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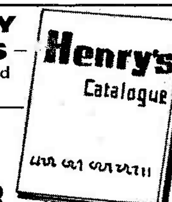

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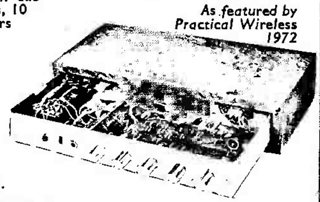

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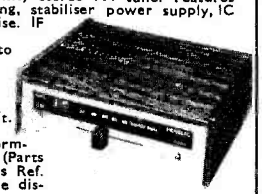

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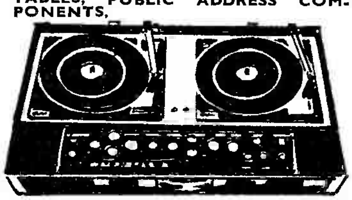

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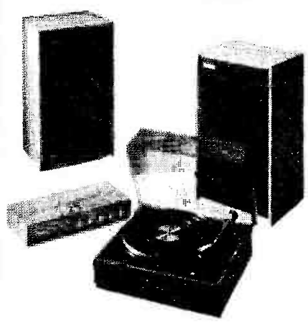

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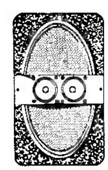

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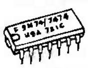
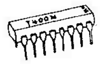
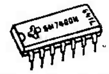

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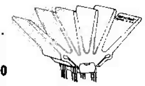

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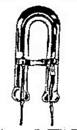

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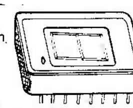

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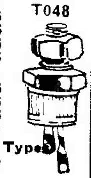
3 Amp
T048



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CRS 3/10AF	100v	40p
CRS 3/20AF	200v	45p
CRS 3/40AF	400v	55p
CRS 3/60AF	600v	65p
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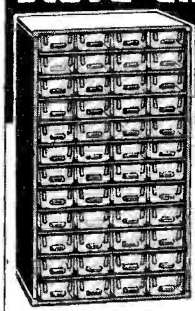

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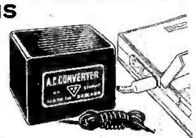

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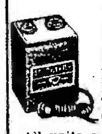

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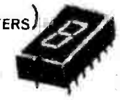

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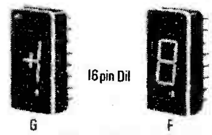

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200V	22p	100V	40p
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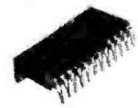

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Rating	Type	Tolerance		Range	Price Each
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¼ watt	Carbon Film	±5%	E24 Series	51Ω to 330KΩ	1½p
½ watt	Metal Oxide Film	±2%	E24 Series	10Ω to 1MΩ	4½p
½ watt	"Cermet" Thick Film	±2%	E12 Series	56Ω to 150KΩ	8p
½ watt	Carbon Film	±5%	E24 Series	10Ω to 10MΩ	1½p
½ watt	Carbon Composition	±0·5Ω	2·2Ω; 2·7Ω; 3·3Ω; 3·9Ω; 4·7Ω		4½p
1 watt	Carbon Composition		5·6Ω; 6·8Ω; 8·2Ω		5½p
1 watt	Carbon Film	±10%	E12 Series	10Ω to 10MΩ	3p
2 watt	Carbon Film	±5%	E12 Series	10Ω to 10MΩ	6p
2½ watt	Wire Wound	±5%	E12 Series	0·22Ω to 0·47Ω	10p
2½ watt	Wire Wound	±10%	E12 Series	1Ω to 270Ω	10p
5 watt	Wire Wound	±5%	E12 Series	0·5Ω to 8·2KΩ	10p
10 watt	Wire Wound			0·5Ω to 6·8KΩ	11p
10 watt	Wire Wound	±5%	10KΩ; 15KΩ; 20KΩ; 25KΩ		17p
15 watt	Wire Wound			10Ω to 6·8KΩ	13½p

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CERAMIC DISC—LOW VOLTAGE—0·01µF, 0·022µF, 0·047µF, **5½p;** 0·1µF, 0·22µF, 0·47µF, **6½p.**

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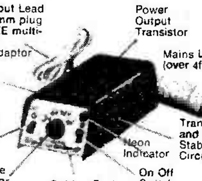

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AC127	13p	ASY26	33p	BC327	26½p	BF179	33p	BSY95A	13p	TIP41A	81p								
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ACY18	21p	BC149	9p	BD131	68p	BF197	16½p	MJE3055	92p	2N914	24½p	2N3703	10p	2N5129	16½p	BA114	9p	OA5	99p
ACY19	25p	BC157	13p	BD132	53p	BF200	35½p	MPF102	27½p	2N1302	20p	2N3704	11p	2N5172	9p	BA115	19p	OA10	94p
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AD149	38p	BC168B	11p	BD135	42p	BF262	25p	MPF105	45p	2N1305	24p	2N3707	12p	2N6076	14p	BA129	23p	OA81	8p
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AD161/2 PR	59p	BC172	17½p	BD138	74½p	BF390	37p	OC35	38p	2N1308	27½p	2N3710	11p	3N152	101p	BA144	20p	OA91	8p
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AF115	14p	BC177	22p	BD140	91½p	BFW10	67p	OC44	13½p	2N1613	22p	2N3771	£1·82	40360	51p	BA148	22p	OA200	11p
AF116	14p	BC178	22p	BD201	£1·55	BFW11	67p	OC45	13½p	2N1711	26p	2N3772	£2·75	40361	50p	BA154	20p	OA202	12p
AF117	14p	BC179	24p	BD202	£1·37	BFW87	38p	OC71	13½p	2N1893	52½p	2N3773	£2·20	40362	50p	BA155	15½p	OA210	19½p
AF118	92p	BC182L	9p	BD203	£1·55	BFX29	43p	OC72	13½p	2N2160	£1·54	2N3819	28p	40408	55p	BA156	16½p	OA211	30p
AF124	24p	BC183L	9p	BD204	£1·37	BFX30	37½p	OC75	15p	2N2219	41p	2N3823	99p	40430	£1·39	BA182	26½p	IN914	8p
AF125	22p	BC184	9p	BF109	75p	BFX88	26p	OC81	13½p	2N2646	55p	2N3903	16½p	40432	£2·17	BA220	7p	IN916	10p
AF126	22p	BC184L	9p	BF115	25p	BFY50	16½p	OC83	25p	2N2905	46p	2N3904	19p	40673	55p	BA221	7p	IN4148	5½p
AF127	22p	BC187	27½p	BF160	25½p	BFY51	16½p	OC140	22p	2N2924	18p	2N3905	23p	AA119	10p	BA222	7½p		
AF139	35p	BC212L	11p	BF167	27½p	BR100	43p	OC170	27½p	2N2926 all	10p	2N3906	25p	AA120	10p	BAV10	11p		
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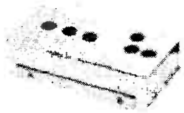

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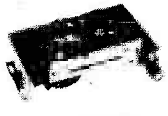

