Practical Electronics

FEBRUARY 1966

PRICE 2'6

HOW TO MAKE

*ELECTRONIC VIBRATO UNIT

* COMPACT POWER UNIT

NEW SERIES

RADIO CONTROL of MODELS



A MODERN DESIGN . . .

PORTABLE RATEMETER

For Solid State Radiation Detector And G.M. Tubes

ADCOLA PRODUCTS LIMITED (Regd. Trade Mark)

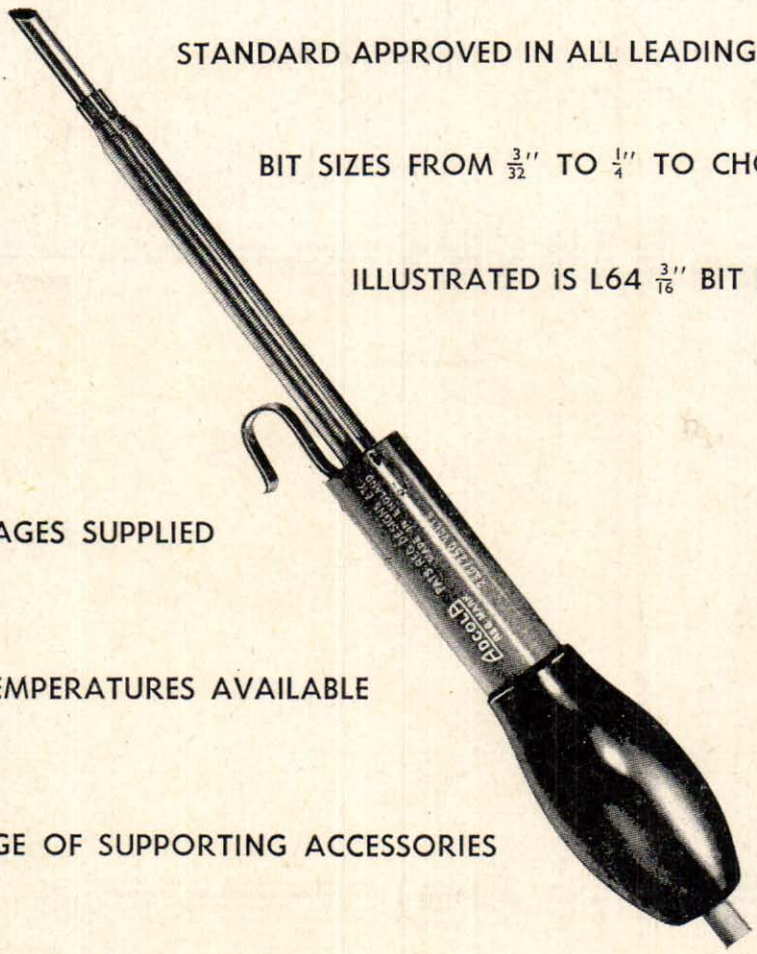
SOLDERING EQUIPMENT

"A" SERIES

STANDARD APPROVED IN ALL LEADING COUNTRIES

BIT SIZES FROM $\frac{3}{32}$" TO $\frac{1}{4}$" TO CHOICE

ILLUSTRATED IS L64 $\frac{3}{16}$" BIT INSTRUMENT



ALL VOLTAGES SUPPLIED

SPECIAL TEMPERATURES AVAILABLE

FULL RANGE OF SUPPORTING ACCESSORIES

FOR SALES & SERVICE APPLY DIRECT TO:

ADCOLA PRODUCTS LTD.
ADCOLA HOUSE
GAUDEN ROAD
LONDON, S.W.4

TELEPHONE:
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VALUE IN VALVES

GUARANTEED 3 MONTHS BY RETURN OF POST

Satisfaction or Money Back Guarantee on goods if returned unused within 14 days. ALL VALVES ARE NEW UNLESS OTHERWISE INFORMED. **FREE TRANSIT INSURANCE. POSTAGE 1/-, valve 6d., 2-11 1/-, Free over 1.**

OZ4	4/	6K8GT	6/-	20L1	16/-	DL92	5/-	EZ80	5/9	U22	6/9
1A7GT	8/3	6K7	5/9	20P1	9/6	DL94	6/6	EZ81	6/-	U24	12/6
1C5GT	7/-	6K7G	2/-	20P3	12/6	DL96	7/3	FC4	8/-	U25	10/6
1D5	7/-	6K7GT	4/9	20P4	17/-	EA50	1/3	FW4/500	7/-	U26	8/6
1D6	9/9	6K8G	5/-	20P5	15/-	EABC80	6/9	GT1C	12/6	U31	7/-
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1S4	7/6	6N7	7/6	30C1	6/9	EBC81	7/9	KT33C	4/-	U107	12/6
1S5	4/6	6P1	9/6	30C15	11/6	EBF80	7/6	KT36	14/-	U191	11/6
1T4	3/-	6P25	8/6	30F5	7/6	EBF83	9/6	KT44	6/-	U281	9/6
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3A4	4/-	6Q6G	6/6	30L1	6/6	EBL21	10/9	KT61	11/-	U301	12/-
3A5	8/9	6Q7GT	8/9	30L15	9/9	EC52	4/9	KT63	4/6	U309	6/6
3D6	4/9	6R7G	9/-	30P4	9/6	EC91	4/6	KT66	13/6	U329	9/6
3Q4	7/-	6S4A7	5/9	30P12	7/6	EC92	8/6	KT76	8/6	U339	11/6
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3V4	6/6	6SG7	4/9	30PL1	9/3	ECC32	4/-	KTW61	5/9	U404	6/-
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5T4	8/-	6SJ7	5/6	35C5	8/6	ECC34	9/-	KTW63	5/9	UABC80	7/-
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5V4G	7/6	6SL7GT	5/9	35W4	6/-	ECC40	9/6	L67	8/-	UB41	7/-
5Y3G	4/9	6SN7GT	4/9	35Z4GT	5/6	ECC81	5/6	LN152	6/6	UBC41	7/6
5Y3GT	5/6	6SQ7	5/9	35Z5GT	7/-	ECC82	6/-	MU14	7/-	UBC81	7/9
5Y4G	9/6	6S87	3/6	41	6/6	ECC83	6/6	N37	10/6	UBF80	7/9
5Z4	9/-	6U4GT	9/6	42	6/6	ECC84	7/6	N78	17/-	UBF89	7/6
5Z4G	7/6	6V6G	4/6	50B5	7/9	ECC85	7/6	N108	17/-	UBL21	12/-
5Z4GT	9/6	6V6GT	6/9	50C5	8/6	ECC88	9/6	N152	8/7	UC92	7/9
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6A7	9/-	6X5GT	6/-	61BT	17/6	ECH21	10/9	PABC80	8/-	UCF80	10/6
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6A8GT	12/9	7C5	7/9	62BT	13/6	ECH42	8/6	PC97	9/6	UCH42	7/3
6AC7	3/-	7C6	7/9	75	5/6	ECH81	7/-	PCC84	6/6	ECH81	7/9
6AG5	2/9	7H7	7/3	78	5/-	ECH83	8/6	PCC85	7/9	UCL82	9/-
6AG7	6/9	7S7	15/-	80	5/6	ECL80	6/6	PCC88	11/9	UCL83	12/-
6AK5	5/-	7Y4	6/-	83	9/6	ECL82	8/-	PCC89	9/6	UF41	8/-
6AL5	3/3	7Z4	6/-	185BT	19/6	ECL83	10/6	PCC189	12/-	UF42	5/8
6AM6	3/-	8D3	3/-	185BTA	19/6	ECL84	12/-	PCF80	8/9	UF80	8/-
6AQ5	6/-	10C1	11/6	807	7/6	ECL86	10/3	PCF82	7/-	UF85	7/6
6AT6	5/-	10C2	14/6	813	49/-	EF22	7/-	PCF84	12/-	UF89	8/-
6AU6	7/-	10F1	4/9	832	14/-	EF36	3/3	PFC86	11/-	UL41	8/-
6AV6	5/9	10F9	10/6	866A	12/6	EF37A	8/-	PCL82	7/3	UL44	14/-
6B7	8/6	10F18	10/-	954	3/9	EF39	7/6	PCL83	9/-	UL46	9/9
6B8G	3/-	10LD11	14/6	955	2/3	EF40	11/-	PCL84	7/3	UL84	6/6
6BA6	5/6	10P13	8/6	956	2/-	EF41	8/-	PCL85	10/6	UM80	3/9
6BE6	5/6	10P14	9/6	1625	5/6	EF42	6/9	PCL86	10/6	UR1C	7/6
6BG6G	15/-	10P18	7/-	6060	7/6	EF50-BR	1/6	PEN25	3/9	UU6	11/6
6BH6	6/6	12A6	2/3	6057	9/6	EF50(A)	2/6	PEN45	8/6	UU7	9/6
6BJ6	5/9	12AHS	11/-	6067	9/6	EF54	3/-	PEN46	4/6	UU8	13/6
6BQ7A	6/6	12AT6	6/6	5763	7/6	EF80	4/6	PL33	9/6	UY1N	11/-
6BR7	8/6	12AT7	5/6	9001	3/6	EF85	6/-	PL36	9/6	UY21	9/6
6BR8	9/6	12AU6	9/-	9002	4/9	EF86	7/6	PL38	15/-	UY41	6/-
6BW6	7/9	12AU7	6/-	9003	5/9	EF89	6/9	PL81	8/3	UY85	6/-
6BW7	5/-	12AV6	6/9	ATP4	2/6	EF91	3/-	PL82	6/6	VP4B	9/-
6C4	2/3	12AX7	6/6	AZ31	7/6	EF92	3/-	PL83	6/6	VP23	2/9
6C5	5/6	12BA6	7/-	AZ41	7/-	EF183	9/9	PL84	7/-	VP41	5/6
6C6	3/6	12BE6	6/6	B36	6/9	EF184	9/6	PL820	8/3	VR105	5/6
6C9	11/-	12BH7	8/9	C1C	8/-	EK32	7/6	PMS4	8/-	VR150	5/-
6CD6G	19/6	12C8	5/6	CBL31	13/6	EL32	3/9	PX4	12/6	W76	4/9
6CH6	6/3	12E1	17/6	CCH35	13/6	EL33	11/-	PX25	9/-	W81	7/3
6D2	3/6	12H6	1/9	CY31	7/6	EL34	11/6	PY31	8/-	X61M	11/-
6D3	9/6	12J5GT	3/3	D77	3/3	EL35	6/-	PY32	10/-	X63	8/6
6D3	3/-	12J7GT	8/-	DA30	11/6	EL38	12/6	PY33	10/6	X65	11/-
6F1	4/9	12K7GT	4/9	DAC32	8/-	EL41	8/-	PY80	6/6	X660	7/9
6F6	7/6	12K8	9/9	DAF91	4/6	EL42	9/6	PY81	6/3	X76M	11/-
6F6G	4/6	12K8GT	11/6	DAF96	7/3	EL81	8/9	PY82	5/9	X78	21/-
6F13	4/9	12Q7GT	4/9	DF33	8/9	EL84	6/6	PY83	6/9	X79	21/-
6F14	9/6	12SA7	7/-	DF91	3/-	EL85	9/9	PY88	8/9	X81M	9/-
6F15	9/6	12SG7	4/6	DF96	7/3	EL91	3/9	PY800	7/9	Y63	6/-
6F19	6/-	12SH7	3/6	DF97	7/6	EL95	6/-	PY801	7/9	Z63	6/-
6F32	4/9	12SJ7	5/6	DH63	5/6	EM34	8/9	PZ30	9/6	Z63	4/9
6F33	4/-	12SK7	4/6	DH76	4/6	EM80	7/6	R19	9/6	Z66	8/6
6H6	1/6	12SN7GT	6/9	DK32	9/6	EM81	0/9	RL18	11/-		
6J5	4/3	12SQ7	8/6	DK91	5/6	EM85	9/6	SP41	2/3		
6J5G	3/-	12SQ7	8/6	DK92	7/-	EN31	16/-	SP61	2/-		
6J5GT	4/3	14S7	17/6	DK96	7/9	EY51	7/6	SU25	16/-		
6J6	3/6	19AQ5	7/9	DL33	7/6	EY86	7/3	SU2150	4/6		
6J7	8/6	19BG6	14/-	DL35	7/6	EY88	9/6	T41	6/9		
6J7G	4/9	20D1	8/9	DL53	9/-	EZ40	7/-	TDD4	8/6		
6J7GT	7/6	20F2	9/6	DL74	6/-	EZ41	7/-	U14	7/6		
				DL82	9/-			U18	7/6		

100's TYPES NOT LISTED S.A.E. ENQS.

CONNECTING WIRE

P.V.C. Bright Colours. Five 25ft. coils only. **4/-**

MAINS TRANSFORMERS

Excellent Quality Guaranteed Upright mounting 250-0-250v., 60mA, 6.3v., 3A (80mA 12/6) Ditto semi-shrouded **9/6**

SPECIAL C.R.T. OFFER

Due to huge Bulk Special Purchase, we are offering CRM141 and MW 36/24 Tubes at the unrepeatable price of 39/-. P.P. 12/6. The above are guaranteed for 6 months.

★ BULK BARGAINS ★

12 POTS. Popular values. 5K. to 2 Meg. Unused, mixed pre-set, long sp., switch, etc. **4/6**

CONDENSERS. 25 mixed Electrolytics. Many popular sizes. List Value £5. Our price **10/-**

100 RESISTORS 6/6
Excellent. Sizes ⅛-3 watt.

100 CONDENSERS 9/6
Miniature Ceramic and Silver Mica Condensers, 3pF to 5,000 pF. LIST VALUE OVER £5.

25 TAG STRIPS 4/-
2, 4, 6, 8-way, etc. Unused.

Tubes

HIGHEST QUALITY— COMPARE OUR PRICES

Carr. & Ins. 12/6

MOST MULLARD, MAZDA, COSSOR, EMITRON, EMISCOPE, BRIMAR, FERRANTITYPES PROCESSED IN OUR OWN FACTORY

	GUARANTEED 6 Months	GUARANTEED 12 Months	NEW TYPES
12in.	£2. 0.0	£3. 0.0	MW 31/74 £3.15.0
14in.	£2.10.0	£3.10.0	
15-17in.	£3. 5.0	£4. 5.0	WM 38/24 £4.15.0
19in.	£3. 5.0	£4. 5.0	
21in.	£3.15.0	£5.15.0	CRM 172 MW 43/64 £6.0.0
23in.	£3.15.0	£5.15.0	

SATISFACTION GUARANTEED

Autochangers, etc.

LATEST GARRARD

All Factory Fresh. All with cartridge. **SRP10** Mono (Single) Player, **£4.19.0.**

SP25 Semi-Transcription (Single), **£11.19.0.**

AUTOSLIM Standard Auto, **£5.19.0.**

AT6 Auto (Limited Number), **£8.19.0.**

AT5 Slimline—similar to AT6, **£7.15.0.**

Model 1,000—Compact low-priced record changer, automatically playing up to 10 records, **£6.19.0.**

Model 2,000—Automatic record changer with large turntable, playing up to 8 records, **£7.19.0.**

Model 3,000—Designed for use with high-compliance cartridges: low-mass arm gives exceptionally low record wear, **£10.10.0.**

AT60—Automatic or manual operation, has precision arm, bias compensator and heavy turntable, **£11.19.0.**

A70—For the critical user—offers automatic playing, with pusher-platform, and many other features, **£19.19.0.**

LAB80—An outstanding automatic transcription turntable for professional reproduction, **£25.**

301—Transcription Heavy Table, **£22.**

401—Transcription turntable with heavy 12in. turntable, machine-cut strobe, neon lamp and speed control, **£29.19.0.**

Model 50—Automatic record changer with large turntable, weight-counterbalanced arm and plug-in pick-up head, **£9.10.0.** B.S.R.

GU7—Single Deck Complete, **£4.5.0.**

UA14 or **U25**—Auto Changer, **£5.15.0.**

PRICES SLASHED

LZ27 TAPE RECORDERS. Famous make, latest Silver/Grey finish, 4 inputs, 2-speed 3¾ × 7½in. Complete with microphone, footage counter, volume level indicator, tone control, spare spool. This machine takes 7in. spools and is a full size Recorder, not a toy! Price normally £30.9.0. 5/- p.p. **£17.10.0**

HITACHI 4 TRACK MODEL TRA-505. This superior 48 guinea recording machine is on very special limited offer. Two channel recording. Plays stereo tapes, 1⅞in. and 3¾in. speed. One track can be listened to on an earphone whilst recording on the second track, and thereafter both tracks played simultaneously through the loudspeaker. Ideal for languages, singing to music, etc. Excellent reproduction through Hi-Flux. Eliptical speaker. A.C. erase. Dimensions 11" × 11" × 5¼". Weight 12 lbs. Dynamic mike. Sound level meter. Footage indicator. Two mixed inputs. **29 Gns.**

TRANS/CEIVER TYPE RT33. The very latest Silver/Black finish. They give a fantastic performance with reliability, long telescopic aerial, crystal controlled. Note a licence is required to transmit. They compare with much dearer models. 2/6 p.p. **£8.19.0**

25 WATT GUITAR SPEAKERS. Very heavy coned 12in. cast chassis. There is nothing to touch it for power handling and quality at the price Plus 5/- p.p. **£4.19.0**

DULCI (VHF) F.M. TUNERS MODEL FMT5. Self powered 200-250 vac. High sensitivity and automatic gain control for long distance reception. Size 11½" × 8½" × 3½" high. Weight 7½lbs. In case finished satin chrome and black. Due to fortunate purchase we can offer limited number of these Hi-Fidelity instruments normally £21.13.5 at **15 Gns.**

ROBOPHONE ORDERS

Your C.O.D. order for any items exceeding £1 can be telephoned to BRIGHTON 680722 at any time day and night for seven days per week.

TEST EQUIPMENT. IT1-1 Transistorised Signal Injector, complete with Transistor Oscillator with Indicator Lamp, Detachable Test Probe and instructions. **35/-**

IDEAL FOR ANY RECORDER. PRICES SLASHED. GUARANTEED APPROX. ½ PRICE. WORLD FAMOUS MAKE BY ENORMOUS PURCHASE.

★ TAPE ★

We offer you fully tensilised polyester/mylar and P.V.C. tapes of identical quality hi-fi, wide range recording characteristics as top grade tapes. Quality control manufacture. Not substandard in any way. Try one for yourself. They are truly worth a few more coppers than acetate, sub-standard, jointed or cheap imports. Try one and prove it for yourself!

Standard Play			Double Play	
3"	150ft.	2/3	3"	300ft. 4/-
4"	300ft.	4/6	4"	600ft. 8/-
5"	600ft.	7/6	5"	1200ft. 15/-
5½"	900ft.	10/6	5½"	1800ft. 19/6
7"	1200ft.	13/6	7"	2400ft. 27/-
Long Play			**Triple Play**	
3"	225ft.	2/9	4"	900ft. 13/-
4"	450ft.	5/6	5"	1800ft. 25/-
5"	900ft.	10/6	5½"	2400ft. 34/-
5½"	1200ft.	13/-	7"	3600ft. 44/-
7"	1800ft.	18/6	**Quadruple Play**	
			3"	600ft. 8/-

Postage 1/- or Post Free less 5% on three reels. Quantity and Trade enquiries invited.

HITACHI AM/FM RADIOS

Latest wonderfully styles, guaranteed top make. 10-transistor with full long and medium waves. Size 9½ × 6⅜ × 12⅜in. Magnificent reproduction. A pleasure to look at. "An aristocrat in its class". 12 months' guarantee against faulty manufacture. Genuine retail price £28.7.6. Unrepeatable. **17 Gns.**

HITACHI PORTABLE TAPE RECORDER

Fabulous quality and reproduction of music. 6 transistor, 1⅞in. and 3¾in. speeds. Output 500mW into high quality speaker. Ingenious single control knob. Fast forward and rewind. Battery level and record level meter. Fast load. Precision capstan drive with dynamic earpiece monitor recording. Radio recording leads. Outside speaker facilities. The most outstanding portable in the country. Size 8⅛ × 3⅜ × 6¼in. Genuine normal price of 35 gns. Unrepeatable. 12 months' guarantee. All spares available. With tape, tape reel, mike, etc. **19 Gns.**

Post: 2 lbs. 2/-, 4lbs., 2/6, 7lbs. 3/6, 15lbs., 4/-, etc. (C.O.D. extra). ALL VALVES LESS 5% AND POST FREE IN DOZENS.

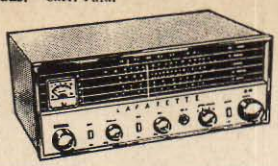
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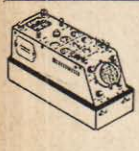
LAFAYETTE HA-63 COMMUNICATION RECEIVER

7 valves plus Rectifier. 4 Bands. 550 kc/s–31 Mc/s. "S" Meter—BFO—ANL—Bandspread Tuning. 200/250v. A.C. Brand New **24 Gns.** Carr. Paid.



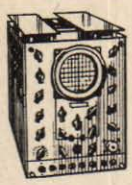
STAR SR.40 COMMUNICATION RECEIVER

4 Bands, 550 kc/s—30 Mc/s. "S" Meter—BFO—ANL—Bandspread Tuning—Built-in speaker 200/250v. A.C. Brand New. **18½ Gns.** Carr. 10/-.



OS/8B/U OSCILLOSCOPES

High quality Portable American Oscilloscope. 3" c.r.t. T/B 3 c/s-50 kc/s X Amp: 0-500 kc/s Y Amp: 0-2 Mc/s. Power requirements 105-125v. A.C. Supplied in brand new condition, fully tested. **£25.** Carr. 10/-. Suitable 230/115v. Transformer **15/6.**



ERSKINE TYPE 13 DOUBLE BEAM OSCILLOSCOPE

Time base 2 c/s-750 kc/s. Calibrators at 100 kc/s and 1 Mc/s. Separate Y1 and Y2 amplifiers up to 5.5 Mc/s. Operation 110/230 volt A.C. Supplied in perfect working order. **£27/10/-.** Carriage 20/-.



CLEAR PLASTIC PANEL METERS

First grade quality, Moving Coil panel meters, available ex-stock. S.A.E. for illustrated leaflet. Discounts for quantity. Available as follows: Type MR. 38P. 1 21/32in. square fronts.

5mA	22/6	1A D.C.	22/6	300V D.C.	22/6
10mA	22/6	2A D.C.	22/6	500V D.C.	22/6
20mA	22/6	5A D.C.	22/6	750V D.C.	22/6
50mA	22/6	3V D.C.	22/6	15V A.C.	22/6
100mA	22/6	10V D.C.	22/6	50V A.C.	22/6
150mA	22/6	20V D.C.	22/6	150V A.C.	22/6
200mA	22/6	50V D.C.	22/6	300V A.C.	22/6
300mA	22/6	100V D.C.	22/6	500V A.C.	22/6
500mA	22/6	150V D.C.	22/6	"S" Meter	1mA 29/6
750mA	22/6				
50μA	32/6				
100μA	29/6				
200μA	27/6				
500μA	25/-				
50-0-50μA	29/6				
100-0-100μA	27/6				
500-0-500μA	22/6				
1-0-1mA	22/6				
1mA	22/6				
2mA	22/6				

POST EXTRA Larger sizes available—send for lists.

ILLUMINATED "S" METER. 1 23/32 in. square front. Cal. in S units. 6V. lamp. **29/6.** P. & P. 1/-. Ditto 2 5/16in. square **39/6.** P. & P. 1/-.



TRANSISTORISED TWO-WAY TELEPHONE INTERCOM.

Operative over amazingly long distances. Separate call and press to talk buttons. 2-wire connection. 1000's of applications. Beautifully finished in ebony. Supplied complete with batteries and wall brackets.
7 gns. pair. P. & P. 5/-.

MAGNAVOX 363 TAPE DECKS

New 3-speed tape deck, supersedes old Collaro studio deck. 2-track **£10.10.0.** 4-track **£13.10.0.** Carr. Paid.

GARRARD RECORD PLAYERS

Brand new and guaranteed

SRP-10 Player	£4 17 6
AUTOSLIM Changer	£5 5 0
1000 Changer	£5 19 6
2000 Changer	£7 10 0
3000 Changer—Stereo	£8 8 0
SP25 Player—Stereo	£12 10 0
DECCADEC, with Deram	£17 17 0
A70 (less cart.)	£22 1 0
LAB80—Mono	£27 0 0
401 Transcription	£30 0 0

All plus P. & P. 5/-.

MINE DETECTOR No. 4A

Will detect all types of metals. Fully portable. Complete with instructions. **39/6.** Carr. 10/-. Battery 8/6 extra.

CALLERS WELCOME!

Open 9 a.m. to 6 p.m. every day Monday to Saturday. Trade supplied.

MODEL ZQM TRANSISTOR CHECKER



It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec.: A: 0-7-0-9967, B: 5-200. Ico: 0-50 microamps, 0-5 mA. Resistance for diode 200Ω—1 MEG. Supplied complete with instructions, battery and leads. **£6/19/6.** P. & P. 2/6.

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200 v. P.I.V. 200mA.	2/6
400 v. P.I.V. 3 amp.	7/6
1,000 v. P.I.V. 650 mA	7/6
800 v. P.I.V. 500mA.	5/6
400 v. P.I.V. 500mA.	3/6
70 v. P.I.V. 1 amp.	3/6
150 v. P.I.V. 165mA.	1/-

Discounts for quantities. Post extra.

AMERICAN TAPE

First grade quality American tapes. Brand new and guaranteed. Discounts for quantities.

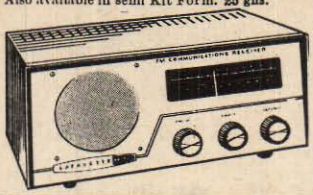
3in., 225ft. L.P. acetate	4/-
3½in., 600ft. T.P. mylar	10/-
5in., 600ft. std. plastic	8/6
5in., 900ft. L.P. acetate	10/-
5in., 1,200ft. D.P. mylar	15/-
5in., 1,800ft. T.P. mylar	35/-
5½in., 1,200ft. L.P. acetate	12/6
5½in., 1,800ft. D.P. mylar	22/6
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7in., 1,200ft. std. mylar	12/6
7in., 1,800ft. L.P. acetate	15/-
7in., 1,800ft. L.P. mylar	20/-
7in., 2,400ft. D.P. mylar	25/-
7in. 3,600ft. T.P. mylar	58/6

Postage 2/-. Over £3 post paid.

NEW MODEL! LAFAYETTE HA-230 AMATEUR COMMUNICATIONS RECEIVER



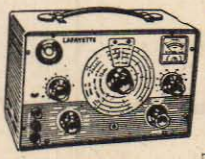
Supersedes model HE-30. 8 valves + rectifier. Continuous coverage on 4 bands. 550 Kc/s—30 Mc/s. Incorporates 1 RF & 2 IF stages, Q Multiplier, B.F.O., ANL, "S" meter, Electrical bandspread, Aerial trimmer etc. Supplied brand new and guaranteed. **33 gns.** S.A.E. for full details. Also available in semi Kit Form. **25 gns.**



NEW MODEL! LAFAYETTE HA-55 AIRCRAFT RECEIVER

108–136 Mc/s. High selectivity and sensitivity. Incorporates 2 RF stages including 6CW4 Nuvistor, 8 tubes for 11 tube performance, solid state power supply, adjustable squelch control, slide rule dial, built in 4in. speaker and front panel phone jack. 220/240V. A.C. Supplied brand new and guaranteed. **19 gns.** Carr. 10/-.

TE22 SINE SQUARE WAVE AUDIO GENERATORS



Sine: 20 cps to 200 kc/s. on 4 bands. Square: 20 cps to 20 kc/s. Output impedance 5,000 ohms. 200/240v. A.C. operation. Supplied Brand New and Guaranteed with instruction manual and leads. **£15.** Carr. 7/6.

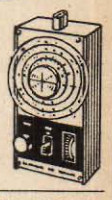


LAFAYETTE TE-46 RESISTANCE CAPACITY ANALYZER

2 PF—2,000 MFD. 2 ohms—200 Megohms. Also checks impedance, turns ratio, insulation 200/250v. A.C. Brand New **£15.** Carr. 7/6.

LAFAYETTE NUVISTOR GRID DIP METER

Compact true one hand operation. Frequency range 1.7-180 Mc/s. 230v. AC operation. Supplied complete with all coils and instructions. **£12.10.0.** Carr. 5/-.



2-WAY RADIOS



Superb quality. Complete with all accessories and fully guaranteed.

3 Transistor **£7.19.6** pr.
4 Transistor **11 gns.** pr.
9 Transistor **£22.10.0** pr.
10 Transistor **28 gns.** pr.

Post extra. (S.A.E. for full details).

These cannot be operated in U.K. without licence.

VOLTAGE STABILIZER TRANSFORMERS



Input 80–120v. and 160–240v. Constant output 110v. or 240v., 250 watts. Brand New Guaranteed. **£10.10.0.** Carr. 7/6.

VARIABLE VOLTAGE TRANSFORMERS

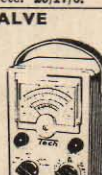


Brand New Guaranteed —Fully Shrouded. Input 230v. 50/60 c/s. Output 0–260 Volts.

1 Amp	£4.10.0
2.5 Amp	£5.17.6
5 Amp	£9.0.0
8 Amp	£13.10.0
10 Amp	£17.0.0
12 Amp	£18.10.0
20 Amp	£32.10.0

2.5 Amp Portable—Metal Case with Meter-Fuses, etc. **£9/17/6.**

MODEL PV-58 VALVE VOLTMETER



11 meg. input. 7 D.C. volt ranges. 1.5-1,500 v. 7 A.C. volt ranges 1.5-1,500 v. 4,000 Peak to Peak. Resistance .2 ohm to 1,000 megohm. Decibels —10db to +65db. Supplied brand new with instructions, leads and probe. **£12/10/-.** P. & P. 3/6.

TS-76 20,000 O.P.V. PUSH BUTTON MULTI-TESTER



Simple operation, D.C. volts up to 1,000 v. A.C. volts up to 1,000 v. Resistance up to 10 megohm. Current up to 250 mA. Decibels —20 to +36 db. **£5.5.0.** P. & P. 2/-.

MODEL TE-12



20,000 O.P.V. 0/0.6/6/30/120/600/1,200/3,000/6,000 v. D.C. 0/6/30/120/600/1,200v. A.C. 0/60μA 6/60/600 MA. 0/6K/600K/6 Meg. 60 Meg. Ω. P.F. .2 MFD. **£5/19/6.** P. & P. 2/6.



MODEL 500. 30,000 o.p.v. 0/.5/1/2.5/10/25/100/250/500/1,000v. D.C. 0/2.5/10/25/100/250/500/1,000v. A.C. 0/50μA/5/50/500mA. 12 amp. D.C. 0/60K/6 Meg./60. Meg Ω. **£8/17/6** Post Paid.

TE-51 NEW 20,000Ω/VOLT MULTIMETER



0/6/60/120/1,200V. A.C. 0/3/30/60/300/600/3,000V. D.C. 0/60μA/12/300 MA. D.C. 0/60K/6 Meg. Ω **85/-.** P. & P. 2/6.

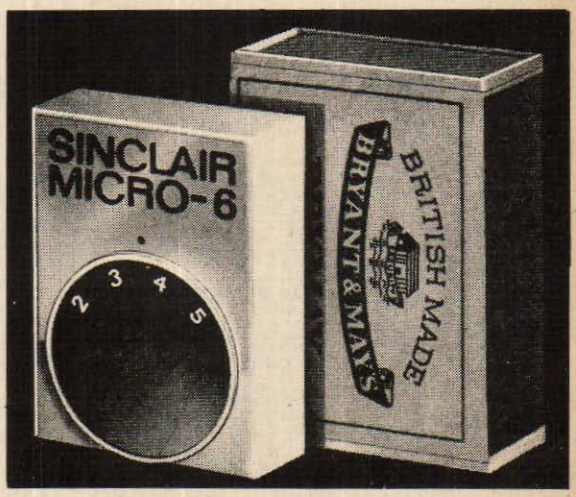
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YOU ARE ALWAYS AHEAD WITH A SINCLAIR DESIGN

The world's smallest radio

SINCLAIR MICRO-6

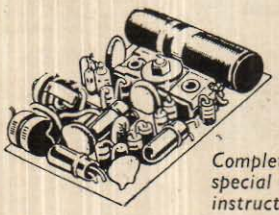


No transistor set has ever yet compared in its class with the Micro-6 for size, power performance and design. Everything except the lightweight earpiece is contained within the smart minute white, gold and black case which weighs under one ounce in working order. Quality of reproduction is outstandingly good so you are certain to derive enormous pleasure from this fantastic set. Order your Micro-6 now. See why it cannot be too highly recommended to build and to use. You can easily have it working in an evening!

SIZE: $1\frac{4}{5}$" × $1\frac{3}{10}$" × $\frac{1}{2}$"
WEIGHT: Under 1 oz.

FANTASTIC RANGE AND POWER

. . and an amazing letter



I have had one of your Micro-6 receivers here in Sydney for about a year and I must say that its performance is very good. The sensitivity is high and the selectivity is quite adequate (it has to separate no less than 8 local stations) and all of them legal too. It is quite a miniature masterpiece!

Congratulations on the release of your F.M. set. You certainly are the leaders in miniature elecctronics. I shall look forward to the release of the Sinclair shirt-pocket colour T.V. receiver with micro-alloy CRT. Thanking you in anticipation and with best wishes for the future.

(signed) P. K. Vaucluse, N.S.Wales

AMAZING CIRCUITRY

The six-stage circuit uses three special transistors to provide two stages of R.F. amplification with double diode detector and high gain 3-stage A.F. amplifier. A.G.C. counteracts fading from distant stations: band-spread brings in Luxembourg like a local station. Plugging in earpiece switches set ON. Tunes over medium waveband by vernier-type dial. Two self-contained batteries give about 70 hours working life.

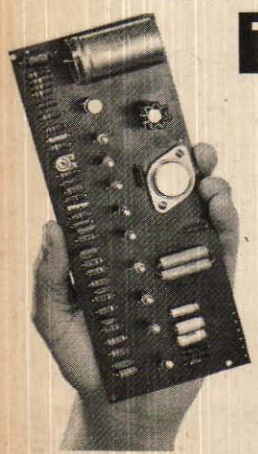
Complete kit of parts inc. special earpiece and instructions **59/6**

MALLORY MERCURY CELL TYPE ZM.312

(2 required) each 1/11
Pack of six 10/6

NEW SINCLAIR DESIGNS
see next page

THE WORLD'S MOST ADVANCED AMPLIFIER



SIZE: $8\frac{1}{4}$" × $3\frac{1}{4}$" × 1"

OUTPUT:

20 WATTS RMS

SINCLAIR X-20

- 20 WATTS R.M.S. OUTPUT INTO 7.5 ohms
- 20—20,000 c/s ±1dB
- Constant square wave amplitude
- 95% conversion efficiency at output
- Input sensitivity—1mV into 5K ohms
- Power requirements—36V.d.c. at 700 mA

The only amplifier in the world to use Pulse Width Modulation, which, with circuitry developed specially by Sinclair gives power and quality years ahead of anything in its class. You can feed any signal source into the X-20—including modern high quality pick-up, radio tuner, guitar. The X-20 manual shows circuits by which pick-ups, etc. can be matched to the integrated pre-amplifier of the X-20 both in mono and stereo. When you have built this 12-transistor amplifier you use it in the same way as any other top quality hi-fi unit except that it is smaller, costs less and behaves perfectly.

Complete kit of parts including transistors and X-20 manual in sealed carton **£7.19.6**

Built and tested with X-20 manual in sealed carton **£9.19.6**

X-20 Power Pack sufficient to drive two X-20's **£4.19.6**

THE X-20 MANUAL details tone and volume control systems for X-20. Mono and Stereo. **FREE WITH EVERY X-20.** Available separately—2/- post free.

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SINCLAIR RADIONICS LTD.
COMBERTON, CAMBRIDGE Telephone: COMBERTON 682

A BRILLIANT NEW TUNER



THE WORLD'S FIRST POCKET-SIZE F.M. TUNER-RECEIVER

SINCLAIR

MICRO FM

- SIZE $2\frac{15}{16}" \times 1\frac{5}{8}" \times \frac{3}{4}"$
- 7 TRANSISTORS
- 2 DIODES
- NO ALIGNING
- PULSE-COUNTING DISCRIMINATOR
- HI FI STANDARDS

A joy for anyone to build!

In styling, the Sinclair Micro FM is the most elegant, most professional looking design in miniaturised equipment ever made available to constructors. **It is also the most original FM design in years. This high quality FM tuner has one output for feeding to hi-fi amplifier or tape recorder; a second output enables it to be used independently as a self-contained pocket FM receiver for personal listening. Barely half the size of a packet of twenty cigarettes, this fully fledged 7 transistor design incorporates many unique and original design features to achieve fantastically good standards of performance. Thanks to Sinclair designers, you can at last build an FM receiver without alignment problems, so that your Micro FM is ready to use the moment you finish building it. With pulse counting detection for better audio quality, excellent sensitivity and A.F.C. for easy tuning, the set's own telescopic aerial will suffice for good reception almost everywhere. THE MICRO FM COSTS POUNDS LESS AND MEANS THAT ANYONE CAN ENJOY THE ADVANTAGES OF FM AT ITS BEST TO-DAY.**

Use it as —

AN F.M. TUNER FOR YOUR TAPE RECORDER



Money Saving!



AS A TUNER FOR YOUR HI-FI *(Space Saving!)*

AS A SELF-CONTAINED POCKET F.M RECEIVER.



(The only one in the World!)

Seven transistor, two diode FM superhet for use as a tuner and as a self-contained pocket receiver. The R.F. amplifier is followed by a self oscillating mixer. Low I.F. dispenses with the need for alignment. A three stage I.F. amplifier produces a square wave of constant voltage which is fed into the pulse counting discriminator. This is converted into uniform pulses, the average output from which is directly proportional to the signal frequency, reproducing the original modulation exactly. After equalisation, the signal is fed to the audio output socket and to the receiver's own audio amplifying stage for using the Micro FM as an independent self-contained receiver. A.F.C. "locks" on each station automatically. THE SINCLAIR MICRO FM is self-contained within a neat black plastic case faced by an elegantly designed front panel of brushed and polished aluminium with spun aluminium tuning dial to match.

