Channel 3 Battery voltage; Channel 4 Baseplate temperature; Channel 5 Battery temperature and Channel 6, R.F. power output on Mode J. The telemetry gives only one parameter per line, whereas Oscar 6 and Oscar 7 had four. As a result, a complete telemetry frame is sent in approximately twenty seconds.

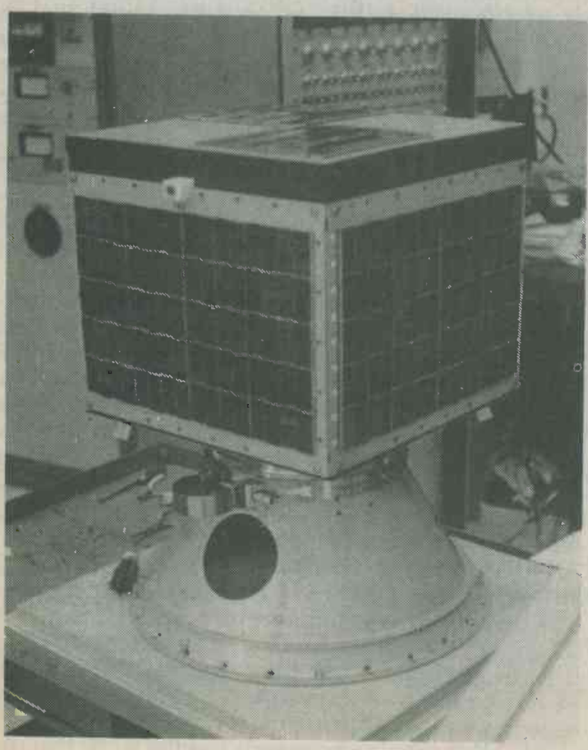
OSCAR 8 is solar powered; weighs sixty pounds and is a fifteen inch rectangular solid thirteen inches high. The anticipated life-time is three years.

An orientation stabilization magnet system is provided as in Oscar 6 and Oscar 7. Solar panels are provided on its four sides and its top face, but not on the bottom, since this is where it is attached to the launch vehicle. A twelve cell, six ampere hour rechargeable nickle-cadmium battery is provided, a battery charge regulator converting the 28-30 volt solar panel voltage to the 14-16 volts required by the battery.

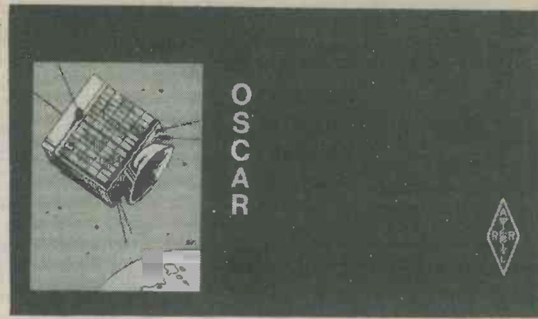
Programmed orbital parameters are: Apogee 577 statute miles. Perigee 549 statute miles. Period 103 minutes. Inclination 99 degrees. The orbit is planned to be sun-synchronous, which means that passes occur at the same time each day. The orbit is just over half the altitude of that of Oscar 7, which is 910 statute miles, which will result in a shorter usable time on an overhead pass of about 18 minutes instead of the 22 minutes provided by Oscar 7 and the horizon range will be 2,000 miles instead of 2,450 miles of Oscar 7.

Radio Amateurs around the world followed the launch sequence by means of the AMSAT Launch Day Operations Nets organised by W3ZM and others from the Goddard Space Flight Centre Radio Club Station WA3NAN, where WB2TNC, operating from WA3NAN, gave a running commentary of the launch and subsequent phases of the orbit injection sequences. These transmissions took place on 14.280 kHz in the 20 metre amateur radio band, and such was the interest shown by the amateur radio fraternity, that for quite long periods, no other signals were heard at all on this frequency — an almost unheard of phenomenon for the 20 metre band — particularly as the period happened to coincide with the ARRL DX Phone Contest!