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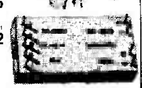

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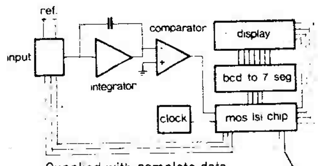

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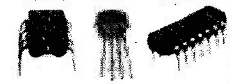

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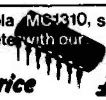

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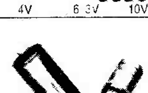
		ZTX313	**11p**	ZTX504	**43p**	ZS142	**33p**		
ZTX107	**9p**	ZTX314	**13p**	ZTX510	**17p**	ZS170	**10p**		
ZTX108	**8p**	ZTX320	**31p**	ZTX530	**21p**	ZS171	**13p**		
ZTX109	**11p**	ZTX330	**15p**	ZTX531	**22p**	ZS172	**16p**		
ZTX212	**14p**	ZTX331	**16p**	ZTX550	**17p**	ZS174	**17p**		
ZTX213	**14p**	ZTX341	**22p**	ZTX551	**17p**	ZS176	**23p**		
ZTX214	**15p**	ZTX382	**13p**			ZS178	**38p**		
ZTX300	**12p**	ZTX383	**15p**	**DIODES**		ZS270	**11p**		
ZTX301	**13p**	ZTX384	**18p**	ZS120	**8p**	ZS271	**16p**		

KSO30A Zener Series as BZY88 Series **11p** each.

ELECTROLYTICS



µF	4V	6.3V	10V	16V	25V	40V	63V	100V
1							6½p	8p
1.5							6½p	
2.2							6½p	
3.3							6½p	
4.7							6½p	8p
6.8						6½p	6½p	
10					6½p		6½p	9p
15				6½p		6½p		
22			6½p		6½p		6½p	11p
33		6½p		6½p		6½p		
47	6½p		6½p		6½p	6½p	8p	
68		6½p		6½p			10p	
100	6½p		6½p		6½p	8p	11p	23p
150		6½p		6½p	6½p	10p	13p	
220	6½p		6½p	8p	10p	11p	19p	31p
330	6½p		8p				22p	39p
470		6½p	10p		13p	19p	26p	48p
680		10p		13p	20p	23p		59p
1000	10p		11p	17p	22p	25p	44p	79p
1500		12p	20p	23p				
2200		18p	20p		36p	44p	79p	149p
3300		20p						
4700	29p			44p	68p	79p	149p	252p
6400				75p	93p			
10000							299p	333p

Potentiometers

5kΩ 250kΩ
10kΩ 500kΩ
25kΩ 1MΩ
50kΩ 2MΩ
100kΩ

Log or lin less switch (and 1kΩ lin)	**13p**
Log or lin with switch	**26p**
Dual less switch	**44p**
Dual with switch 10kΩ, 100kΩ and 1MΩ, log only	**57p**
10kΩ log + 10kΩ antilog less switch	**44p**

10kΩ, 25kΩ — Single **33p**
50kΩ, 100kΩ — Dual **55p**

New Silver and Black Knob **16½p**

Presets

Vertical or Horizontal
0·1 watt **5½p** 0·25 watt **7p**

100Ω	1kΩ	10kΩ	100kΩ	1MΩ
250Ω	2·5kΩ	25kΩ	250kΩ	2·5MΩ
500Ω	5kΩ	50kΩ	500kΩ	5MΩ

Cermet Type to 1MΩ only, **41p.**

VDR's & Thermistors

A15B	82½p	GL23	£1·10
CZ1	16½p	R53	£1·49
CZ4	14½p	R54	£1·61
CZ13A	14½p	VA1005	16½p
CZ19	14½p	VA1026	14½p
E298CD A258	13p	VA1033	11p
E298ED A258	11p	VA1034	11p
E298ED A260	11p	VA1039	16½p
E298ED A262	11p	VA1040	11p
E298ED A265	11p	VA1053	11p
E298ED P268	11p	VA1055S	11p
E298ZZ 05	13p	VA1056S	11p
E298ZZ 06	11p	VA1066S	11p
E299DD P336	11p	VA1067S	16½p
E299DD P338	11p	VA1077	14½p
E299DD P342	11p	VA1098	21p
E299DD P348	11p	VA1104	29p
GL16	£1·10	VA1107	29p

Other types obtainable upon application

POWER SUPPLY UNITS

AC-DC & DC-DC

Different Voltages
All English make
Fully Guaranteed
for parts & labour

AC.601 240V A.C. INPUT
OUTPUTS 3V, 4·5V, 6V, 7·5, 9V & 12V D.C.
MAX. CURRENT 500mA

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OUTPUT 6V, 7·5V, 9V D.C.
MAX. CURRENT 500mA

AC.201 INPUT 240V. A.C.
OUTPUT 9V & 12V. D.C.
MAX CURRENT 1 AMP

AC.105 INPUT 240V A.C.
OUTPUT 12V
MAX. CURRENT 6 AMP

AC.101 INPUT: 240V A.C.
OUTPUT 6V OR 7·5V or 9V
MAX CURRENT 500mA

DC.301 FULLY STABILIZED
INPUT: 12V D.C.
OUTPUT 6V, 7·5V & 9V D.C.
MAX CURRENT 500mA

DC.101 Suitable to use from Car cig. lighter.
INPUT: 12V DC
OUTPUT 7·5V or 9V DC
MAX CURRENT 500mA

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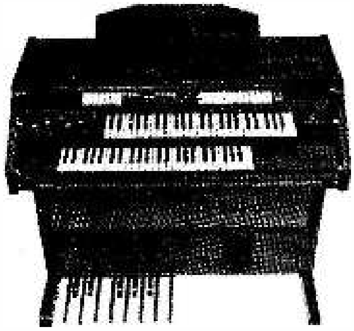
D.I.Y. ELECTRONIC ORGAN KITS



In use throughout the world by professionals

★Portable—4 octave keyboard with 10 voices, 3 pitches—vibrato, **£145·29**. ★ Console—5 octave keyboard with 10 voices, 3 pitches. Keyboard can be split into solo and accompaniment. Vibrato, built in amplifier and speaker **£250·93**. ★Console—2 x 4 octave keyboards and 13 note pedal board, 29 voices. Vibrato, Delay Vibrato, Sustain, Reverberation, Percussion, Wah Wah, **£406·00**. ★Console—2 x 5 octave keyboards and 32 note pedal board, 32 voices. Vibrato, Delay Vibrato, Sustain, Reverberation, Percussion, 3 Couplers, etc., at **£572·55**.

V.A.T. please add 10%—show separately on order.

All components can be bought separately. Send 50p for 24-page catalogue which includes details of specialised components plus free vouchers worth 50p.

Also available—WIRELESS WORLD SOUND SYNTHESIZER KITS complete with reprinted instructions.