- TUNES FROM 88-108 M/cs.
- ONE OUTPUT FOR HI-FI AND TAPE, ONE FOR PERSONAL LISTENING
- STANDARD 9-VOLT BATTERY HOUSED IN CASE
- AUDIO RESPONSE 10-20,000 c/s ± 1dB
- SIGNAL TO NOISE RATIO 30dB at 30mV

Complete kit including telescopic aerial, case, dial, earpiece and instructions

£5.19.6

FULL SERVICE FACILITIES AVAILABLE TO ALL SINCLAIR CUSTOMERS

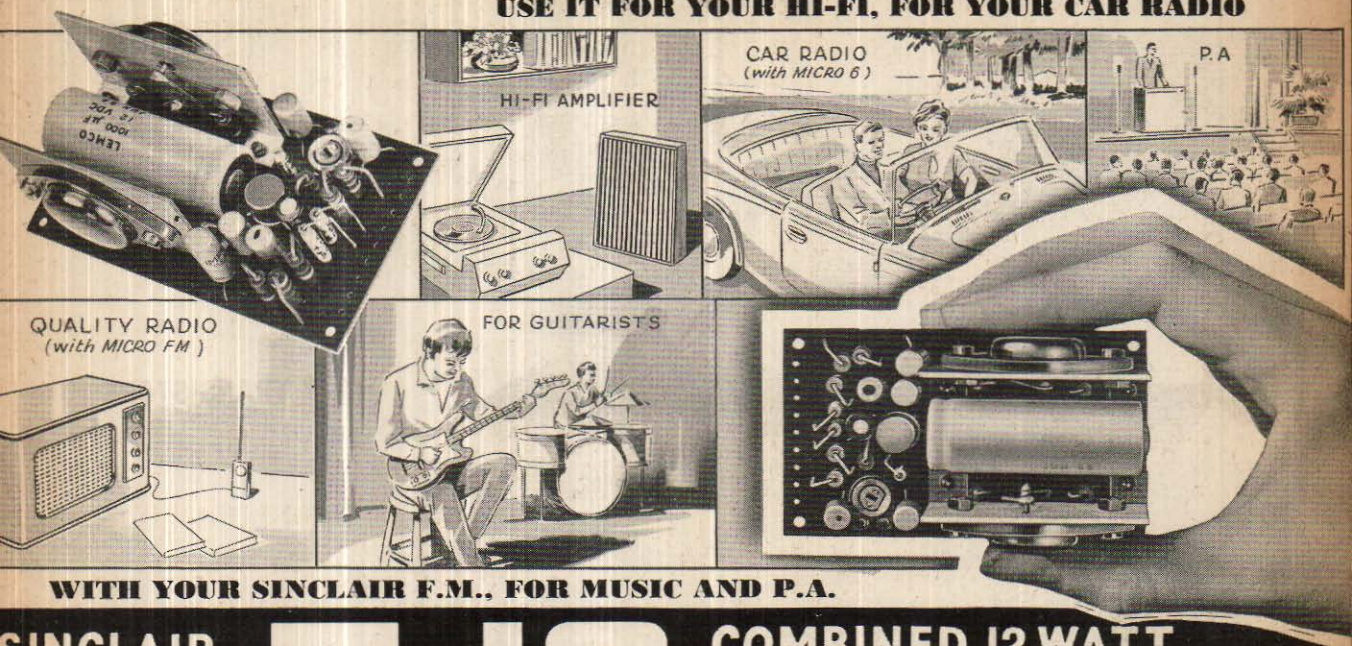
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Telephone: COMBERTON 6

A BRILLIANT NEW AMPLIFIER

USE IT FOR YOUR HI-FI, FOR YOUR CAR RADIO



WITH YOUR SINCLAIR F.M., FOR MUSIC AND P.A.

SINCLAIR Z.12 COMBINED 12 WATT HI-FI AMPLIFIER AND PRE-AMP

Greater Power and Versatility

3" × 1¾" × 1⅓"

•

WEIGHS 3 oz.

•

12 WATTS R.M.S.
(24 WATTS PEAK)

•

USE IT WITH THE MICRO-6 OR MICRO F.M.

In the Z.12 manual included with every Sinclair Z.12 integrated 12 watt hi-fi amplifier and pre-amp will be found a number of tone and volume control systems from which you will be able to select one best suited for your requirements. Mono and stereo are shown, and none of these circuits costs more than a few shillings to add.

Here is the hi-fi amplifier you have always dreamed of—very small, very powerful and of the highest possible quality. Sinclair's latest design, the Sinclair Z.12 meets all these requirements AND MORE to give you the most versatile, dependable amplifier system ever. In conformity with original Sinclair design, the Z.12 incorporates its own special pre-amplifier to which you add whichever of the tone and volume control circuits shown in the Z.12 manual suits you best. The Z.12 achieves even greater versatility, since it operates efficiently from any power supply between 6 and 20 volts, D.C. This makes it as attractive for use in car radios, guitars, P.A. systems, etc. as for the very best hi-fi it is designed for. In fact, the Z.12 is the ideal amplifier wherever the need is for great power and quality from the smallest possible unit. The Sinclair Z.12 comes to you ready built, tested and guaranteed. The Z.12 manual included makes simple work of installing and using the unit.

Technical Details: *8 transistor hi-fi amplifier with pre-amp and ultra-linear class B output. Special H.F transistors are used in original circuitry to achieve laboratory standards of performance. Superb quality is assured by generous negative feed back.* **FREQUENCY RESPONSE—15-50,000 c/s ±1dB! OUTPUT—12 watts RMS continuous sine wave (24 watts peak), 15 watts RMS music power (30 watts peak). OUTPUT IMPEDANCE—suitable for 3, 7.5 and 15 ohm speakers. Two 3-ohm speakers can be used in parallel if required. INPUT—2mV into 2K ohms. POWER SUPPLY—6 to 20V d.c. from power unit available or batteries. SIGNAL TO NOISE RATIO—better than 60dB. QUIESCENT CURRENT CONSUMPTION—only 15mA. IDEAL FOR BATTERY OPERATION.**

Z.12 Amplifier and pre-amp ready built, tested and guaranteed

Sinclair Power Pack for above **£2.14.0**

89/6

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COMBERTON CAMBRIDGE

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for which I enclose Cash/Cheque/Money

Order value £.....s.....d.

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Should you not be completely satisfied with your purchase when you receive it from us, your money will be refunded in full and at once without question. It is important to quote Pr.E26 should you prefer to write your order instead of cutting out this coupon.

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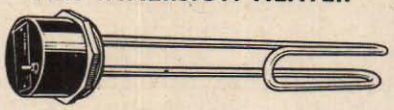
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5¾" L.P. 1200 ft.	11/6	5¾" T.P. 2400 ft.	32/6
7" L.P. 1800 ft.	18/6	7" T.P. 3600 ft.	42/6

P. & P. on each 1/6, 4 or more post free.

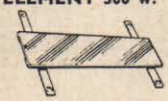
3 kW IMMERSION HEATER

Complete with Variable Thermostat 90° to 180°F. 20 amp. A.C. and **GEC** double pole 20 amp. mains switch. 11," 14", 27", 30" and 36". State length required. **£2.0.0** plus 5/- P. & P.



"PREMIER" KETTLE ELEMENT
1000 w., 5/- + 3/- P. & P. Retaining nut and flange 2/6, switch plug to suit 2/6.

GEC FLAT HEATER ELEMENT 500 w.

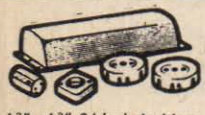


Can be used for wash boilers, washing machines, etc. Five or six elements can be used in parallel to give 2500/3000 watts. Sizes 5½" x 1½", copper enclosed. 2/6 each, P. & P. 1/-. 4 or more Post Paid.

3 to 4 WATT AMPLIFIER KIT

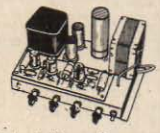


comprising chassis 8¾" × 2½" × 1". Double wound mains transformer, output transformer, volume and tone controls, resistors, condensers, etc. 6V6, ECC81 and metal rectifier. Circuit 1/6 free with kit. **29/6** plus 4/6 P. & P.



40w. FLUORESCENT LIGHT KIT incorporating **GEC** Choke size 8¼" × 1¾" × 1¾", 2 bi-pin holders, starter and starter holder, **11/6.** P. & P. 4/6.
Similar to above: 80w. Fluorescent Light Kit incorporating **GEC** choke size 11¼" × 1¾" × 1¾", 2 bi-pin holders, starter and starter holder, **17/6.** P. & P. 5/6.

8-watt 5-valve PUSH-PULL AMPLIFIER & METAL RECTIFIER



Size: 9 × 6 × 1¼" A.C. Mains 200-250v. 5 valves. For use with Std. or L.P. records, musical instruments, all makes of pick-ups and mikes. Output 8 watts at 5 per cent total distortion. Separate bass and treble lift controls. Two inputs, with controls, for gram. and mike. Output Transformer tapped for 3 and 15 ohms speech coils. Built and tested. **£3.19.6.** P. & P. 8/-.

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Combined Portable and Car Radio
The Radio with the "Star" Features



- ★ **7-transistor superhet. Output 350 mW.**
- ★ **Wooden cabinet, fitted handle with silver-coloured fittings, size 12½ in. × 8½ in. × 3½ in.**
- ★ **Horizontal tuning scale, size 11½ in. × 2½ in. in silver with black lettering.**
- ★ **All stations clearly marked.**
- ★ **Ferrite-rod internal aerial.**
- ★ **Operated from PP9 battery.**
- ★ **I.F. neutralisation on each stage 460 kc/s.**
- ★ **D.C. coupled output stage with separate A.C. negative feed back.**
- ★ **All components, ferrite rod and tuning assembly mounted on printed board.**
- ★ **Fully comprehensive instructions and point-to-point wiring diagram.**
- ★ **Printed circuit board, back-printed with all component values.**
- ★ **Fully tunable over medium and long waveband.**
- ★ **Car aerial socket.** ★ **Full after-sales service.**

ONLY
£4.4.0
Plus 6/6 Post & Packing

POWER SUPPLY KIT to purchasers of Elegant Seven parts, incorporating mains transformer, etc. A.C. mains 200-250v. Output 9v. 50mA, 7/6 extra.

4 in. SPEAKER. Parts list and circuit diagram **2/6.** FREE with parts.
Shop Hours 9 a.m. — 6 p.m. Early Closing Wednesday
All enquiries stamped addressed envelope

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Interleaved and Impregnated. Primaries 200-230-250v. 50 c/s. Screened.

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Push-Pull 8 watts, EL84 or 6V6 to 3Ω or matched to 15Ω 9/9

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Following types for 3 and 15Ω speakers—

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Push-Pull 15–18 watts. 6L6, KT66 22/9

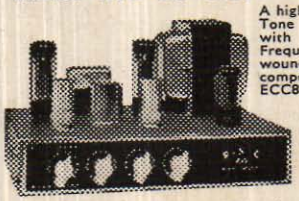
Push-Pull Mullard 510 Ultra Linear 29/9

Push-Pull 20 watts, sectionally wound 6L, KT66, EL34, etc. 49/9

CHARGER TRANSFORMERS. All with 200–230–250v. 50 c/s. Primaries: 0–9–15v. 1½a, 12/9; 0–9–15v. 2a, 14/9; 0–9–15v. 3a, 16/9; 0–9–15v. 5a, 19/9; 0–9–15v. 6a 23/9; 0–9–15v. 8a, 28/9

AUTO (Step up/Step down) TRANS. 0–110/120–230/250v. 50–80 watts. 13/9; 150 watts 27/9; 250 watts. 49/9; 500 watts. 99/9

R.S.C. A10 30 WATT ULTRA LINEAR HIGH FIDELITY AMPLIFIER

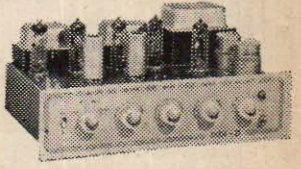


A highly sensitive Push-Pull high output unit with self-contained Pre-amp. Tone Control Stages. Certified performance figures compare equally with most expensive amplifiers available. Hum level 70 dB down. Frequency response ±3dB 30-20,000 c/s. A specially designed sectionally wound ultra linear output transformer is used with 807 output valves. All components are chosen for reliability. Six valves are used EF86, EF86, ECC83, 807, 807, GZ34. Separate Bass and Treble Controls are provided. Minimum input required for full output is only 12 millivolts so that **ANY KIND OF MICROPHONE OR PICK-UP IS SUITABLE.** The unit is designed for **CLUBS, SCHOOLS, THEATRES, DANCE HALLS** or **OUTDOOR FUNCTIONS,** etc. For use with Electronic **ORGAN, BASS, LEAD OR RHYTHM GUITAR, STRING BASS,** etc. For standard or long-playing records. **OUTPUT SOCKET PROVIDES** L.T. and H.T. for **RADIO FEEDER UNIT.** An extra input with associated vol. control is provided so that two separate inputs such as Gram and "Mike" can be mixed, 200-250v. 50 c/s. A.C. Mains output for 3 and 15 ohm speakers. Complete kit of parts with fully punched chassis and point-to-point wiring diagrams and instructions. Supplied factory built with EL34 output valves and 12 months' guarantee, for 14 **Gns.** If required perforated cover with carrying handles can be supplied for 19/9. Send S.A.E. for leaflet, also speaker. **Terms: DEPOSIT 11 Gns.** Carr. 10/- 45/- and 9 monthly payments of 32/4 (Total 16 Gns.)

HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

PUSH-PULL ULTRA LINEAR OUTPUT

"BUILT-IN" TONE CONTROL PRE-AMP STAGES



Two input sockets with associated controls allow mixing of "mike" and gram., as in A10. High sensitivity. Includes 5 valves, ECC83, ECC83, EL84, EL84, EZ81. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut". Frequency response ±3 dB 30-20,000 c/s. Six negative feedback loops. Hum level 60 dB down. ONLY 23 millivolts input required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs for **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING BASS, LEAD or RHYTHM GUITARS, etc. OUTPUT SOCKET** with plug provides 300v. 30mA, and 6.3v. 1.5a for supply of a **RADIO FEEDER UNIT.** Size approx. 12 × 9 × 7in. For A.C. mains 200-250v. 50 c.p.s. Output for 3 and 15 ohms speaker. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. (Or factory built 51/6 extra). Only **8 Gns.** Carr. 10/- If required louvred metal covers with 2 carrying handles can be supplied for 18/9. **TERMS ON ASSEMBLED UNITS: DEPOSIT 33/3** and 9 monthly payments of 24/1 **(Total £12.10.0).** Send S.A.E. for illustrated leaflet detailing Cabinets, Speakers, Mikes, etc.

AUDIOTRINE HI-FI TAPE RECORDER KIT

25½ GNS. Carr. 17/6



REALISM AT INCREDIBLY LOW COST, CAN BE ASSEMBLED IN AN HOUR.

Incorporating the latest Tape Transcriptor. The Audiotrine High Quality Tape Amplifier with negative feedback equalisation for each of 3 speeds. High Flux P.M. Speaker, empty Tape Spool, a Reel of Best Quality Tape and a Handsome Portable Carrying Cabinet tastefully covered in two contrasting shades of Rexine and Vynair. **Size 14½ × 15 × 8½ in.** high and circuit. Total cost if purchased individually approximately **£40.** Performance equal to units in the **£60-£80** class. S.A.E. for leaflets. TERMS—**4 gns. deposit and 12 monthly payments of 42/- (Total 28 gns.)** **ONLY 3 PAIRS OF SOLDERED JOINTS PLUS MAINS**

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6/12v. 2a 6/11	6/12v. 4a 12/3	6/12v. 10a 26/9

COMPLETE POWER PACK KIT Consisting of Mains, Trans., Metal Rectifier, Double electrolytic, smoothing choke chassis and circuit. For 200/250v. A.C. mains. Output 250v,. 60mA, 6.3v., 2a. **19/11**

FANE 122/10 20 WATT. HEAVY DUTY LOUDSPEAKER. 12in. 15 ohm. With exceptionally robust 2 in. diameter voice coil assembly. **5 GNS.** Post 5/6

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W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS. HF1012. 10 watts rating. Where a really good quality speaker at a low price required, we highly recommend this unit with an amazing performance. **£4.19.9.** Please state whether 3 ohm or 15 ohm required.

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AUDIOTRINE HI-FI SPEAKER SYSTEMS



Consisting of matched 12in. 12,000 line, 15 ohm high quality speaker; crossover unit (consisting of choke, condenser, etc.) and Tweeter. The smooth response and extended frequency range ensure surprisingly realistic reproduction. Standard 10 watt. rating. **£4.19.9. Carr. 5/-. Or Senior 20 watt. £6.19.6. Carr. 7/6**

R.S.C. **BABY ALARM or INTER-COMM KIT.** Complete set of parts with diagrams, etc. Housed in two polished walnut finished cabinets of pleasing design. High sensitivity. For 200–250v. A.C. mains. Fully isolated. Controllable at both units. An intercomm. of this class would normally cost £20–£30. **Only 89/6, carr. 5/-. Ready for use, 6 gns.**

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Covered in two-tone Rexine/Vynair. Ideal for vocalists and Public Address. Normally supplied for 15 ohm matching but can be supplied for 100v. line for 35/- extra.

Type C58. 15-20 watts. Fitted five 8in. high flux speakers. Overall size approx. 42 × 10 × 5in.

12½ Gns. Carr. 10/-. Or deposit £2 and 9 monthly payments of 27/9 **(Total £14.9.9.)**

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12 in. 10 WATT HIGH QUALITY LOUDSPEAKER



In walnut veneered cabinets. Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only **£4.19.6** Carr. 5/6 Terms: Deposit 11/3 and 9 monthly payments of 11/3 **(Total £5.12.6).** 12in. 20 WATT HI-FI LOUDSPEAKERS IN CABINETS. Size 18 × 18 × 10in. Finish as above. **£7.19.6** Terms: Deposit 17/9 and 9 monthly payments of 17/9 **(Total £8.17.6).** Carr. 8./6

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As recommended in the Practical Electronics Oscilloscope in March and April issues. **£2.10.0.** P.P. 5/-. Base 6/6.

PHOTOCELL TYPE GS16
Caesium Antimony Side-on Anode HT 160V. Sensitivity 160μA/Lumen. 5/-. P.P. 1/6.

MINIATURE TRANSISTOR TYPE IF COILS
Set of three 465kc/s miniature IF Transformers wound on Ferrite Cores. 10/-. P.P. 1/6.

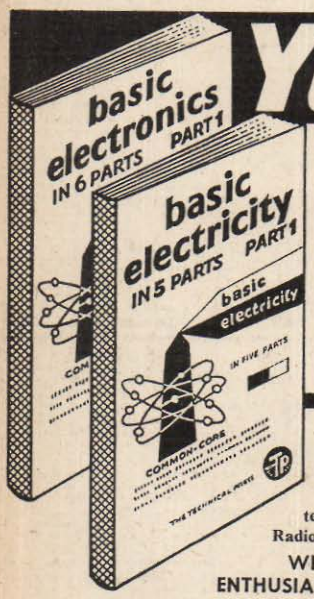
FERRITE ROD AERIALS
PW/FRI for LW/MW pocket superhet, 5" rod. 8/6. RA2W for LW/MW Transistor sets with aerial coupling. 12/6. Ferrite Rods only ¼" dia. × 6" long. 1/9.

LA2 POT CORE ASSEMBLY
Complete with coil former. For use up to 100 kc/s. Max. 'Q' at 80kc/s-475. 65 turns for 1mh 7/6. P.P. 9d.

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DLR5, Low Impedance, balanced armature. Earpieces can be used as sound powered Microphones. 10/-.
CLR, High Impedance (2000Ω per insert). 15/-.
No. 10 Assembly:
Moving Coil Headphones with moving coil Hand Microphone fitted with press-to-talk switch. Rubber earpads. Cord terminated with army type 6-point moulded connector. Low impedance. Brand new. 20/- ea.
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Famous wartime "cat's eye" used for seeing in the dark. This is an infra-red image converter cell with a silver caesium screen which lights up (like a cathode ray tube) when the electrons released by the infra-red strike it. It follows that as light from an ordinary lamp is rich in infra-red these cells will work burglar alarms, counting circuits, smoke detectors and the hundred and one other devices as will the simpler type of photo cell. Here then is a golden opportunity for some interesting experiments, price **5/-** each. Post 2/-. Data will be supplied with cells if requested.

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Type "C" is a small porcelain thermostat as fitted to electric blankets, etc. 1½ amp. setting adjustable by screw through side. **3/6**. P. & P. 6d.

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BLACK LIGHT UNIT. 40 watt intensity, comprises lamp, lamp holder and 40 watt choke. Only **19/6** plus 6/6 carr. & ins.

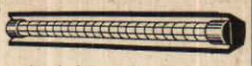
TIMER KIT. Special offer of all components except metal box to make mains operated interval timer for photography, etc. **12/6** plus post 2/6.

Simmerstat Heater Regulator

Suitable to control elements, heater, soldering irons and boiling rings up to 2,500 watt. Complete adjustable, normal price 55/- each, special snip price **12/6** plus 2/- postage and insurance.

Where postage is not definitely stated add 2/- to all orders under £3. Also add 2/6 if you would like our new 100 page list of bargains.

INFRA-RED HEATERS



Make up one of these latest type heaters. Ideal for bathroom, etc. They are simple to make from our easy-to-follow instructions—uses silica enclosed elements designed for the correct infra-red wavelength (3 microns). Price for 750 watts element, all parts, metal casing as illustrated, **21/6** plus 3/6 post and insurance. Pull switch 3/- extra.

SNIP FOR RECORD LOVERS

Acos GP73 Turnover Cartridge



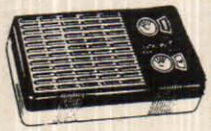
for Stereo—LP—and 78 records fitted with two styli—diamond for Stereo and L.P—Sapphire for 78. This is mounted and is a standard replacement for the most famous record players using Garrard—B.S.R. Collaro, etc. The regular price of this Cartridge is **55/-**, we offer these new and perfect for **15/-** (less than the price of one Stylus) plus 2/- post and insurance.

GANGED POTS



Standard Type and size with good length of spindle—made by Morganite. List price is 10/- each but if you act quickly you can have them at **12/-** doz. (or **1/6** each if less than doz.). Following values in stock all "lin" — 5K + 5K — 10K + 10K — 100K + 100K — 500K + 500K — 1 Meg + 1 Meg, all new and unused. Post 2/9 on first doz. then 1/- per doz. 6 doz. or more post free.

OUR BARGAIN OF THE YEAR



A complete kit of parts to build this 6-transistor 2 wave superhet receiver at only 39/6 plus 3/6 post and ins.

"CORONET" Mk. IV

It fully covers the medium-wave band and that part of the long-wave band to bring in B.B.C. Light. The circuit includes a highly efficient slab aerial, 2½ in. P.M. speaker. Overall size approximately 4¼ × 2¼ × 1¼in. Supplied complete with carrying case and instructions.

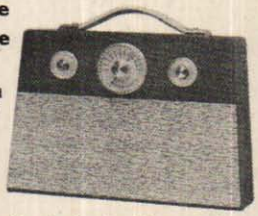
750 mW TRANSISTOR AMPLIFIER



4 transistors including two in push-pull-input for crystal or magnetic microphone or pick-up—feedback loops—sensitivity 5m/v. Price **19/6**. Post and insurance 2/6.

THIS MONTH'S SNIP

Transistor set case with carrying handle size 10″ × 8″ × 3″



Made from best plywood and covered two-tone fabric—very smart—suitable for receiver——amplifier extension Speaker, etc.—Originally listed at **29/6**—but offered this month at only **15/-** plus 5/- post and insurance; also given free with it is a printed circuit board to suit it and building instructions for fine two-wave radios—Don't miss this grand offer.

THE "MINY" TAPE RECORDER



of the many tape recorders to offer at £12 or less we have at last found one we can recommend. This instrument uses two motors, is completely portable and is beautifully styled and looks like a good tape recorder.

Among its many good features is a switch on the microphone to stop and start the tapes. A very useful feature for you when recording, and for your typist for note-taking, stock-taking, etc. Other points are twin track recording—40 mins. with normal tapes, standard batteries.

Although originally sold at £16/16/0, we are able this month to offer for only **£7/19/6** plus 5/- Post and Insurance. Brand new and complete with microphone, batteries, tape and spools, nothing else to buy.

Don't miss this AMAZING Offer

MAINS POWER PACK

MAINS POWER PACK designed to operate transistor sets and amplifiers. Adjustable output 6 v.-9 to 12 volts for up to 500 mA (class B working. Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9 and others. Kit comprises: mains transformer-rectifier, smoothing and load resistor, 5,000 and 500 mfd. condensers, zener diode and instructions. Real snip at only 14/6 plus 3/- post.

SEED & PLANT RAISING



Soil heating wire and transformer. Suitable for standard size garden frame. **12/6** plus 2/6 post & insurance.

TWO-WAY RADIOS



Give communication over ¼ mile. FULLY transistorised—crystal controlled, built-in telescopic aerial—press button operation —PP3 batteries—pair instruments, complete and ready to use **£7/9/6**, plus 5/- post and insurance. G.P.O. Lic. Req.

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Will save time and improve efficiency. Ideal in home—office—shop—surgery, etc. Complete outfit comprises Master unit and three substations each of which can call the master and have full two-way working. No wiring problems as subs fitted with 60ft. twin flex and they plug into sockets. Also included is packet of staples—and battery. **Nothing else to buy—£7/15/0** plus 4/6 post and insurance.

13 AMP SOCKETS



Change all those old-fashioned ones to these modern fused types or install a new ring main. White sockets for surface mounting or for letting into wall or skirting —best make (G.E.C.). **5/6 with switch** or **3/9 less switch.** Six or more post free, otherwise add 2/-.

HEAT AND LIGHT UNIT



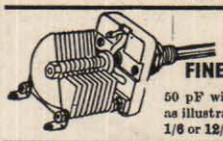
Gives 300 watts of heat with approx. 150 watts of light and simply fits in place of lamp. **29/6** Plus 3/6 carriage and insurance.

BATTERY ELIMINATOR



With this you can operate your pocket radio from the mains. You can also recharge PP3 batteries five or six times. **Only 18/6** plus 3/- post and insurance. Will save its cost in no time.

FINE TUNERS



50 pF with long spindle as illustrated.
1/6 or **12/-** dozen.

TURRET TUNERS



By the famous Cyldon or Brayhead firms, complete with coils, but less coil cover, valves and knobs—all 35mc/s —wonderful bargain at **6/6** each plus 2/9 post.

FIVE CORE CABLE

Ideal for switching circuits, intercoms, P.A. run, etc., each core flex copper with rubber insulation, cores covered overall in tough rubber or P.V.C. **9d.** per yd. or 30 yds. length **15/-** plus 5/- post.

Noughts and Crosses Machine—an opportunity to make this very amusing item described in Practical Electronics. Kit of 19 switches only **40/-** post paid.

Neons for Panel Game Switch, etc., not the midget type but possibly more suitable. 12 for **10/6** post paid.

Midget wired ended type (1/3 Ex-equip.) or 1/9 new.

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A complete comfort level control system in a compact tough plastic block that you install simply by plugging into any 3-pin power point. Just insert the heater plug in the socket provided on the Beckastat, set the thermostat knob control and room temperature is automatically controlled with the greatest operating economy. Cuts electricity consumption by half. For 200/250v A.C. Suitable for all electrical heaters — maximum efficiency obtainable with appliances up to 2 kW. Can be supplied with 15A round pin or 13A ring main power point fittings. State type required.

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High grade leak proof nickel iron accumulators, each enclosed in a vitreous enamelled welded iron case, size overall 2¾ in. × 1 in. × 3¾ in. high. Cells are rated 1·2 v at 2·5 AH and are almost indestructible; they will withstand tremendous overloads without damage and may be left in a discharged condition for long periods without deterioration. Can be used singly or in multiple units for lamps, models, controls, bells, burglar alarms, flash equipment, radios, etc. Each cell is unfilled and unused and supplied with dry electrolyte and filling and charging instructions 6v. set (5 cells) **15/-** Carr. 5/-

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Can be actuated by permanent or electromagnets to provide excellent basis for a wide range of inexpensive devices such as burglar alarms, limit switches, door bell switches, etc. Tremendous reliability factors and a working life of about 100 times that of microswitches and the uses to which they can be put is limited only by imagination. Each switch supplied complete with specification, instructions and ideas information. **SUITABLE MAGNETS 1/- extra.**

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Specially manufactured to provide electro-magnetic operation of Dry Reed Switch described above. Coil is simply pushed on to glass tube and centrally located over switch contacts. Works from any 4–12 v. D.C. supply. Size overall ½ in. diam. × ¾ in. long.

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TYPE 1—Plastic encapsulated 1¼ in. diam. × ¼ in. thick. Time response 2 megohms. Resistance 100 Lux-700 to 3,000 ohms. Max. volts 200. Max. current 250 mW. **10/-** Post Free

TYPE 2—Plastic encapsulated ⅜ in. diam. × ¼ in. thick. Time response 1 megohm. Resistance 100 Lux-500 to 2,000 ohms. Max. volts 150. Max. current 7 mW. **8/6** Post Free



TYPE 3—Glass sealed with M.E.S. base. Glass envelope ⅝ in. diam., overall length 1 in. Time response 90 megohms. Resistance 100 Lux-0·05 to 0·15 megohms. Max. volts 150, Max. current 75 mW. **6/6** Post Free



TYPE 4

TYPE 4 — Hermetically sealed, glass window faced. ¼ in. diam. × ¼ in. thick. Time response 1 megohm. Resistance 100 Lux-15,000 to 50,000 ohms. Max. volts 100. Max. current 20 mW. **5/-** Post Free

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Selenium cells are photogenerative, i.e. light energy is converted by the cell into electricity which can be measured directly by a micro-ammeter or used, in conjunction with an amplifier, as the triggering current for alarm and safety devices and photo-electric counting mechanisms. Selenium cells are particularly suitable for use in luminous fluxmeters, exposure meters, photo-electric colorimeters, fire alarms, etc. Type available size 1½ in. × 1⅛ in. Spectral response represents a curve resembling that of a man's visual sensitivity. Output is approximately 200 μA at 3,000 Lux. **3/6** Post Free

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by Ericsson, supplied brand-new, boxed and complete with performance and connection data. Max. operating speed: 10 kc/s. Anode voltage: 440/475 v. Current: 0·8 mA. Cathode voltage: 35 v. max. Pulse Amplitude: 120 v. min. Size overall 1·3 in. dia. × 2·64 in. Fitted with standard duodecal base. **15/-** Post free

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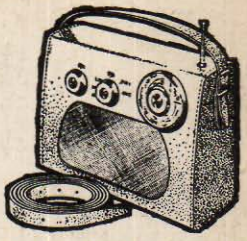
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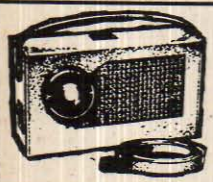
TRANSONA SIX



● **8 stages—6 transistors and 2 diodes**

This is a top performance receiver covering full Medium and Long Waves and Trawler Band. High-grade approx. 3in. speaker makes listening a pleasure. Push-pull output Ferrite rod aerial. Many stations listed in one evening including Luxembourg loud and clear. Attractive case in grey with red grille. Size 6½ × 4½ × 1¾in. (Uses PP4 battery available anywhere.) Carrying Strap 1/- extra.

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MELODY SIX

● **8 stages—6 transistors and 2 diodes**

Our latest completely portable transistor radio covering Medium and Long Waves. Incorporates pre-tagged circuit board, 3in. heavy duty speaker, top grade transistors, volume control, tuning condenser, wave change slide switch, sensitive 6in. Ferrite rod aerial. Push-pull output. Wonderful reception of B.B.C. Home and Light, 208 and many Continental stations. Handsome leather-look pocket size case, only 6¾ × 3¾ × 1¾in. approx. with gilt speaker grille and supplied with hand and shoulder straps.

Total cost of all parts now only **£3.9.6** P. & P. 3/6 *Parts Price List and easy build plans 2/- (Free with kit)*



NEW TRANSONA FIVE

"Home, Light, A.F.N. Lux. all at good volume" G.P., Durham

● **7 stages—5 transistors and 2 diodes**

Fully tunable over Medium and Long Waves and Trawler Band. Incorporates Ferrite rod aerial, tuning condenser, volume control, new type fine tone super dynamic 2¾ in. speaker, etc. Attractive case. Size 6½ × 4½ × 1¾in. with red speaker grille. (Uses 1289 battery available anywhere.)

Total cost of all parts now only **42/6** P. & P. 3/6 *Parts Price List and easy build plans 2/- (Free with kit)*

POCKET FIVE



● **7 stages—5 transistors and 2 diodes**

Covers Medium and Long Waves and Trawler Band, a feature usually found in only the most expensive radios. On test Home, Light, Luxembourg and many Continental stations were received loud and clear. Designed round supersensitive Ferrite Rod Aerial and fine tone 2¾in. moving coil speaker, built into attractive black case with red speaker grille. Size 5½ × 1½ × 3¼in. (Uses 1289 battery available anywhere.)

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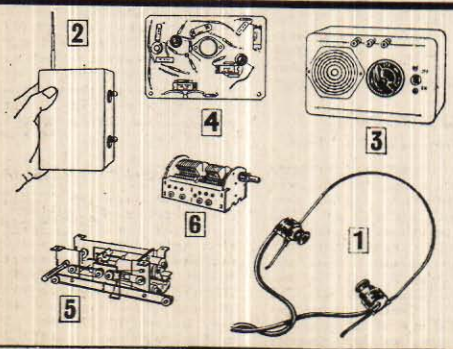


SUPER SEVEN

● **9 stages—7 transistors and 2 diodes**

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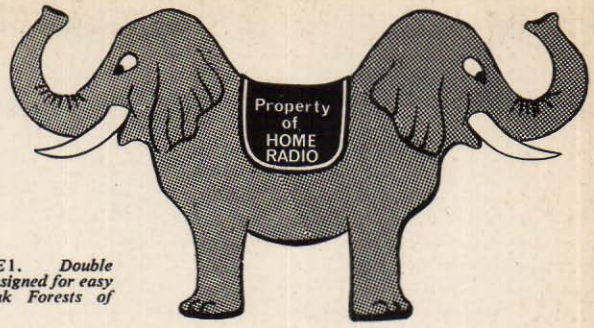
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Home Radio Ltd., Dept. PE, 187 London Road, Mitcham, Surrey

VOL. 2 No. 2
FEBRUARY 1966

Practical Electronics

DRAWING THE LINE

THE demarcation between electrics and electronics has never been altogether clear and obvious. Sometimes the distinction is based on quite tenuous grounds. For example, the presence of a solitary rectifier might be considered a valid reason for applying the description "electronic" to a circuit composed otherwise entirely of conventional electrical devices. Whereas this classification might be in order according to the word of the generally accepted definition of electronics, it is arguable whether it is in accord with the spirit of this definition.

Anyhow most of us have an instinctive feeling for what is legitimate electronics, and such border line cases have not caused any undue concern—except maybe to the pedant. Every circuit or piece of apparatus has usually fitted nicely into the electronic or the electric pigeon hole without any bother at all.

But now things are changing, and with that rapidity we are becoming accustomed to in electronic affairs. The encroachment on electric territory by electronics has developed from a surreptitious movement into unconcealed full scale invasion. The vital force behind this offensive is the thyristor, alias the silicon controlled rectifier, known colloquially as s.c.r. This semiconductor device was invented only a few years ago, but already it has caused a minor revolution in electrical power technology. The thyristor is the solid state counterpart of the gas filled triode or thyratron and it is far more versatile and easier to use than this older device. In this vigorous campaign, valuable support has been provided by the new kind of semiconductor rectifiers, which are closely related to the thyristor.

With the aid of these semiconductor electronic devices (and make no mistake, we do claim these as being 100 per cent genuine members of the electronic clan) the smooth and precise control of high voltage and high current circuits has become almost effortless—both in terms of manual exertion by the operator and electrical power consumed in the controlling circuit. Thyristors are also being widely used in static convertors for changing a.c. to d.c., and in inverters where the reverse process takes place.

Lower down the power scale we find the thyristor equally useful and versatile. And here we are getting quite literarily nearer home, with a host of interesting possibilities concerning mains operated appliances: lighting, heating, and power tool control—for instance. (Watch these pages!)

With this fusion of electrics and electronics the rather arbitrary and artificial distinction between these two related fields will be harder to maintain in the future. Perhaps British Standards will be called upon one day to redefine these terms for the general convenience of all. So far as this magazine is concerned, our readers may rest assured we will know where to draw the line. It will anyhow be fairly flexible, and we will always be prepared to give or take a diode or two!

THIS MONTH

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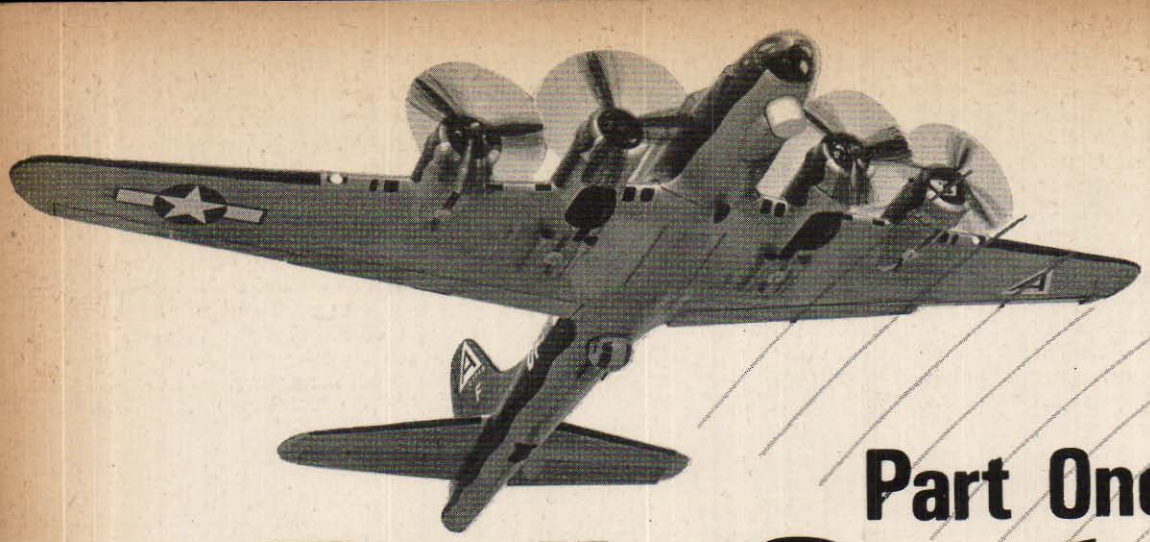
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Part One
Radio Control

BASICALLY this series aims to provide as comprehensive a description as possible of model radio control systems, their scope and the type of circuits and equipment employed. Emphasis will be placed on descriptions of proven circuits rather than original designs since the demands involved are highly specialised.

Certain requirements peculiar to radio control operation, as such, are only properly met by practical development and proving under typical working conditions. By far the greater majority of successful radio control operation, in fact, is done with commercial equipment, which has reached its high degree of reliability through continual practical development.

The majority of circuits to be published can readily be used by the individual constructor, should he so desire. However, demands for home construction are usually best met by commercial kits which are normally based on a printed circuit panel and thus conform to "professional" standards as regards layout, as well as offering proven designs.

Kits are readily available of both single-channel and conventional multi-channel transmitters and receivers, and undoubtedly represent the best starting point for those who do not wish to purchase ready-made commercial equipment. There is also a substantial saving in cost by building from kits, compared with the price of ready-made equipment. The kit price is very little more than a complete set of components and materials for building completely from scratch from a circuit design.

Certain elements, such as pulsers, decoders, servo-amplifiers, and so on, do lend themselves more readily to individual designs since these are ancillary to the basic requirement of a proven transmitter-receiver combination, and here the home constructor can feel on easier ground. This can also apply where the application can be regarded as "derated" compared with model control requirements, e.g. for simple remote control switching systems.

The description "model radio control" refers specifically to units produced for authorised operation for command signalling only (i.e. not speech), and now widely used for the remote control of model aircraft, boats and other working models. Identical, or similar, units are also employed industrially and com-

GLOSSARY OF TERMS...

ACTUATOR
An electro-mechanical device providing a mechanical output force for control movement or operation

A.F.
Audio frequency (nominally within the range 20 to 16,000 c/s)

AMPLIFICATION
Increase in voltage of current of a signal

ANTENNA
American terminology for aerial (commonly quoted in association with American equipment)

"BANG-BANG" CONTROL
Control movement which is either full "on" (on receipt of signal) or neutral (with no signal)

CARRIER WAVE
Transmitter r.f. (radio frequency) signal which may be turned on and off for signalling purposes; also basic transmitter signal on which audio frequency tones may be superimposed for "tone" operation

CASCADE
System or method of electrically connecting a number of actuators (usually escapements) in series to increase the number of sequential controls available

CHANNEL
A single source of control intelligence or signal

COMPOUND ACTUATOR
A sequential actuator with additional facilities for switching or operating an additional actuator or actuators

CRYSTAL
Circuit component used to control the frequency of an oscillator

CRYSTAL CONTROLLED
Transmitter circuit stabilised at a "spot" carrier frequency by a crystal

DETECTOR
That part or element of a receiver circuit which detects or picks up the signal

DROP-OUT
The current at which the armature of a relay or escapement "drops out" or moves on to the back contact under spring tension

mercially, although the basic essence of model control units is simplicity and compactness, with a light duty requirement only in terms of mechanical output.