The flight of the launch vehicle was followed; the ejection of the Landsat spacecraft noted; orbit correction burns were carried out and then OSCAR A-O-D was ejected, to become Oscar 8.



OSCAR 8 the latest of the series of Orbital Satellites carrying Amateur Radio. Photo: courtesy AMSAT



The ARRL is now handling QSL cards, report forms and information generally on Oscar 8. Address is: ARRL OSCAR Operations, 225 Main St., Newington, Con. 06111, U.S.A.

G2BVN was the first to report telemetry reception and minutes later, W0PHD reported the first American reception of signals. Stations reporting reception of the telemetry on the first two orbits included GM8BKE, VE6SW and N6DD. DL3SX telephoned Washington D.C. from Germany with telemetry data. Initial telemetry signals were only transmitted on Mode J as it had been decided not to extend the 10 metre antenna until the satellite stopped spinning following its launch, so as not to hazard the 10 metre antenna. However, early telemetry data indicated that the spin rate following launching was only 1.3 rpm. In view of this, telemetry command signals were sent, which deployed the 10 metre antenna, and to the surprise and delight of those who could only monitor the 29.4 MHz beacon, signals were heard coming from the Mode A beacon.

The launch commentary from the Goddard Space Flight Centre was picked up by Richard Limebear, G3RWL, who runs the AMSAT-UK Oscar Net on Sunday mornings on 3.780 kHz and who then put out a commentary for the benefit of European radio amateurs. A surprising number of stations in this country and in Europe called in on this net so they were thus able to participate in the launch excitement!

Following its launch, OSCAR 8 was kept in a "quiet" mode for some days, no general communications being encouraged. During this time, tests on spin-rate, sensitivity, battery voltages and charging rates, temperatures, etc., were carried out. The University of Surrey Oscar Command Station was one of those who took part in these tests.

An interesting little note appeared in "Ham Radio Report" No. 190 giving the information that OSCAR A-O-D was transported to its launch site on the two front first class seats in a D.C. 10 Jumbo Jet, aircraft and was suitably decorated with a corsage by a thoughtful air hostess!

Since launch OSCAR 8 appears to be performing well. Some problems have been encountered by the fact that the 10 metre band has been "wide open" on occasions since its launch, with consequent QRM to its 29.4 MHz beacon and communication channels. However, with increasing sunspot activity with the next sunspot cycle, some interesting results should become apparent with Oscar 8 being in the low orbit it is in its relationship with the various ionospheric layers. ■

Trade News . . .

MEGA DRILL STAND ACCEPTS RANGE OF PCB DRILLS

Mega Electronics Ltd. of 9 Radwinter Road, Saffron Walden, Essex, announce the introduction of a new, low-cost p.c.b. drill stand (patent applied for) designed for use with conventionally hand-held p.c.b. drill units.

Designated the Photolab PLST-12A, the drill stand has been specifically introduced to meet requirements in the production of prototype printed circuit boards. It is constructed with a strong base of machined cast iron supporting precision steel guides by means of which the standard 12V drill is raised and lowered.

Important features of the PLST-12A are its combined simplicity and accuracy, and the fact that it will accept both the Mega and other proprietary drills of 34mm. diameter as well as drills such as the Titan, at 41mm. diameter. Additionally, the same basic drill stand is available to special order from Mega, capable of accepting drills between 20mm. and 41mm. diameter, at marginal extra cost.

Printed circuit boards of up to 10 x 9in. overall will be accepted by the drill stand.

ELECTROVALUE ADD TO THEIR RANGE

From Electrovalue Ltd., the well-known component distributors, comes news of three valuable additions to their already wide range of electronic components and associated ancillary items. First is a touch control dimmer I.C. type S566B by Siemens. This allows on-off switching to a predetermined level. Increase or decrease of brilliance is achieved by maintaining contact with the touch pad until the required level is obtained. A remote control facility is available. Delivery is from six to twelve weeks according to quantity requirements.