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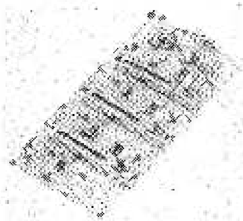
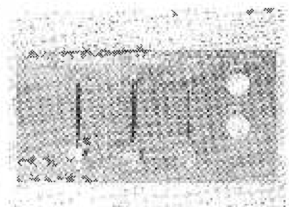
DABAR MN3 MIXER KIT





INTRODUCING THE NEW DABAR MINI THREE CHANNEL MIXER KIT WITH THE FOLLOWING FEATURES:

★ Three inputs easily adjustable to suit users input requirements, e.g., Mic., Tape, Disc., etc.
★ Uses advanced design with five integrated circuits.
★ Slider fader volume controls mount directly on P.C. board.
★ Full range bass and treble controls.
★ Guaranteed top grade components with fibreglass printed circuit board, ready-drilled and tinned.
★ Battery operated (2 x PP3) not supplied with kit.
★ Easy to follow assembly instructions (available separately 25p).
★ Attractive ready punched facia plate, available at extra cost, gives that professional finish to the unit.
★ Size: 9·5" x 4·8" x 2".

PRICE: KIT ONLY £11·00
FACIA PLATE £1·50
MANUAL AND ASSEMBLY INSTRUCTIONS 25p
AVAILABLE READY BUILT WITH FACIA £15·00

ALL PRICES INCLUDE V.A.T. & POSTAGE IN U.K.
S.A.E. ALL ENQUIRIES

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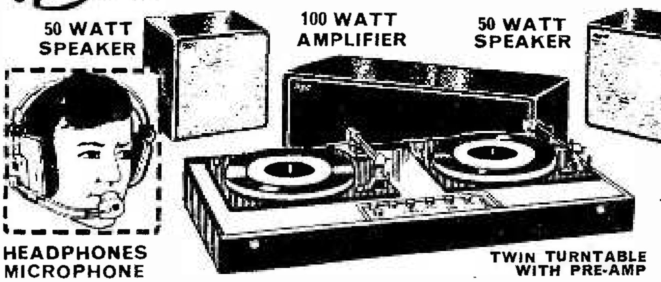
RSC GROUP/DISCO UNITS



PACKAGE OFFER
Units listed below
(a) 100w POWER AMPLIFIER
(b) PAIR OF HI-FI HEAD-PHONES
(c) MATCHING DYNAMIC 'MIKE' (attached to h'phone)
(d) PAIR 50 WATT SPEAKERS Black Rexine covered Cabinets Size approx. 18″ × 18″ × 8″
(e) RSC TDI DISCO CONSOLE

(a) (b) (c) (d) & (e) **£149·95** Carr. £3·00

Terms Deposit £30 and 18 monthly payments of £8·33 (Total £179·94).

RSC TDI DISCO CONSOLE

Incorporating twin Garrard SP25 or BSR MP60 type turntables and Sonotone or Acos Cartridges with diamond stylii. Separate Vol. controls for each turntable. Also MONITORING FACILITIES, plus Treble and Bass Controls. Separate input for 'mike' with vol. control switch. Black Vynide covered Cabinet with lid. see illustration on left
Or Dep. £9·95 and 12 mthly pymts £5·85 (Total £80·15) **£69·95**
Carr. £1·50

FANE ULTRA HIGH POWER LOUDSPEAKERS

All power ratings are R.M.S. continuous. 2 YEARS' GUARANTEE High flux ceramic magnets. ALL CARRIAGE FREE.

'POP' 100	'POP' 60	'POP' 50
18″ 100 Watt	15″ 60 Watt	12″ 50 Watt
14,000 gauss 8/15Ω	14,000 gauss 8/15Ω	13,000 gauss 15Ω
£25·95	**£14·75**	**£11·99**
Dep: £5·95 and 9 monthly payments £2·56 (Total £28·99)	Dep. £3·75 and 9 monthly payments. £1·50 (Total £17·25)	Dep £2·99 and 9 monthly payments £1·28 (Total £14·51)
FOR BASS GUITAR, ELECT. ORGAN, ETC.		PAIR SUITABLE ALL PURPOSES

R.S.C. COLUMN SPEAKERS

IDEAL FOR VOCALISTS AND PUBLIC ADDRESS

All types 15 Ohms covered in Rexine and Vynair
TYPE C4100 IS ALSO SUITABLE FOR BASS GUITAR OR ELECTRONIC ORGAN

TYPE C132 30-40 WATTS Fitted two exceptionally efficient, low feedback howl characteristic high flux 13″ × 8″ 20 watt speakers. Terms: Dep. £2·95 and 9 m'thly payments £2·43 (Total £24·82) Carr. 65p. **£21·95**

TYPE C313 50 WATTS Low feedback characteristic. Fitted three 13″ × 8″ deep cone high flux speakers with high power voice coils. Size approx. 54″ × 14″ × 11″. Dep. £4·72 & 9 mthly pymts £3·58 (£36·94) Carr. 85p **£32·72**

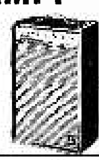
TYPE C4100 100 WATTS inc. four 12″ 50 watt speakers for conservative rating. Extra heavy construction. Size approx. 58 × 16 × 10″ Acoustically filled and pressurised. Terms: Dep. £15·50 & 12 mthly. pyts. £5·46 (Total £81·02). Carr. £1·50 **£71·50**

FANE SPEAKERS 'POP' 25/2 12 in. 25 WATT

Dual Cone 15 Ω (for uses other than Bass Guitar or Electronic Organ). Carr. free **£7·95** or Dep. £1·25 and 9 mthly payments 89p (Total £9·26).

MINSTREL 8W GUITAR AMP.

Incorporating Tremolo and 13″ × 8″ or 10″ Speaker. Output 8 watts R.M.S. Continuous. 3 Jack Inputs for Microphone and Instrument. Mains Neon Controls: Volume, Tone, Tremolo Speed Tremolo Intensity.
Terms: Deposit £2·75 and 9 monthly payments £2·17 (Total £22·28). **£19·95**
Carr. free



FANE CRESCENDO SPEAKERS

Full range available at
ALL BRANCHES

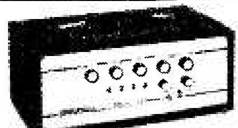
GROUP/DISCO EQUIPMENT PACKAGE OFFERS

F.A.L. PHASE 50 MK.III AMPLIFIER	£39·93	PACKAGE PRICE
PR. FANE POP 25/2 25W L/SPEAKERS	£15·90	**£51·50** carr. £1·10
Terms: Deposit £7·50 and 12 monthly payments of £4·29 (Total £58·98)	£55·83	
F.A.L. PHASE 50 MK.III AMPLIFIER	£39·93	PACKAGE PRICE
PR. FANE POP 50 L/SPEAKERS	£23·98	**£59·50** carr. £1·10
Terms: Deposit £9·50 and 12 monthly payments of £4·88 (Total £68·06)	£63·91	

OTHER PACKAGE OFFERS AVAILABLE

FAL PHASE 50 Mk.III AMPLIFIER 50 WATT.