For mass appeal, too, price is a major factor, resulting in the development of transmitter-receiver combinations retailing at £15–£20, or something like one half this figure in prefabricated kit form for home assembly. At the other end of the scale, however, model radio control units embrace quite sophisticated miniaturised electronics in the form of superhet receivers capable of decoding multi-channel transmitter signals in the form of quadruple-proportional electro-mechanical (servo) outputs. Price for the complete equipment in this category can range as high as £400–£500.

ably greater technical problems involved), the expanding use of 27·255Mc/s by other services in America, notably for street traffic lights, seriously restricted the usefulness of the band from a practical hobby point of view.

Accordingly the F.C.C. allocated a further five spot frequencies for "Citizens Service" in 1958: 26·995, 27·045, 27·095, 27·145, and 27·195Mc/s. More recently, the subject of additional "spots" has received further review to take advantage of and expand the possibilities of simultaneous superhet operation. Currently the (American) Academy of Aeronautics and the F.C.C. are also negotiating for five additional v.h.f. frequencies: 72·08Mc/s, 72·24Mc/s, 72·40Mc/s, 72·96Mc/s and 75·64Mc/s.

# of Models

By R.H.WARRING

FREQUENCY ALLOCATION

Model radio control, as such, started in the United States in the mid-1930s, utilising home-built equipment capable of providing a reasonably reliable single-channel signalling system with a carrier frequency of the order of 50Mc/s.

The majority of such designs—and successful designs were relatively few in number—were produced by radio "hams" who were also model aircraft enthusiasts. Despite a considerable growth and development in the immediate post war years, it was not until early 1950 that the (American) F.C.C. approved "Citizens Service" frequencies, which eliminated written and code tests on these frequencies and put radio control within the reach of thousands of model enthusiasts rather than radio enthusiasts. The permitted frequencies, known as "Citizens" bands, were 465 and 27·255Mc/s, with a maximum of 5 watts input to the final stage of the transmitter.

Apart from the inevitable "crowding" resulting from the use of a single spot frequency (the u.h.f. band being largely neglected because of the consider-

Little or no development of model radio control units took place in this country until after the war, but at an early period the British Post Office allocated two wavebands for model work—26·96 to 27·28 Mc/s and 464–465Mc/s (the latter, since January 1963, re-allocated as 468Mc/s) with transmitter output power not to exceed five watts.

A licence for operating any such transmitter is obligatory, but is obtainable simply on application to the Radio Branch, Radio and Accommodations Dept., G.P.O. Headquarters, London, E.C.1. The cost of the licence is £1, covering a period of five years.

Whilst designers and manufacturers were at one period actively concerned with development of equipment for the 465Mc/s band, this has now largely fallen into disuse (and was never at any time particularly popular due to the high cost; the severe limitation imposed by the directional nature of such u.h.f. signals). The so-called 27Mc/s band has, therefore, become the accepted world "standard" for model radio control, leading manufacturing countries in addition to the U.S.A. and Great Britain being Germany and

END VOLTAGE
Minimum practical (useable) voltage of a battery on discharge; also used to describe minimum useful voltage, although this can be a different value

ESCAPEMENT
Electro-mechanical device or actuator embodying an escapement movement triggered by movement of an armature

FIELD STRENGTH
Actual or measured strength of a transmitter signal at a specified distance (range)

FIELD STRENGTH METER
Circuit with meter capable of tuning to a transmitter signal and measuring the strength of signal received

FILTER
Electronic equipment for passing a required tone frequency and blocking all other tones

GALLOPING GHOST
Specific type of simple-simultaneous control (see also "Simple-Simul")

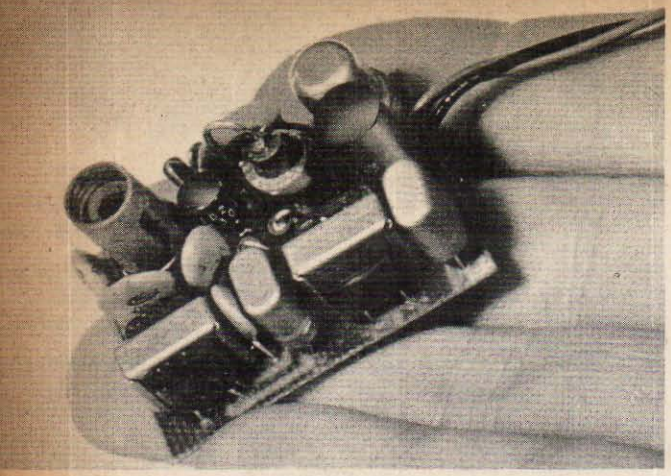
GAP
Distance between armature and inner ("make") contact on a relay; distance between armature and coil core on an escapement; distance between a reed and its fixed contact

GROUND RANGE
Range of a transmitter between two ground positions (strictly speaking, the range achieved ground-to-ground with a particular transmitter-receiver combination)

HARD VALVE
Conventional vacuum thermionic valve

HARNESS
Complete wiring system for a transmitter circuit or, more usually, a complete receiver installation





Miniature single-channel receiver

Japan. Some equipment is still designed to operate on the 50–54Mc/s band in the U.S.A., and on the 40–41Mc/s band in Germany; the circuitry involved is basically the same but can be adapted to 27Mc/s operation, if necessary, by change of component values.

CRYSTAL CONTROL

About the only marked difference between the productions of the various countries is that the United States, with its insistence on "spot" frequencies, has invariably employed crystal-controlled transmitters. The crystal control of transmitters is also obligatory in Germany, but not in this country.

Consequently, the majority of earlier British equipment featured non-crystal controlled transmitters and such types are still produced today, where the saving in the cost of the crystal can represent a favourable selling (or building) price. In the main, however, the advantages offered by freedom of drift with a crystal controlled transmitter are universally recognised, and such a simple method of transmitter carrier frequency control becomes strictly necessary for the operation of a superheterodyne receiver.

From a diversity of early original designs, modern circuits fall into a more or less standard and well established pattern. Apart from seeking greater reliability (i.e. largely better circuit stability and efficiency), the most marked trends have been towards miniaturisation and increasing the functions obtainable from a single carrier frequency.

Miniaturisation has been greatly influenced by the development and availability of suitable transistors, both for valve functions and switching duties (e.g. to replace relays). This is even more desirable with multiple-function signalling when the receiver circuit must be extended to decode pulsed or modulated signals.

HOW MANY CHANNELS?

A basic distinction is drawn between a *single-channel* and a *multi-channel* system. In the case of simple single-channel radio control a single signal only is transmitted, the receiver decoding this in the form of an on-off switching function. The transmitter signal may be simply the *carrier* signal (27Mc/s) which is switched on and off; or a lower frequency *tone* signal (usually of the order of 600–1,000c/s) which is applied to modulate the carrier. In the latter case the carrier may remain switched on all the time and the tone keyed for signalling, or carrier and tone keyed simultaneously (e.g. to conserve the transmitter batteries). The two methods are known respectively as "carrier (or c.w.)" and "tone".

With a *multi-channel* system the usual method is to provide for modulating the carrier by a number of different audio frequency tones which can be keyed separately. The receiver circuit is then so designed to decode each tone modulated signal separately, or distinctively. Provision may also be made to transmit and decode two or more tone-modulated signals simultaneously, in which case the multi-channel transmitter-receiver combination is said to be capable of *simultaneous* operation.

ACTUATOR CONTROL

As far as the output side of the receiver is concerned, regardless of the number of channels involved, each channel performs an on-off switching function, which is used as a "command" for an actuator circuit. An actuator is, basically, an electro-mechanical device, which translates on-off signalling into mechanical

GLOSSARY OF TERMS CONTINUED

HORN
Fixed lever arm attached to control surfaces, connecting to a pushrod for movement

IDLING CURRENT
Current drawn by a receiver under "idling" or quiescent conditions (i.e. with no transmitter signal present)

KEYING LEAD
Separate switch (usually microswitch) and lead plugging into a transmitter (usually ground-standing type)

KEY or KEYING SWITCH
The switch or switches on the transmitter controlling on-off switching of the signal

KICK-UP
Mechanical linkage on a compound actuator providing an additional mechanical movement

27 MEGACYCLES PER SECOND
The nominal frequency for model radio control operation in Great Britain (27 million cycles per second)

MICROSWITCH
Precision on-off switch with light action and extreme sensitivity

MODULATION
Superimposition of an audio frequency (i.e. a tone) on an r.f. signal (e.g. a carrier wave)

MODULATOR
Circuit for providing modulation — in model radio control work normally an audio oscillator

M.O.P.A.
Master oscillator power amplifier circuit (transmitters)

MULTI-CHANNEL or "MULTI"
Transmitter or receiver or transmitter-receiver combination capable of working via separate tone signals

NOISE
Extraneous random or spurious signals present in a receiver circuit

NO-LOAD VOLTAGE
Open-circuit battery voltage (i.e. measured directly with a high resistance voltmeter)

"P"
Positions on an actuator—e.g. 3p, 2PS/N, etc.

PACK
A set of batteries made up to the required voltage or voltages

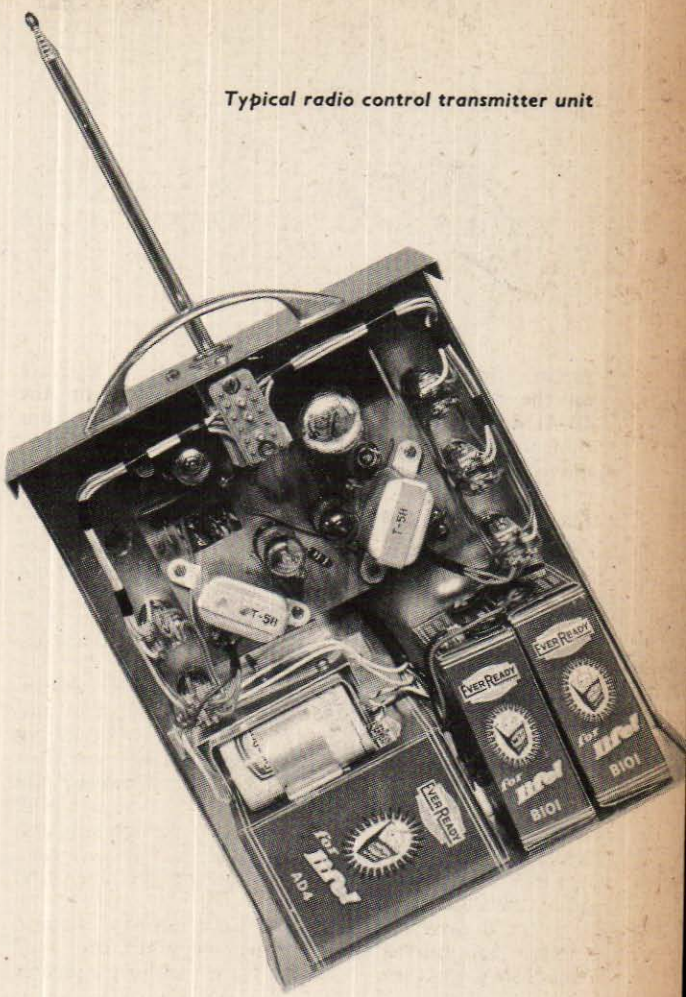
output. In its simplest form it could consist merely of a d.c. electric motor. An "on" signal completing the motor circuit would then cause it to drive in a certain direction for as long as the signal was held on; the motor would stop when the signal was released (producing an "off" function). If controlled by two separate servo circuits with opposite battery polarity, each switched by its own signal channel, operation of one signal would cause the motor to drive in one direction; and operation of the other signal would drive the motor in the other direction.

Whilst this may have certain applications, the practical actuator normally operates on a limited movement basis—i.e. on receipt of signal "on" it drives or moves to a limiting position and stops. On release of the signal, the actuator then drives or moves back to its original position or "self-centres". The resulting control movement is thus either full on (on receipt of signal), or neutral, i.e. centred (on release of signal).

This type of control movement is known as "bang-bang" and is characteristic of the greater majority of all model control systems as regards main or critical controls. It is the only simple way of knowing where a control surface is, i.e. it must be either full on or neutral. If the self-centring action of the actuator was removed, the control could be "inched" to intermediate positions according to the amount of time the signal was held on, but the actual position could only be determined indirectly by observing the response.

This is an entirely unsatisfactory action for practical control of a fast moving object, such as a model aeroplane in flight, although it may be quite satisfactory for secondary or "trim" controls. It is, in fact, used in such cases where it is not critically important that the actual position of the control should be known.

Proportional movement can only be obtained accurately by using the actuator on a closed loop system with feedback, coupled with a proportional control signal from the transmitter. This can be accomplished, for example, by pulsing the control signal and varying the mark-space ratio for proportional signalling. The necessary modifications can be applied to standard circuitry, but only at the expense of considerable complication. Attempts to simplify the overall system (for example, by a simplified form of "proportional" actuator operating on an open loop) are not as satisfactory as conventional "bang-bang" controls as a control method, and are generally much less reliable.



Typical radio control transmitter unit

PROPORTIONAL CONTROL
Graduated control movement where the displacement of a control is directly proportional to the displacement of the keying switch

PROGRESSIVE CONTROL
Non self-centring control movement where the control position may be "inched" in either direction and stops in its last position on cessation of signal

PULSE
Basically any quick signal, but normally applied to a transmitter signal interrupted with a specific or variable mark-space ratio

PULSER
A device for connecting to a transmitter to provide a pulsed signal

PULSE RATE
Rate of pulsing an interrupted signal (pulses per second)

PULSE WIDTH
Duration of signal-on pulses, or "mark"

QUICK-BLIP
Very quick signal on transmitter key or button used to close momentarily a pair of contacts on a suitable actuator for operation of a "compound" service

RANGE
Nominally the distance over which a transmitter will continue to provide satisfactory response from a receiver

REED BANK
A special form of relay with a number of individual reeds as armatures, each resonant at specific tone frequencies

REED RECEIVER
Multi-channel receiver incorporating a reed bank

RELAY
Electro-mechanical switch comprising coil, spring-loaded armature and sets of contacts (usually two contacts only for model work, the armature forming the third contact)

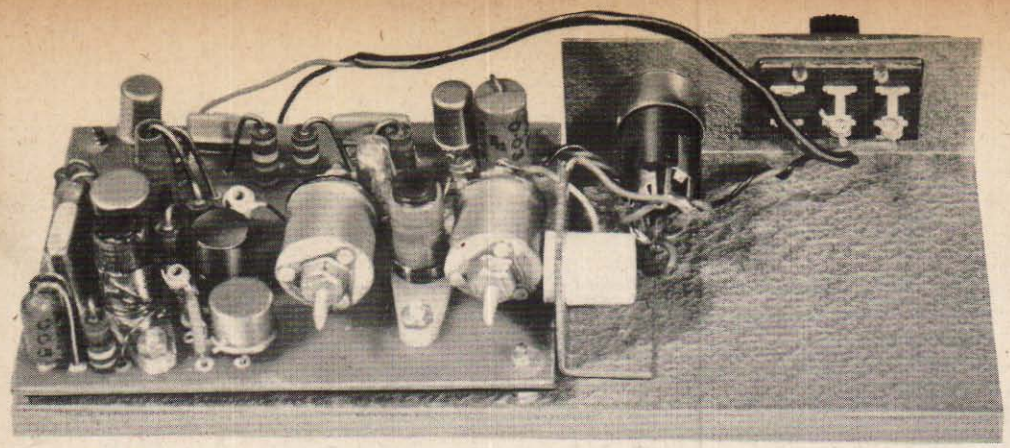
RELAYLESS
Receiver with amplified output operating on actuator direct

R.F.
Radio frequency

SELF-NEUTRALISING
An actuator which automatically reverts to its neutral or central control position on release of signal

SEQUENCE
Operation of individual control movements one after the other or in sequence rather than by individual selection

SEQUENCE SWITCHER
Device used with single-channel control systems providing individual circuit outlets for sequential switching



Basic transmitter unit removed from its case

WHICH SYSTEM?

The design and application of the circuit elements and the various systems involved will be discussed in detail under separate headings in subsequent articles. It is important to appreciate that radio control for models is not a single entity but embraces a range of different types of equipment. Equally, its performance as a functional unit is tied both to its "command" scope (i.e. single- or multi-channel) and the mechanical performance of the actuator(s) under command.

The majority of commercial radio control productions, in this country at least, are of the simple single-channel type, principally because this is the least expensive form of radio control and thus enjoys the largest demand. The scope offered by simple single-channel radio control is, however, strictly limited, since if the actuator is designed to produce more than one control movement it can only repeat a particular movement in sequence. This sets a definite limit to the maximum number of separate sequential movements which can be operated on a practical control basis, depending on the speed of the object being controlled.

Multi-channel signalling, on the other hand, offers direct selection and signalling of the same number of control movements as there are signalling channels available. The number of individual channels available is limited only by practical considerations of circuit element design—12 channels being a practical maximum where a reed-relay is used as the decoding element in the receiver, virtually no limit in the case of tone filter decoding, except for the increasing bulk and cost of the receiver.

Ten or twelve channel "multi" is quite adequate coverage for all likely model applications as this will give complete control of a model aircraft, with "bang-bang" control movements for rudder, elevators, and ailerons, and progressive (non-self-centring) controls for engine throttle and elevator trim. The more complex, and considerably more expensive, quadruple-proportional control systems are an advance on this but do not give more control—only smoother control.

Modern circuits achieve a very high degree of reliability, equivalent virtually to that of the domestic radio. Many such sets, in fact, are fully wired and cater for external leads for batteries and servos, and are pretuned, so that they can be installed and operated by modellers with no previous radio experience.

The design and development of model radio control units is highly specialised, requiring more than just a knowledge of electronics. Problems arise which are peculiar to the demands of radio control systems as such, and not just to sound receiver and transmitter design. Such factors are only worked out by practical operating experience.

GLOSSARY OF TERMS CONTINUED

SHORTING PLUG
Two-pin plug with outlets connected (i.e. short circuited) to provide a bridge across a two-point socket

SIGNAL
Any real control (transmitter) signal

"SIMPLE-SIMUL"
Simplified form of "proportional" control response from a pulsed transmitter signal

SIMULTANEOUS
Operation of two controls at the same time via two simultaneously keyed transmitter signals

SINGLE-CHANNEL
Transmitter or receiver, or transmitter-receiver combination operating on a single signal system

SUPERHET
Type of receiver working on the superheterodyne principle matched to its corresponding transmitter by a crystal frequency separated by the i.f. frequency

SUPER-REGEN
Super-regenerative type of receiver, and the most commonly used type for simple systems

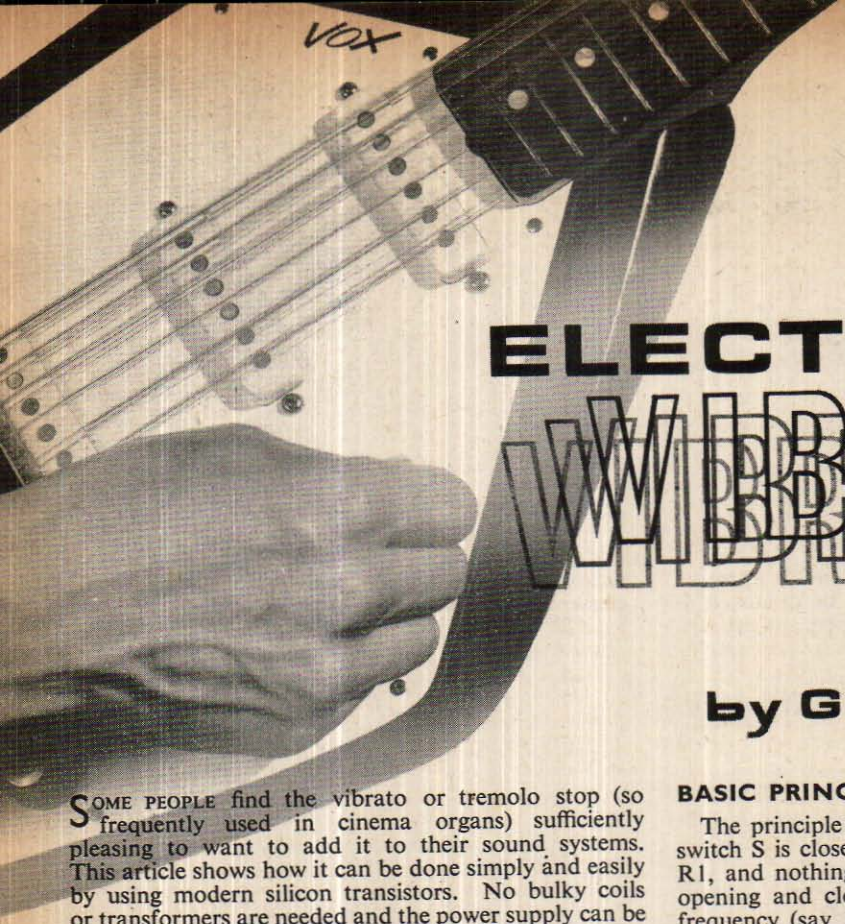
TONE
Audio frequency superimposed on carrier wave, each tone representing a separate signal

TONE FILTER
Filter element for decoding tone signals at the receiver end

TONE RECEIVER
Receiver which responds to a tone modulated signal (single-channel); or a number of separate tone modulated signals (multi-channel)

TONE TRANSMITTER
Transmitter employing an a.f. tone signal superimposed on a carrier for transmitting signal intelligence (single-channel); or a number of separate superimposed tone signals (multi-channel)

TRIM
Basically the adjustment of a model aeroplane for satisfactory flight performance, but also referred to a progressive control movement (e.g. elevator trim)



ELECTRONIC VIBRATO UNIT

by G. WAREHAM

SOME PEOPLE find the vibrato or tremolo stop (so frequently used in cinema organs) sufficiently pleasing to want to add it to their sound systems. This article shows how it can be done simply and easily by using modern silicon transistors. No bulky coils or transformers are needed and the power supply can be obtained from the main amplifier. Apart from the power supply, only two connections are needed to insert the vibrato unit into the sound system.

A vibrato circuit is just a device for modulating the amplitude of the audio signals. It is often achieved by inserting into the a.f. amplifier an extra stage of amplification, but in this case a stage whose gain is varied periodically is used to produce the desired effect. Unfortunately, it is hazardous to add an extra stage to a multi-stage amplifier. Doing so carries a risk of unexpected low frequency instability in the form of "motor-boating". The constructor then finds he has two vibrato effects, one of which can be controlled at will and another which cannot be controlled.

The device to be described here adds no extra stage. Instead, it is placed across the path of the audio signals, and modulates them by periodically short-circuiting them. It is called a shunt modulator.

BASIC PRINCIPLE

The principle of operation is shown in Fig. 1a. If switch S is closed, the audio signal is all dissipated in R1, and nothing appears at the output. Periodically opening and closing of the switch at a suitable low frequency (say 10c/s) would produce a vibrato effect. Musicians tend to use the term "vibrato" for deep modulation at low frequencies, and "tremolo" for the fluttering effect produced by shallower modulation at a higher frequency. The unit described here produces both effects.

Of course, the circuit in Fig. 1a is impractical on its own. Real vibrato units use, instead of a mechanical switch, a non-linear impedance controlled by a low-frequency oscillation. Ordinary semiconductor diodes are suitable, and can be connected as shown in Fig. 1b. Here R1 is in practice the source impedance of the a.f. signals, and R2 is the input impedance of the next stage of the main a.f. amplifier.

We have as yet no means of "fading in" the vibrato effect, and Fig. 1c shows how a potentiometer VR1 can be added to make this possible. (It should be a "log. law" component as used for a volume control.)

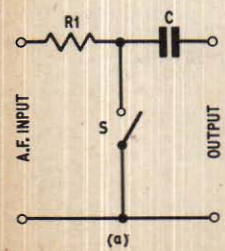


Fig. 1a. Principle of the shunt modulator

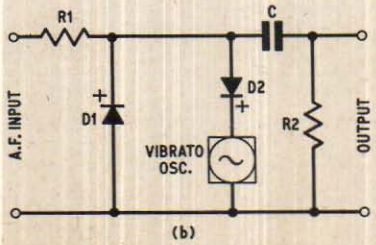


Fig. 1b. Practical modulator using diodes instead of a mechanical switch

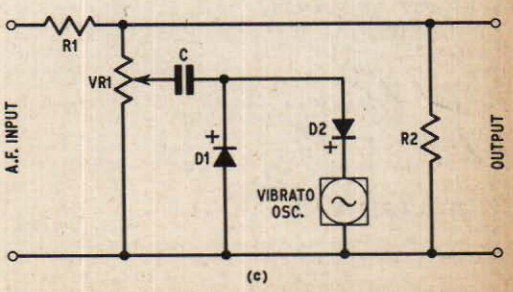


Fig. 1c. Modulator with a fader control

INSERTION LOSS

Connecting a shunt modulator inevitably attenuates the a.f. signals, and if one is not careful the amount of attenuation can be excessive. It is necessary to select certain component values to suit the particular equipment to which the vibrato unit is to be added. This is quite straightforward. The equivalent circuit of the modulator is given in Fig. 2. Here r_d is the effective resistance of the two diodes in parallel, and the other resistances are the same as before.

Ideally, r_d varies between zero and infinity, to produce the required modulation. In practice, it varies between a few hundred ohms and a few hundred-thousand ohms, the exact figures depending on the type of diode used.

The circuit behaves as a potential divider or inverted-L attenuator even when r_d is infinitive, and thus produces the "insertion loss" of the device. Thus if the value of R3 is small compared with that of R1 the loss is large, and vice versa. The insertion loss could be eliminated by making R1 zero, but this would prevent total modulation; R1 is usually there already, and outside the control of the constructor.

A little thought shows that, for small loss, the value of R1 should not be larger than that of R2 and R3 in parallel. A good rule is to make R1 equal to R2 and R3 in parallel. (The insertion loss is then 6dB.) A typical case is shown in Fig. 3, where the vibrato modulator is connected across the grid circuit of one of the amplifier stages. Here the source resistance is virtually equal to the anode load R_L of the preceding stage, and the load R2 is virtually the same as the grid leak resistor (Rg) of the next stage. In this case, VR1 can have a value somewhere between that of R1 and R2. The precise value is not critical, but it should not be too large compared with R1, or the vibrato fade-in control will be too " fierce ", that is, the vibrato will come in suddenly when VR1 is turned up almost to maximum. In valve amplifiers a typical value for VR1 would be about 250 kilohms; in transistor amplifiers it would be about 5 kilohms.

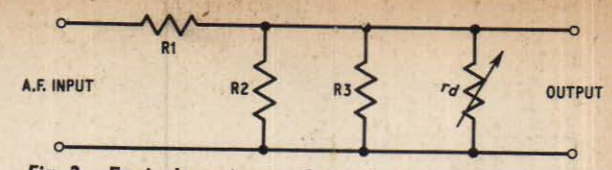


Fig. 2. Equivalent circuit of the shunt modulator

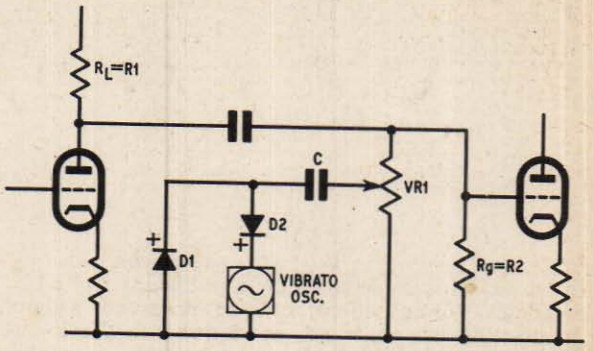
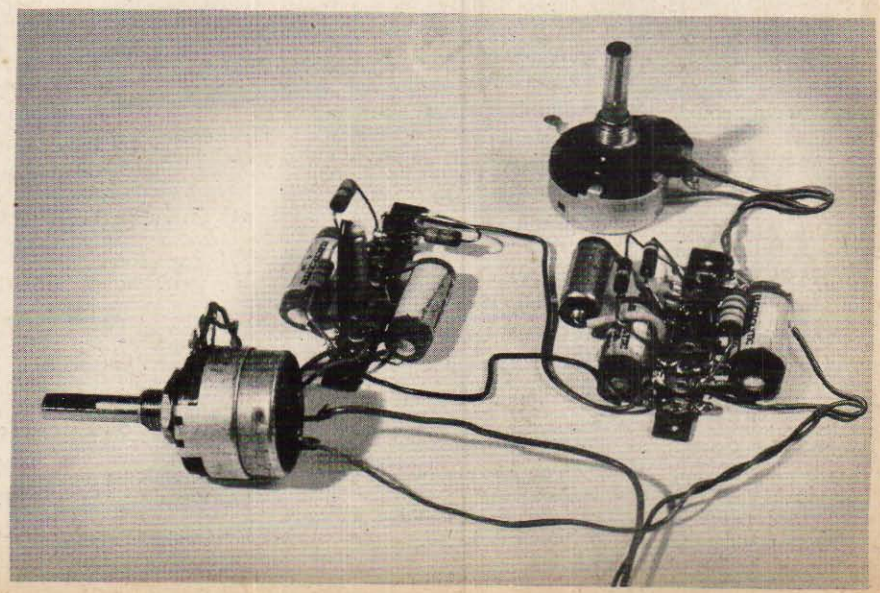


Fig. 3. One method of connecting the modulator between two stages of an existing valve amplifier

BREAKTHROUGH

One more component must be selected by the user. This is the capacitor C shown in Fig. 1c and Fig. 3. If it is too small, modulation depth is reduced. If it is too large, unwanted ticking noises will be produced on the loudspeaker. These are simply the audible effects of the vibrato oscillator output, some of which appears at the junction of the two diodes and then gets into the amplifier via C. To reduce this effect, the value of C is chosen so that its impedance is no smaller than R_1 at the lowest frequency of interest. If it is equal to R_1, then $C = 1/(2\pi f R_1)$. In valve amplifiers C is usually in the range 0·01μF to 0·1μF; in transistor amplifiers it would be between about 0·1μF to 1μF.



Photograph of the assembled tag strips ready for mounting in the amplifier cabinet or chassis

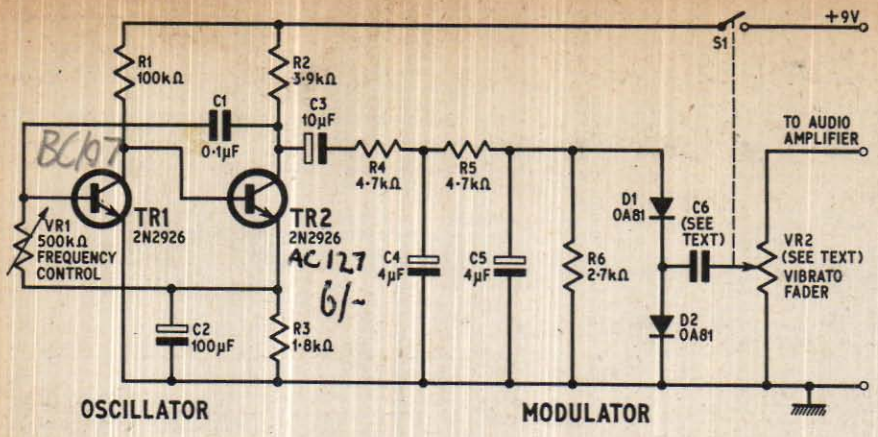


Fig. 4. Complete circuit of the vibrato unit for construction. The values of C6 and VR2 depend on the impedance of the amplifier to which it is connected (see text). VR1 is ganged to S1 so that the unit can be switched on and off

Choice of *C* is invariably a compromise, but by good luck it is made easier by a peculiarity of human hearing. Vibrato effects can be produced without modulating the entire a.f. band down to the lowest frequency. Modulating the harmonics is enough to create the effect. Thus *C* can be smaller than at first seems necessary, and breakthrough of the fundamental vibrato frequency is correspondingly reduced.

Vibrato harmonics are attenuated less by C, and they must be reduced by making sure that the vibrato waveform applied to the diodes contains no high harmonics. Perfectionists may say that the vibrato oscillator should generate a pure sine wave. This is difficult to achieve, especially if the vibrato frequency is variable, and even a pure sine wave gets distorted by the diodes, and harmonics are thereby created. The ideal design would ensure that the vibrato wave form which appears at the junction of the diodes was a sine-squared pulse.

In practice, there is always some breakthrough, but good results can be obtained without too much difficulty, partly by selecting C and partly by ensuring that the audio input signals to the vibrato modulator are between approximately 100mV to 1 volt.

This is typical of the level of signals at the input to a modern power amplifier. Thus a possible position for the vibrato unit is between the pre-amplifier and the power amplifier. If the pre-amplifier has a low impedance output, e.g. a cathode follower, it will probably be necessary to use an actual physical resistor for R1—a few thousand ohms. The modulator may also be connected across the audio path at some intermediate stage, say between first and second stages of a pre-amplifier (see Fig. 3). The vibrato circuit should not be connected so that it comes inside a negative feedback loop, or the negative feedback will act against the modulation.

COMPLETE CIRCUIT

Now let us look at the complete circuit (Fig. 4). Two *npn* silicon planar transistors type 2N2926 are used in a relaxation oscillator type of circuit. The frequency (5–30c/s approx.) is controlled by C1 and VR1. An inverse-log. potentiometer is best, but if this is not available use an ordinary log.-law volume control, connected so that the resistance increases when the knob is turned clockwise. The frequency then decreases with clockwise movement.

Before being applied to the diodes, the oscillator output is filtered by R4, C4, R5, and C5, removing some of the harmonic content.

COMPONENTS . . .

Resistors

R1	100kΩ	R4	4·7kΩ
R2	3·9kΩ	R5	4·7kΩ
R3	1·8kΩ	R6	2·7kΩ

All resistors 10% ¼ watt carbon.

Potentiometers

VR1 500kΩ inverse log. or log. carbon
VR2 250kΩ *or* 5kΩ log. carbon (see text) with S1 ganged switch (Radiospares)

Capacitors

C1	0·1μF	paper	150V
C2	100μF	elect.	12V
C3	10μF	elect.	12V
C4	4μF	elect.	12V
C5	4μF	elect.	12V
C6	(see text)	paper	150V

Transistors

TR1 2N2926, TR2 2N2926 (Obtainable from Amatronix Ltd., 396 Selsdon Road, Croydon, Surrey)

Diodes

D1 OA81, D2 OA81 (Mullard)

H.T. Dropper for 9V supply

Either

Resistors

R7 To be calculated (see Fig. 6a)
R8 2·7kΩ
Both 10% 1 watt carbon

Capacitor

C7 1,000μF elect. 12V

Or

Resistor

R7 (see Fig. 6b) 10% 1W carbon

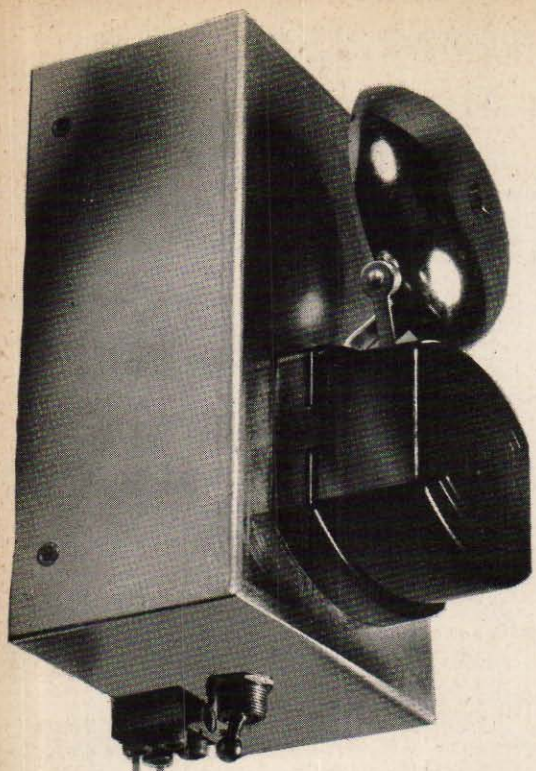
Diode

D3 OAZ212 (9 volts) (Mullard)

Miscellaneous

Two 8 way tag strips; P.V.C. wire; Screened wire

continued on page 119



Burglar ALARM

by B.H.BAILY

MANY OF us have, at some time or other, spent considerable time and money on our doors, ensuring that they are quite secure against the threat of the nocturnal prowler. But how many stop to think how easy it is for the would-be thief to slip the catch on a ground floor window.

For less than the price of a good lock, it is possible to ensure the safety of the whole house. The burglar alarm described here can be made up from equipment to be found in most experimenters' spares boxes. Even if all parts had to be purchased, the total cost need not exceed 35s.

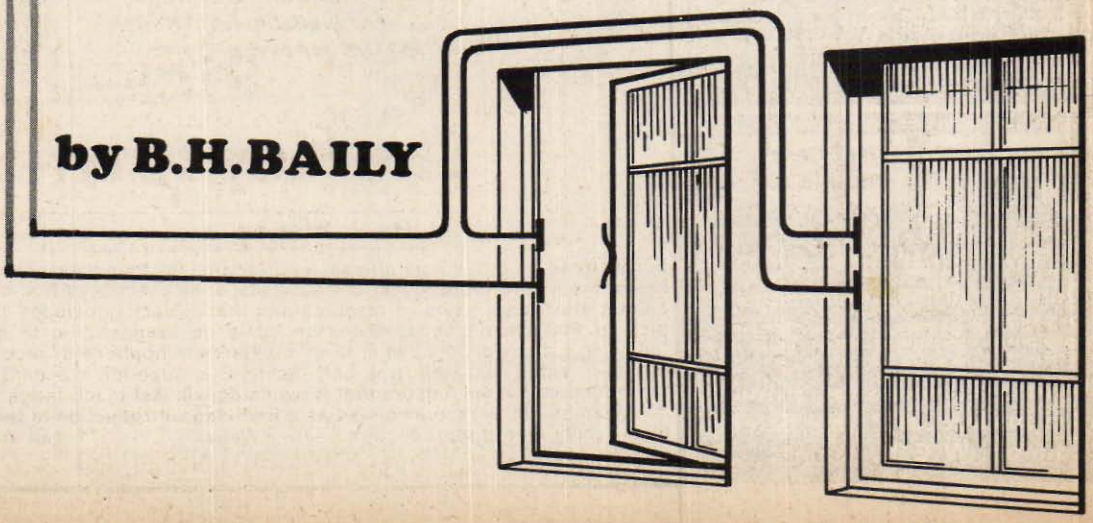
OPERATION

The device operates on a simple but most effective principle employing a continuous "loop" of fine enamelled wire, such as found in a.f. chokes and transformers. Since the loop carries only a few microamps of current, its resistance is not likely to affect the operation. If the loop is broken at any point, the cessation of the small flow of current immediately results in the ringing of an alarm bell, which will not be stopped by the subsequent closing of the broken loop. Hence, even if the thin inconspicuous wires are traced and cut, the alarm will still be operated. A switch, conveniently mounted on the main alarm unit, enables the unit to be made inoperative whilst doors and windows are in use during daylight hours.

ALARM POSITIONS

All windows and doors are fitted with simple contacts made from thin brass shim. Stationary contacts are arranged in pairs, secured close together by means of small brads on the closing side of the casement. A moving contact, having bowed ends, is fixed to the door or window such that it bridges the two stationary contacts. A self-cleaning action takes place when the moving contact on the window passes over the fixed contact.

Using the twin wire technique, installation is simplicity itself, since the twin loop is simply run from one pair of contacts to the next, in strict rotation. No short circuit must be allowed across the twisted pair, except by the contact pair at the window end of a run. Any number of individual or collective runs can be joined into the main loop circuit by splicing them into one leg of the existing run.





Amazing Kodak Quadruple Play Tape brings mains recorder playing times to battery portables!

Tiny 3¼" reel gives up to 5½ hours playing time

Now—revolutionize your battery tape recorder, add *hours* of extra playing time and enjoyment with Kodak Quadruple Play Tape, the modern miracle in sound recording. Just one tiny 3¼" reel holds 800ft. of tape—enough for up to 5½ hours playing time.* (That's over 100 'pops' with time to spare!). And a 4" reel, holding 1,200 ft. can give you up to 7¾ hours playing time. There's a 3" reel, too. Sound recording pleasure has *never* been extended like this before!