DUAL-IN-LINE SWITCHES by Erg form another new item from Electrovalue. The range covers from one pole change-over to one pole 8 way or 10 pole on-off or change-over. These switches may be used for low-level circuits or for circuits rated up to 100 volts or 1 Amp. Contacts are heavy gold on nickel plate. Colour coded actuators are standard on most ranges of these U.K. made switches.

JOY-STICK CONTROLLED POTS, with two 100K tracks at 90° to each other, the lever operates between the two tracks in joy-stick style.

BREMA AND ICEA BACK OLYMPIA SHOW

Official backing for the Home Entertainment Show to be held at Olympia from September 11-17 is announced by BREMA, the British Radio Equipment Manufacturers Association, and ICEA the International Consumer Electronics Association.

Both are to join the organising committee to ensure maximum benefit to those involved and to the industry as a whole.

In announcing its support for the Olympia Show, Alan Godfrey, chairman of BREMA's Commercial Committee, said: "We recognise the value of promotion at the start of the selling season. Everybody — dealers, wholesalers, manufacturers and the trade Press — now knows our policy for the next two years."

That policy also includes the maintenance in 1979 of the TV Radio and Hi-Fi Spring Trade Shows in London hotels, and full support for Home Entertainment Week — the nation-wide series of local promotions launched so successfully last year and taking place this year from September 18-24 immediately following the national event at Olympia.

Also backing the Week are the ICEA, the FBA (Federation of British Audio), RETRA (the retailers association) the BBC and the IBA.

NEW TOOLS FOR THE ELECTRICIAN ADDED TO C.K. RANGE

Three new small hand tools for the electrician have been added to the C.K. range by CeKa Works Ltd., of Pwllheli, Gwynedd, North Wales.

Included are two C.K. mainstester screwdrivers, clearly marked for the 100-500 voltage range.

The mainstesters available in 5″ and 8″ models — with 2″ and 4½″ insulated blades respectively — incorporate permanently 'safety-sealed' neon assemblies within yellow plastic handles. Earth contact rivets are at the red handle ends and the 5″ model is fitted with a sturdy sprung pocket clip. Both screwdrivers are supplied in protective plastic display wallets.

A display card of twelve 8″ mainstesters is available to the trade or volume user.

The third new C.K. electrician's tool is a medium sized snipe nosed plier.

The 5½″ precision box-jointed plier has fine-polished heads, and jaws — with inside serrations — cranked to an angle of 60°. The handles, with black moulded-on PVC grips, incorporate a double leaf spring for light, yet positive, handle tension.

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ATTENTION SWL'S & DXERS. Aerial tuner units, matches random length wire aerials over 1.5 — 32MHz, pi network, size 8 x 5 x 3ins. R.F. Preselector, covers 1.5-32MHz, up to 25dbs gain, size 8 x 5 x 3ins. Active aerials still available as last month. S.A.E. for details. Amtest, 55 Vauxhall Street, Worcester, WR3 8PA.

FOR SALE: Ex-A.M. rotary motor generator. 12V d.c. at 3.8 amps to 480V at 0.04 amps. £2.00 plus carriage. Box No. G356.

WANTED: FAX equipment, manuals, service sheets, etc. G2UK, 21 Romany Road, Oulton Broad, Lowestoft, Suffolk, NR32 3PJ.

FOR SALE: Model MTB, 48 inch. Taplin twin engine. Fitted twin rudders with steering mechanism for r/c. Needs completing. S.A.E. for details. £50 o.n.o. Box No. G357.

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(Continued on page 764)

INDEX TO VOLUME THIRTY-ONE

August 1977–August 1978

AMPLIFIERS

AMPLIFIER ANCILLARIES

ELECTRONICS

GENERAL

IN YOUR WORKSHOP

RECEIVERS

RECEIVER ANCILLARIES

TELEVISION

TEST EQUIPMENT

NEWS AND COMMENT

NEW PRODUCTS

RADIO TOPICS

RECENT PUBLICATIONS AND BOOK REVIEWS

SHORT WAVE NEWS

TRADE NEWS

ELECTRONICS DATA