Solid state. 4 Separately controlled inputs Plus master vol. control. Ind. Bass and Treble Controls. Protective circuit to guard against damage from accidental shorts. Output for Speaker/s 3 to 30 ohms. Size 17″ × 7″ × 7½″ 200-250v. A.C. mains. Output 50 watts music rating. Or deposit £6·93 & 9 monthly payments £4·22. Total £44·91. **£39·93**



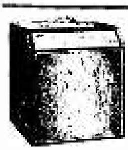
HIGH QUALITY LOUDSPEAKER UNITS

ALL TWO TONE REXINE AND VYNAIR FINISH
L125 50 WATT Fitted pair of 12″ 50 watt high flux speakers for conservative rating. Impedance 8-15 ohms. Carr. £1·50 **£37·95**
Or deposit £3·95 and 9 monthly payts. of £4·34. Total £43·01

L12/20 12″ 20-25 WATT 13,000 lines 15 ohms Dep £2·15 & 9 mthly pymts £1·50 (Total £15·65) **£13·15** Carr. 55p.

L12/10 10-15 Watt veneer finish cabinet 12″ unit 8-15 ohm. Size approx. 14″ × 14″ × 9″. Carr. 50p. Dep. £1·25 & 9 mthly pymts £1·06 (Total £10·79) **£8·25**

RSC PHANTOM '50'



Combined 50W Amplifier and 12in. Loudspeaker.

For Lead Guitar, Mic., Gram, Radio, Tape (Not for use with Bass instruments). Inc. 3 inputs and 2 vol. controls plus Treble, Bass and Presence. Output Jack for additional 15 ohm Speaker. Attractively finished in black with silver-finished fascia and trimmings. Compact size. Fitted carrying handle. Terms: Deposit £8·95 and 12 monthly payments £4·97 (Total £68·59). Carr. £1·50 UK Mainland
SAE for leaflet **ONLY £59·95**

CREDIT TERMS AVAILABLE ON PURCHASES OVER £10 (Kits Excepted) INTEREST CHARGES REFUNDED ON CREDIT SALES Settled in 3 months

RSC BASS-REGENT 50 WATT AMPLIFIER

A powerful high quality all-purpose unit for lead, rhythm, bass guitar, vocalists, gram, radio, tape. Peak Output rating. Loudspeaker unit either horizontal or vertical mounting.
★ Two extra heavy duty 12in. 50w Loudspeakers.
★ Four Jack inputs and two Volume Controls for instant use of up to four pick-ups or "mikes". Bass and Treble controls. Send S.A.E. for leaflet.
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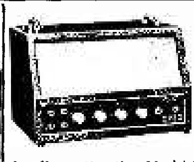
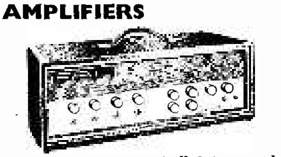
RSC GP30 HI-FI AMPLIFIER



For Guitar, Vocal or Instrumental Group

A 4 input, 2 vol. control Hi-Fi 30 watt unit with Separate Bass and Treble controls. Current valves. Peak output rating. Strong Rexine covered cabinet with handles. Attractive black/silver P.V.C. fascia. Neon indicator. For 200-250v. A.C. mains. For 3 or 15 ohm speakers. Send S.A.E. for leaflet. Terms: Deposit £4·40 and 9 monthly payments of £2·75 (Total £29·15). **£25·85** Carr. 75p

FAL TWIN CHANNEL AMPLIFIERS



Solid State. 4 sep. controlled inputs plus master volume control. Individual Bass and Treble controls. Output for speakers 3–30 ohms. Protective circuitry against damage from short circuits.

FAL 'SUPER 50'
50W ATTS MUSIC RATING **£59·50**
Terms: Dep. £8·50 & 12 mthly. payments £4·97 (Total £68·14) Post free

FAL 'SUPER 100'
100 WATTS MUSIC RATING. Terms: Dep. £11·95 & 12 mthly. pymts. £6·63 (Total £91·51). Prices include protective dust cover. **£79·95**
Post free

R.S.C. BATTERY/MAINS CONVERSION UNITS

TYPE BM1. An all-dry battery eliminator. Size 5½ × 4½ × 2½in. approx. Completely replaces batteries supplying 1·5v and 90v, to battery radio where A.C. mains 200/250v. Post 30p 50c/s is available.
ASSEMBLED READY FOR USE **£4·15**

FAL PHASE 100/2 AMPLIFIER

100 WATTS MUSIC RATING. Solid State. Sep. Bass and Treble Controls. 4 separate controlled inputs plus master control. Output for speakers 3–30 ohms. Includes protective circuit against damage from short circuits. Terms: Deposit £7·86 & 12 monthly payments £6·05 (Total £80·45). **£69·85** Carr. free

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MIDGET CLAMPED TYPE 2½ × 2⅝ × 2½in.

250v., 60mA, 6·3v. 2a	£1·10
250-0-250v., 60mA 6·3v 2a	£1·16

FULLY SHROUDED UPRIGHT MOUNTING

250-0-250v. 60mA, 6·3v. 2a., 0-5-6·3v. 2a.	£1·55
250-0-250v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·45
300-0-300v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·45
300-0-300v. 130mA, 6·3v. 4a. c.t., 6·3v. 1a. For Mullard 510 Amplifier	£2·95
350-0-350v. 100mA, 6·3v. 4a., 0 5-6·3v. 3a.	£2·45
350-0-350v. 150mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·95
425-0-425v. 200mA, 6·3v. 4a., c.t., 5v. 3a.	£5·45
425-0-425v. 200mA, 6·3v. 4a., Twice 5v. 3a.	£5·60
450-0-450v. 250mA, 6·3v. 4a., c.t., 5v. 3a.	£6·00

TOP SHROUDED DROP-THRO' TYPE

250-0-250v. 70mA, 6·3v. 2a., 0-5-6 3v. 2a.	£1·49
250-0-250v. 100mA, 6·3v. 3·5a.	£1·71
250-0-250v. 100mA, 6·3v. 2a., 6·3v. 1a.	£1·75
350-0-350v. 80mA, 6·3v. 2a., 0-5-6·3v. 2a.	£1·81
250-0-250v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·45
300-0-300v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·45
300-0-300v. 130mA, 6·3v. 4a., c.t. 6·3v. 1a. Suitable for Mullard 510 Amplifier	£2·85
350-0-350v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·45
350-0-350v. 150mA, 6·3v. 4a., 0-5-6·3v. 3a.	£2·85

FILAMENT or TRANSISTOR POWER PACK Types 6·3v. 1·5a. 55p; 6·3v. 2a. 60p; 6·3v. 3a. 85p; 6·3v. 6a. £1 45; 12v. 1a. 61p; 12v. 3a. or 24v. 1·5a £1·50; 0-9-18v 1½a £1·25; 0-12-25-42v 2a £1·95.