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The secret of these phenomenally long playing times lies in the unique thinness of the tape base. The thinner the base the greater the length that can be wound on to a given reel—and the longer the playing time.
Kodak Quadruple Play Tape, has a base so fantastically thin it's even thinner than the *oxide coating* on Standard Play Tape!

STRENGTH WITH LENGTH

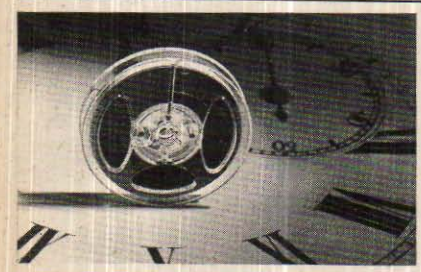
Microscopically thin as it is, Kodak Quadruple Play Tape is no weakling. The Polyester base has been specially pre-stretched and treated to overcome distortion during use. In fact, it will stand up to every stress likely to be met with under all normal conditions, *no matter what the make of your battery tape recorder.* And if you exercise a little extra care you can even use Kodak Quadruple Play Tape on mains recorders, too.

TOTAL UNIFORMITY

Advanced techniques of emulsion coating, developed in Kodak's world-famous research laboratories, have been applied to Quadruple Play Tape with the result that its oxide coating is uniform to within *millionths* of an inch. *The combination of smoothness, sensitivity and signal-to-noise ratio that stems from this extreme coating precision cannot be equalled by any other tapes in the world.*

PLANNED FOR LOW SPEEDS

Another unique extra! Kodak Quadruple Play Tape is actually *planned* for low-speed operation and has a boosted high-frequency response at low tape speeds. This means that at the speeds you'll most likely be using with a portable you'll suffer far less of the usual drop in quality. Your battery portable will surprise even you!



You don't miss a minute of pleasure with the tape that plays on . . . and on . . . and on!

What the magazine 'Tape Recorder' said about Kodak Quadruple Play Tape. August 1965.

"My tests show that the sensitivity at optimum bias is higher than normal, that the high-note response is much improved over normal tapes and that the drop-out count and amplitude fluctuation are the lowest of any tape yet tested".
"Test tones and sustained musical notes showed a smoothness seldom heard at this tape speed (3¾ i.p.s.)".

Review by Alec Tutchings.

MINIMUM PRINT-THROUGH

Normally, thin tapes are highly susceptible to print-through. But Kodak Quadruple Play Tape has a remarkable resistance to this unwelcome 'echo' effect.
In fact, print-through is up by only an inaudible 1·5dB on Standard Play Tape. This feature alone would be enough to set this tape apart!

ACCLAIMED BY THE EXPERTS

Britain's Sound Recording press and many independent experts have been unanimous in praising this and other Kodak Tapes. The BBC and ITV use millions of feet of Kodak tape—and so do professional recording studios the world over. Without a doubt Kodak Tapes have set totally new standards in performance and quality—standards of which *you* can now take advantage. Fill in the coupon below for full details—then see your Kodak dealer and give your recorder the tape it *really* deserves!

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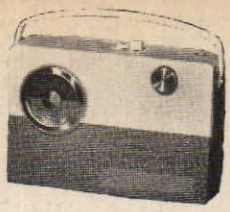
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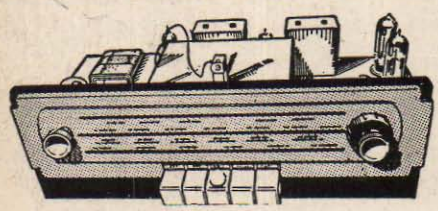
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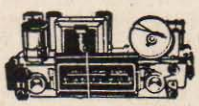
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COMPONENTS . . .

Resistors
R1 15kΩ R2 220Ω
Both 10%, ½ watt carbon

Transistor
TR1 NKT217 (Newmarket)

Diode
D1 OA81 (Mullard)

Relay
RLA 150Ω (G.P.O. type 600) with set of change-over contacts (available from G. W. Smith & Co. (Radio) Ltd.)

Switch
S1 Single-pole on/off toggle switch

Bell
3–8 volt bell

Miscellaneous
Two flat pack 4½ volt batteries
Chassis 6in × 4in × 2½in (aluminium)
Eyelet board or laminated wiring board for mounting TR1, D1 and R1
Enamelled copper wire (about 30 s.w.g.)
Two-way clip terminal block
Spring clip (see photograph)
P.V.C. covered wire, 4 B.A. and 6 B.A. nuts and bolts.

CIRCUIT

With the alarm loop circuit completed the quiescent current drain via R1 is about 300 microamps. Slightly higher quiescent currents may occur if the unit is mounted near a radiator, but this current will never normally build up sufficiently to operate the relay.

Battery economy can be achieved by experimenting with the value of R1, as the current gains of a batch of transistors of the same type can be diverse in value. This can be achieved by replacing R1 by a 50 kilohm potentiometer. The base-emitter circuit is left open and the potentiometer reduced from 50 kilohms until the relay operates. Remove the potentiometer and measure its resistance. Reduce this value by ten per cent as this compensates for battery deterioration, then insert a preferred value resistor approximating to this calculated resistance but not exceeding it. The relay used was a 150 ohm G.P.O. 600 type with two sets of changeover contacts. The unused contacts were removed to improve its sensitivity, the packing spacers being replaced and the securing screws carefully adjusted so as not to damage the bobbin. Other switching transistors may be tried as there is nothing critical in their choice, however the selection of R1 will have to be ascertained for each transistor type as previously described.

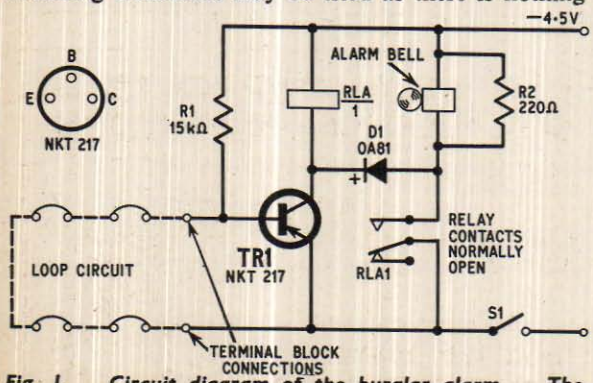


Fig. 1. Circuit diagram of the burglar alarm. The transistor connections are shown looking at the underside

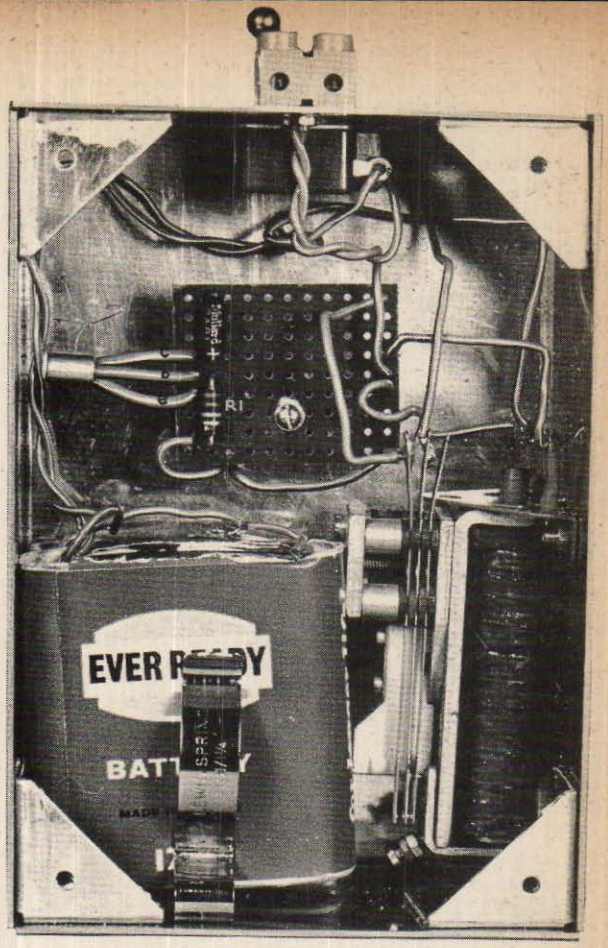


Fig. 2. Layout of components under the chassis. R2 is mounted inside the bell housing.

Diode D1 prevents the collector current from taking the low resistance bell path and so not actuating the relay. It also acts as a hold-in path for the relay when the contacts close. It can be seen that the bell maintains its clamour even though the loop circuit may be completed.

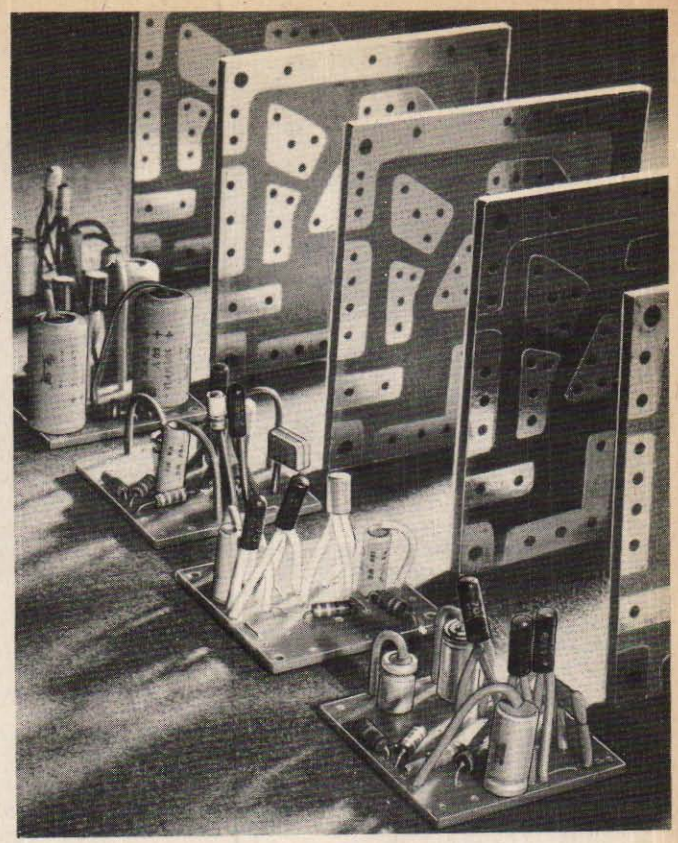
Testing of the system is just a matter of listening for the bell when the alarm is switched on, and then checking windows and doors to ensure that the contacts are closed. Resistor R2 damps the transient "ringing" spikes that appear across the bell in its action. These induced back e.m.f.s. could easily damage the transistor if they were not suppressed.

CONSTRUCTION

The unit was assembled on a chassis 6in × 4in × 2½in. This makes a compact and attractive mounting for the bell. A piece of copper clad wiring board or a tagstrip serves to mount TR1, D1, and R1. The board is fitted to the chassis with a spacer so that it stands clear from the chassis. The board and spacer are fixed with a 6 B.A. nut and bolt. The relay position is not critical provided sufficient space is left for the two 4½ volt batteries which are held by a cut down spring clip. The batteries are wired in parallel, i.e. with positive terminals common and negatives common. The loop circuit from the windows is connected to the unit via the two-way plastics covered terminal block. ★

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MORE about DISCS

AN EARLIER article (October, 1965 issue of PRACTICAL ELECTRONICS), intended as an introduction for the layman interested in experimenting with audio through the medium of disc reproduction, described the main features of mono and stereo discs and provided some guidance on the often misunderstood question of stylus size. The comments offered on that occasion inevitably lead us on to the pick-up—its characteristics and the form it takes.

CHOOSING A CARTRIDGE

The following notes summarise the most important points that the experimenter—and particularly the beginner—will wish to bear in mind when choosing a pick-up. They are of course technical points, but first there is a matter which comes under the heading of common-sense. Plan sensibly: do not get into the situation where too much is spent on electronics and too little is left for the pick-up.

In disc reproduction, disappointment is all too often attributable to inadequacies at the pick-up end of the chain. Therefore enough money must be allocated to this component. Of course, sensible planning also means consistency: one does not use a £30 pick-up with a 5-watt breadboard amplifier. But do start the right way; if disc reproduction is to be given pride of place, then the pick-up must head the list of components to be purchased. Much depends on this.

CERAMIC OR MAGNETIC

The next matter to be emphasised is quite a fundamental one, for it affects cost and much else besides. Pick-ups can be divided into two main groups—ceramic and magnetic—and the experimenter must choose according to the cash he has available and the standard of quality he wishes to achieve.

In general, ceramic types cost up to about 6 guineas (in cartridge form), and there are a few models at around £3, including a diamond stylus, for stereo. Crystal cartridges, on the other hand, are quite rare nowadays and are largely superseded by the ceramics.

From the point of view of cost and quality, magnetic pick-ups start approximately where the ceramics leave off. Prices for cartridges range up to about £30, but the most popular price range for stereo models is £10-20. Are magnetics "better" than ceramics, as the prices suggest? Yes, they are; compare the best magnetic with the best ceramic and the conclusion will be that the former gives livelier and cleaner yet more delicate sound.

To develop this theme, the magnetic type offers better transient response and is capable of performing with less distortion. Its construction is generally such that it offers a tinier mass (the armature and stylus assembly) to be moved and accelerated by the modulated groove. This in fact is one of its most important attributes, making for better fidelity of reproduction. But there is a penalty to be paid for such refinement: the magnetic pick-up gives a small output, typically 5mV average from each stereo channel.

We shall have to say a little more about the significance of output voltages. But first we shall return to the ceramic pick-up. Recent examples represent remarkably good value for money, and the experimenter with a limited amount to spend will certainly be attracted to one or other of them. In fact, ceramics are well suited to medium and low-cost stereo outfits—those costing up to about £100, this estimate being based on retail prices of ready-made equipment. The enthusiast intent on assembling a non-compromise system, well clear of the £100 mark, will almost certainly include a magnetic.

Pick-up playing weight is another relevant point. The best magnetic types track at lower pressures than their ceramic counterparts, and with some examples the figure may be around 1 gramme. This makes for reduced record wear and also means less distortion provided the arm is equal to the task. However, beware of making rules about this. One regularly encounters "difficult" discs which confound theory and complicate practice by refusing to reproduce unless the anticipated pressure is increased. (The answer is: don't buy them; but that is another story.)

The word "cartridge" has been used freely so far, and probably every reader will know that it refers to the actual mechanism of the pick-up. The arm in which it is mounted must of course be of suitable quality, and the beginner will find it convenient to get the cartridge and arm from the same manufacturer. (The advanced enthusiast needs no reminding of alternative approaches enthusiast needs no reminding of alternative approaches.)

We should note that in a few cases the two parts are designed as one integral unit. However, the experimenter will want the interchangeability and versatility of separate components, and therefore the other possibilities are excluded from this article.

OUTPUT AND RESPONSE

Now we must return to pick-up characteristics. A data sheet presented with last November's PRACTICAL ELECTRONICS listed the main operating principles of cartridges, but it is necessary to summarise here some outstanding points about output and response.

As already mentioned, the magnetic pick-up is a low output device. The ceramic gives a higher output,

typically around 70mV average from each channel. In specifications the output is often quoted in relation to recorded velocity, so that a magnetic model might be said to deliver 1mV per cm/sec at some particular frequency. In that case it would be fair to say that the average output was 5mV.

Obviously this question of output affects the choice of amplifier. In the case of the magnetic pick-up just quoted, the amplifier must have a sensitivity of at least 5mV. If a ceramic is to be used, the amplifier can be correspondingly less sensitive. In practice, amplifiers are designed with one or the other of the main types in mind, and sometimes there are facilities for both types. An owner of a low-sensitivity amplifier, wishing to change to a magnetic pick-up, will probably be able to make or buy a transistorised pre-amplifier which will boost the pick-up voltage.

A related matter is that of equalising the output of the cartridge. It consists essentially of raising the level of the bass and reducing that of the treble—accurately and in a controlled way. The means of doing this depends on the type of cartridge and its response to the signal on the record.

A ceramic cartridge has built-in equalisation for the recording characteristic as long as the amplifier input presents a load of about 2 megohms. The result, seen as a response curve, is far from precise but is generally thought to be acceptable having regard to the low price of the cartridge. Moreover this useful property of the ceramic does mean that circuit complications are minimised. Connected to its high-impedance load the cartridge gives a signal voltage which does not have too big a departure from a level response in the bass and treble. Not surprisingly, the more costly ceramics do this job most successfully.

Things are quite different with the magnetic pick-up. Its response follows the recording characteristic, exhibiting a drop in the bass and a rise in the treble. An expensive pick-up adheres closely to this characteristic, with departures from it as small as 1 dB. This means that the amplifier input circuits must not only provide high sensitivity but also a very accurate response equalisation.

In fact the circuits must have a response which is the opposite of the recording curve—a mirror image, as it were. The signal, after passing through these circuits, emerges with a practically level response and is passed on for further amplification. The amateur need not worry about the actual circuit details unless he is designing his own amplifier from scratch (if he is doing so, he will hardly need the above explanation).

Of course, in nearly all cases the procedure will be to take a proven circuit and use it as it stands. Thus, if a magnetic cartridge is to be used, the main requirement is to check that the circuit has been designed for the job. It must give adequate sensitivity and the correct response characteristic.

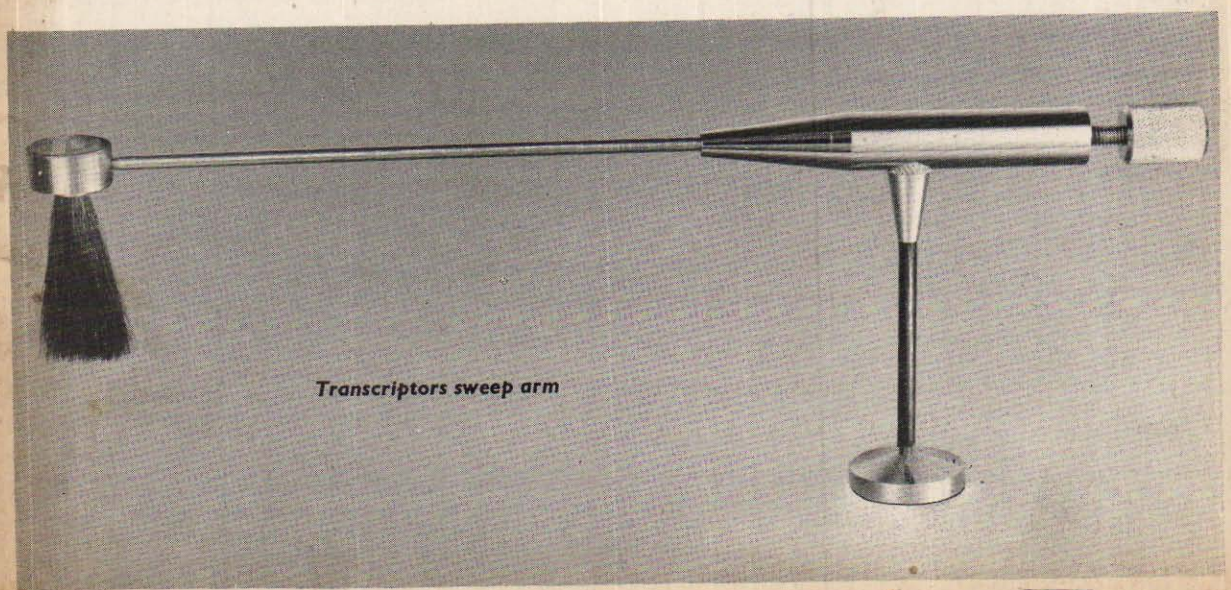
In practice it is the R.I.A.A. characteristic, which is the same as that defined in the British Standard dealing with recording matters. Stereo and mono discs can be regarded the same way as far as response is concerned (provided that the mono discs are not very old ones).

STYLUS LIFE

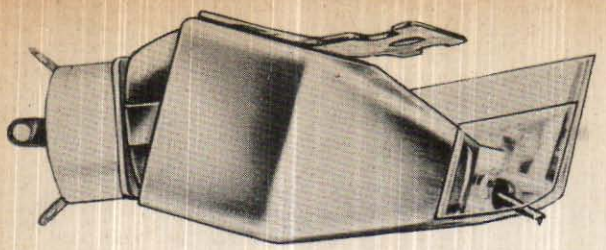
At the present stage of development of disc reproduction, it is essential to use a diamond stylus. There is little to be said for a sapphire as its life is so short. A diamond lasts at least twenty times as long if treated with care. Even the most moderately priced cartridge has a diamond as standard fitting, though of course this must be checked before purchase.

It is difficult to do more than generalise about stylus life. As a rough guide, a diamond may give 1,500 hours of use, but carelessness over record cleanliness and pick-up adjustment might halve this figure. The figure just quoted is for a lightweight magnetic pick-up, but styli give different lengths of service according to type of pick-up and conditions of use.

Most users realise that dust influences record wear and stylus life. Take precautions to exclude it as far as is practicable. Anti-static and other cleaning preparations which leave a thin deposit in the record groove cannot be recommended without qualification. Indeed, they should not be used at all if the pick-up is of very advanced type tracking at around 1 gramme.



Transcriptors sweep arm

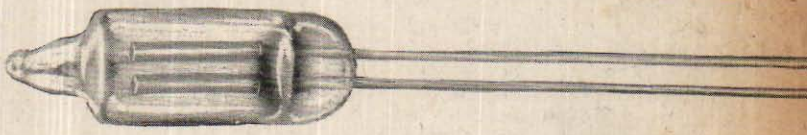


Pickering 380A cartridge

Sparing use of well known and proven preparations is not a bad thing when playing weights are higher. There are, incidentally, cleaning devices which sweep the groove without leaving a film. Microscopic inspection of the stylus for damage and wear is especially important. It is a good plan to find a suitably equipped dealer and to have the stylus inspected at intervals of not more than 500 hours of use. Keep a check on use: you can say that three l.p. record sides equals one hour of use.

A final word. It is most unwise to flick the stylus to check whether the amplifier is working! Damage can all too easily result. Some users touch the stylus with the intention of cleaning it, but a miniature cleaning brush is safer and more effective. Devices are available for fixing near the turntable and pick-up head.

NEON NOVELTIES



THIS is the sixth of a series of short articles illustrating some of the many uses of neon lamps. The neons employed are all miniature wire-ended types as shown above.

Two examples which are ideally suited to these applications are those supplied by Radiospares (striking voltage 65 volts), and the Hivac type 3L general purpose neons. The latter type requires a striking voltage of 80 volts and maintaining voltage of 60 volts.

Some neon indicators have a resistor wired in series with one of the neon wires to make them suitable for mains voltages. These would normally be unsuitable for the circuits described unless the resistor is removed or short-circuited.

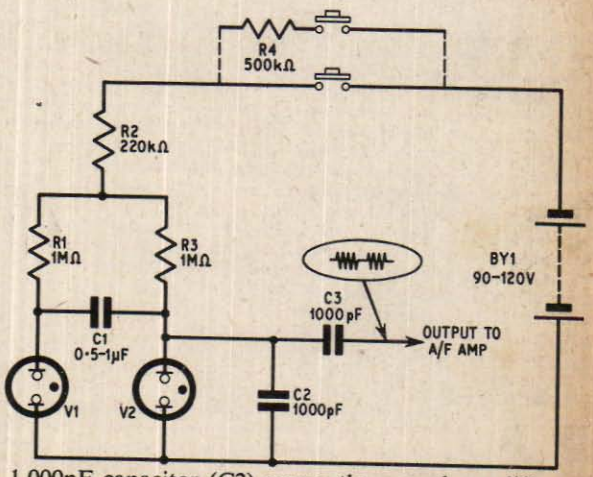
SIX NEON WARBLER

by R. Bebbington GRAD.I.E.R.E.

THIS SIMPLE but unusual circuit has a variety of uses and can be assembled in a few minutes. As an audible alarm indicator or call device its distinctive tone makes it easily recognisable and, by using different values of resistors as indicated, several push-button positions may be easily identified. The larger the series resistor, the slower the warble. When a push-button is operated the neons will flash alternately and the circuit will oscillate by virtue of the small capacitor across one of the neons. Thus the circuit combines a warning warbler with a warning winker.

A small transistor amplifier is adequate for most audio applications as the output from the 1,000pF coupling capacitor (C3) is quite large. If this device is used in conjunction with a valve audio amplifier its supply may be derived from the h.t. line with a suitable series dropping resistor.

For those readers interested in amateur dramatics the sound of the warbler makes it ideal for science fiction sound effects. The flashing neons also provide an effective display particularly in a darkened room. The pitch of the note may be varied by replacing the



1,000pF capacitor (C2) across the neon by a different value capacitor. A smaller value will produce a higher frequency note; a larger value lowers the frequency.

the 73 page

by Jack Hum G5UM

How—and where—to Listen

"How best to achieve a satisfactory return from the operation of a newly acquired communication set". This we said last time was the question which "The 73 Page" should discuss as a matter of first priority in 1966.

Why? Because every year the thousands of young people who discover radio for the first time—and especially amateur communication radio—have little idea, and less guidance, about how they should approach this exciting new world with a view to participating actively in it.

Many come to it through accidentally overhearing an amateur transmission while they are tuning the short wave bands on their domestic radio sets. Some indeed are intrigued by the sudden breaking in of a mystery voice on top of the favourite television or broadcast programme (received on a maladjusted set, be it added!). It turns out to belong to "that chap down the road with the big aerial".

To many more the interest is triggered off by the casual purchase of a magazine such as PRACTICAL ELECTRONICS in which attention is paid to the world of amateur communication—and it is this purchase which can mean that you are hooked for life!

Whatever the initial trigger pulse, there is no question at all that before long the urge to explore the short wave spectrum needs to be satisfied by the acquisition of a receiver capable of doing the job properly—which most broadcast sets with short waves are not. A fully equipped communication receiver becomes a "must"—and by "fully equipped", we mean engineered to give high sensitivity, associated with a particularly effective a.g.c. characteristic that enables those weak and distant stations, not only to be winkled out, but to be held at a readable level clear of the disconcerting fading so characteristic of the short waves.

Six Bands

The six high frequency bands allocated by international agreement to the Amateur Service are shown in the accompanying diagram. When it is remembered that they provide a mere 3,100kc/s of space to accommodate a total world amateur population of some hundreds of thousands (and increasing every year), two inescapable conclusions emerge: that there is little enough room for all who wish to transmit, and that fortunately not all of them come on at once!

Many years ago it was "Forty" that provided most interest to the listener to amateur transmissions. As the band where equipment and aerial needs were modest in both size and cost, and where European friendships could be made with the greatest of ease—and at great signal strength—7Mc/s had no peer.

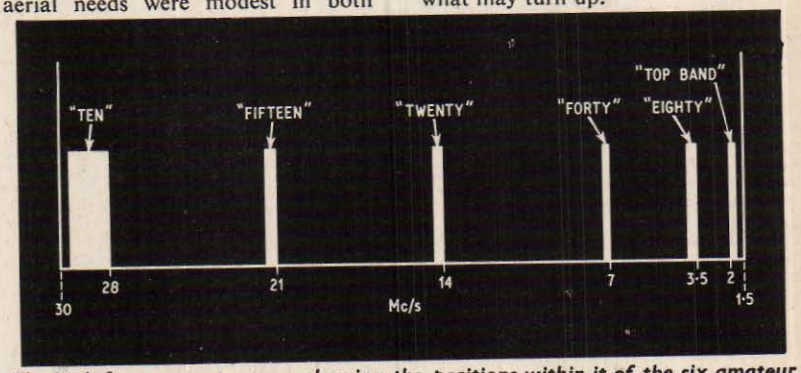
Sadly, this is no longer true. At successive international conferences more of "Forty's" space has been given over to broadcasters and less to amateurs, and in the mere 100kc/s that remain intruders devastate the kilocyclic scene.

Top Band Topics

Today it is not "Forty" but "Top band" that attracts newcomers to "the 73 movement", and for many good reasons. Power input is restricted to 10 watts, aerials in the average urban *locale* must of necessity be small (the half wavelength required for efficient radiation demands an exorbitant 264 feet of space), and daylight attenuation is high; all these factors make "One Sixty", or "Top Band", ideal for cosy local contacts. At night the range extends to 1,000 miles, a large amount of c.w. activity emerges, and the listener who is anxious to improve his knowledge of morse is in his element.

Harmonically related to "One Sixty" is the 80 metre band. Here again much excellent telegraphy may be heard in the lower frequency area with telephony in the upper section in accordance with the tidy band planning system self-imposed by the amateur movement.

On each of the three remaining bands starting at 14, 21 and 28 Mc/s—their extents are shown in the diagram—it is once again a case of "c.w. at the low end, phone in the rest". These are the bands where, subject to many laws of nature, world wide communication is possible. No wonder they exert a constant fascination upon the great majority of transmitting men throughout the world and remain a source of never-ending interest to the short-wave listener: he never knows what may turn up.



The high frequency spectrum showing the positions within it of the six amateur h.f. band allocations and their respective widths, as follows:

"Top Band"	*1·8 to 2·0Mc/s*	*"Twenty"*	*14·0 to 14·350Mc/s*
"Eighty"	*3·5 to 3·8Mc/s*	*"Fifteen"*	*21·0 to 21·450Mc/s*
"Forty"	*7·0 to 7·1Mc/s*	*"Ten"*	*28·0 to 29·7Mc/s*

Total available space 3,100kc/s; much of it shared by other Services.

Systematic exploration of each of these bands by day as well as by night discloses their special characteristics, especially if supported by a well documented log. This way the listener achieves a satisfactory return from the use of his communication receiver—which is where we came in.

A final thought; the entire h.f. amateur allocation discussed above would fit easily into just *one* of the u.h.f. allocations. To this area we must address ourselves next time.



Cyril Ornadel



Antony Hopkins

It's people like this



Steve Race



Sir Arthur Bliss

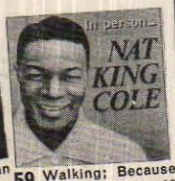
who choose records like these



117 Danube; Emperor; Vienna Woods etc. Vienna SO Ruel.



63 Steam-team! Cuban Carnival; Yesterdays; 9 more!



59 Walking; Because You're Mine ☐ more Nat greats.



131 Kissa Me Baby & lots more by the 10 Blues Kings. ☐



126 12 top hits of '64. Great album — ☐ great year!



19 Melody of Love; White Christmas; 10 more tops. ☐



58 Honeysuckle Rose; 7 more terrific Duke specials. ☐



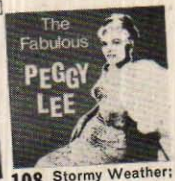
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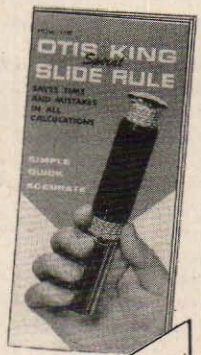
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Book reviews

UNDERSTANDING ELECTRONIC CIRCUITS

By Farl J. Waters.
Published by W. Foulsham & Co. Ltd.
160 pages, 8¾in. × 5½in. Price 24s.

I HAVE no doubt that many newcomers to electronics have been confused in their search for a primer in this exploding technology by the vast weight of books aimed at them specifically. In this cornucopia of basic electronic texts, it is difficult to find one book that is lucid and succinct in its presentation of commonly used electronic circuits.

In this book, however, these facets are evident. Beginning with an explanation of the circuit essentials such as resistors, capacitors, reactance, impedance, transistor and valve fundamentals, it moves on to the theory and functioning of amplifiers, oscillators, modulators, frequency mixers, converters, limiters, detectors, discriminators, power supplies, pulse generators, a.v.c. and a.f.c. control circuits.

Every component that appears in a circuit has a functional explanation so that a step by step analysis of the whole is obtained, making the grasping of the most complex circuit an easy task.

An additional bonus to would-be students is the list of review questions that appears at the end of each chapter, each of which is fully answered at the end of the book.

G.G.

THE ELECTRON IN ELECTRONICS

By M. G. Scroggie, B.Sc., M.I.E.E.
Published by Iliffe Books Ltd.
276 pages, 8¾in × 5¾ in. Price 45s

A SERIOUS study of electronics is impossible without some knowledge of modern physics. Whereas classical ideas of an easily visualised model of the atom with its planetary electronics may still suffice for an elementary understanding of ordinary electrical currents, they are totally inadequate to explain (for example) how heat and light cause electrons to be emitted from surfaces, how conduction takes place in semiconductor materials, and other electronic phenomena.

A new mental approach is needed when considering the modern ideas of sub-atomic particles. Unless one is a physicist, or versed in higher mathematics, much must be taken on trust in this bewildering world of the quantum theory, wave mechanics and the uncertainty principle.

Mr. Scroggie has undertaken no slight task in interpreting these abstruse ideas for the electronically-minded reader. His book is intended to provide an introduction to the subject; the treatment is largely descriptive and the mathematics involved do not go beyond G.C.E. "A" level. The author's relaxed and entertaining style of writing will no doubt provide encouragement for the inevitably oft perplexed reader to persevere with the task of assimilating these strange and sometimes contradictory notions that form part of modern physics.

J.V.

RADIO AMATEURS' EXAMINATION MANUAL (Fourth Edition)

By B. W. F. Mainprise, B.Sc. G5MP
Published by Radio Society of Great Britain
60 pages, 9¾in × 7½in. Price 5s

"All applicants for an amateur transmitting licence must first pass the Radio Amateurs' Examination—no exemptions are allowed by the General Post Office. . . ."

IT is well to quote the opening words of the Foreword to this manual, for there is much general misunderstanding concerning the requirements to be met before one can legally operate transmitting equipment.

Prospective amateurs will appreciate this book. The subject matter is arranged to correspond closely with the various items of the RAE syllabus. Most of the text is in question-and-answer form. Specimen questions taken from previous years' examination papers are included. The final chapter contains model answers to all the questions set for the 1962 examination. Among the appendices are the Conditions of the Amateur (Sound) Licence A, including changes made in July 1964; and the RAE syllabus.

FUNDAMENTALS OF MODERN SEMI-CONDUCTORS

By Barron Kemp and R. H. McDonald
Published by W. Foulsham & Co. Ltd.
160 pages, 8¾in. × 5½in. Price 24s.

THIS book could well be described as a compendium of semiconductor technology. The presentation is entirely qualitative with no recourse to mathematics. It is liberally illustrated with circuit applications, characteristics and physical diagrams indicating individual semiconductor action, which does much to complement what is, in essence, a reference book of semiconductor families.

Commencing with an introductory chapter on solid state physics, it goes on to demonstrate transistor action with typical characteristics. The treatment given to various industrial techniques of junction formations is comprehensive and this lends itself to a fuller understanding of the working principles of multilayer semiconductors in later chapters.

A chapter on diodes and rectifiers deals with the well known Zeners and s.c.r.'s as well as those types with more specialised application to computers, such as binistors.

The transistor family of mesa, planar, epitaxial, field effect, photo types and many others are described adequately but at times rather dryly in terms of chemical synthesis. This is one of my criticisms of an otherwise excellent book. There is a great deal on manufacturing techniques that might have been given to a fuller description of the principles and applications of some of the lesser known devices.

My other criticism is the lack of a glossary which would be in character with a book of reference, for words such as "gigacycles" and "eutetic temperature".

G.G.

ELECTRONIC BUILDING BLOCKS



PART 11

by R. A. DARLEY

LAST MONTH we discussed the monostable and bistable members of the multivibrator family, including the binary version of the bistable. This month we shall deal with the applications of this particular circuit.

BINARY SYSTEM

When using numbers for counting, adding, and multiplying, it is common practice to employ the decimal system based on the number 10, i.e. we use ten numerals, 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 as basic units, and we indicate the magnitude of any complete number by showing the numerals against a power of 10.

To give a specific example, the number 9278 is our shorthand way of saying $9000 + 200 + 70 + 8$. All numbers are based on the power of 10; for example, $100 = 10 \times 10 = 10^2$. Similarly $1000 = 10^3$ and $1 = 10^0$. A number derived from powers of 10 is shown in Table 11.1. This number 9278 is equal to $(9 \times 10^3) + (2 \times 10^2) + (7 \times 10^1) + (8 \times 10^0)$.

TABLE 11.1. DECIMAL NOTATION

Powers	10^3	10^2	10^1	10^0
Decimal factor ...	1000	100	10	1
Decimal number	9	2	7	8

Unfortunately, transistors and other electronic devices do not have a convenient way of counting in powers of 10. All that the transistor can offer as the basis of a system of numbers is its alternatives of being either on or off, i.e. a choice of two states. Thus, the basic system that is used in electronics is based on the "power-of-two" or binary system. Table 11.2 gives the equivalent powers-of-two for decimal numbers, and the appropriate binary digits in the last line representing the decimal number 87, expressed in its binary form as 1010111. Note that the "power" table starts with "1" (expressed as 2^0 in the power-of-two series).

TABLE 11.2. BINARY NOTATION

Powers	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Binary factor ...	64	32	16	8	4	2	1
Binary number	1	0	1	0	1	1	1

In the coded section, a choice of only two numbers, either 0 or 1, are available. Using this table, other numbers may be expressed in binary form as shown by the following examples:

109 = 1101101	117 = 1110101
23 = 10111	11 = 1011

The highest number that can be derived from the above table is 127, i.e. twice the highest number (128) minus 1.

BINARY COUNTER CIRCUITS

The circuit that is generally associated with binary counters and dividers is the binary bistable multivibrator, shown in "block" form in Fig. 11.1a. Here, the elements that are of interest are the two output terminals, taken from the transistor collectors, and the single input terminal. The circuit may be any one of the binary types described in detail last month.

Assume initially that the transistor TR1 is off and TR2 is on; if *pnp* transistors are used, TR1 output terminal will be at near full negative potential and TR2 output terminal at near zero volts. Thus, if the negative potential is used to indicate a number, TR1 output terminal is indicating that "0" input pulses have been fed to the circuit.

When a positive input trigger pulse is fed to the circuit, the transistors will change state and TR2 output terminal will go negative, indicating that "1" input pulse has been fed to the circuit.

To indicate numbers greater than "1", binary units can be connected in cascade; Fig. 11.1b shows the connection of four such cascade units. The individual blocks are of the type just discussed.

The output at TR2 collector (b) of each block is used to supply the input trigger pulse for the following block: two input pulses are needed to give a single output trigger pulse from each block. Thus, one block divides by 2, two blocks divide by 4, three blocks divide by 8, and so on.

The table included in Fig. 11.1b shows the state of the circuit with succeeding input pulses. On each block, "1" indicates an "off" transistor (near full negative potential output at collector) and "0" indicates the on transistor (output at near earth potential). TR1 output terminals are indicated by (a) and TR2 outputs by (b).

The four block circuits shown give one output pulse for 16 input pulses, i.e. the circuit divides by 16. Note that, on the sixteenth pulse, the circuit reverts to the state as at "0" input pulses; the cycle of events then repeats itself again, and so on *ad infinitum*.