CHARGER TRANSFORMERS 0-9-15v. 1½a. £1·10. 2½a. £1·25; 3a. £1·40; 5a. £1·60; 6a. £1·85; 8a. £2·20

AUTO (Step UP/step DOWN) TRANSFORMERS 0-110/120v. 200-230-250v. 50-80 watts £1·25, 150 watts, £2·10 250 watts £3·00; 500 watts £6·40

OUTPUT TRANSFORMERS

Push-Pull 8 watts EL84 to 3 Ω or 15 Ω	95p
Push-Pull 10 watts 6V6, ECL86 to 3-5-8-15 Ω	£1·55
Push-Pull EL84 to 3 or 15 Ω 10-12 watts	£1·50
Push-Pull Ultra Linear for Mullard 510, etc.	£2·45
Push-Pull 15-18 watts, sectionally wound 6L6, KT66, etc., for 3 or 15 Ω	£2·20
Push-Pull 20 watt high quality sectionally wound EL34, 6L6, KT66 etc. to 3 or 15 Ω	£3·65

SELENIUM RECTIFIERS
F. W. (Bridged)
All 6/12v. D.C. output. Max. A.C. input 18v.
1a, 28p. 2a, 39p. 3a, 55p. 4a, 72p. 6a, 88p.

SMOOTHING CHOKES
150mA, 7-10H, 250 Ω 77p; 100mA, 10H, 200 Ω 56p; 80mA, 10H, 350 Ω 55p; 60mA, 10H, 400 Ω 28p.

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ON LEADING BRAND TAPE AND TURNTABLE UNITS
ALL PRICES INCLUDE V.A.T
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AKAI CR81D Tape Unit £58·95 (Rec. Price £84·10) Carr. £1
GOLDRING GL72 T/Table & P.U. £29·95 (Rec. Price £37·29) Carr. 75p
Or for £3 extra Goldring G800 Cartridge worth over £10 fitted to above unit.
GOLDRING GL75 T/Table P.U. **£34·50** (Rec. Price £47.19) Carr. 85p.
Or for £3 extra Goldring G800 Cartridge worth over £10 fitted to above unit.
BSR MP60 T/Table & P.U. **£9·95** (Rec. Price £14·95) Carr. 40p

T/TABLES with MAGNETIC CARTRIDGE, PLINTH & COVER
GARRARD SP25 with G800 **£17·95 SPECIAL PRICE** (Carr. £1)
BSR MP60 with G800 **£17·95 SPECIAL PRICE** (Carr. £1)
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GARRARD AP76 with G800 **£28·95 SPECIAL PRICE** (Carr. £1)
LEAK DELTA 30 Amplifier **£49·95** (Rec. Price £76·89) Carr. 40p
LEAK DELTA 70 Amplifier **£59·95** (Rec. Price £94·49) Carr. 45p
LINEAR 202 10 + 10W ,, **£29·95** Carr. 54p

RSC G66 MkII 6+6 WATT high quality STEREO AMPLIFIER

Individual Ganged Controls: Bass, Treble, Volume and Balance. Printed circuit construction employing 10 Transistors plus Diodes. Output rating I.H.F.M. Frequency range 20-20,000 c.p.s. Bass Control ± 12db. Treble Control ± 13db. Selector switch for P.U. or Tape/Radio. For loudspeaker output impedances of 3 to 15 ohms. For standard 200-250v. A.C. mains operation. Attractive Black and Silver finished metal fascia plate and matching control knobs. COMPLETE KIT OF PARTS INCLUDING FULLY WIRED PRINTED CIRCUIT and COMPREHENSIVE WIRING DIAGRAMS & INSTRUCTIONS **£12·65** Carr. 40p
Or FACTORY BUILT IN TEAK VENEERED CABINET as illustrated £16·50 or dep. £2·50 and 9 monthly payments £1·83 (Total £18·97).

AUDIOTRINE HIGH FIDELITY SPEAKERS

Heavy construction. Latest high efficiency ceramic magnets. Plasticised Cone surround. "D" indicates Tweeter Cone providing extended frequency range up to 15,000 c.p.s. Impedance 3 or 8-15 ohms. PLEASE STATE CHOICE.
Exceptional performance at low cost.

HF808T	8	10W	£2·98	HF120D	12"	15W	£5·50
HF102D	10"	10W	£3·30	HF126	12"	15W	£6·35
HF120	12"	15W	£4·95	HF126D	12"	15W	£6·85

FANE 807T HIGH FIDELITY SPEAKER

A full range 8in. 10 watt unit for excellent sound quality, in suitable enclosure. Cast chassis Roll P.V.C. cone surround and long throw voice coil to achieve very low fundamental resonance of 30 c.p.s. Tweeter cone is fitted to extend high note response. Frequency range 25 Hz to 15 KHz. Gauss 10,000. Impedance 3 or 8-15 Ω. **£3·99**
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MODEL 803T 8" 15w. with parasitic Tweeter. Response 25 Hz to 15 KHz. Gauss 13,000 Imp 3 or 8-15Ω. **£5·50** List £6·99

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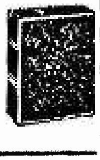
HI-FI SPEAKER ENCLOSURES MODERN DESIGN

Teak veneer finish. Acoustically lined. Sizes approx. Carr. 35p. per enc.
JE8 Size 16" × 11" × 9". Pressurised. Gives pleasing results with any 8in. Hi-Fi speaker. **£5·50**
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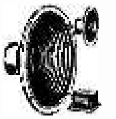
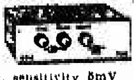
SE12 For excellent performance with 12in. Hi-Fi speaker and tweeter 25½ × 16 × 9in. **£7·95**

AUDIOTRINE HI-FI SPEAKER SYSTEMS

Consisting of matched 12in. 11,000 line 15 Watt 15 ohm high quality speaker, cross-over unit and tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction. **£6·50** Carr. 33p
OR SENIOR 15 WATT INCLUDING HF126 15,000 LINE SPEAKER **£7·65** Carr. 39p

R.S.C. TA6 6 Watt HI-FI AMPLIFIER

200-250v. AC mains operated. Frequency Response 30-20,000 c.p.s. −2dB. Harmonic Distortion 0·3% at 1,000 c.p.s. Separate Bass and Treble 'lift and cut' controls. 3 input sockets for Mike, Gram, Radio or Tape. Input selector switch. Output for 3-15 ohm spkrs. Max. sensitivity 5mV Output rating I.H.F.M. Fully enclosed enamelled case, 9½ × 2½ × 5¼in. Attractive brushed silver finish facia plate 10½ × 3¼in. and matching knobs. Complete kit of parts with full wiring diagrams and instructions. **£8·50** Carr. 40p.
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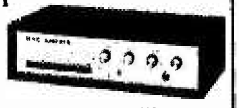
Only high grade components by leading manufacturers


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For Magnetic or Ceramic Pick-Ups regardless of Price. Output (per channel) 15 watts RMS into 8Ω. Frequency Response 7 Hz to 70 KHz ± 1½ dB.