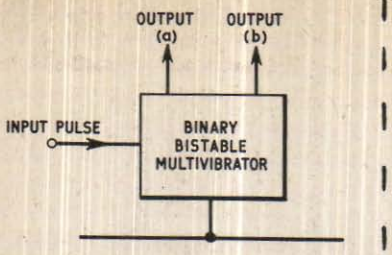
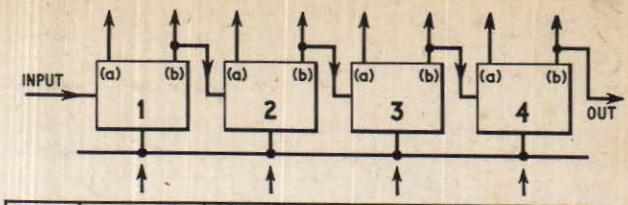


Fig. 11.1a (above). Block diagram of the binary bistable multivibrator



PULSE 0	1	0	1	0	1	0	1	0
,, 1	0	1	1	0	1	0	1	0
,, 2	1	0	0	1	1	0	1	0
,, 3	0	1	0	1	1	0	1	0
,, 4	1	0	1	0	0	1	1	0
,, 5	0	1	1	0	0	1	1	0
,, 6	1	0	0	1	0	1	1	0
,, 7	0	1	0	1	0	1	1	0
,, 8	1	0	1	0	1	0	0	1
,, 9	0	1	1	0	1	0	0	1
,, 10	1	0	0	1	1	0	0	1
,, 11	0	1	0	1	1	0	0	1
,, 12	1	0	1	0	0	1	0	1
,, 13	0	1	1	0	0	1	0	1
,, 14	1	0	0	1	0	1	0	1
,, 15	0	1	0	1	0	1	0	1
,, 16	1	0	1	0	1	0	1	0

Fig. 11.1b (right). Four binary bistable circuits connected in cascade form. The associated table shows the state of the circuit with succeeding input pulses

BINARY "DECIMAL" DIVIDER CIRCUIT

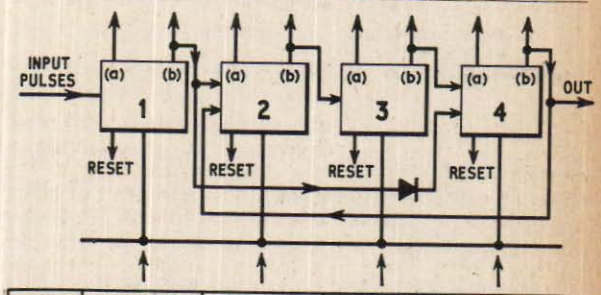
Whilst the binary system is the only one that the electronic circuit can basically work with, man finds it far more useful to use a "scale-of-ten" or decimal system; to be of any real use, therefore, the machine must be made to show results in a decimal form. As far as divider circuits are concerned, this means that the circuits must be made to divide by 10, as opposed to 8 or 16.

The circuit of Fig. 11.1b can be quite easily modified to give decimal operation, and Fig. 11.2 shows the block diagram in modified form.

Here, two feedback loops are included in the circuit, one taking the output from block 1(b) forward to the base of block 4(a), and the other taking the output of 4(b) back to the base of 2(a). A diode is included in the line from 1(b) to 4(a) connected in such a way that only positive going trigger pulses are passed, their purpose being to switch 4(a) off if it is turned on. During most of the working cycle of the circuit, 4(a) is switched off, so positive trigger pulses from 1(a) have no effect on this transistor.

Included in Fig. 11.2 is a table showing the state of the circuit with succeeding input pulses. Comparing this table with that of Fig. 11.1b, it can be seen that, up to and including the ninth pulse, the two circuits operate in an identical manner. In Fig. 11.2 it is the operation of the circuit on the tenth pulse that is of greatest interest. Note that, if the feedback loops were not included, block 2 would again switch on the arrival of this pulse; by including the feedback loops, however, the operation of the circuit is changed at this stage.

Before the arrival of the tenth pulse, block 4 had been switched, so that 4(a) is now on and is vulnerable to positive trigger pulses from 1(b) which will switch if off again; when the tenth pulse arrives, block 1 switches and sends the positive going trigger signal to 4(a), switching 4(a) off and 4(b) on; an output trigger pulse is thus made available at 4(b) output. The trigger signal from 1(b) output is coupled to 2(a) and tends to switch that transistor on; the output of 4(b) is coupled back to 2(a) base, however, and as



PULSE 0	1	0	1	0	1	0	1	0
,, 1	0	1	1	0	1	0	1	0
,, 2	1	0	0	1	1	0	1	0
,, 3	0	1	0	1	1	0	1	0
,, 4	1	0	1	0	0	1	1	0
,, 5	0	1	1	0	0	1	1	0
,, 6	1	0	0	1	0	1	1	0
,, 7	0	1	0	1	0	1	1	0
,, 8	1	0	1	0	1	0	0	1
,, 9	0	1	1	0	1	0	0	1
,, 10	1	0	1	0	1	0	1	0

Fig. 11.2. Feedback loops convert the circuit in Fig. 11.1b to a "divide-by-ten" or "decimal" divider

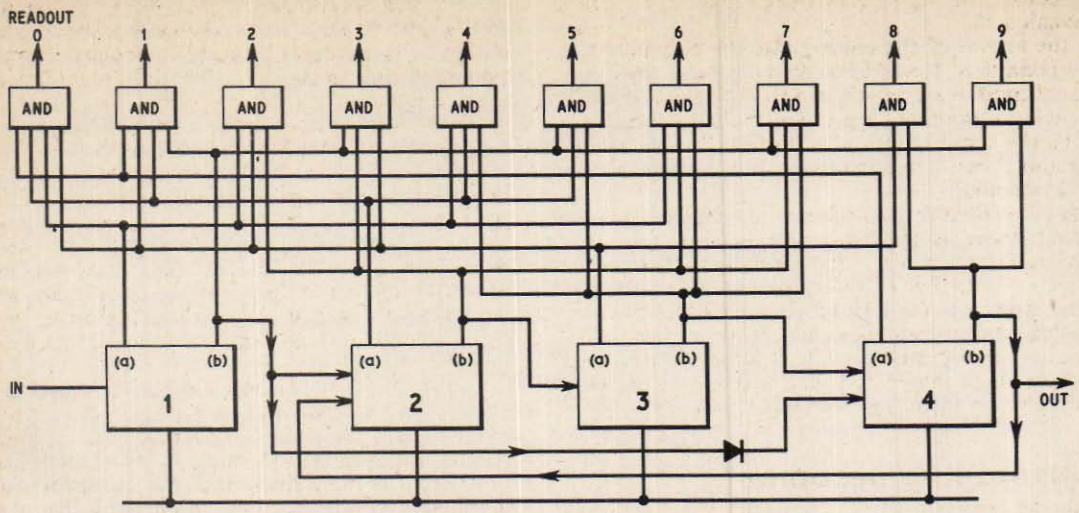


Fig. 11.3b. Combination of the four binary bistable circuits and the AND gate decoder

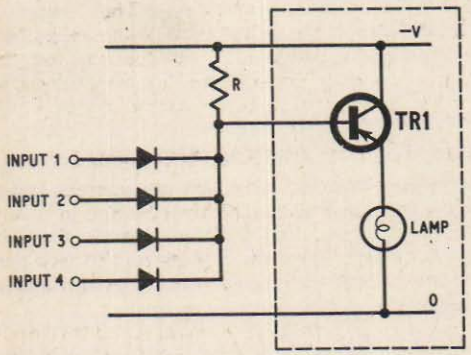


Fig. 11.3a. AND gate with readout facility

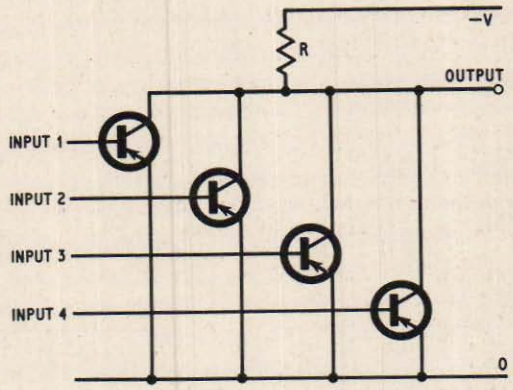


Fig. 11.4a. Basic circuit of a transistor NOR gate

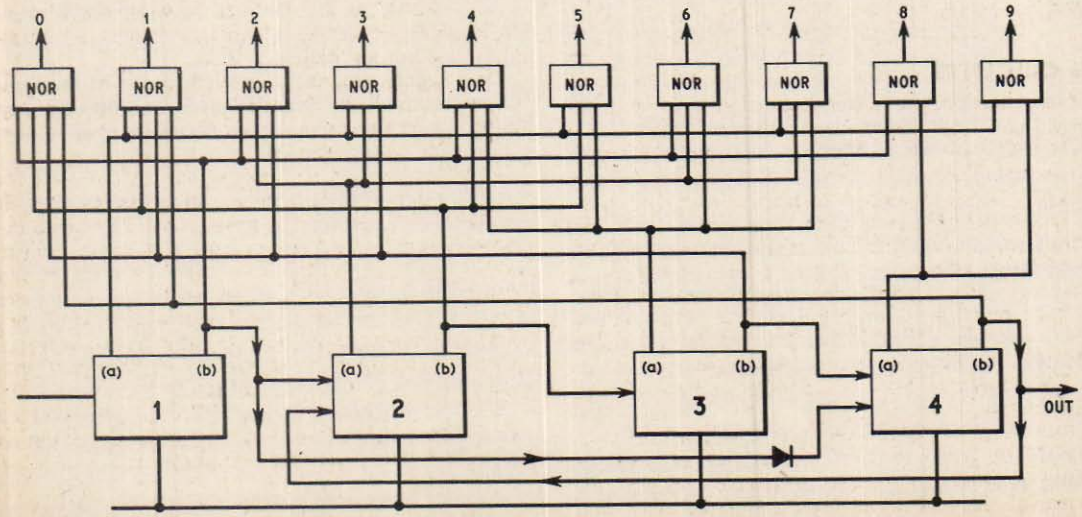


Fig. 11.4b. Complete decimal unit and NOR gate decoder

block 4 switches it sends back a signal to 2(a) base which countermands that arriving from 1(b). Thus, 2(a) remains off.

On the arrival of the tenth pulse, the circuit reverts to the condition it was at with no pulses; this condition, referred to as "reset", can be obtained artificially by applying a positive trigger pulse to TR1 transistors in all blocks simultaneously. This can be achieved by taking the "reset" terminals via a reset switch to a positive potential.

It may be noted that, although the "decimal" system described above is the most widely used type, it is not the only one in use; the feedback paths can be arranged in a number of ways; one manufacturer, for example, prefers to use a system in which the output of 4(a) is fed back to both 2(a) and 3(a) simultaneously. These alternative systems, as is so often the case with electronic circuits that have a wide number of variations, offer little or no advantage over one another.

COUNTING AND DECODING

So far we have considered the binary "decimal" unit purely as a divider, giving a single output pulse for every 10 input pulses; as often as not, however, the circuit is required to "count" the number of pulses fed into it and give a visual indication of that count in the decimal system.

Referring back to the table in Fig. 11.2, it can be seen that each individual input pulse begets its own set of transistor states, unique to itself. A count of three pulses is indicated by 1(b), 2(b), 3(a) and 4(a) outputs all being at near full negative volts; this condition of the circuit is unique to the third pulse. This, information is held in coded form in the circuit according to the number of pulses that have been counted. If suitable "decoding" circuits are used, this information can be translated into decimal form.

In principal, such "decoding" circuits are simple, but can be fairly complex in practice. Referring to the above example and to the tables, any given number within the range 0–9 inclusive can be represented by no more than four "bits" of information; for example, when negative potentials are available at 1(b), 2(b), 3(a) and 4(a) simultaneously, the number "3" is indicated.

GATE CIRCUITS

All that is needed, then, to indicate that number, is an electronic "gate" with four input terminals and a single output terminal, the circuit being so arranged that an output is available only when all four inputs are connected. The four input terminals must be connected to the relevant points on the counter unit, and the output terminal taken to a visual read-out device, such as a lamp. Such an electronic gate is known as an AND gate, for the simple reason that input 1 *and* 2 *and* 3 etc. must be connected before the output becomes available. Fig. 11.3a shows an example of the AND gate; to be more precise, a negative logic AND gate. The explanation of the gate circuit is a slight over simplification.

The four diodes and the resistor comprise the gate. For simplicity, assume that input signals will be either fully negative or at zero potential, and that the impedance of the resistor is high compared with that of the diodes. The output of the gate is taken from the junction of diodes and resistor.

If any one of the inputs to the gate is at zero potential, current will flow through that diode to the negative rail via the resistor; since the impedance of the diode is low, the output of the gate will be at near zero potential, due to the fact that the diode and resistor act as a potential divider.

Connecting two or more inputs of zero potential will cause little significant change to the output potential of the gate; conversely, connecting one or more of the inputs to a negative signal will make no difference to the gate output, since the zero potential input signal holds the output at near zero potential, and thus reverse biases those diodes that have the negative potential applied to their inputs. It is only when all inputs have negative potentials applied (no inputs at zero) that the output of the gate can rise to a significant negative value.

In Fig. 11.3a this negative output potential is shown as being used to drive a read-out unit (shown within the dotted square), which in this case is simply an emitter follower with a lamp as its emitter load; in practice, it is more likely that the transistor would be Darlington connected with another, to give a reasonably high input impedance.

Fig. 11.3b shows the block diagram of a complete decimal counting unit, and an AND gate decoding system and readout facilities. The basic binary "decimal" unit is the same as that shown in Fig. 11.2 and the table in Fig. 11.2 can be applied to both diagrams. A large collection of diode gates, as shown, is sometimes referred to as a "matrix".

ALTERNATIVE DECODING UNIT

In the case that we have just considered, the system relies on the negative potentials from the off transistors in the binary "decimal" unit to operate the decoding unit. An alternative system relies on the zero potential of the on transistors to give gate operation and decoding.

In this case the gates also have, say, four inputs and one output, but the negative output only becomes available when no negative inputs (or zero volts to all inputs) are applied. Such a gate is called a NOR gate, since the negative output is available when neither 1 *nor* 2 *nor* 3 etc. negative inputs are applied.

Fig. 11.4a shows the gate in basic form, but using transistors as active elements. Here, all transistors share a common collector load.

If a negative signal is applied to one of the inputs, its transistor will be biased hard on and the common collector, which also serves as the output of the gate, will fall to near zero potential.

If another negative input signal is applied to another input, all that will happen is that the current flowing in the common collector resistor will be shared between two transistors and the output of the gate will change by no significant amount. It is only when no negative inputs are applied, i.e. all inputs are at zero potential, that all currents are cut off and a significant negative output potential becomes available at the output of the gate. A number of variations of this gate exist, in some no transistors are used at all.

Fig. 10.4b shows, in "block" form, the connections used when employing the NOR gate decoding system with the binary "decimal" counting unit.

Next month: Counter/timer units, electronic gates, and triggering circuits

THE instrument to be described embodies a number of circuits used collectively for the purpose of operating a range of Geiger-Müller (G.M.) counters and silicon surface barrier (s.s.b.) detectors.

The ratemeter in its complete form could represent to the science teacher an ideal means of demonstrating the relative characteristics of the two types of detector with various kinds of radiation. To the amateur it might be a useful and interesting instrument for radio-activity investigation at home or in the field where its self-contained power supplies and low weight allow complete freedom of movement.

GENERAL ARRANGEMENT

The electronics of the ratemeter are divided into five sub-units: G.M. Amplifier; S.S.B. Amplifier; Expander Stage; Ratemeter; and E.H.T. Generator and Power Supplies.

The physical arrangement of the instrument closely follows the same general pattern.

The majority of components comprising each sub-unit are mounted on a separate printed wiring board; four of these boards are installed in the underside portion of the main chassis and the fifth, the power supply board, is mounted on the top decks. The two transformers, and certain other components, as well as the dry batteries, are mounted directly onto the chassis. All operating controls and the meter are on the front panel. The loudspeaker unit is fitted inside the metal case.

Fig. 1 provides the key to the whole assembly. All sub-units are shown in block diagrammatic form with key references to inter-unit wiring and also references to appropriate circuit diagrams. All those components not included on the separate boards, but mounted on the chassis, front panel, and case, are shown in detail with all appropriate wiring.

Although the instrument is described in its complete form, capable of operating both types of detector, there is no reason of course, why only one type of detector should not be catered for with obvious economies where limited resources or interest so dictate. An example of this might, for instance, be where only alpha particles were to be detected. In this case only the S.S.B. detector amplifier, the ratemeter and two 9 volt batteries would be required to use S.S.B. detectors such as the 20th Century types SSNO3K and SSNO5K.

CHASSIS CIRCUIT

With reference to the inter-unit diagram Fig. 1, it can be seen that the instrument permits a solid state radiation detector and a G.M. counter to be connected simultaneously, the switch S1 ("S.S.B./G.M.") selecting the required device. An e.h.t. supply is internally generated and is available for direct application to the G.M. circuit or, suitably reduced, to the s.s.b. detector circuit. The amount of reduction needed will depend upon the maximum permissible voltage for the particular detector used.

With S1 in the "G.M." position the e.h.t. voltage is variable from zero to maximum by the front panel control VR1 ("G.M. E.H.T.").

In the "S.S.B." position S1 makes operative an internal preset e.h.t. control VR2 which sets the voltage across a variable attenuator chain R1, R2 and VR3 before being applied to the s.s.b. detector. VR3 is a front panel control ("S.S.B. VOLTS).

S2 ("ABG/A") is associated with the s.s.b. detector amplifiers. The purpose of this switch is to select the output either of the s.s.b. amplifier, whose output for alpha pulses is large in relation to others, or that of the expander stage whose added gain enables beta and gamma radiations to be detected in addition to alpha. In this way discrimination against beta and gamma pulses can be obtained by virtue of their small size. In the "ABG" (alpha + beta + gamma) position of S2 the noise discriminator control VR5 ("DISC") is operative. S4 ("M/B") selects internal battery or mains power and S5 ("E.H.T. OFF") enables the e.h.t. generator to be shut off completely.

The count rate, in three switched ranges (0–5, 0–50, and 0–500 counts per second) selected by S3 ("COUNTS/SEC and OFF") is displayed on a moving coil meter M1.

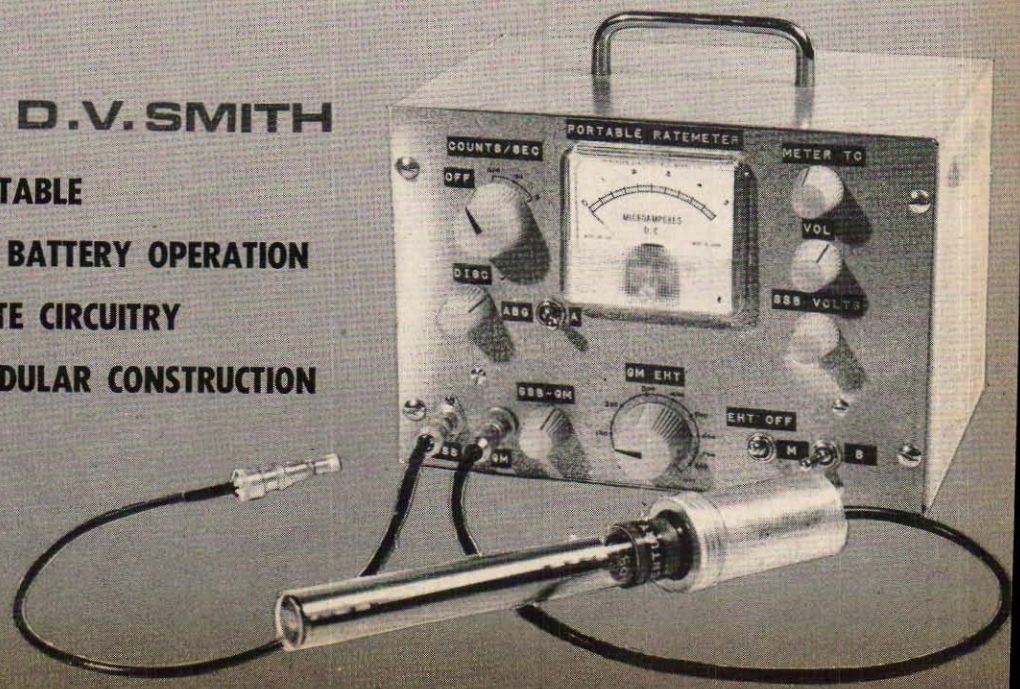
by D.V. SMITH

COMPLETELY PORTABLE

MAINS OR BATTERY OPERATION

ALL SOLID STATE CIRCUITRY

SEMI-MODULAR CONSTRUCTION



The "OFF" position of this control disconnects all power supplies. Audible indication of counts is provided via a loudspeaker LSI, the volume of which is controllable by VR4 ("VOL"). Control is given also of the meter time constant by VR6 ("METER T.C.").

The individual circuits of the sub-units will now be described.

G.M. AMPLIFIER

The simplest of these circuits is the G.M. amplifier (Fig. 2) in which TR1 and TR2 are connected as a cascaded emitter follower amplifier.

No voltage amplification is required with the large pulses usually obtained from a G.M. counter, but since the source impedance is rather high, some impedance transformation is necessary to drive the ratemeter circuit without undue attenuation. The cascaded emitter-follower circuit adequately fulfills this requirement.

The diodes D1 and D2 protect TR1 from the danger of large voltage transients.

The output is taken from point *H4* to the ratemeter, via S1.

S.S.B. DETECTOR ELECTRONICS

NOTE: A full description of the electronic circuitry required for solid state detectors appeared in an introductory article entitled *A Solid State Radiation Detector*—see PRACTICAL ELECTRONICS June 1965. Reference to this previous article is recommended if amplification of the concise circuit descriptions which appear below is required.

The s.s.b. circuitry is arranged in two sections, the first, the S.S.B. Amplifier, is for alpha particle detection. In this application large signals are experienced not requiring high gain, and consequently a high signal to noise ratio is achieved. The Expander Stage is intended as an add-on unit to extend the capability of the combination for the detection of beta and gamma radiation.

S.S.B. AMPLIFIER

The circuit of the S.S.B. Amplifier is shown in Fig. 3.

The outer shell of the s.s.b. detector is taken to the common earth line and the collector connected via the 1 megohm load resistor R10 to a positive bias supply. The voltage pulse appearing across the load is applied to the base of TR3 which is operating as a low noise emitter follower. TR4 and TR5 are conventional voltage amplifiers with a total gain of about 500. The output from TR5 collector is fed via a differentiating network, C13, R21, and R22, to TR6 which operates as a phase splitter output stage. The purpose of this differentiation is to enhance the signal to noise ratio by limiting the bandwidth of the amplifier.

A positive output (with link between A-B) is obtained via C15 at point *F2*.

If it is not intended to add the expander stage for beta and gamma detection, an economy may be made where an instrument sensitive to negative pulses is used. The output in this case may be taken via the output capacitor C15 direct from the collector of TR5 and so obviating the need for TR6. The loss of the differentiating network making no difference in this type of operation.

EXPANDER STAGE

The circuit of the expander stage is shown in Fig. 4. It consists of an input emitter follower, a variable current discriminator/amplifier and an emitter follower output stage with a similar protecting network as in the S.S.B. Amplifier.

The positive going output from point *F6* on Fig. 3 is applied to the input of the expander stage. The input emitter follower TR7 is necessary to drive the low impedance current discriminator TR8 without upsetting the output of TR6 in the first section.

The operation of TR8 as a current discriminator is very simple. The standing base current set by VR5 and the 15 kilohm base resistor R31 is used as the negative discriminator bias which the positive going signal current from TR7 must overcome for the pulse

PORTABLE RATEMETER

SPECIFICATION...

APPLICATION	For use with wide range of G.M. and solid state radiation detectors
G.M. SENSITIVITY	100mV
S.S.B. INPUT SENSITIVITY	
Single Stage Only	Alpha particles down to 200keV
With Expander Stage	Beta and gama radiation down to 50keV
THREE COUNT RANGES	0–5; 0–50; 0–500 counts per sec
RESOLVING TIMES	10msec, 1msec, and 100μsec respectively for the above ranges
METER	Variable time constant; set zero and calibration control
E.H.T. SUPPLY	0–800V, continuously variable

COMPONENTS . . .

Resistors

R1	22MΩ 1W	R28	120kΩ
R2	22MΩ 1W	R29	1·2kΩ
R3	22MΩ 2W	R30	100kΩ
R4	2·2MΩ	R31	15kΩ
R5	4·7MΩ	R32	10kΩ
R6	4·7MΩ	R33	120kΩ
R7	4·7MΩ	R34	120kΩ
R8	4·7kΩ	R35	3·3kΩ
R9	4·7kΩ	R36	1MΩ
R10	1MΩ	R37	10kΩ
R11	2·2MΩ	R38	3·3kΩ
R12	2·2MΩ	R39	100kΩ
R13	68kΩ	R40	68kΩ
R14	150kΩ	R41	3·3kΩ
R15	4·7kΩ	R42	330Ω
R16	47Ω	R43	68kΩ
R17	100Ω	R44	4·7kΩ
R18	150kΩ	R45	2·2kΩ
R19	4·7kΩ	R46	100Ω
R20	47Ω	R47	18kΩ
R21	68kΩ	R48	470Ω
R22	33kΩ	R49	10Ω
R23	3·3kΩ	R50	10Ω
R24	3·3kΩ	R51	430Ω
R25	1MΩ	R52	68Ω
R26	100Ω	R53	12kΩ
R27	120kΩ	R54	12kΩ

All ±10%, ¼W carbon unless otherwise stated.

Potentiometers

VR1	10kΩ linear	VR5	10kΩ log
VR2	10kΩ linear, preset	VR6	500Ω linear
VR3	2MΩ linear	VR7	2kΩ linear, preset
VR4	10kΩ linear	VR8	5kΩ skeleton preset

Capacitors

C1	2,500pF paper 500V (T.P.C.)
C2	0·025μF paper 500V (T.P.C.)
C3	0·25μF paper 500V (T.P.C.)
C4	100μF elect. 6V (Sub mins)
C5	5,000μF elect. 6V (Sub mins)
C6	500μF elect. 25V (Tubes)
C7	1μF paper 250V (T.P.C.)
C8	470pF ceramic (1,000V)
C9	5,000pF ceramic (500V)
C10	0·5μF elect. 15V (Sub mins)
C11	8μF elect. 15V (Sub mins)
C12	0·5μF elect. 15V (Sub mins)
C13	1,000pF ceramic 500V
C14	50μF elect. 15V (Sub mins)
C15	0·1μF plastic 250V (Polyesters)
C16	0·1μF plastic 250V (Polyesters)
C17	0·1μF plastic 250V (Polyesters)
C18	0·1μF plastic 250V (Polyesters)
C19	0·1μF plastic 250V (Polyesters)
C20	0·1μF plastic 250V (Polyesters)
C21	250μF elect. 25V (Tubes)
C22	0·1μF plastic 250V (Polyesters)
C23	22pF ceramic
C24	47pF ceramic
C25	1μF elect. 15V (Sub mins)
C26	2,000μF elect. 25V (Tubes)
C27	0·05μF elect. 500V (T.P.C.)
C28	1μF elect. 250V (T.P.C.)
C29	0·05μF elect. 500V (T.P.C.)
C30	0·1μF elect. 1,000V (T.P.C.)
C31	0·1μF elect. 1,000V (T.P.C.)
C32	2,000μF elect. 25V (Tubes)
C33	2,000μF elect. 25V (Tubes)

Note: Information in brackets is the form of coding used by Radiospares Ltd.

Switches

S1	Midget wafer 4-pole, 2-way
S2	Toggle, s.p.d.t.
S3	Wafer, 4-pole, 4-way
S4	Toggle, d.p.d.t.
S5	Toggle, s.p.d.t.

Transformers

T1	Mains transformer, 200-250V tapped primary. Secondary 16·3V 0·3A centre tapped
T2	Mains transformer, 200-250V tapped primary. Secondary 6·3V 1A centre tapped

Transistors

TR1-TR13 OC44 Mullard (13 off)
TR14-TR17 OC81 Mullard (4 off)

Diodes

D1	Silicon	OA202 Mullard
D2	Silicon	OA202 Mullard
D3	Zenner	6·8V OAZ244 Mullard
D4	Silicon	125V r.m.s. 500mA Radiospares REC50
D5	Zenner	6·8V OAZ244 Mullard
D6	Silicon	800 p.i.v. 500mA International Rectifier SD98 or 98S
D7	Silicon	800 p.i.v. 500mA International Rectifier SD98 or 98S
D8	Silicon	125V r.m.s. 500mA Radiospares REC50

Plugs and Sockets

PL1	Coaxial free plug	P.E.T. type 101
SK1	Coaxial fixed socket	P.E.T. type 101
PL2	Coaxial free plug	Belling Lee
SK2	Coaxial fixed socket	Belling Lee
PL3	Mains input fixed 3-pin plug	Radiospares
SK3	Mains input free 3-pin socket	Radiospares

Miscellaneous

BY1	9V battery 2X Exide H30 4·5V
BY2	9V battery Ever Ready PP9
FS1	Fuse cartridge, 1A
LS1	Loudspeaker 3in, 35Ω speech coil
M1	Moving coil meter, 100μA f.s.d., 2½in, panel mounting

Sundry Items

Chassis: 18 s.w.g. aluminium 6½in × 8¾in × 3in. Battery clamps: 18 s.w.g. aluminium. Component board cradle and retaining strip: ⅛in thick s.r.p.b. Case: 10in × 7in × 7in (Tele-Radio). Carrying handle. Seven knobs. Four stand-off insulators. One fuse holder. Screened lead (single miniature microphone cable). Veroboard.

Radiation Detectors

G.M. tube	Type G10H	20th Century Electronics
SSB detector	Type SSNO3K or SSN05K	20th Century Electronics

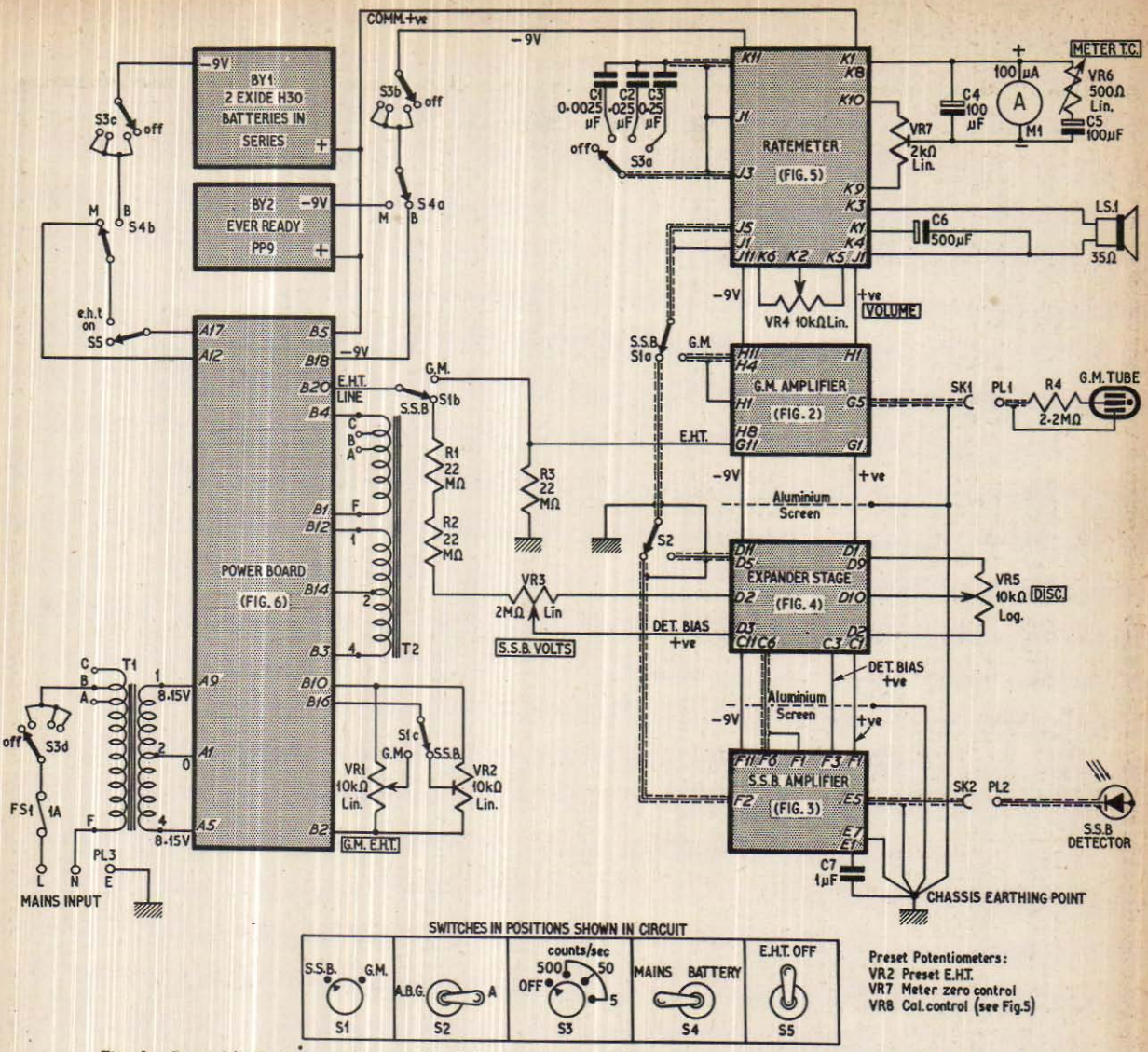
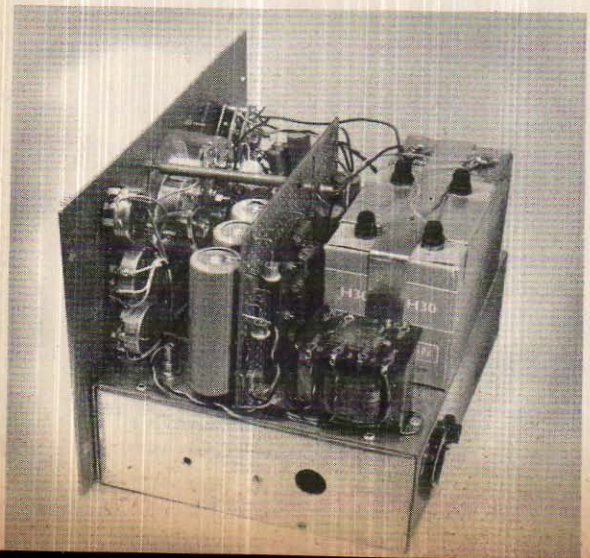


Fig. 1. Portable Ratemeter inter-unit wiring diagram. The ratemeter is divided into five sub-units and the physical arrangement follows closely the same general pattern as this key diagram



to be detected. Once this has happened TR8 operates as an amplifier, and the resulting negative pulse is fed to the output (point *D5*) via emitter follower TR9.

Due to the action of the discriminator the output pulses are no longer proportional to the radiation energy lost into the detector.

RATEMETER

Simply expressed, the ratemeter circuit (Fig. 5) applies a constant charge to a meter for every input pulse regardless of its size or duration. The meter then reads the average current which is proportional to the count rate.

If the pulses applied to the meter were of the same short duration as those from the radiation detector then the average current on low pulse rates would be rather too low to be of great use. A more satisfactory arrangement has therefore been adopted in which the length of the pulse is artificially "stretched" by a monostable multivibrator.

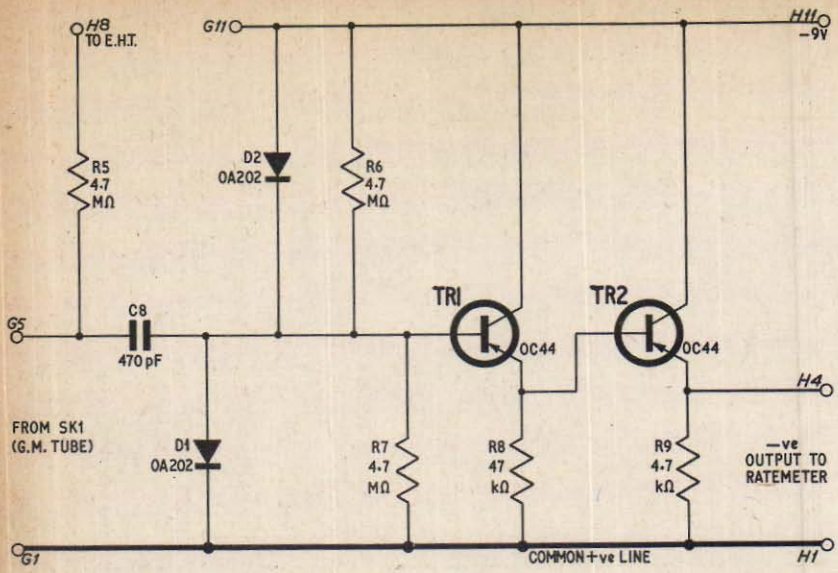


Fig. 2. Circuit diagram of the Geiger-Muller tube amplifier. The diodes D1 and D2 protect TR1 from the danger of large voltage transients

The effect of this is to magnify the charge per pulse applied to the meter while still retaining the necessary linear relationship of average current to count rate. The amount of stretching is related to the count rate range and is a satisfactory compromise between meter deflection and count losses. In other words if the stretching were too long the likelihood of pulses occurring during the insensitive period would be too high and an unacceptable counting error would result although the meter deflection would be good.

The resolving (stretching) time "T" is defined such that if one or more pulses arrive within a time "T" of a former pulse, only the former is recorded. The circuit is therefore "paralysed" for a time "T" after each registered pulse.

The true count rate of random pulses can be obtained from the expression:

$$N_t = \frac{N_o}{(1 - N_o T)}$$

where N_t is the true count rate
N_o is the observed count rate
T is the resolving time

For example, if our system has a resolving time of 1 millisecond and a count rate of 25c/s, is observed, the true rate will be:

$$N_t = \frac{25}{(1 - 25 \cdot 10^{-3})} = 25{\cdot}7\text{c/s},$$

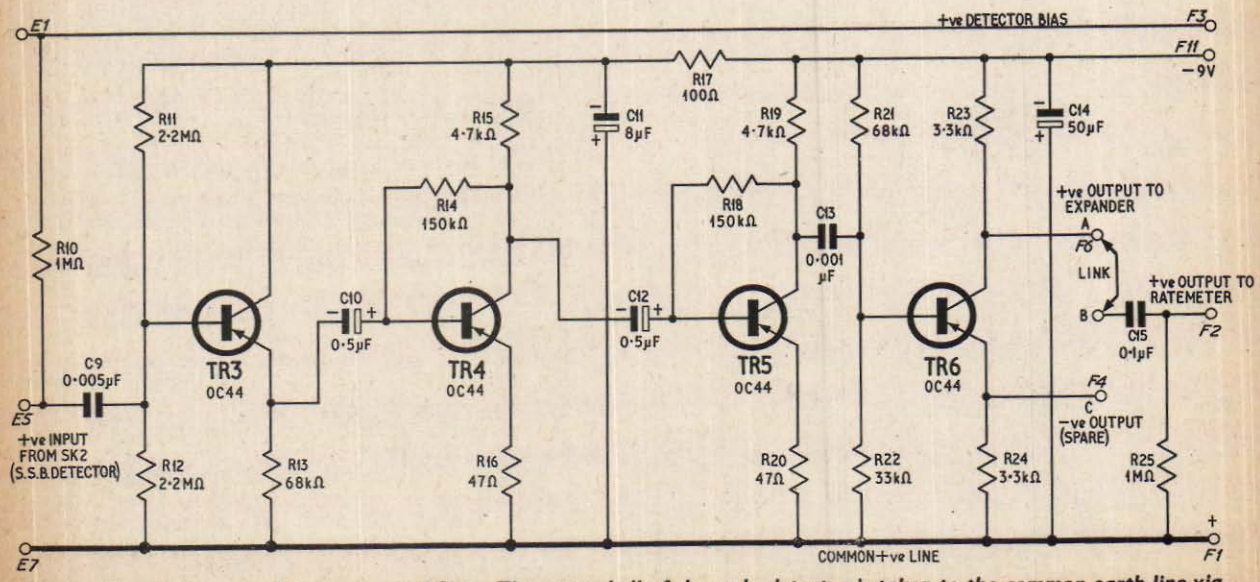


Fig. 3. Circuit diagram of the s.s.b. amplifier. The outer shell of the s.s.b. detector is taken to the common earth line via PL2, SK2, see Fig. 1

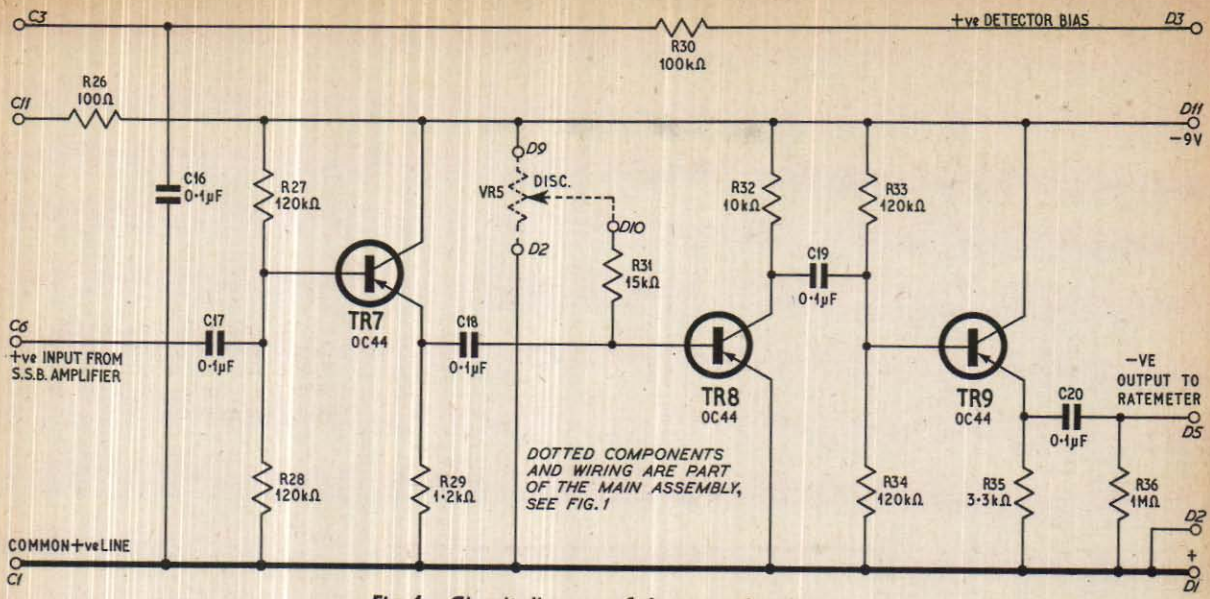


Fig. 4. Circuit diagram of the expander stage

which is near enough for most purposes. The approximate resolving times of the ratemeter on its three ranges are 10mS on 5c/s, 1mS on 50c/s, and 100μS on 500c/s. If the G.M. counter has a longer "dead" time than the resolving time of the system then this will be the governing factor. The s.s.b. detector is much faster than the G.M. tube and so will not complicate the issue in this way, although very little difference will be made in any case.

The action of the circuit (Fig. 5) is briefly as follows: A negative going input pulse greater than about 100 millivolts in amplitude will start to turn TR10 on. The positive going pulse appearing at TR10 is transferred via one of the three timing capacitors C1, C2, C3, to TR12 base. This transistor, normally held on by the current through R40, begins to turn off. The negative pulse produced at TR12 collector is fed via R39 and C23 to TR11 base and begins to turn TR11 on. The current through TR11 is in phase with the current through TR10 through R38 and therefore the action is regenerative, causing a rapid transition to the astable condition.

At the end of the duration of the input pulse TR10 cannot initiate a reversal of the action in turning off as TR11 has "clamped" TR10 collector.

The charge on the timing capacitor leaks away through R40 until TR12 begins to turn on and the circuit rapidly reverts to its original state. The duration of the astable condition depends on the value of the timing capacitor and R40.

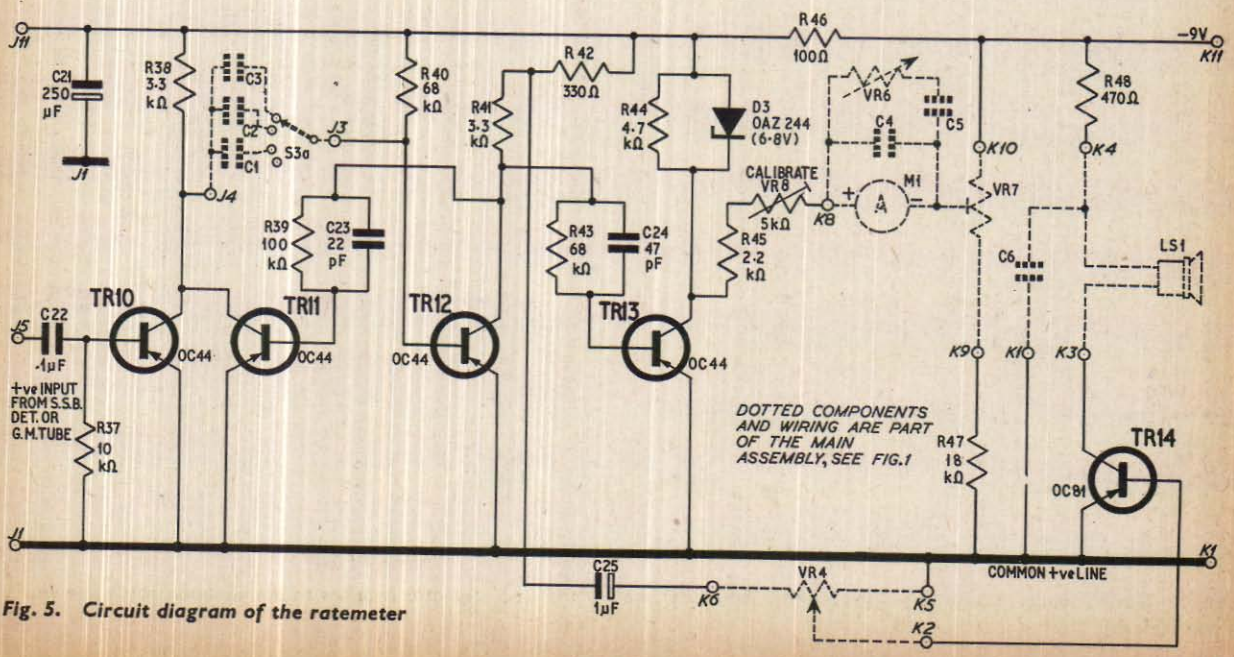


Fig. 5. Circuit diagram of the ratemeter

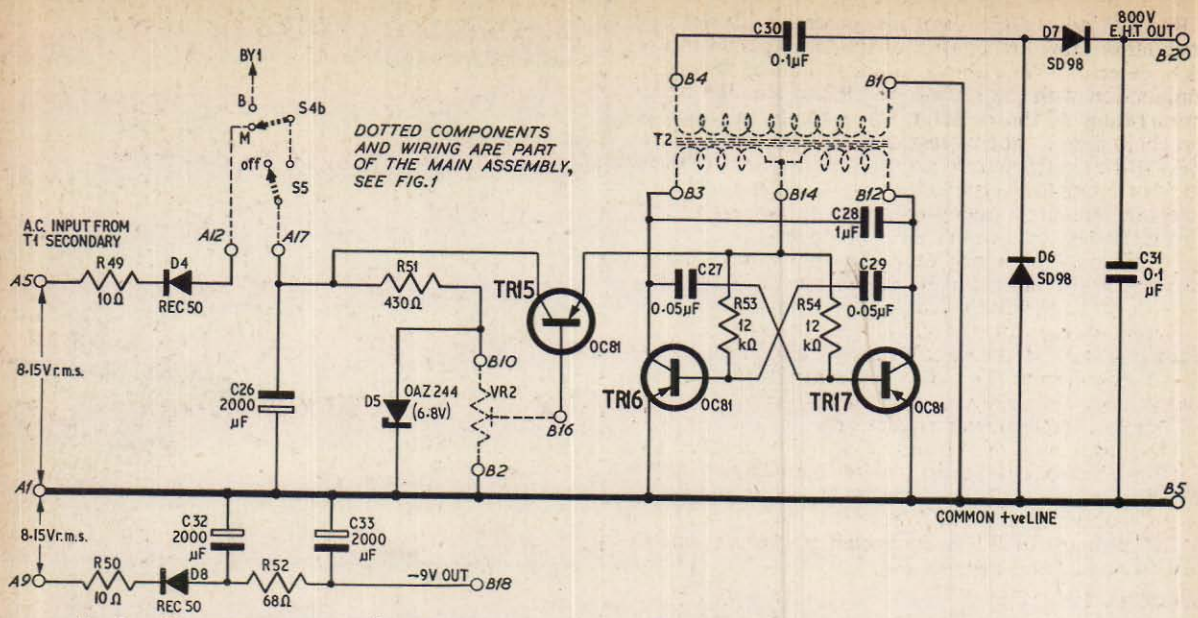


Fig. 6. The e.h.t. generator and power supply circuits. The components above the common positive line are the e.h.t. generator and those below this line form the h.t. supply circuit

The rectangular negative-going pulse appearing at TR12 collector during the astable period is fed to TR13 base via C24 and R43 turning TR13 hard on. Current then flows through the meter circuit for the duration of the pulse, causing a deflection of the pointer of M1.

METER CONTROLS

The meter time constant potentiometer VR6 ("METER T.C.") and its associated capacitors C4 and C5 are a simple arrangement provided so that the meter is slow to change its deflection on low or fluctuating count rates if desired.

VR7 is a meter zero control for backing off current in the meter caused by leakage in TR13. In the instrument described it is a preset control mounted inside the case but it is felt that many constructors might prefer it to be a front panel control and there is no reason why this should not be so if space can be found for it. The need for this control can be eliminated at extra cost by replacing TR13 by a silicon transistor type 0C202.

The purpose of the Zener diode D3 is to stabilise the meter reading against variations caused by changes in the supply voltage.

The values used for the timing capacitors are nominally, 0·25µF for 5c/s, 0·025µF for 50c/s, and 0·0025µF for 500c/s. These ranges should suffice for most purposes but can obviously be altered to suit individual requirements.

With a fixed value of R40, the values of the timing capacitors must be fairly accurate multiples of each other for good range agreement. Adjustment can be made by "padding" where necessary with suitable value capacitors in parallel.

The calibrating control VR8 enables the instrument to be initially set up. Ideally this should be done with a pulse generator but a source of low voltage 50c/s pulses can be used for the 50c/s range and to check the corresponding point on the 500c/s range.

The split collector load of TR12 is a source of low impedance pulses for driving the audio stage TR14. The combination of R48 and C6 is to prevent excessive pulses appearing on the supply line. It will also have the effect of causing the volume of sound to decrease somewhat as pulse rate increases, particularly on the higher count ranges. This, the author believes, is a desirable feature as audible indications of counts are more useful at low rates and tend to become a nuisance at high rates.

E.H.T. GENERATOR AND POWER SUPPLIES

The circuit of Fig. 6 can be divided into two distinct sections: all that above the common positive line is the e.h.t. generator; below this line is the h.t. supply circuit. Each section is supplied from separate halves of the mains transformer secondary.

Dealing first with the e.h.t. generator: the transistors TR16 and TR17 are operated as a free running multivibrator, the load of which is the tuned 6·3 volt winding of T2. This transformer is the readily available *Radiospares* Standard Filament (6·3V) type which has a centre tapped 6·3 volt winding and is ideal for this purpose. It is drawn in dotted, since it is physically located on the main chassis (see Fig. 1). The operating frequency of the multivibrator is about 1kc/s, determined by C28, together with R53, R54, C27 and C29.

The winding on T2 which normally is the mains primary is now the secondary from which the e.h.t. voltage is obtained. This output is fed to the voltage doubling circuit C30, C31, D6, and D7, and appears as smooth d.c. at the e.h.t. output point B20. The output voltage is controlled by VR1 or VR2 which, via the transistor TR15, regulates the drive to the multivibrator. The e.h.t. voltage has a near linear relationship to the angular rotation of VR1 and use is made of this by calibrating the "G.M. E.H.T." knob in volts. Zener diode D5 stabilises the output against input supply variations.

R1, R2 and VR3 form the potential divider for attenuation and fine control of the bias applied to the s.s.b. detector. The above values should be chosen in conjunction with the setting of VR2 to suit the maximum rating of the detector. The total resistance of the chain should not be less than 20 megohm. However, this arrangement is shown only as a demonstration of possible systems where specially selected detectors are used operating at up to 300 volts and normal battery operation becomes unwieldy.

For the most popularly used detectors a maximum of 25 volts is the limit and it would obviously be more economical to obtain this voltage from a battery.

Drive voltage for the e.h.t. generator is obtained from one half of the centre tapped secondary of the mains transformer T1. The a.c. output of approximately 8·15 volts r.m.s. is rectified by D4 and applied to TR15 and so to the multivibrator.

The other half of T1 secondary provides the h.t. for the other four sub-units. After rectification by D8 and filtering by C32, R52, and C33, a d.c. output of − 9V is obtained at point *B18*.

The primary of T1 is connected to the a.c. mains supply via S3d and FS1, see Fig. 1.

BATTERIES

Two separate 9 volt batteries are incorporated in the ratemeter. These enable the instrument to function normally in the absence of a.c. mains supplies. BY1 is composed of two 4·5V batteries connected in series and is used to drive the e.h.t. generator. This supply is fed in at point *A17*. BY2 is a single 9V layer type battery and it supplies h.t. to the various sub-units.

The mains input circuit and all power supply switching arrangements are clearly shown in the inter-unit wiring diagram, Fig. 1.

The construction of the ratemeter will commence next month.

Trade literature

readers requiring further information about any of the items mentioned in this column should forward request direct to the company concerned. It is requested that all enquiries be made by post only.

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ELECTRONIC VIBRATO UNIT

continued from page 95

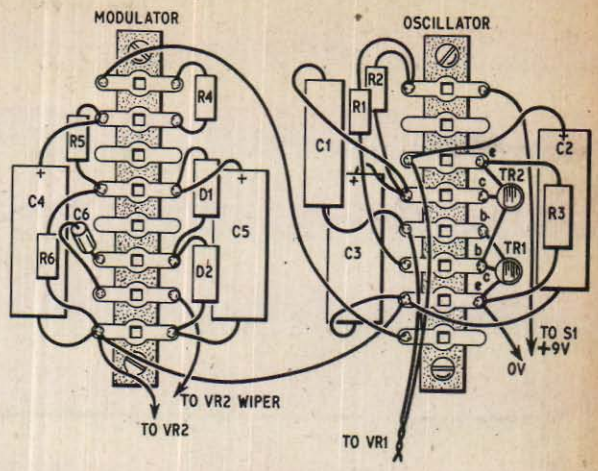


Fig. 5. Wiring of the modulator and oscillator

TWO TAG STRIPS

The complete vibrato unit can be made up in any one of a variety of methods. The prototype, shown in the photograph, was made on two separate tag strips.

Fig. 5 shows the layout and wiring of the components on the tag strips. Little description is necessary since the illustrations give all the required details.

When the final unit has been completed and the wiring has been checked, the terminals across VR2 can be connected to the guitar amplifier across the grid resistor as shown in Fig. 3. Since this part of the amplifier circuit has a high impedance, the connecting wire from the vibrato unit should be as short as possible and screened, with the screen connected to chassis.

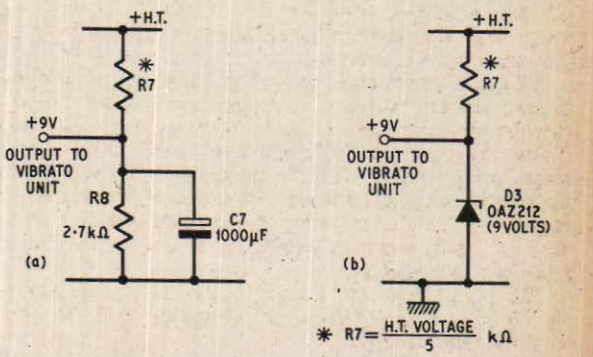


Fig. 6a. Method of obtaining a 9 volt supply for the vibrato unit using a resistive potential divider
Fig. 6b. Another method of obtaining 9 volts. R8 and C7 are replaced by a 9 volt Zener diode

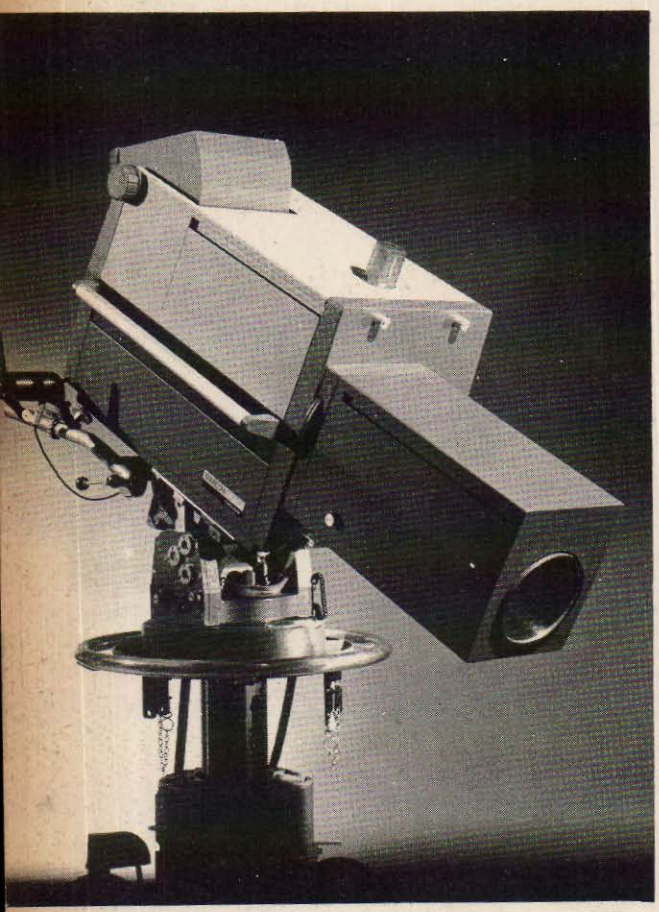
POWER SUPPLIES

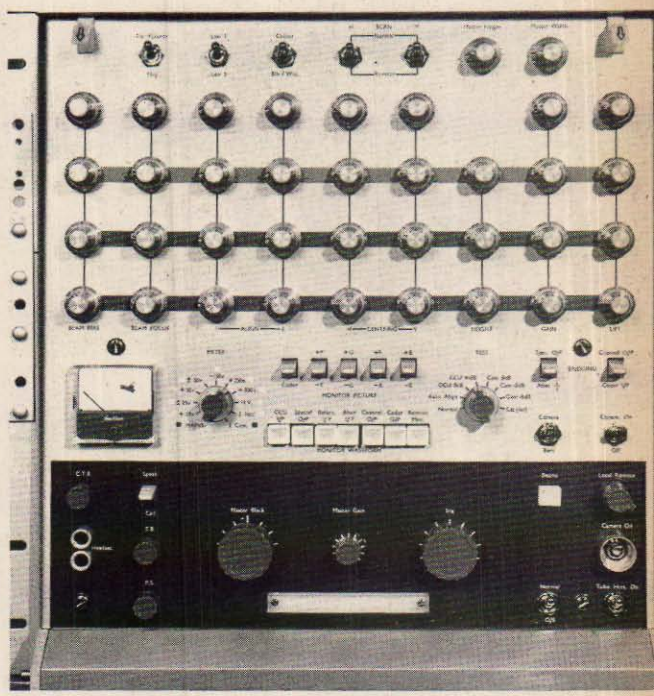
Most amplifier h.t. supplies will provide an extra 5mA without trouble, and this is ample. Two ways of connecting the power supplies are shown in Fig. 6. Of these, the method (b), shown in Fig. 6b, using a Zener diode, is the best and occupies less space. Alternatively, a 6·3 volt l.t. supply may be rectified and smoothed, or the unit may be battery operated.

This unit should not be used on a.c./d.c. equipment.★

ELECTRONORAMA

HIGHLIGHTS FROM THE CONTEMPORARY SCENE





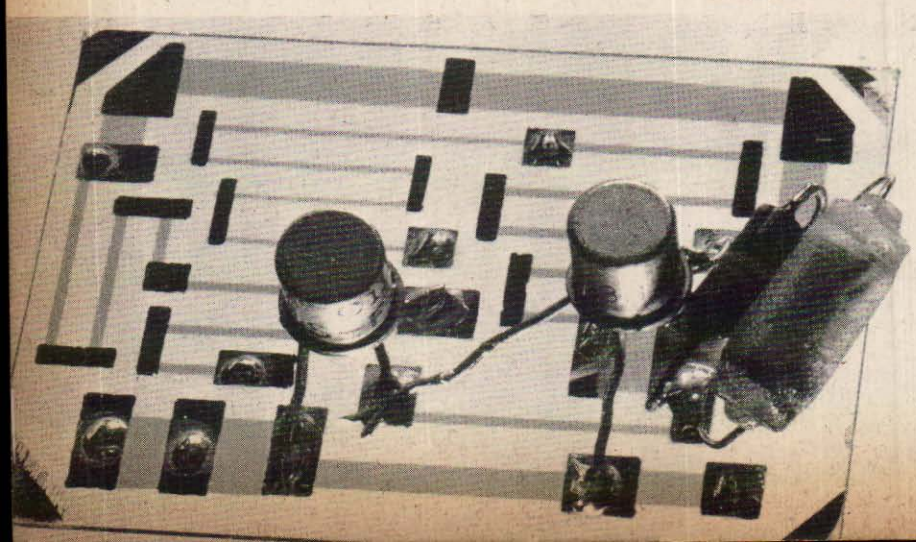
New Colour Television Camera

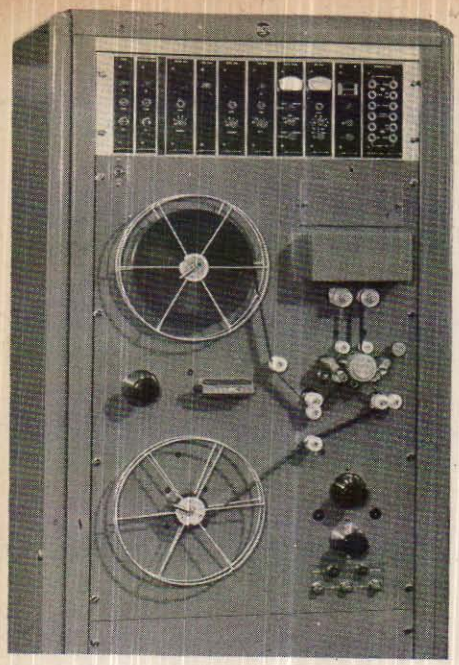
A NEW colour television camera using four plumbicon pick-up tubes has been developed by The Marconi Company. It is claimed that this new camera will avoid the difficulties previously encountered with previous versions using three colour tubes. Colour pictures are not so dependent on accurate registration and compatible monochrome pictures should be considerably better.

Transistor circuitry is used with over sixty "thin films". A high quality luminance signal is produced by a single tube and the other three are used to contribute colour information to the signal.

This Mark VII camera is virtually unaffected by external magnetic fields.

The three pictures on this page show the camera itself (above left), the camera control unit (above), and a "thin film" circuit of the video amplifier (left). The resistors can be seen as transparent grey tracks, while the gold pad connections appear black. The ni-chrome resistors are deposited on a thin layer of glass and are virtually unaffected by changes in temperature.





Magnetic Film Recorder

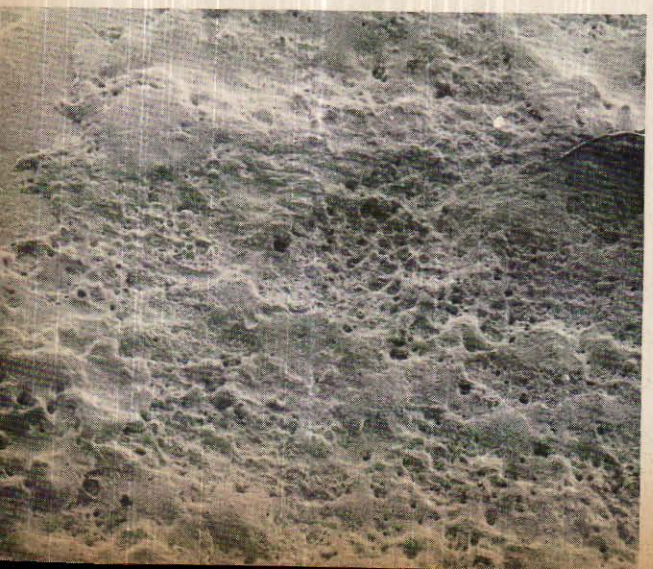
A NEW British magnetic film recorder and reproducer has been developed by RCA Great Britain Ltd., using solid state circuits built in plug-in modular form. Single or multi-track heads can be used on films up to 35mm wide using adjustable rollers. The plug-in modules are housed in a "nest" shown above.

The equipment has been designed so that schools as well as industry can record their own sound tracks on 16mm or 17½ and 35mm film. The heads can be positioned to provide centre or edge track recording or a combination of both.

New Scanning Electron Microscope

THE picture below shows an enlarged view (X49) of a relay contact that has become pitted. This photograph was taken with the help of a new electron microscope (shown right). The microscope is the brain child of the Cambridge Instrument Company and Professor Oatley at Cambridge University.

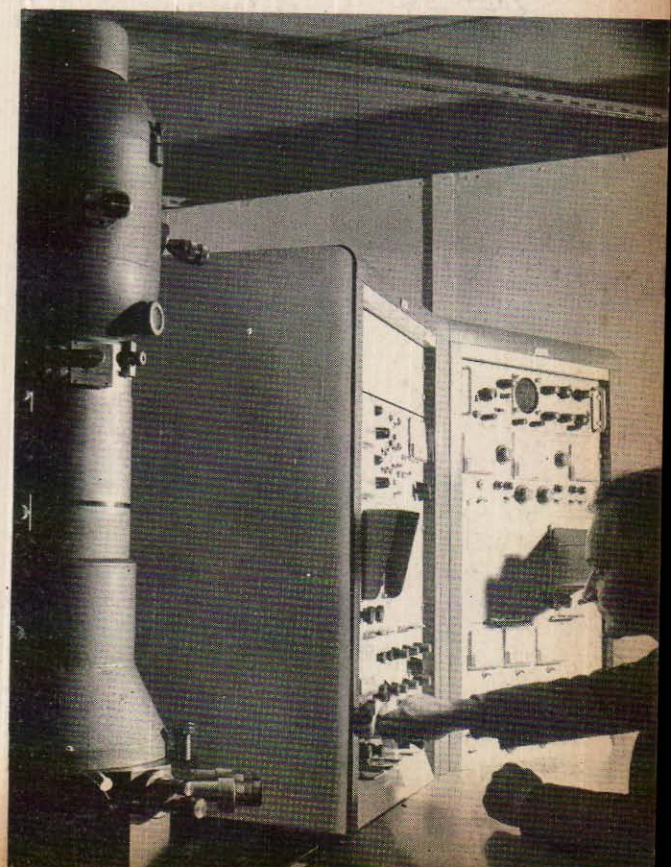
By scanning the specimen with an electron beam it can give much clearer and more detailed pictures which are displayed on a cathode ray tube.





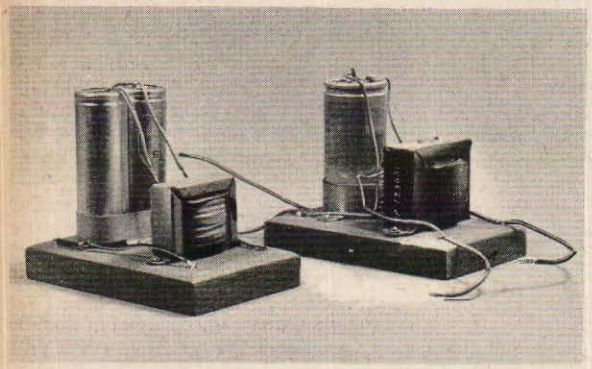
British Colour TV Equipment in France

THE Office de Radiodiffusion Television Française in Paris is fitted with telecine equipment and image analysis which have been supplied by British colour television companies in the Rank Organisation. In the picture above an O.R.T.F. technician is shown adjusting the preset control of a Bush colour monitor, on which the O.R.T.F. programme symbol is displayed. Telecine and scanner equipment were supplied by Rank Cintel.



BEGINNERS start here... 16

An Instructional Series for the Newcomer to Electronics



As an example of our new knowledge, consider the smoothing network found in most power packs. It generally consists of two capacitors and an inductance arranged as in Fig. 16.1.

The alternating current from the mains supply is converted into "pulsating d.c." by the action of a rectifier (not shown here). This current, really a.c. mixed with d.c., is too rough to use in electronic equipment. It is therefore passed through a smoothing or filter circuit.

Referring to Fig. 16.1, the first capacitor C1 offers an easy path for the a.c. variations, but the inductor L1 opposes them. To d.c., however, L1 offers very low resistance, while capacitors C1 and C2 offer an infinite barrier. The small amount of a.c. that manages to pass through L1 is provided with an easy return path via C2.

COMPONENTS . . .

HIGH VOLTAGE FILTER

C1 16μF electrolytic 500V
C2 16μF electrolytic 500V
} Dual unit, both capacitors in same can

L1 10 henry choke, 65mA — Standard h.t. smoothing choke, approximate size 1¾in × 2⅛in × 1⅞in. Osmabet or similar

LOW VOLTAGE FILTER

C1 5,000μF electrolytic 15 to 25V
C2 5,000μF electrolytic 15 to 25V
L1 0·1 henry choke 2A
Not generally available, but easily made up as described in the text. Material required: old loudspeaker transformer; small reel of 24 s.w.g. enamelled copper wire

Miscellaneous Items for Both Units
Wooden baseboard, approximately 5in × 3in × ½in. Brass wood screws. Black and red plastic covered wire. Perforated zinc for the cover.

The first capacitor C1 charges up on the positive going "peaks", but returns some of this charge to the supply line when the a.c. component is moving negative-wise. This capacitor is often referred to as a *reservoir* capacitor, and it contributes largely to the smoothing or filtering action of this circuit.

In this manner smooth, steady d.c., like that from a battery, is obtained to work the "load" which is some electronic device connected across points *c* and *d*.

Transformation of the pulsating d.c. into "pure" d.c. is indicated graphically in Fig. 16.2.

We will now proceed to the construction of two filter units—both based on the circuit given in Fig. 16.1. This work will enable you to gain a little more soldering experience, and afford the opportunity to handle further types of components in a practical sense. The filters themselves will be very useful in later work. In fact they will be essential for producing smooth d.c. from the a.c. mains, via suitable transformers and rectifiers, which will be put to work operating the future practical projects we have lined up for this series.

HIGH VOLTAGE FILTER

This unit will smooth rectified a.c. (that is, pulsating d.c.) of about 250 volts pressure, supplying currents up to about 60mA. (Don't forget m stands for "milli", meaning a thousandth, and A is the abbreviation for "ampere", which is a measure of current flow.) This filter can therefore be used to supply valve equipment drawing not more than the above mentioned amount of current.

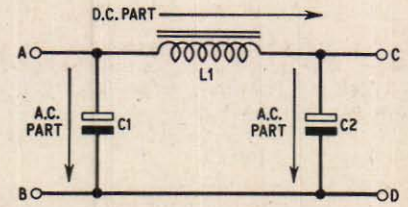


Fig. 16.1. A typical LC filter, used to smooth pulsating d.c. It is often called a "π" (Greek letter pi) filter, from its shape

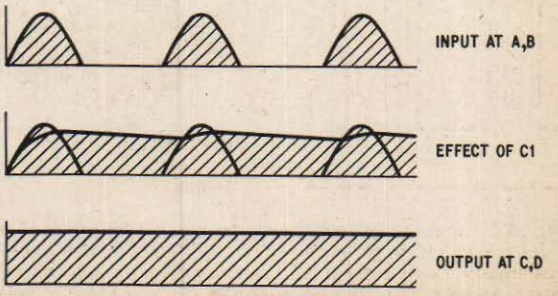


Fig. 16.2. These waveforms illustrate the smoothing action of the filter

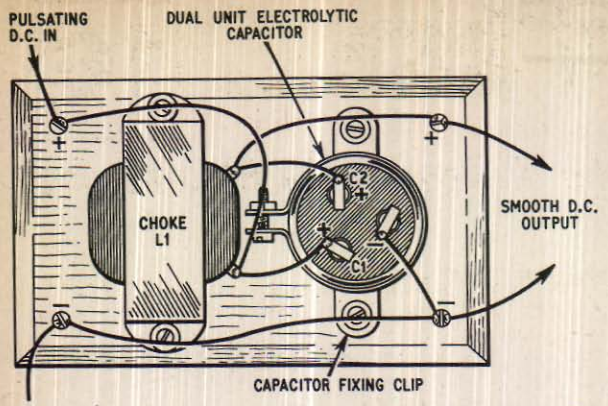


Fig. 16.3. A top view of the high voltage filter unit. The low voltage filter is identical except that C1 and C2 will be two separate components

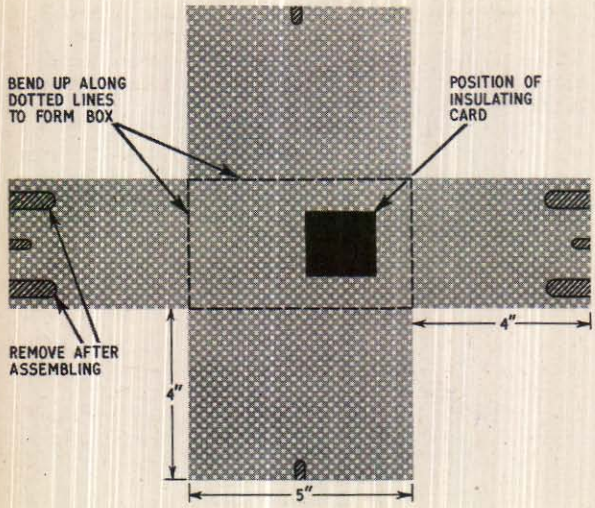


Fig. 16.4. Preparation of the perforated zinc sheet to make a cover. The sides can be bent up, and card corners stuck on. This is strong and easier to carry out than soldering the perforated zinc

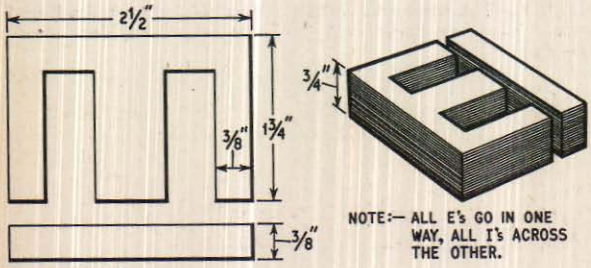


Fig. 16.5. Size of standard laminations suitable for the O·1H 2-amp choke for second filter. The stack of laminations should be about ¾in for best results. A thin piece of paper should be inserted between the E and I stack. This just keeps the laminations apart, thus introducing a small air gap in the magnetic path

Construction is carred out on one of our standard wooden baseboards, and a perforated zinc cover is added to shield the high voltage points from the possibility of being touched. The diagrams and photographs show just where everything goes. It is useful to remember that this unit added to the output of an existing power pack will give a vast improvement in the smoothing, probably eliminating any residual hum still present in the original circuit.

IMPORTANT POINTS

Remember to connect up the electrolytic capacitors correct way round and to connect the supply positive to positive and negative to negative. Note carefully any information printed on the electrolytic capacitors. Make sure that the voltage ratings indicated on the capacitors agree with the details given in the components list.

Sometimes the aluminium can is connected internally to the negative side of the capacitors; when this is so, a separate negative solder tag may not be provided and external connection is then made by attaching a lead under one of the screws on the metal fixing clip. This brings us to another important point: always ensure that you obtain the appropriate fixing clips when you purchase electrolytic capacitors.

Small wooden panels, nearly the size used in our designs, are on sale in Woolworth's Stores. These are meant to take electrical fittings, (plugs points etc.) mounted on walls. As they say—just the job!

LOW VOLTAGE FILTER

The second filter unit supplies around 12 volts at one to two amps, and is suitable for supplying circuits employing transistors. There is no need to cover up with a shield this time, unless you would like to make one for matching the other unit, but be careful not to mistake which unit is which, or trouble will arise indeed! (Perhaps different coloured paint would overcome this hazard.)

SMOOTHING CHOKE

The components list mentions everything except the smoothing choke (L1) for the low voltage, high current unit. This particular component cannot be readily obtained in the shops, but can be made from an old loudspeaker transformer or choke similar in size to the one used in the high voltage filter. Such components can be salvaged from an old radio or television set, or a dealer will supply them. Secondhand components are quite suitable for this purpose.

Strip the transformer or choke right down, keep the laminations and bobbin, but dispose of the fine wire that formerly filled it. Now wind on about 400 turns of 24 s.w.g. enamelled copper wire. When you have covered the coil you have produced with a protecting layer of tape, replace the laminations. Notice that all the "E" laminations go in one way, and all the "I" strips go on the other end, with a piece of paper between. See Fig. 16.5. The lamination shroud now goes on, and the component is ready to be screwed down.

It is unlikely that you will be able to obtain a dual unit capacitor for the values required in this second filter unit. Two separate capacitors (as detailed in the components list) can be mounted side by side on the board. Note the remarks concerning electrolytic capacitors in general given in the section dealing with the high voltage filter.

Next time we shall discuss changing a.c. into d.c. and d.c. into a.c.

NEW PRODUCTS

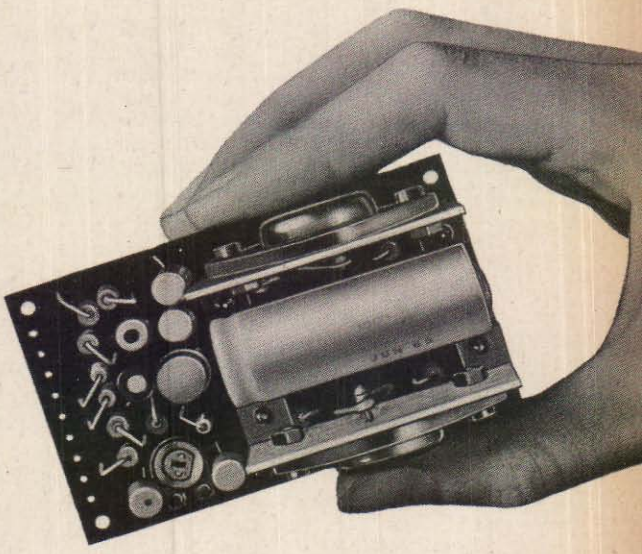
Miniature 12 watt Amplifier

Sinclair Radionics Ltd., Comberton, Cambridge.

Our photograph shows a really small amplifier, measuring 3in × 1¾in × 1⅛in. Called the Sinclair Z-12 it has a claimed maximum power output of 15 watts music power (12 watt r.m.s.) with a signal-to-noise ratio of less than 60dB. There are eight transistors in the amplifier, which operates from any d.c. power supply between 6 and 20 volts. The frequency response is 15 to 50,000 c/s ± 1dB and the quiescent current consumption is 15mA. Input sensitivity is 2mV into 2 kilohms.

The user can add his own tone and volume control circuit to suit his own requirements. Some suggested tone control circuits are given in the manual which is supplied with the amplifier.

The price of the Z-12 amplifier supplied built, tested and guaranteed is £4 9s 6d.





Chassis Punches

The British Tap & Die Co. Ltd., Triangle Works, Montagu Road, Edmonton, London, N.9.

The chassis punches depicted here are made from ground hardened steel and designed to cut accurate, clean holes in flat or curved sheet metal up to 16 s.w.g. mild steel, aluminium, brass or copper.

Although chassis punches are rather expensive items the amount of time saved and the clean burr-free finish obtained is well worth the outlay.

These punches are available individually or in four sets of four punches in the following ranges: ½in; ⅝in; ¾in; 1in, ⅝in; ¾in; ⅞in; 1in, 1in; 1¼in; 1½in; 2in, 1⅛in; 1¼in; 1⅜in; 1½in.

The price of the sets range from £3 13s 0d to £5 12s 0d; all sets are packed in polished wooden cases.

Instrument Cleaner

Multicore Solders Ltd., Multicore Works, Maylands Avenue, Hemel Hempstead, Herts.