COMPLETE KIT (less cabinet). Carr. 70p. Cabinet if req. £5 extra. **£22·50**

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FACTORY BUILT UNIT INC. CABINET with 12 months' guarantee. Or Dep. £7 and 9 monthly payments £4·54 (Total £47·86). **£42·50**

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★ Moderate size only 25 × 14 × 10in. approx.
★ Response 30-20,000 c.p.s. Impedance 15 ohms
★ Performance comparable with units costing considerably more

COMPLETE KIT **£25·25** Carr. 65p

Consists of (1) 12in. 15 watt Bass unit with cast chassis, Roll rubber cone surround for ultra low resonance, and ceramic magnet. (2) 3-way quarter section series cross-over system. (3) 8 × 5in. high flux middle range speaker. (4) High efficiency tweeter. (5) Appropriate quantity acoustic damping material. (6) Handsome Teak veneered cabinet. (7) Circuit and full instructions. Terms: Deposit £5·25 and 9 monthly payments £2·56 (Total £28·29).

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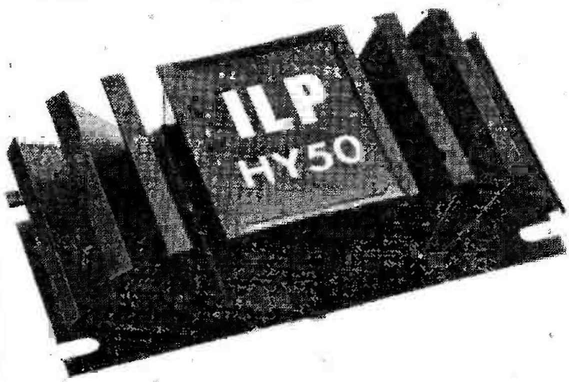
SECOND GENERATION 25 WATT HYBRID



A brand new hybrid fabrication technique, recently perfected in our laboratories, has enabled us to achieve our latest range of completely integrated devices.
We have now finally reduced the modular amplifier to a simple input/output device requiring only the addition of a basic unstabilized (split line) power supply.
The HY50 takes medium power modules to their logical conclusion by incorporating with it a heatsink, which is designed in special high conductivity alloy, sufficient for normal audio use without additional chassis sinking. All this without significantly increasing the size of the module comparable in size to a packet of 'King-size' cigarettes.

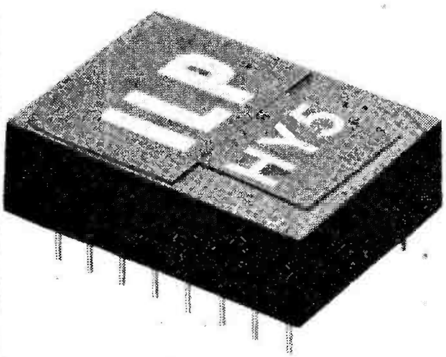
Consistent with modern thinking a triple rated output circuit with a load fuse allows for peak transient response without distortion but ensures the necessary protection.

	SPEC.
OUTPUT POWER:	25 watts RMS. 50 watts peak music power
LOAD IMPEDANCE:	4-16Ω Into 8Ω
INPUT SENSITIVITY:	Odb (0·775 volts RMS)
INPUT IMPEDANCE:	47KΩ
TOTAL HARMONIC DISTORTION:	Less than 0·1% at 25 watts typically 0·05
SIGNAL/NOISE RATIO:	better than 75db
FREQUENCY RESPONSE:	10Hz-50KHz ± 1db
SUPPLY VOLTAGE:	± 25 volts
SIZE:	105 x 50 x 25 mm

Price £5·40 mono, £10·80 stereo

Price inclusive of VAT & P & P

NEW HY5 PRE-AMPLIFIER



Unchallenged for two tears, the HY5, our unique multifunction preamplifier/tone hybrid, has been brought into line with the advancements in our power hybrids.
Like the HY50, the new HY5 has no external components & has been redesigned to run off a split power-line with improvements in signal/noise, overload, capability & reduced distortion. The output has been increased to match the power module (Odb), and to share the same power supply.
Overall size is reduced by the use of a new thin film circuitry while the device still retains all the functions of the earlier device.
When combined with the HY50 & power supply only potentiometers are required to complete a simple mono amplifier with input & output facilities expected to be found on Hi-Fi amplifiers.
The combination of two HY5's two HY50's sharing a common power supply (PSU50) are linked by a balance control to form a complete stereo system.

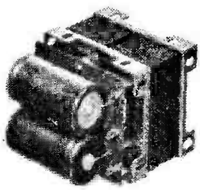
SPEC.

INPUTS
Magnetic Pick-up 3mV (within 1db RIAA curve)
Ceramic Pick-up up to 3mV
Microphone 10mV
Tuner 250mV
Auxiliary 3–100mV
Input impedance 47kΩ 1kHz

OUTPUTS
Tape 100mV.
Main output, Odb (0·775volts)

ACTIVE TONE CONTROLS
Treble ± 12db at 10kHz
Bass ± 12db at 100Hz
OVERLOAD CAPABILITY (equalization stage) 40db on most sensitive input
OUTPUT NOISE LEVEL (below 10mV magnetic input) 68db
DISTORTION 0·05% at 1kHz
SUPPLY VOLTAGE ± 16-25 volts
SUPPLY CURRENT 15mA
Price £4·51 mono, £9·02 stereo
Price inclusive of VAT & P & P

POWER SUPPLY PSU50



The new PSU50 has a low profile look being only 2¼ inches high and can be used for either mono or stereo systems.

SPEC.
OUTPUT VOLTAGE ± 25 volts
INPUT VOLTAGE 210-240 volts
SIZE L. 70, D. 90, H. 60 mm

Price £5·23
Price inclusive of VAT & P & P

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Garrard Zero 100 (sgle)	£30·95
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Goldring GL72	£24·95
Goldring GL72/P	£31·90
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Thorens TD125 AB Mk II	£96·95
Thorens TD160 AB & C	£52·45
Thorens TD165 AB & C	£46·95
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Please add 95p P & P and Ins.

Alpha Highgate FT150	£32·95
Amstrad Multiplex 3000	£23·80
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Rogers R/brook FET 4 (Cased)	£36·50
Sinclair 2000 tuner	£26·95
Sinclair 4000 tuner	£27·95
Teleton GT202 (N/P)	£29·95

SPEAKERS

£1·65 for P & P (Per Pair)

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Please add 95p P & P and Ins.

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Amstrad Integra 4000	£23·90
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Sinclair PZ6 Power Supp.	£6·15
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Sinclair PZ8 Power Supp.	£6·15

TUNER/AMPLIFIERS

Please add £1·10 P & P and Ins.

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Goodmans Mod. 90	£86·75
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NEW WIDE RANGE WOBBULATOR. 5 MHz to 150 MHz up to 15 MHz sweep width. Only 3 controls, preset RF level, sweep width and frequency. Ideal for 10·7 or TV IF alignment, filters, receivers. Can be used with any general purpose scope. Full instructions supplied. Connect 6 3V A.C. and use within minutes of receiving. All this for ONLY **£5·75, P. & P. 25p.** (Not cased, not calibrated.)