We are always being warned by manufacturers to be extremely careful when cleaning certain types of instruments, meters, tape heads, etc. Now Multicore Solders have just announced their new Bib instrument cleaner which is ideal for cleaning tape heads (without risk of damage to the tape) as well as instrument panels, radio and television cabinets, telephones, and other items made from plastics, chrome and glass.

The new cleaner is contained in a plastics "squeeze" bottle (4fl ozs) and is anti-static, non-flammable, non-toxic, antiseptic and will not scratch or smear. During testing we found that when used on television screens to prevent static it is desirable to use a chamois leather. The use of other types of materials tended to leave "detached particles" on the screen which were very difficult to remove.

The retail price of the 4fl ozs size is 4s 6d.



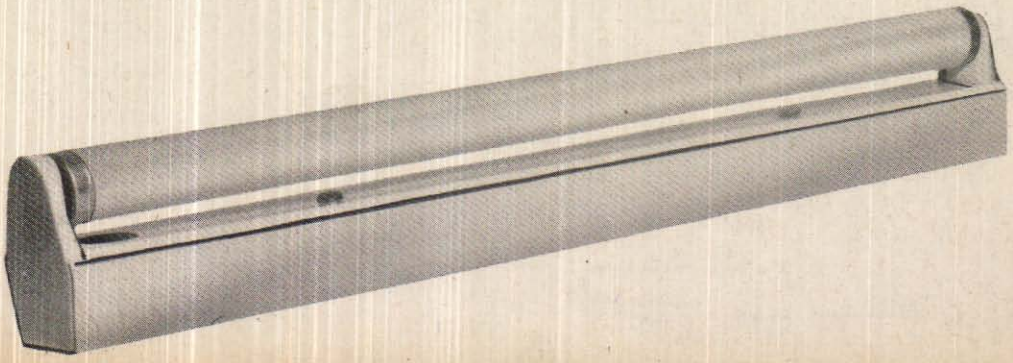
Low Voltage Fluorescent Light Fitting

Osmabet Ltd., 46, Kenilworth Road, Edgware, Middlesex.

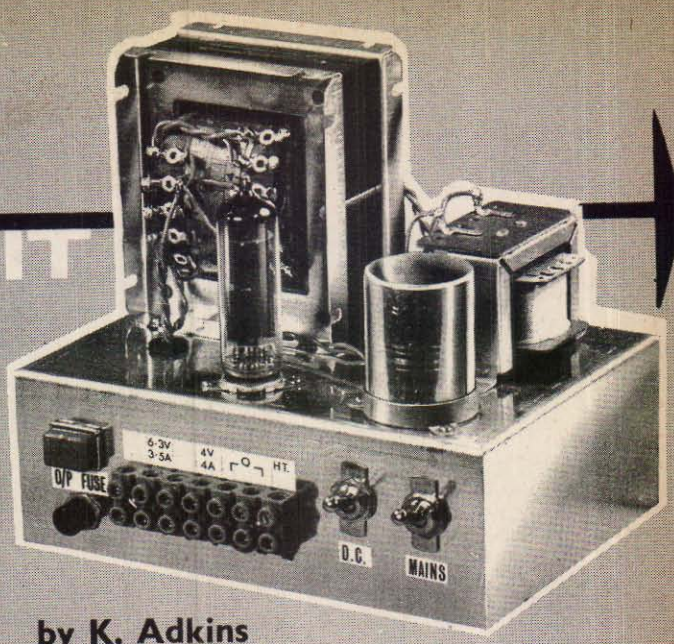
A new product with many applications, (for example, in caravans, cars, boats, workshops, and as emergency lighting) is the "Newlite" low voltage fluorescent light fitting. This unit is claimed to be equal to any mains operated fitting and uses standard mains 2ft 20 watt tubes.

The main feature of the unit is a transistor operated inverter for use with a 12 volt battery which is rated at 2 amp to step up the voltage.

The unit weighs 2¾lb less tube, is 25in long and fixed by means of two screws. The retail price of the Newlite is £6 10s 0d less tube.



COMPACT POWER UNIT



by K. Adkins

A USEFUL adjunct to a workshop bench is a d.c. power source that has a general purpose appeal to the majority of valve circuit applications. The beginner, attempting the construction of mains-operated equipment for the first time, should find little difficulty in making this unit. It will provide a valuable exercise in wiring commonly used components.

INTRODUCTION

The unit was originally designed to provide power for a small amateur radio station, comprising a home built receiver and transmitter for top band. The usual heater supply of 6·3 volts at a few amps was required, together with an h.t. supply of 250 volts at 60 to 70mA. The receiver and transmitter were not intended to draw h.t. at the same time!

Also, and most important, there was very little room available on an already crowded table top, and so the unit had to be physically small.

Thus this unit was evolved, using a chassis 7in × 5in × 2½in. It was constructed as far as possible with components that were to hand.

CIRCUIT

It can be seen from Fig. 1 that the circuit employs full wave rectification, with the usual capacitor and choke smoothing and filtering arrangement.

A double pole switch S1 is incorporated in the mains input, thus ensuring complete isolation from the mains when S1 is off. The unit is equipped with fuses to protect it from overload conditions.

An EZ81 was used as the double diode rectifier. This valve has a 6·3 volt heater which is supplied by the 6·3 volt 1 amp transformer winding with one side taken to chassis. A pilot lamp LP1 is fitted and connected across the same winding.

After rectification, the supply is smoothed by the π-filter made up of C1, L1, and C2. On no load the reservoir capacitor C1 is charged to about 350 volts. On full load of 65mA the output is reduced to 250 volts.

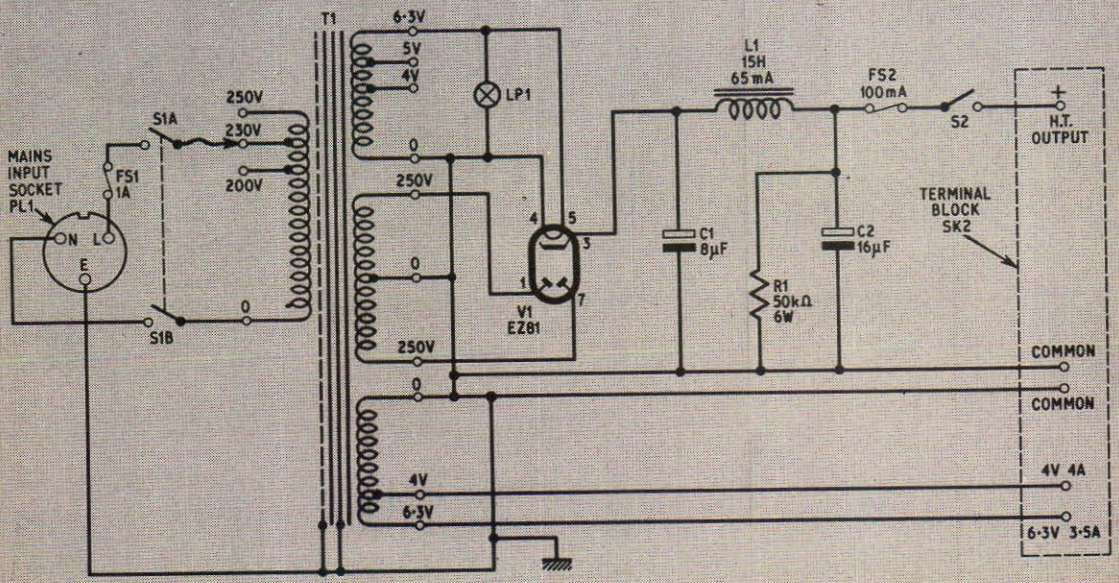


Fig. 1. Circuit diagram of the complete power unit

SPECIFICATION . . .

A.C. INPUT	200 to 250 volts, 50c/s mains
D.C. OUTPUT	250 volts, 65mA
A.C. OUTPUT	6·3 volts, 3·5 amp *or* 4 volts, 4 amp

It is a characteristic of this type of power unit, where the regulation is poor, that the output voltage will vary between the limits given, dependent on the load current drawn.

The ripple fundamental frequency of 100 c/s is reduced by the factor $L_1C_2\omega^2 - 1$. This was measured and found to have an r.m.s. value of less than 0·5 volts which can be neglected for many practical applications.

A single "canned" electrolytic, 8 + 16μF at 500V working was used for capacitors C1 and C2, the latter being shunted by a "bleeder" resistor R1, the function of which is to discharge C1 and C2. This is a rather important feature since it prevents the possibility of shocks should the h.t. line be touched immediately after switching off the unit. An h.t. switch, S2, is incorporated after the "bleeder" resistance so that the h.t. may be switched off independently of the 6·3V heater supply.

There is one other heater winding made available on the unit giving either 4 volts 4 amp, or 6·3 volts 3·5 amp. It will be seen from the circuit diagram that one side of each 6·3V heater winding is connected to chassis. In the wiring of the output side of the transformer, all tags marked "0", including the tag marked screen should be taken to a common point on the chassis.

All the output voltages at the terminal block are quoted as being relative to "0" or "chassis". If the valve heaters of an external piece of equipment connected to the unit are connected to chassis on one side, it is important that both earth lines are made common, otherwise the heater winding will be short-circuited.

The 1 amp fuse gives transformer protection, but prudence should be exercised in all cases. It is worth mentioning at this point that the common line should be connected to earth at the power unit end only, otherwise hum may arise from earth loops.

COMPONENTS . . .

Resistor
R1 50kΩ 10% 6W wirewound

Capacitors
C1 8μF elect. 500V
C2 16μF elect. 500V } in the same can

Choke
L1 15H 65mA

Transformer
T1 Primary 200-230-250 volts
Secondary 1: 250-0-250V, 80mA;
2: 4V 4A *or* 6·3V 3·5A;
3: 4V, 5V 2A, *or* 6·3V 1A
(Douglas mains transformer type MT 1 AT)

Valve
V1 EZ81 (Mullard)

Switches
S1 Double-pole, on-off, toggle switch
S2 Single-pole, on-off, toggle switch

Fuses
FS1 1A (cartridge type with panel mounting fuseholder)
FS2 100mA (cartridge type with panel mounting fuseholder)

Plugs and Sockets
PL1, SK1 Chassis mounting mains connectors 3-pin (Bulgin type P73 or similar)
SK2 Terminal block, at least 5-way (see photographs)

Lamp
LP1 6·5V, 0·15A with red indicator mounting

Miscellaneous
Chassis 7in × 5in × 2½in (H. L. Smith & Co. Ltd., 287 Edgware Road, London W2); B9A valveholder; Five-way tag strip, centre tag chassis mounting; Grommets for ⅜in dia. mounting hole; P.V.C. covered wire; Nuts and bolts 4B.A. and 6B.A., ½in long; Expanded metal 16in × 14in for protective cover.

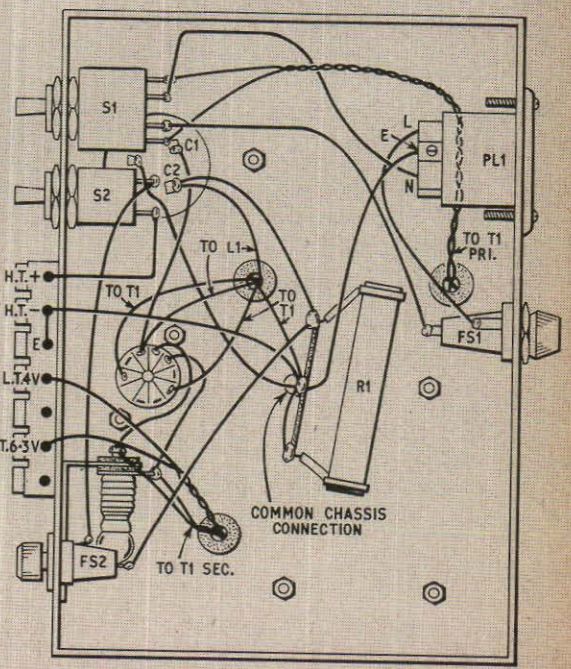


Fig. 2. Underside view of the chassis

CONSTRUCTION

The chassis of 16 s.w.g. aluminium sheet, was bought. It is a commonly available size and no difficulty should be found in acquiring one (see components list).

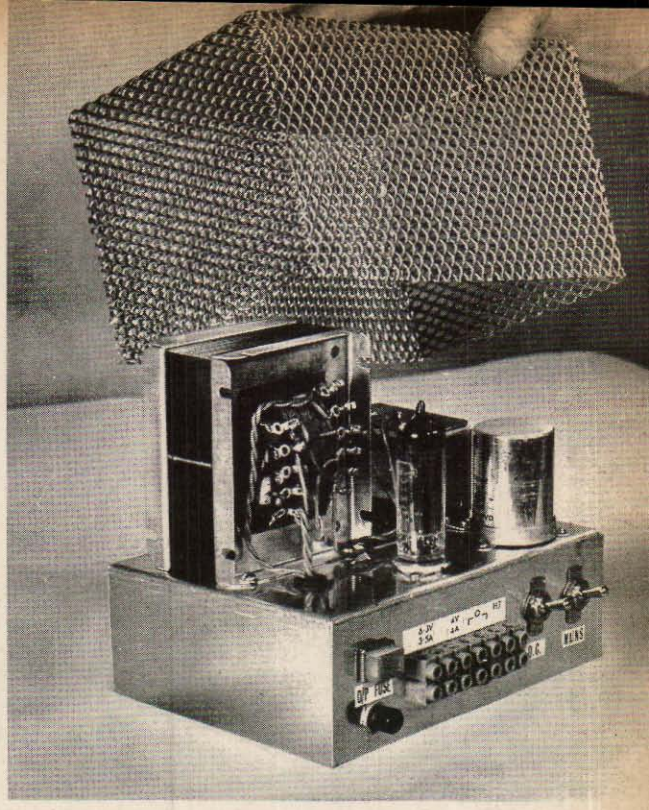
The mains supply is connected via socket SK1 to the mains fuse and mains windings of T1. Make sure that the correct mains tappings are used to suit the mains supply voltage. The chassis drilling details in Fig. 3 conform to the components specified and these should be followed if the small physical size of the whole unit is to be maintained.

Leads are taken from the transformer and choke to the underside of the chassis, through rubber grommets fitted to the chassis, to the valveholder tags and capacitors. R1 is mounted on the tag strip, the mounting tag of this strip is the common connection for all leads going to chassis.

All leads carrying a.c. should be twisted, to reduce the risk of hum pick-up. The wire used for the 6·3V and 4V supplies should not be too thin if several amperes are to be carried (18 s.w.g. will suit all heater wiring here). The outputs are taken by way of five holes drilled through the front of the chassis. The ends are then bared and held securely by the lower screws of the terminal block. It is important that the holes drilled should be free from burrs to obviate any chance of short circuits due to puncturing the insulation. The use of grommets will also obviate these risks. The output leads should be insulated as far as possible into the terminal block.

When the wiring has been completed it should be thoroughly checked; then the power unit may be tested. No difficulty should be experienced in getting the unit to work as the circuit is quite simple.

In practice, the unit has served its purpose very well, producing virtually no hum and running quite cool with a continuous drain of 70mA from the h.t. terminals. ★



Complete power unit showing the cover made from expanded metal. This cover can be attached to the chassis with self-tapping screws

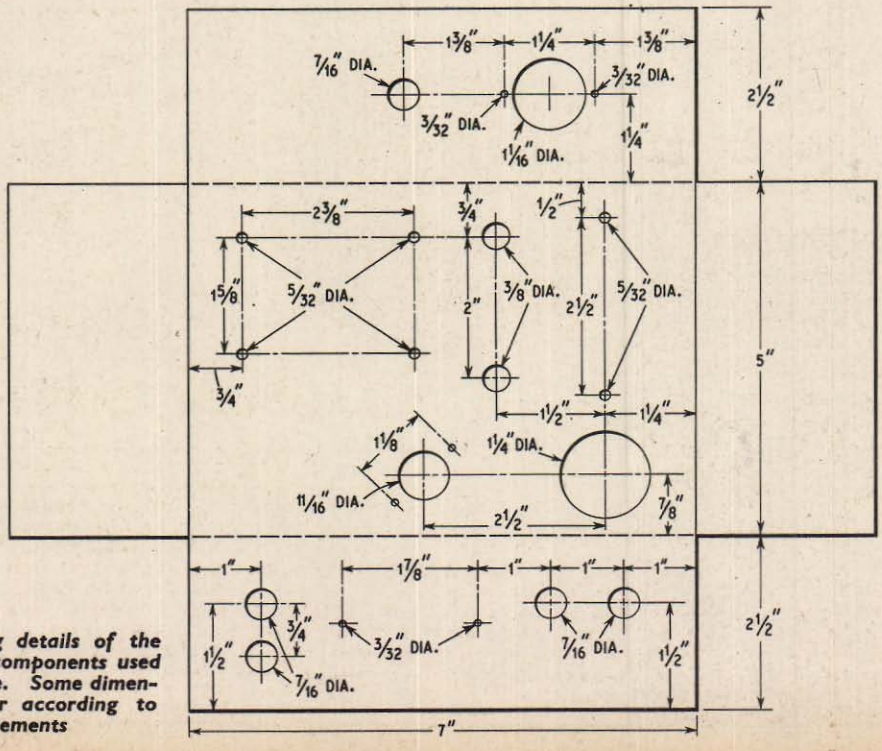


Fig. 3. Drilling details of the chassis for the components used in the prototype. Some dimensions may differ according to individual requirements

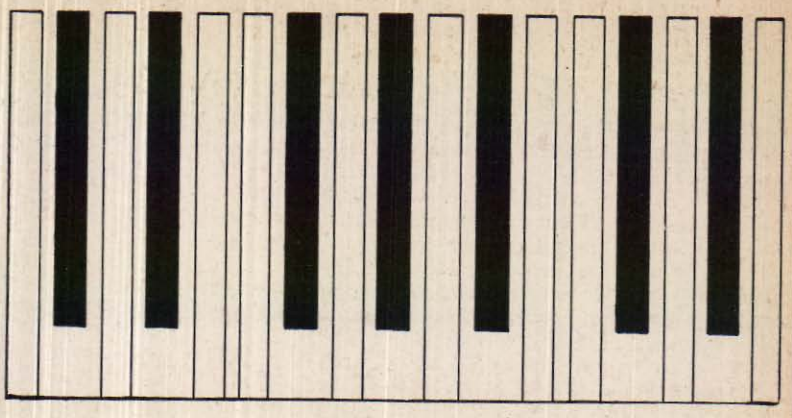
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Making music the hard way!

Transistor Electronic Organs for the Amateur

By Alan Douglas and S. Astley

There are undoubtedly easier ways of making music than by first constructing an electronic organ—but to the enthusiast there can be no other way. This is the fourth book by Alan Douglas, who is probably the country's leading writer on this type of equipment. It presents not only a detailed design for a full scale organ, but a complete explanation of everything to do with transistorised organs. It is written in a simple style especially for the amateur constructor, and profusely illustrated with clear diagrams. **eighteen shillings net**



Dispelling an old theory

Pick-ups The Key to Hi-Fi

By J. Walton

For many years it has been the assumption that the loudspeaker is the weakest link in the record reproducing chain. This book challenges that theory. The author, after many years of research into the subject, concludes that it is the pick-up that causes most distortion. It is no exaggeration to say that, by following his advice, the owner of an ordinary gramophone or record player or the hi-fi enthusiast will not only achieve a superior standard of record reproduction, but will ensure that his records will last much longer.

"... can be highly recommended as a first-class introduction to the subject of high quality record reproduction."—*Hi-Fi News.* **ten shillings net**

NEWS BRIEFS

Audio Fair 1966

THE AUDIO FESTIVAL AND FAIR will be held as usual in the Hotel Russell in London from 14 to 17 April.

Visitors will see a few changes in the layout of the Festival exhibits this year when they will be invited to climb yet another flight of stairs; an extra floor is being used with the aim of encouraging exhibitors to hire a second demonstration room in place of a booth. The purpose of this idea is to reduce the number of booths on the ground floor and provide extra gangway space which, in the past, has been hopelessly congested.

Fog Warning

A NEW photoelectric device to detect and give warning of fog on motorways and other major roads has been developed by the Lancashire Dynamo Electronic Products. An infra-red beam is projected by a light source transmitter to a remotely mounted photocell receiver. If the beam is partially or completely cut off by fog, the warning system is brought into operation.

The device has been undergoing tests by Staffordshire County police and local authority officials.

Degree Course in Computing Science

THE FIRST full-time degree course in Computing Science has already begun at the Stafford College of Technology. Students are being trained in all aspects of programming and data processing (generally known as "software") but not in electronics technology, which is covered in other courses.

The principle aims of the course are: to help to fill the increasing need for skilled computer programmers throughout the country; to offer to suitable candidates with the G.C.E. in subjects other than science subjects (for example, Geography, Economics, Languages) an opening where these subjects could be suitably applied during the course and later in industry.

The course is open to students who have two G.C.E. "A" levels and three other G.C.E. "O" levels, similar in fact to the requirements for almost any other degree course. It is based on a four year curriculum (honours degree) of combined college work and industry experience arranged in the now familiar and popular "sandwich" system.

Applicants who do not possess these qualifications, but who have other suitable qualities, aptitude, and a keen sense of vocation, will be considered on individual merits, but competition is keen and due regard will be exercised to the *potential* of candidates.

The approval of the Ministry of Education and Science and the Council for National Academic Awards has been given, bringing the course in line with other types of university degree course. It has been devised with the full co-operation of the English Electric Leo Marconi Company who have provided computing equipment and lecturers.

Our photograph shows the English Electric "Deuce" computer being introduced to students in the College by the computer supervisor.

Full details of the course can be obtained from The Principal, Staffordshire College of Technology, Beaconside, Stafford.

Teaching Aids

DEVELOPMENT of "language laboratories" for schools has progressed very well. A new prototype, made by Tolnai of Sweden, uses 2in wide tapes. The master tape has 36 tracks with a capacity for up to 84 hours of instructional material (enough for one year's syllabus); a slave loop tape can store some of this material as required for short repetition sessions.

This equipment was exhibited by RCA Great Britain Limited recently with another prototype programmed teaching aid which uses 16mm film strip. This uses a simple "telephone dial" type of answer selection system in which, if the answer is correctly selected, steps the film on to the next frame or, if incorrectly selected, steps it to additional information.

Two models of video tape recording equipment were also demonstrated, using the revolving head, frequency modulated, no-bias recording principles already well established.

PAL Colour for U.K.

THE Postmaster-General, the Rt. Hon. Anthony Wedgwood Benn, M.P., announced in the House of Commons on 2 December, 1965, that the Television Advisory Committee appointed by the Government had recommended the adoption of the German PAL colour television system for United Kingdom. This was immediately followed by an urgent request by Mr. Bryan, M.P., for the granting of a second channel for I.T.A. to operate on the 625 line system, so that it can come into line with the B.B.C. and broadcast colour pictures on 625 lines.

Royal Charter

A ROYAL CHARTER has been granted to the Engineering Institutions' Joint Council, which is now called the Council of Engineering Institutions. The E.I.J.C. was formed three years ago by councils of thirteen engineering institutions, including the I.E.R.E. and the I.E.E., to promote greater mutual exchange of ideas and co-operation in allied subjects.

The Duke of Edinburgh has agreed to accept the office of Founder-President for a period of five years. Existing corporate members of any of the constituent institutions are entitled to describe themselves as Chartered Engineers (C.Eng.).



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KEDOCO CLASSIC SS20/7 20 WATTS

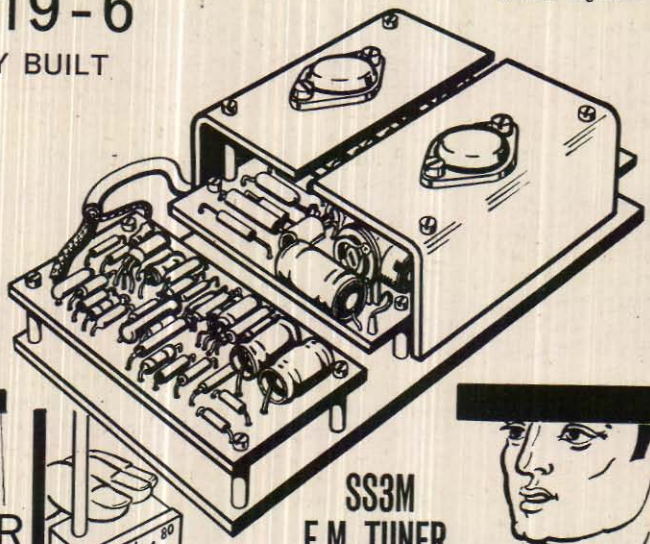
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READY BUILT

Believe it or not we have actually produced an all transistor integrated HIFI amplifier complete with pre-amp and tone controls giving 20 watts power output and ready to operate for only £9 19s. 6d. The KEDOCO CLASSIC SS20/7 is the result of several years of research and investigation into the various approaches to solid state amplification. The end product, Kedoco engineers claim, with complete confidence, is the finest power amplifier available today and stands above all others for quality in a class of its own. The CLASSIC requires a 30 volt power supply but consumes only 20mA*. It will operate into most speakers but the best results are obtained with 3 ohms. We are confident you find this amplifier excels others costing many times its price.

SPECIFICATION— 20 watts output max. Distortion less than 0.1%. Frequency response flat from 16c/s to 20kc/s. Noise 80dB down on max. output.

* quiescent



POWER SUPPLY

30 volt
3 amps
Ready built and ideal for your Kedoco Classic and will power 2 of them

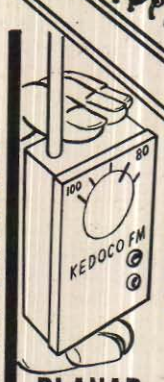
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Types KZ7.5, KZ5.6 KZ8.2, KZ6.2 KZ9.1. KZ6.8
10% tolerance.
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Temperature coefficient 0.01% per degree C.

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SS3M F.M. TUNER

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Kit with full Instructions



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69/- READY BUILT

3 watts output. 6 silicon planar epitaxial transistors. 2 diodes and one zener. All mounted on precision printed circuit board. HIFI at its cheapest — 16 c/s to 30 kc/s flat response. Many other uses. Requires 18 volt power supply. Will operate directly from crystal pick-up. Used with tape Pre-amp it makes a complete Tape Amplifier. Also tone controlled HIFI Pre-amp available at 39/-.

PLANAR EPITAXIAL SILICON TRANSISTOR

KPS 24 7/11
KPS 25 9/11

Double diffused npn. Suitable from audio to RF power applications. I_{co} less than 100nA. B_{vebo} greater than 30 volts. Power output at 28mc/s typically 300mW. Emitter/base breakdown voltage greater than 5 volts. Typical F_t 300mc/s. h_{fe} KPS 24 min h_{fe} 20 KPS 25 min 50

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ACP4	6/–	EBC41	7/–	EL41	7/–	KTZ63	5/–			VR105/30	5/–	3A4	4/–	6AT6	3/6	6L6GA	7/6	12H6	2/–	77	6/6	6064	7/–
AC6PEN	5/–	EBC80	5/–	EL42	8/–	MH4	5/–	RK72	6/–			3D6	4/–	6AU6	7/–	6L7G	4/–	12J5GT	2/6	78	5/–	6065	6/–
AL60	5/–	EBF80	6/6	EL50	8/–	MHLD6	10/–	S11E12	10/–	VR150/30	5/–	3B7	5/–	6AX4	8/–	6L34	4/6	12J7GT	6/6	80	5/6	6080	22/–
AR8	5/–	EBF83	7/6	EL81	8/–	ML6	6/–	S130P	15/–			3B24	5/–	6B7	6/–	6LD20	5/9	12K7GT	2/–	81	9/–	7193	1/9
ARP3	3/–	EBF89	6/9	EL83	6/3	N78	15/–	S130	12/6	VU33A	4/–	3E29	50/–	6B8G	2/6	6N7	6/–	12K8M	10/–	82	8/–	7475	2/–
ARP12	2/6	EC52	4/–	EL84	5/–	NE17	7/–	SP2	8/6	VU39	6/–	3Q4	6/–	6BA6	4/–	6N7G	5/9	12Q7GT	3/3	84	8/–	8013A	25/–
ARP34	3/6	EC53	12/6	EL85	8/–	OB3	7/–	SP41	1/6	W21	5/–	3Q5GT	7/6	6BA7	5/–	6Q7G	6/–	12SA7	7/–	85A2	8/–	8020	8/–
ARTP1	6/–	EC70	4/–	EL91	4/6	OC3	5/–	SP61	1/6	W118	8/–	3S4	4/–	6BE6	4/3	6R7	5/6	12SC7	4/–	220PA	7/–	9001	3/–
ATP4	2/3	EC90	2/–	EL95	5/–	OD3	5/–	SP210	3/6	W119	8/–	3V4	5/9	6BJ7	7/–	6SA7	7/–	12SG7	3/–	220TH	4/–	9002	4/6
ATP7	5/6	EC91	3/–	EM80	6/–	OD3	5/–	T41	6/6	X66	7/6	4C27	35/–	6BR7	9/–	6SA7GT	6/6	12SH7	3/–	225DU	9/–	9003	6/–
AU7	55/–	EC81	4/–	EM81	7/6	OZ4A	5/–	TD04-20	70/–	X118	8/–	4D1	4/–	6BW6	9/–	6SK7GT	4/–	12SJ7	5/–	307A	5/6	9004	2/6
B6H	15/–	EC82	5/–	EM84	6/3	PC84	5/–	TP22	5/–	X145	8/–	5A173G	5/–	6C4	2/–	6SC7	7/–	12SK7GT	3/–	350B	8/–	9006	2/6
BD78	40/–	EC83	6/–	EN31	10/–	PC85	7/–	TP25	15/–	YP	1/–	5A174G	5/–	6C5G	2/6	6SC7GT	5/–	128N7GT	5/9	357A	70/–	C.R. Tubes	
BL63	10/–	EC84	5/6	ES1U74	80/–	PC89	10/–	TT11	5/–	Y63	5/–	5B/251M	25/–	6C5GT	6/–	6SF5GT	5/6	128R7	5/–	368A	5/–	CV1596	
BS4	8/–	EC85	6/6	ESU208	6/–	PCF80	6/6	TT15	35/–	Y65	4/–	5B/254M	40/–	6C6	3/–	6SH7	5/–	128Z7	5/–	393A	15/–	(09J)	55/–
BS5	20/–	EC91	4/–	EY51	5/6	PCF82	6/6	TTR31	45/–	Y66	8/–	5B/255M	35/–	6C8G	3/–	6SJ7GT	5/6	12Y4	2/–	446A	8/–	VCR97	28/–
BS84	47/6	EC92	7/–	EY86	6/6	PCF84	6/6	TZ0520	4/–	Z800U	20/–	5R4GY	9/–	6CH6	4/6	6SJ7Y	6/6	14L7	7/–	703A	30/–	VCR138	30/–
B2134	16/–	EC92	3/–	EY91	3/–	PCF86	6/6	TZ20	16/–	Z801U	10/–	5T	7/–	6C21	80/–	6SK7	4/6	15D2	6/–	705A	10/–	VCR517	
CC3L	2/–	ECH81	5/–	EZ40	6/6	PCF801	9/–	U8	8/–	1A3	3/–	5U4G	4/6	6CL6	9/–	6SL7GT	5/6	19E2	15/–	715B	60/–	VCR517B	35/–
CL33	9/–	ECH83	7/6	EZ41	6/6	PCL82	7/–	U12/1	8/–	1A5GT	5/–	5V4G	8/–	6D6	3/–	6SN7	3/6	19G3	10/–	717A	3/–	VCR517C	40/–
CY31	6/6	ECL80	6/–	EZ80	5/6	PCL83	8/3	U17	5/–	1B22	30/–	5X4G	8/6	6E5	6/–	6SQ7GT	6/–	19G7	5/–	724A	15/–		40/–
D1	1/6	ECL82	7/6	EZ81	3/6	PCL84	7/–	U18	6/–	1C5GT	6/–	5Y3G	4/–	6F6G	4/–	6SR7	5/3	19J1	6/–	801	6/–	3FP7	45/–
D41	3/3	ECL83	10/–	F/6057	5/–	PCL85	8/6	U25	11/–	1D8GT	6/–	5Y3GT	5/–	6F6GT	5/9	6U4GT	9/6	19M1	8/–	803	22/6	3EG1	40/–
D61	6/–	ECL86	10/–	F/6061	5/–	PCL86	9/–	U26	8/–	1E7G	7/6	5Y3WGTB	9/–	6F17	5/–	6V6G	5/–	20P4	13/–	807	8/–	5CP1	30/–
D77	3/3	EF36	3/6	F/6063	4/–	PCL805	9/–	U27	8/–	1F2	3/–	5Z4G	6/6	6F23	5/–	6V6GT	7/6	21B6	9/–	808	8/–	5FP7	12/6
DA30	12/6	EF37	7/–	FW4/500	6/6	PL36	7/6	U52	4/6	1G6GT	6/–	5Z4GT	8/–	6F24	6/–	6V6M	8/–	25L6GT	5/6	811	17/6	8BD	40/–
DAF96	6/–	EF40	8/–	FW4800	8/6	PL38	16/–	UABC80	6/–	1L4	2/6	5Z4GT	8/–	6F13	5/–	6X5G	5/–	25Y5	6/–	813	60/–	Photo Tubes	
DD41	4/–	EF41	6/–	G1/236G	9/–	PL81	7/–	UBF80	5/6	1LA4	6/–	6AB7	4/–	6F32	4/–	6X5GT	5/3	25Z4G	6/6	815	35/–	CMG8	5/–
DF73	5/–	EF50	2/6	G50/2G	5/–	PL82	5/–	UBF89	6/6	1LC6	7/–	6AC7	2/–	6F33	3/–	6Y6G	6/–	25Z5	7/6	829A	30/–	GS16	12/6
DF91	3/–	EF52	6/–	GM4	45/–	PL83	6/–	UBL21	11/–	1LN5	6/–	6AG5	2/6	6G6G	2/6	6-30L2	10/–	25Z6GT	8/6	829B	50/–	931A	55/–
DF92	3/–	EF53	4/6	GZ32	10/–	PL84	6/6	UCC85	6/6	1N34	4/–	6AG7	6/–	6H6M	1/6	6Z4	5/–	28D7	6/–	830B	4/–	6097C	350/–
DF96	6/–	EF55	8/–	GZ34	10/–	PL504	9/–	UCH42	8/–	1N70	4/–	6AH6	10/–	6J4WA	10/–	30	5/–	30C15	9/6	832A	45/–	Transistors	
DK92	6/6	EF71	7/6	H63	7/–	PL505	12/6	UCH81	6/–	1R4	5/–	6AJ7	3/–	6J5	6/–	7B7	7/6	30F5	8/6	832	15/–	OC16	20/–
DK96	5/6	EF72	5/–	HK54	22/6	PY33	8/6	UCL82	8/–	1R5	3/6	6AK5	5/–	6J5G	2/–	7C5	10/–	30F9	8/6	843	5/–	OC22	23/–
DL92	5/–	EF73	5/–	HL2K	2/6	PY80	5/6	UCL83	10/–	1S4	5/–	6AK6	6/–	6J6	3/6	7C6	7/–	30FL1	10/6	866A	14/–	OC25	13/–
DL93	6/–	EF74	4/–	HL23	6/–	PY81	5/6	UF41	8/–	1S5	4/6	6AK7	6/–	6J6W	6/–	7C7	6/–	30P19	15/–	884	10/–	OC26	13/–
DL94	5/9	EF80	5/–	HL23DD	5/–	PY82	5/–	UF89	6/–	1T4	2/–	6AL5	3/–	6J7G	5/–	7H7	7/3	30PL1	8/–	954	4/6	OC44	6/–
DL96	6/6	EF85	4/6	HL41	4/–	PY83	6/–	UL41	7/6	2A3	5/–	6AL5W	7/–	6J7M	8/–	7Q7	7/–	35L6GT	7/–	955	2/6	OC45	5/–
DL810	8/–	EF86	6/6	HVR2	9/–	PY800	6/6	UL84	5/6	2B26	8/–	6AM5	2/6	6K6GT	5/6	7V7	5/–	35T	17/6	956	2/–	OC71	4/6
DL819	15/–	EF89	5/–	K3A	30/–	PZ1-35	9/–	UU5	7/–	2C26	7/–	6AM6	4/–	6K7G	2/–	7Z4	4/6	35W4	5/–	957	5/–	OC72	6/–
E80F	23/–	EF91	2/9	KT32	8/–	PZ1-75	12/–	UU9	8/6	2C26A	3/–	6AQ5	7/–	6K7GT	4/9	8D2	2/6	35Z3	8/–	958A	4/–	OC81M	7/–
E88CC	12/–	EF92	2/–	KT33C	6/–	QP21	6/–	UY21	7/6	2C34	2/6	6AQ5W	9/–	6K7G	2/–	9B8	3/6	35Z4GT	6/–	1612	5/–	OC82	10/–
E90CC	10/–	EF95	5/–	KT44	5/9	QP25	5/–	UY85	5/–	2C45	22/6	6AQ6	9/–	6K8G	3/–	9D2	3/–	35Z5GT	6/–	1616	3/–	OC122	18/–
EA50	1/–	EF95	5/–	KT63	4/–	QP230	5/–	VMP4G	12/–	2C46	30/–	6AQ6W	9/–	6K8G	3/–	12A6	2/6	37	4/–	1619	5/–	OC200	10/6
EA73	7/–	EF183	8/–	KT66	16/–	QS150/15	10/–	VP23	3/–	2C51	12/–	6AS6	4/–	6K8GT	8/3	12AH7	5/–	38	4/–	1625	6/–	XC141	10/–
EABC80	5/9	EF184	8/–	KT67	15/–	QS95/10	5/6	VP133	9/–	2D21	5/–	6AS6W	9/–	6K8M	8/6	12AH8	11/–	41MP	4/–	1626	3/–	XC142	15/–
EAC91	3/6	EL32	3/9	KT76	8/6	QS1202	8/–									12AT7	4/–	2158G	6/–	1629	4/6	XC155	20/–
EAF42	8/–	EL34	10/–	KT88	22/–	QV04/7	8/–									12AU7	5/–	50L6GT	8/–	2051	5/–	XC156	22/6
EB34	1/6	EL35	5/–	KTW61	4/6	RS	8/–									12AX7	6/–	53A	7/6	4043C	3/6	2N247	9/6
EB91	3/–	EL37	16/–	KTW63	2/–											12AY7	10/–	57	6/–	4063	3/–	2N502	47/–
																12BA6	5/6	58	6/–	4313C	30/–	2N585	10/6
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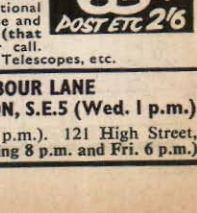
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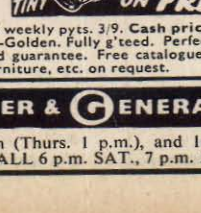
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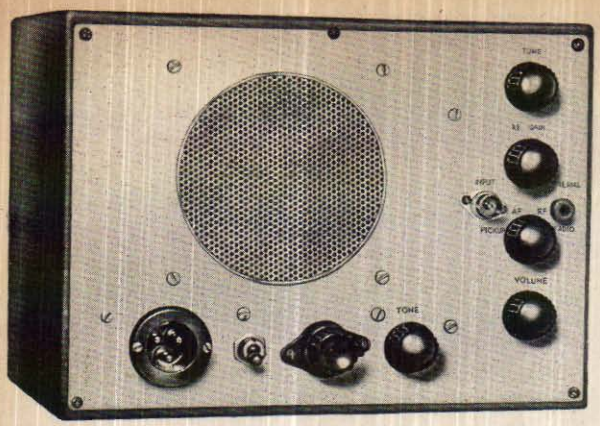
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A.F. and R.F. SIGNAL TRACER

by C. P. May

DUE TO changing techniques in construction and new components, there is very likely to be a substantial surplus of old, but still serviceable, components in constructors' work rooms. It is with this in mind that the following article is aimed at making good use of these parts; alternatively, if purchases have to be made, the cost could be very low.

This unit will perform well as a signal tracer for both a.f. and r.f. signals, as an amplifier suitable for use with a microphone or pick-up, or as a radio receiver. An extremely versatile test set such as this can be made up quickly and cheaply. Component values are, to a certain degree, flexible.

VARI-MU

Referring to Fig. 1, it can be seen that the first two stages constitute an r.f. amplifier. The anode loads (R2 and R7) of both of these valves are resistors, so that the gain is independant of frequency up to about 1 Mc/s. Hence the unit does not have to be tuned to the same frequency as the signal being traced. Above about 1 Mc/s the shunt capacitance from anode to earth of each valve reduces the gain. The response can be improved at the expense of gain by reducing the value of R2 and R7 or by removing C4 and C6. Alternatively, C4 and C6 can be reduced to about 1,000pF so that their decoupling effect only applies at high frequencies—but this latter technique requires a wide-band oscillator and an oscilloscope.

The first stage is a variable-mu pentode and the gain is controlled by a potentiometer in the cathode circuit. This is better than using a "straight" r.f. pentode and a potentiometer in the grid circuit, for in this position it damps the input and is liable to pick-up phenomena. The second stage is a high-mu pentode. Since the stage gain is approximately equal to $R_L g_m$, where R_L is the load resistor, a high g_m enables a low value of R_L to be used. This in turn reduces the effect of stray shunt capacitances since the gain falls by 3dB when $R_L = 1/j\omega C_s$.

The detector (V3) is a 6H6 with both halves strapped in parallel. This could, with advantage, be replaced by a semiconductor diode such as an OA78. This is

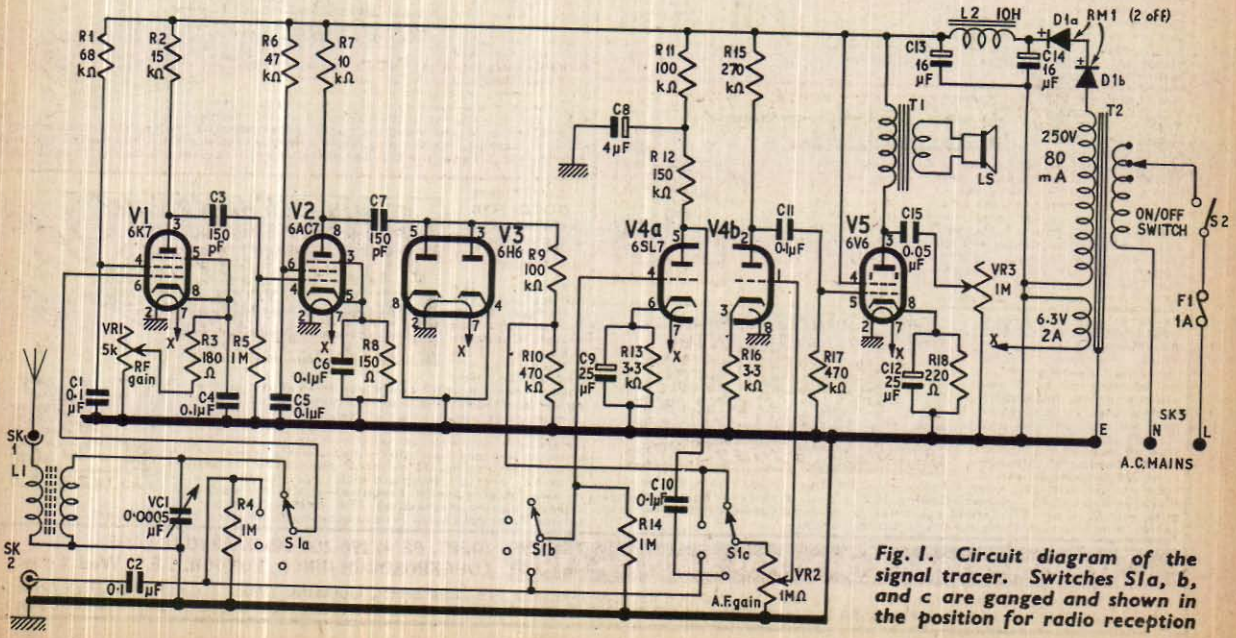


Fig. 1. Circuit diagram of the signal tracer. Switches S1a, b, and c are ganged and shown in the position for radio reception

followed by two triode audio amplifiers (V4a and V4b) in cascade. When used to trace r.f. signals, or as a radio, only one stage (V4b) is needed. The other stage (V4a) is provided to give sufficient gain for use with microphones or pick-ups, or for tracing very low level audio signals. The anode of V4a is decoupled by C8. If hum is excessive in the "radio" position, the anode load of V4b (R15) could be divided into two components, 100 kilohms and 150 kilohms, with an 8μF decoupling capacitor between their junction and chassis, as in the case of V4a anode load.

The output stage (V5) is a conventional power beam tetrode. A certain degree of tone control is possible by C15 and VR3. These components by-pass high frequencies to earth. The degree of attenuation is controlled by VR3. The value of C15 can be varied to suit individual loudspeakers and personal preferences. The unit does not really merit the inclusion of more elaborate tone controls, since it is not intended as a high fidelity instrument.

A simple power supply is included. This uses a metal rectifier, giving half-wave rectification, a reservoir capacitor (C14) and a smoothing circuit L2 and C13. Provided a separate heater supply is available on the transformer, a valve rectifier such as an EZ80 or a 6X4 could be used. In this case, it is best to include a protecting resistor of about 100 ohms and 2 watts rating in series with each anode of the rectifier.

FOUR FUNCTIONS

The various functions of the instrument are selected by the 3-pole 4-way rotary switch S1. In the first position (as shown in Fig. 1), the signal from the aerial, connected to SK1, is fed to the grid of V1 via the tuned circuit comprising L1 and VC1. This single tuned circuit provides adequate selectivity if only local stations are required. Some improvement can be achieved by ensuring that the "chassis" is earthed through the mains plug.

A probe can be connected to the coaxial socket SK2, so that the signal in a radio receiver or amplifier can be traced. With the switch in the second position this signal is fed via the d.c. blocking capacitor C2 through S1a to the grid of V1.

The other two switch positions provide high level and low level a.f. inputs to V4b and V4a respectively. Both are high impedance inputs.

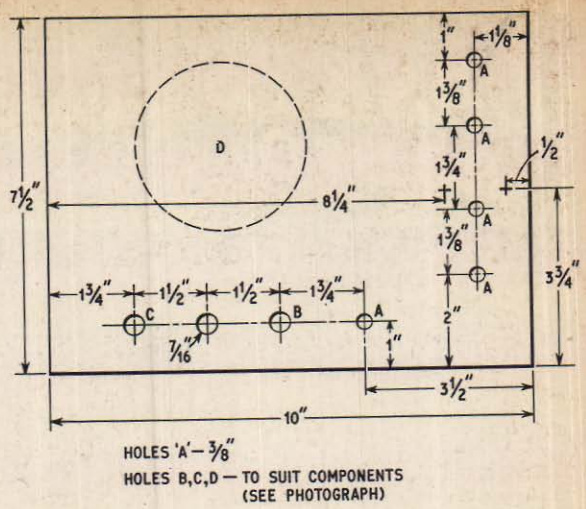
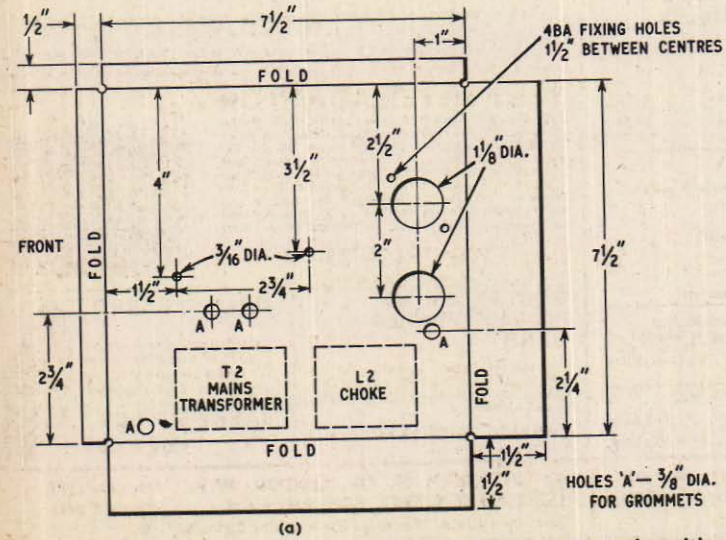


Fig. 2. Suggested layout and drilling details of the front panel

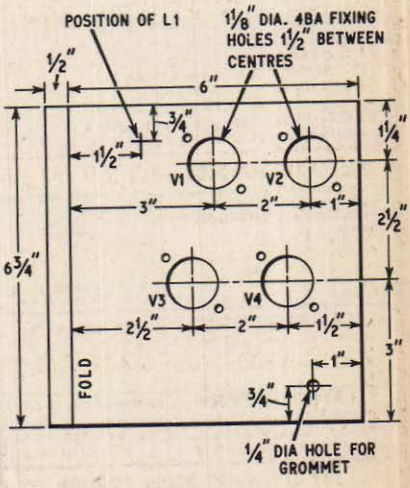
CONTROL PANEL

The front panel is made from 14 s.w.g. aluminium but other strong material will suit just as well. The spacing of the controls on this panel is not critical but it will be found that the diagram in Fig. 2 shows a logical scheme whereby leads are kept to a minimum. All fixing holes for the controls are ⅜in diameter except possibly the mains switch, which may need a 7/16in hole. The mains socket hole is 1 1/16in diameter and the indicator lamp hole will depend on the actual item if fitted.



(a)

Fig. 3a. Drilling details of the power unit chassis with suggested positions of T2 and L2 The output transformer T1 will have to be fitted in position after final assembly according to the space available



(b)

Fig. 3b. Drilling details of the side panel, with a fold for fixing to the front panel

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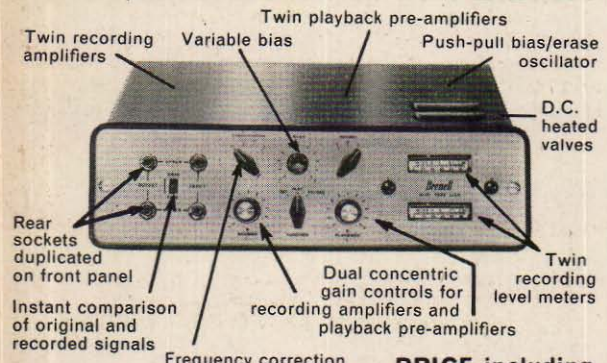
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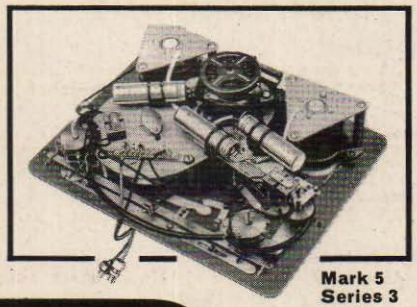
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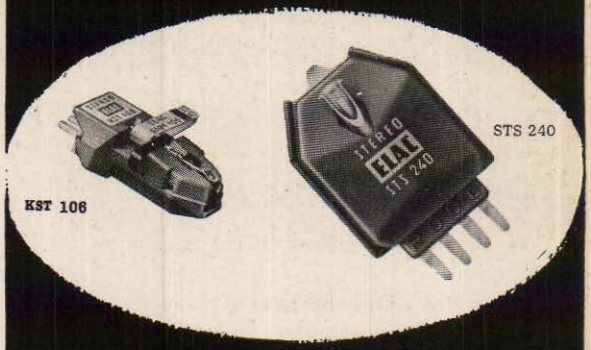


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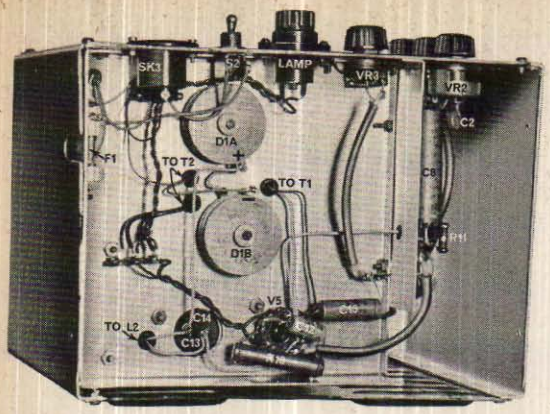


Fig. 4. View of the underside of the main chassis

Construction and drilling details for the main chassis and the side plate are shown in Figs. 3a and 3b. This side plate is attached to the side of the chassis by 4 B.A. nuts and bolts; if required the plate can be bent along one side to secure it to the front panel, giving a firm mounting for this panel.

Full dimensional details for drilling have not been provided in the interests of the constructor, who may prefer to use different components or possibly devise an improved layout.

CHASSIS

It is probably best to obtain a ready made chassis of approximately similar dimensions as shown. Constructors who have facilities for bending sheet metal to the shape of the chassis, will find it easier if they mark out the positions of the bends with a scriber, then lay out the main components to be mounted on the chassis.

The positions of the fixing holes can then be marked and drilled before bending. Additional holes (for example, for grommets where leads will pass through

COMPONENTS . . .

Resistors

R2	68kΩ	R10	470kΩ
R1	15kΩ	R11	100kΩ
R3	180Ω	R12	150kΩ
R4	1MΩ	R13	3·3kΩ
R5	1MΩ	R14	1MΩ
R6	47kΩ	R15	270kΩ
R7	10kΩ	R16	3·3kΩ
R8	150Ω	R17	470kΩ
R9	100kΩ	R18	220Ω 2W

All resistors 10% ½ watt carbon except R18

Potentiometers

VR1	5kΩ	log. or linear, carbon
VR2	1MΩ	log. carbon
VR3	1MΩ	log. carbon

Capacitors

C1	0·1μF	paper	350V
C2	0·1μF	paper	350V
C3	150pF	mica	350V
C4	0·1μF	paper	150V
C5	0·1μF	paper	350V
C6	0·1μF	paper	150V
C7	150pF	mica	350V
C8	4μF	elect.	350V
C9	25μF	elect.	25V
C10	0·1μF	paper	350V
C11	0·1μF	paper	350V
C12	25μF	elect.	25V
C13	16μF	elect.	350V } combined in one can
C14	16μF	elect.	350V }
C15	0·05μF	paper	350V
VC1	500pF	variable, mica or air dielectric	

Plugs and sockets

PL1 & SK1	Single-pin wander plug and socket
PL2 & SK2	Coaxial plug and socket
PL3 & SK3	Mains connector 3-pin 5A (Bulgin type P73 or similar)
	(PL1 is connected to the aerial lead and PL2 is connected to an external probe)

Transformers

T1	Output transformer: pri. 8,500 Ω, sec. 3Ω
T2	Mains transformer: pri. 200–250V; sec. 250V 80mA, 6·3V 2A

Inductors

L1	Medium wave coil (Denco miniature dual purpose type "blue" range 2) *Or* (if to hand) Wearite type PHF3
L2	L.F. choke 10H 80 mA

Valves

V1	6K7	(These can be replaced by miniature types with similar characteristics)	EF85
V2	6AC7		EF80
V3	6H6		EB91
V4	6SL7		ECC81
V5	6V6		6BW6

Diode

D1a & b Metal rectifier type RM1 (2 off in series) *or* Silicon rectifier type BY114

Switches

S1	3-pole 4-way wafer switch
S2	Single-pole, on-off, toggle switch

Fuse

F1 Chassis mounting fuseholder and 1A fuse

Loudspeaker

LS 5 in. circular, 3 ohms

Miscellaneous

Chassis 7½in × 7½in × 1½in *or* sheet aluminium 16 s.w.g. 9½in × 9½in;
Side plate made from sheet aluminium 16 s.w.g. 6¾in × 6¼in;
Front panel made from sheet aluminium 14 s.w.g. 10in × 7½in;
Case made from 16 s.w.g. aluminium or plywood;
Tag strips; p.v.c. covered wire, coaxial cable;
4 B.A. and 6 B.A. nuts and bolts;
Grommets to fit ¼in and ⅜in diameter holes;
Five knobs; five international octal valveholders

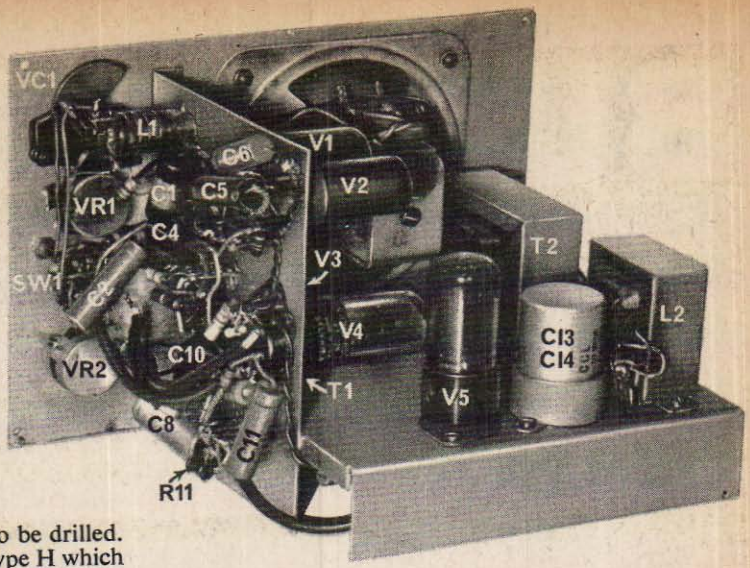


Fig. 5. The completed unit ready for fitting in a cabinet. V3 and T1 are hidden from view in the inside corner. The tuning coil L1 used on the prototype and shown here is the type PHF3

the chassis) will be required and should also be drilled. A common and useful size grommet is the type H which requires a $\frac{3}{8}$in diameter hole drilled in the chassis. These and $\frac{1}{4}$in types are suggested for this unit.

After completing the drilling and bending operations, the components can be mounted and wired up. Start with the heater leads, which should be twisted and run from the 6·3V winding of the mains transformer to each valveholder in parallel. One side of the heater winding is connected to chassis as close to the transformer as possible. The majority of components (resistors and capacitors) are connected direct to the valveholder tags and tag strips.

The layout is not critical but the important points to bear in mind are to use short grid and anode leads and keep them apart. Screened cable should be used for all grid leads, with the screen connected to chassis at the end furthest from the grid connections.

A guide to component positions is indicated on the two photographs in Figs. 4 and 5. It will be appreciated by many readers that full wiring details in this case cannot be provided due to the massing of components near the valveholders. The pin connections for each valve are shown in the circuit diagram (Fig. 1); the pins are numbered in a clockwise direction starting from the spigot key, when looking at the underneath.

Since resistors are so cheap, there is no point in departing from the values given. However, most of the capacitors can be altered, provided a little commonsense is used. The mains transformer is not critical, but if the output voltage is significantly greater than 250V, C13 and C14 must be of higher voltage rating, and an additional stage of RC decoupling applied to reduce the smoothed h.t. voltage to less than 300 volts.

PERFORMANCE

No test equipment, with perhaps the exception of a voltmeter is required. There should be no trouble from instability provided due care is taken in the layout and screening. When used as a radio, good reception of medium wave programmes is possible with a few feet of wire as an aerial. The gain of the a.f. stages may be increased by decoupling R16 with a 25μF 25V electrolytic capacitor. Conversely, a lower gain is obtained if C12 is omitted. ★

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Intending contributors are requested to observe the style in our published articles with regard to component references on circuit diagrams and the arrangement of the components list.

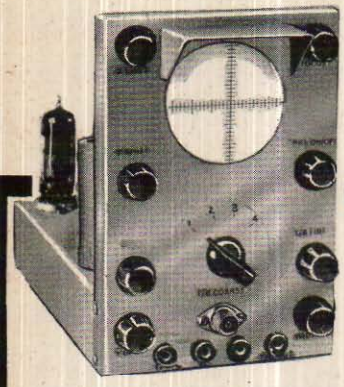
The text should be written on one side of the paper only with double spacing between lines. If the manuscript is handwritten, ruled paper should be used, and care taken to ensure clarity, especially where figures and signs are concerned.

Diagrams should be drawn on separate sheets and not incorporated in the text. Photographic prints should be of a high quality suitable for reproduction; but wherever possible, negatives should be forwarded.

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JOHN VALENCE

MIND MORE THAN MATTER

To those without at least some elementary theoretical knowledge, a piece of electronic apparatus is just a meaningless collection of parts and wiring. The secrets of its operation cannot be deduced by patient observation. The components remain inanimate and betray to the onlooker nothing that is indicative of their purpose or present state of operation. Even that one visible manifestation of life—the emissive surface of the thermionic cathode—is becoming increasingly rare.

I suspect that so far as the uninitiated are concerned, the mystery will only deepen as time goes by. Not because of greater complexity of circuits, but because of the shrinking of the physical components. Conventional, or perhaps I should use the vogue expression *discrete*, components can at any rate usually be recognised and related to the symbolic representation on the circuit diagram. It is an entirely different story in the case of microminiature components and integrated circuits. Due to their small size they are naturally less revealing to the naked eye. Potted, canned, or encapsulated—they don an anonymity that completely baffles the casual onlooker.

It seems quite certain that electronics will become more and more a study of the abstract. There will be an even greater dependence on theoretical knowledge in the future. Without such knowledge the tiny sliver of silicon will be as meaningless and as insignificant as a bread crumb. But to the minds of those "who know", the marvellous secrets of such microcosms of modern electronics will be exposed.

MINI EXCHANGE

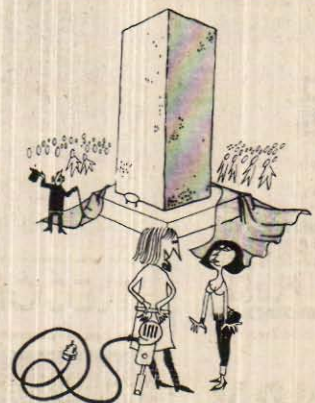
Where will it all end? A fascinating thought on the possibilities arising from further micro-miniaturisation was given by Professor Cherry during his recent lectures on World Communication delivered to the Royal Society of Arts.

The Professor suggested that it would one day be possible to build a complete telephone exchange in a sealed container and install this down in a manhole. I think this is a wonderful succinct illustration of the effect advancing technology may well have on our way of life.

Just consider such a small container replacing a large building that at present houses racks of equipment with heating, lighting and other services (such as are necessary even in an automatic exchange) all laid on. And consider all those valuable building sites the G.P.O. will be able to relinquish in 1984 or thereabouts. Sold or rented to builders of office blocks or perhaps multistorey car parks, the income would solve all the financial problems of the G.P.O. for quite a little time to come I reckon.

ART IN INDUSTRY

It is the fashionable thing for industry to act as patron to the arts. The famous firm of Mullards are as generous in their sponsorship of modern artists as they are in the educational field. Anyone who has seen this Company's educational films will agree that the artist and cartoonist are well employed in putting over a difficult and most abstract subject in a lively and yet factual manner.



***"Actually, I haven't touched it. I was going to call it* Power Cut *but I settled for* Solid State"**

Sometimes art is used purely for its own sake. The Mullard Electronics Centre in London has three specially commissioned works by leading contemporary artists. A 50ft mural in aluminium by Niczewski occupies the central position. Called "Creation Sequence" this mural depicts in both abstract and directly representational forms the sequence of events from the development of an idea to its realisation as something tangible and of value to mankind.

"Theme on Electronics" by Barbara Hepworth has stood in the Centre for a number of years and has no doubt been seen by many readers. Commissioned in 1957, this brass sculpture is (as these things go) inevitably dated, and perhaps that is why I find it attractive and easy on the eye.

How different are my reactions when I gaze upon the Centre's latest acquisition: Bobrowski's "Nucleus".

I confess to being a Philistine in matters concerning modern art. They say the main purpose of this kind of work is to provoke thought. Well it certainly does that. This weird contraption suggests to me the unfortunate offspring of some crustaceous animal which had been frightened by a radar scanner! To my mind, this heavy metallic machinery is a most inappropriate symbol of the mysterious, nebulous heart of the atom.

After gazing on this sinister masterpiece of modern sculpture it was refreshing to turn and look at another form of art displayed near by. The subjects were the everyday work of the electronic tube factory. Could the graceful, elegant shapes of the cathode ray tubes and valves and their delicate internal structures be bettered by an artist?

It is here, I suggest, in these and other examples of electronic hardware that we have the true symbolism of electronics. Many of the functional parts of electronic engineering are not without a beauty of their own. Do we really have to look outside the industry and import kinky symbolic art to provide a supposed artistic interpretation of this virile industry?

Readout—
A SELECTION FROM OUR POSTBAG

Crookes radiometer

Sir—I am trying to obtain a Crookes Radiometer and wonder if any of your readers know where these may be obtained.

The Crookes Radiometer is an evacuated glass bulb with a "paddle wheel" mounted on an almost frictionless bearing inside the bulb. One face of each paddle blade is painted white, the other side is black, and when a light is shone on the paddle it rotates slowly.

I would be very grateful for information from readers as to where I might obtain one.

M. J. Bunce,
Gillingham,
Kent.

Your description is correct except that a little gas (air) is left inside the bulb. The black faces of the paddle blades absorb heat energy from rays falling on them and so become slightly warmer than the white faces. Molecules of air striking the black faces absorb some of this energy and are accelerated. The sum of the impulses of the rebounding accelerated molecules creates a pressure over the black area greater than that over the white area on the opposite face of the paddle. Thus the wheel rotates.—
—R.W.S.

Microwave cooking

Sir—Would it be at all possible that in the near future you might produce in your magazine a design etc., for a microwave heater or cooker?

I know that so far, no periodical has touched this subject yet is one which I am sure would attract much interest. The expense I know is high, but not out of the reach of the average man's pocket when compared with other hobbies etc., and if a reliable cooker could be made to function, electricity bills would soon repay expenditure in units saved.

P. Stonelake,
Torquay.

We are afraid your suggestion is not feasible for amateur construction, yet! For one thing the special u.h.f. radio valve is extremely expensive and hardly likely to be available on the open market.

Tachometer circuit

Sir—I have had every copy since the first number and find something of interest in most numbers.

The tachometer circuit shown is very simple and rugged, I make no claim as the originator of it as it comes from a Mullard publication. The recommended Zener is OAZ224 for 12V systems and OAZ222 for 6V systems. These are not available in New Zealand so I have used a OAZ204 which seems O.K.

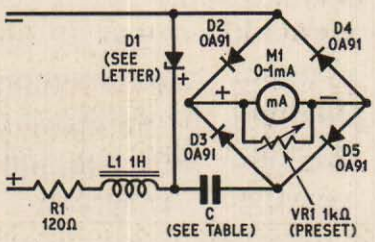
The 1 henry choke is rather bulky but can be constructed on a Mullard transformer core, type FX2240, with 500 turns of 36 s.w.g. copper wire on a 25mm former type number DT2179.

I would like to ask if anyone has made up the "Voice Display Unit" by Mr. J. Hermiston in the June '65 issue.

The main trouble here is that much of the equipment advertised in European magazines is unobtainable in New Zealand hence most things have to be as simple as possible.

I am interested in this particular subject and would welcome any information from your readers.

John C. W. Hardy,
Tauranga,
New Zealand.



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	0-7000	·47μF	·33μF	·22μF
	0-9000	·33μF	·22μF	—

Switching problem

Sir—I have an electrical problem. I would like to know if it is possible to make one master switch operate a group of light switches, 20 in number, so that each light is switched in numerical order and remains on. The master switch could be cam or perhaps photo-electric cell operated.

O. Havard,
Stroud,
Glos.

The solution to your problem calls for relays instead of ordinary switches. Each light being controlled by the contacts of a relay (a relay for each light) and the master switch energising all the relays but not simultaneously. The idea is to arrange timing circuits in relation to the relay windings so that the relays energise, thereby switching on their appropriate lights, in the required order.
—G.J.K.

Any other ideas?

Unstable neons

Sir—With reference to *Neon Novelties No. 4*, "Music Generator". I would like to warn intending constructors that, from my own experience, simple neons are very unstable as oscillators. I doubt if they are suitable even for a monophonic instrument and I am certain that they are useless for polyphonic purposes using the simple circuit shown.

Their striking and extinguishing voltages drift continually and the position of the discharge on the electrodes can change from time to time.

I have constructed a fully polyphonic two manual and pedal electronic organ using simple neons. In my case they are synchronised from a 12-valve master oscillator and in effect operate as frequency dividers each neon feeding its own buffer amplifier. Even today, after six years domestic use, drift is still taking place and during most playing sessions it is necessary to adjust the charging resistor associated with some note or other. I also noted that the simple neon is very unstable and hard to synchronise in darkness.

Probably neons with stabilising characteristics such as the NT2 would be very satisfactory but lack of funds prevented me from trying this out.

The tone produced from an unfiltered saw-tooth waveform is horrible!!!

Peter J. Horn,
Wallasey,
Cheshire.

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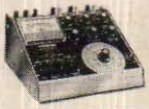
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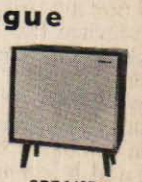

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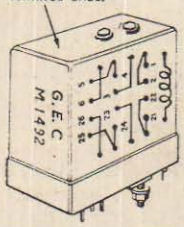
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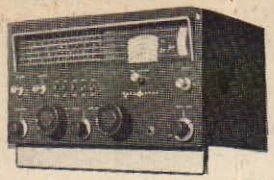
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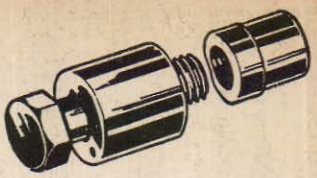
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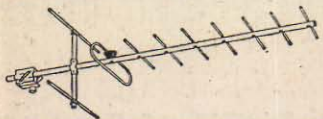
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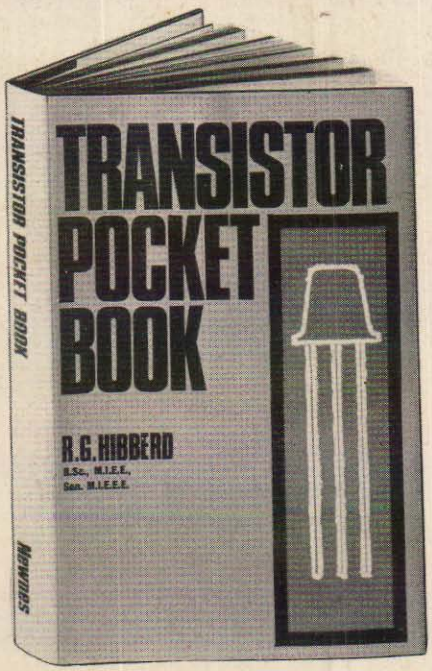
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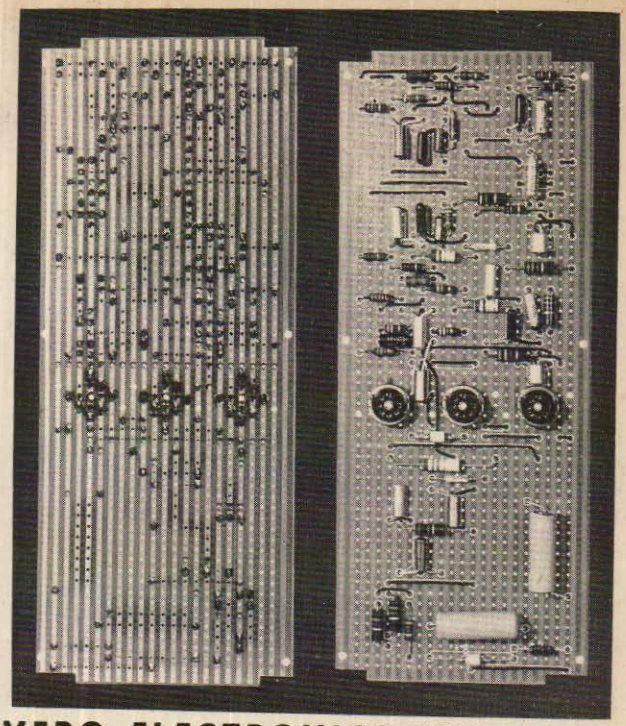
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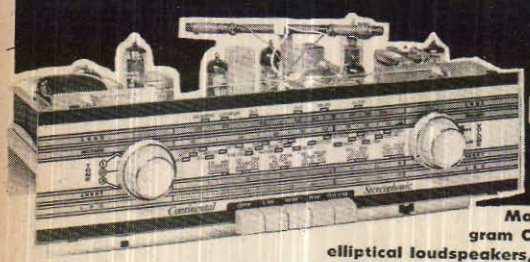
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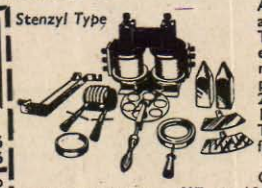
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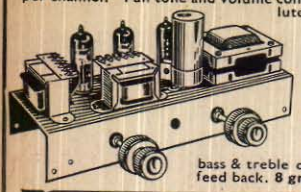
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A top-quality record player amplifier. This amplifier (which is used in a 29 gn. record player) employs heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. x 2½in. d. x 5½in. h. Ready built and tested. **PRICE 69/6.** P. & P. 4/9.

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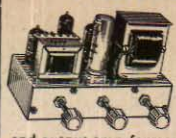
B.S.R. MONARDECK (Single speed) 3¾in. per sec., simple control, uses 5¼in. spools, £6/15/- plus 7/6 carr. and ins. (Tapes extra.)

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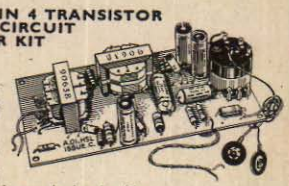
3-VALVE AUDIO AMPLIFIER MODEL HA34



Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½in. w. × 4in. d. × 4½in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, separate Bass, Treble and volume controls. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls.

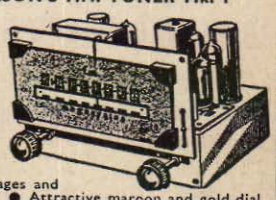
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10uf ...	3Volt	30uf ...	6Volt	30uf ...	12Volt	16uf ...	25Volt
12uf ...	3Volt	50uf ...	6Volt	1uf ...	15Volt	32uf ...	25Volt
20uf ...	3Volt	100uf ...	6Volt	2uf ...	15Volt	2uf ...	30Volt
30uf ...	3Volt	2uf ...	9Volt	4uf ...	15Volt	16uf ...	30Volt
40uf ...	3Volt	10uf ...	9Volt	5uf ...	15Volt	25uf ...	30Volt
25uf ...	6Volt	20uf ...	9Volt	6uf ...	15Volt	1uf ...	40Volt
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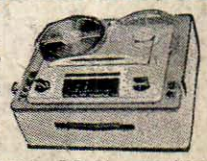


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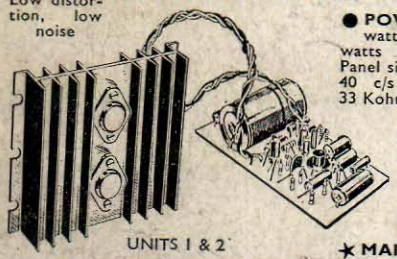


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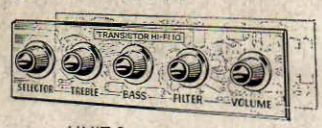
UNIT 5

PREAMPLIFIERS. Mono and stereo versions, 8 inputs, 1½ to 300mV at 1k to 500k. Response 30 c/s to 20 kc/s. Complete range of controls. Mains unit or battery operated. For pickups, tuners, tape, microphones, etc.

UNIT 3. Mono full-function pre-amplifier. Size: 9½ × 2½ × 2in. PRICE BUILT **£5.10.0** P.P. (Brown/Gold front 2/- panel plate 8/6)

UNIT 4. Simplified version of Unit 3. Price **65/-.** P.P. 1/6. Panel plate **6/6.**

UNIT 5. Stereo preamplifier for use with two units 1 or 2. Size 9 × 3¼ × 1⅝in. PRICE BUILT **£10.19.6** P.P. 3/6 (Front panel plate **12/6**)



UNIT 3

THE FINEST QUALITY HI-FI AT UNBEATABLE PRICES

TRANSISTOR TRANSMITTER/RECEIVERS



● ½ mile range **PRICE PER PAIR £7.19.6.**
● 5 mile range **PRICE PER PAIR £22.10.0**

4-CHANNEL MICROPHONE MIXER

Transistorised, 4 inputs up to 100 Kohm. Full mixing. **PRICE 49/6**
Stereo version 72/6

Let us quote for parts for your circuit. Send a list for quick reply. Quality components at realistic prices

● Complete Reycounter Kit with meter box, 79/6, p.p. 2/-. All parts in stock for 'PE' transistor Tape Recorder.

SINCLAIR DESIGNS

★ New Pocket FM Radio Kit **£5.19.6**
★ Micro-6 MW/ radio **59/6**
★ TR750 "Addon" power amp. **39/6**
★ Micro injector **27/6**
★ Micro amp. **28/6**
★ X10 Amp. kit **£5.19.6** BUILT **£6.19.6**
★ Z12 **89/6**
★ X20 kit **£7.19.6** BUILT **£9.19.6**



5 WATT AND 1½ WATT PACKAGED AMPLIFIERS

★ 6-Transistor push-pull printed circuit designs
★ Size only 2⅜ × 2 × 1½in.
★ 5 watt 18 volt, 1½ watt 12 volt
★ For 3 to 5 ohm speakers
★ 7mV into 1 Kohm. 30 c/s to 16 kc/s



(New Version)

PRICES BUILT **1½w. 65/-** P.P. 1/6 **5w. 79/6** P.P. 1/6

● MONO PREAMPLIFIER

Full range of controls. Inputs for M/c, Pu, tuner etc. Output 6-10mV. Suitable for any sensitive transistor amplifier (as above) 7½ or 12 or 18 volt operated.
Price Built and Tested 79/6 p.p. 2/6

TRANSISTOR PORTABLE TEST EQUIPMENT



All units size 6⅜ × 4⅜ × 2¾in.
★ RF generator, 150 kc/s to 350 mc/s in 8 ranges. RF, Mod. RF, AF outputs.
PRICE £9.10.0
★ Resistance/capacitance bridge. **£8.5.0.**
★ Audio generator 10 c/s—100 kc/s. 4 ranges. **£16.15.0.**

VHF/FM TUNER TO ASSEMBLE

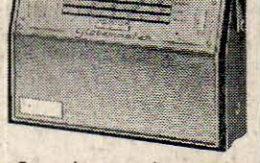


★ Two pre-built units plus metal work and front panel
★ Size: 9½ × 3½ × 4in.
★ 88 to 108 mc/s tuning
★ 100mV to 100Kohm output
★ 6-Transistor printed cct. superhet design
Total Cost **£12.17.6** P.P. 2/6
(All units available separately)

NEW 3-WAVEBAND PUSH-BUTTON PORTABLE SUPERHET TO BUILD

★ SHORT WAVES (17-50m)
★ MED. WAVES
★ LONG WAVES

TOTAL COST TO BUILD **£8.19.6** P.P. 3/6



6 Transistors, 1 watt push-pull output. Special circuit for car aerial. Car and tape sockets. Telescopic and ferrite aerials. Full tuning on all wavebands. Push-button coil pack. Cabinet size 11 × 7½ × 3½in. Black fabric with chromed handle and fittings. THE ONLY FULLY TUNABLE MW/LW/SW RADIO AVAILABLE FOR HOME CONSTRUCTION.

HI-FI All makes available—New demonstration room opening shortly.

VHF/FM TRANSISTOR TUNER TO BUILD

TOTAL COST £6.19.6
P.P. 2/6 (complete with frontplate)
(Gold sprayed cabinet **20/-** extra).



★ 5-Transistor 4 diodes
★ Printed circuit superhet
★ Geared tuning 87 to 105 mc/s FM
★ RF stage and double tuned IFT's
★ Output up to 1 volt peak up to 100 Kohm
★ 9 volt 9mA supply
★ Size in cabinet 4 × 3½ × 2¼in.
★ All parts sold separately

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