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EARPIECES. Magnetic, with 2·5mm or 3·5mm plug on lead **12p.** CRYSTAL (with 3·5 plug only) **30p.** (ALL up to 6 for **9p**).
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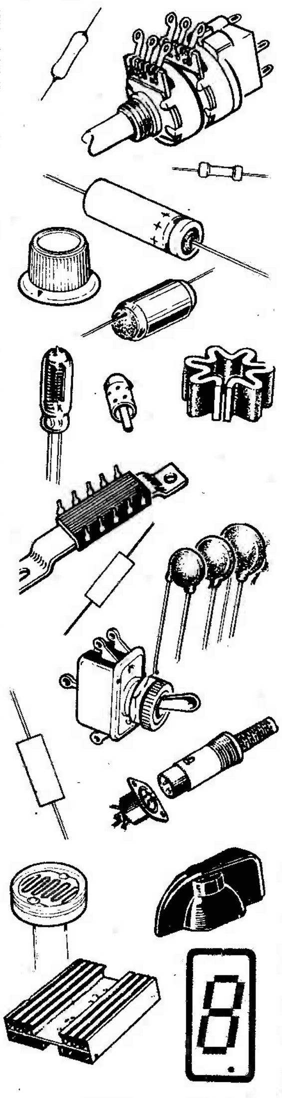

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ELECTROLYTIC CAPACITORS

Axial Lead

Rated volt.: Capacity μF	3V	6·3V	10V	16V	25V	40V	63V	100V
0·47	—	—	—	—	—	—	11p	8p
1·0	—	—	—	—	—	11p	—	8p
2·2	—	—	—	—	11p	—	8p	9p
4·7	—	—	—	11p	—	8p	9p	8p
10	—	—	—	—	8p	9p	8p	8p
22	—	—	8p	—	9p	8p	8p	10p
47	8p	—	9p	8p	9p	8p	10p	13p
100	9p	8p	8p	8p	9p	10p	12p	19p
220	8p	8p	9p	10p	10p	11p	17p	28p
470	9p	10p	10p	11p	13p	17p	24p	45p
1,000	11p	13p	13p	17p	20p	25p	41p	—
2,200	15p	18p	23p	26p	37p	41p	—	—
4,700	26p	30p	39p	44p	58p	—	—	—
10,000	42p	46p	—	—	—	—	—	—

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SINGLE P20 lin. 100 Ω to 2·2M Ω **14p**.
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RESISTORS—10%, 5%, 2%

Code	Power	Tolerance	Range	Values available
C	1/20W	5%	82 Ω–220K Ω	E12
C	1/8W	5%	4·7 Ω–470K Ω	E24
C	1/4W	5%	4·7 Ω–10M Ω	E12
C	1/2W	5%	4·7 Ω–10M Ω	E24
C	1W	5%	4·7 Ω–10M Ω	E12
MO	1/2W	2%	10 Ω–1M Ω	E24
WW	1W	10% ±1/20 Ω	0·22 Ω–3·9 Ω	E12
WW	3W	5%	1 Ω–10K Ω	E12
WW	7W	5%	1 Ω–10K Ω	E12

Code	1–9	10–99 (see note below)	100 up*
C	9	8	7·5
C	1	0·9	0·75 nett
C	1	0·9	0·75 nett
C	1·2	1	0·95 nett
C	2·5	2	1·6 nett
MO	4	3	2 nett
WW	7	7	6
WW	7	7	6
WW	9	9	8

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MO—metal oxide, Electrosil TR5, ultra low noise.
WW—wire wound, Plessey.

Values:
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Prices are in pence each for quantities of the same ohmic value and power rating. NOT mixed values. (Ignore fractions of one penny on total value of resistor order.) *Prices apply to units of 100 only.

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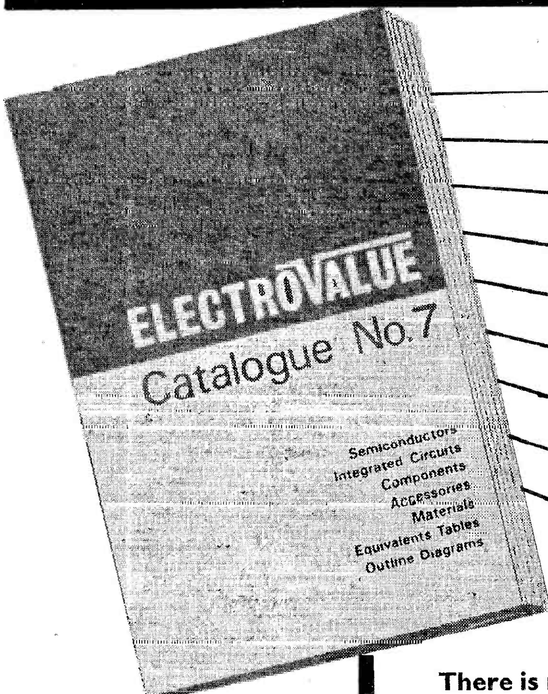
CATALOGUE 7



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5CG8	.55	6EW6	.75	9D7	.65	30FL1	.75	DAF91	.30	ECC189	.53
5T4	.30	6E5	1.00	10C2	.65	30FL2	.75	DAF96	.44	ECC804	.60
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5Y3GT	.60	6F13	.55	10F9	.65	30FL14	.85	DH63	.59	ECF82	.34
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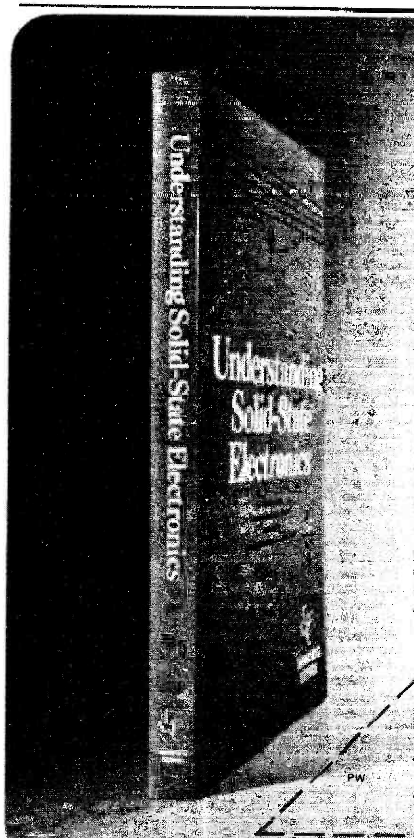

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680µF	13p	150µF	8p	10µF	6½p
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950 Kit. Five matched speakers and crossover unit for handling up to 45 watts, from 20 to 20,000 Hz. Huge - 19″ x 14″ (approx.) high efficiency 16, 500-gauss bass unit built on a heavy diecast frame. The four 10,000 gauss tweeters, each $3\frac{1}{4}''$ dia. approx., are fed by the crossover with a critically adjusted signal for maximum fidelity. Impedance at 1 kHz is 8 ohms. Bass coil 2″, others 0·5″. Recommended list price £44·00.

OUR PRICE £25·00 £1·50 p & p

15″ 14A/780. Bass unit on a rigid diecast chassis. Superior cone material handles up to 50 watts RMS, and is treated to give a smooth frequency response. Resonance 30 Hz. Fluse 360,000 Maxwells. Impedance at 1 kHz is 8 ohms. 3″ voice coil. Rec. retail price £40·80.

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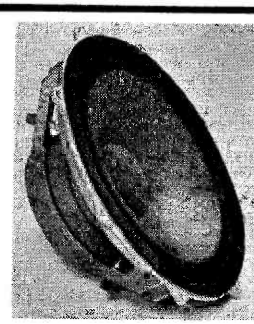

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RTVC

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The unique VISCOUNT III amplifier, plus the Garrard SP25 Mk III deck, plus the magnificent Duo Type III matched speakers (or Duo Type II for a small room) give you an audio installation that will prove unbeatable for listening pleasure! And the teak finish will harmonise and enhance virtually any style of interior decor! On the brushed aluminium front panel of the amplifier you'll find all the facilities you need—volume, bass, treble and balance controls, plus switches for mono/stereo, on/off function and bass and treble filters. Plus headphone socket on the back.
The heart-stopping timbre of Tom Jones at his most virile . . . the last lingering harmonics of a solo performance by Heifetz or Menuhin. . . , the pathos and the panache of Liza Minelli . . the majestic sonorities of the brass band and the elfin subtleties of the virtuoso clavichordist—hear every nuance with a fidelity that you have *never* experienced before!
Come and hear VISCOUNT III! If it's inconvenient to travel, buy by post in the confidence that you won't be disappointed (and with a 24-carat Money-Back Guarantee to give you extra reassurance). Don't settle for second-best!
SPEAKERS: **Duo Type II** Size approx. 17in × 10½in × 6½in. Drive unit 13in × 8in with parasitic tweeter. Max. power 10 watts 8 ohms. Simulated Teak cabinet. £14·00 a pair + £2·20 p. & p. **Duo Type III** Size approx. 23½in × 11½in × 9½in. Drive unit approx 13½in × 8½in with HF speaker. Max. power 20 watts, 8 ohms. Freq. range 20Hz to 20kHz. Teak veneer cabinet. £32·00 a pair + £3·30 p. & p.

STILL ONLY £49 COMPLETE

PRICES : SYSTEM 1

Viscount III R102 amplifier	£24·20 + £1 p & p
2 Duo Type II speakers	£14·00 + £2·20 p & p
Garrard SP25 Mk III with MAG. cartridge /plinth & cover	£18·00 + £1·75 p & p
total	£56·20
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PRICES : SYSTEM 2

Viscount R102 amplifier	£24·20 + £1 p & p
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Garrard SP25 Mk III with MAG cartridge plinth & cover	£18·00 + £1·75 p & p
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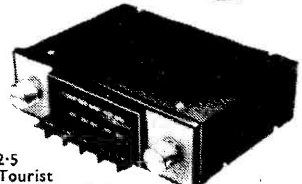
THE TOURIST PUSH-BUTTON CAR RADIO KIT £6·60

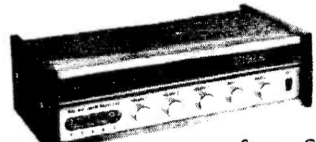


The Tourist PB is suitable for 12 volt working on both negative and positive earth vehicles. It covers the full medium and long wave bands. It is permeability tuned and sturdily constructed. Output is a full 2·5 watts into an 8 ohms speaker. But the Tourist PB will operate into any loud-speaker from 8 to 15 ohms.
Apart from the output stage, which is an integrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modulised IF stages which are pre-aligned before despatch. As well as electronic components this kit also contains 2 diamond-spun aluminium knobs, elegant matching front panel, dial, washers, screws and wire.
The Tourist PB can be mounted in any standard size dash panel and it has an illuminated tuning scale. Chassis size is: 7in wide, 2in high and 4$\frac{3}{16}$in deep. Circuit diagram and comprehensive instructions 55p free with parts.
Fully retractable and lockable car aerial £1·37 post paid.

CAR RADIO KIT £6·60 p. and p. 55p. Speaker with baffle and fixing strips £1·65, + 23p p. & p. post free if bought with the kit. Send stamped addressed envelope for leaflet.
If you can solder on printed circuit board, you can build this push-button car radio kit. It's simple—just follow the step-by-step instructions.

RELIANT Mk IV

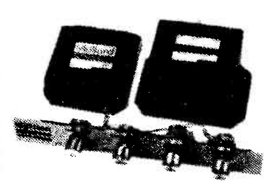
MONO AMPLIFIER



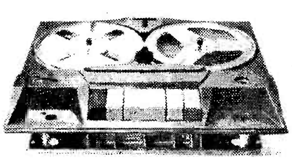
*5 Electrically Mixed inputs. *3 Individual Mixing controls. *Separate bass and treble controls common to all 5 inputs. *Mixer employing F.E.T. (Field Effect Transistors). *Solid State Circuitry. *Attractive Styling.
INPUTS 1. Crystal Mic or Guitar 9mV. 2. Moving coil Mic. or Guitar 8mV. Inputs 3, 4 & 5 are suitable for a wide range of medium output equipment (Gram, Tuner, Monitor, Organ, etc.) All 250mV sensitivity. Output 20 watts into 8 Ω (suitable for 15 Ω.) Size approx. 12½ x 6 x 3½ ins. **£13·50** p. & p. 60p

UNISOUND MODULES

ONLY £7·64 + 55p. p & p

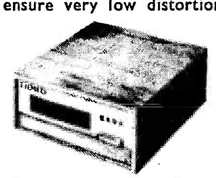


For the man who wants to design his own stereo—here's your chance to start, with Unisound—pre-amp, power amplifier and control panel. No soldering—just simply screw together. 4 watts per channel into 8 ohms. Inputs: 120mV (for ceramic cartridge). The heart of Unisound is high efficiency I.C. monolithic power chips which ensure very low distortion over the audio spectrum.



PE TAPE LINK CONSTRUCTORS

Suitable 3 speed tape deck, **less heads.** Caters up to 5¾ins. spools. 240V AC mains. Unused but store soiled hence no warranty. £1 p. & p. **£4.00**



IN-CAR ENTERTAINMENT AT HOME

With this elegant stereo 8 track add on unit, audio enthusiasts now have the opportunity to extend their systems to include the playing of 8 track cartridges. Simply select your channel, by push button, four digital lamps indicate channel selected. The Viscount III, the fabulous Stereo 21 and the Unisound Modules will accept this unit, simply connect up. **£10·60** + 90p. p. & p.

SEE OPPOSITE PAGE FOR ADDRESS DETAILS

DIAGNOSIS

OF all the constructional projects that you can possibly think of, which do you think would attract the least interest? Before you answer, take a look at our contents page this month and you will very likely find a clue. It is probably understandable that test equipment does not reach the realms of glamour in most constructors eyes, perhaps because it does not perform an entertaining function. But if you are always looking for entertainment you will be missing out on the "nitty-gritty" of the true do-it-yourselfer.

What does test equipment conjure up in your mind on first impact; a box of knobs, dials and meters, a standard performance by which your other projects are compared, or a dull boring necessity to the spectrum of your fullest activities? All of these are confirmed to us by readers who write to us asking for guidance in fault-finding or setting-up.

If you have test gear, that's fine; if you bought it ready made, you should know what it can do for you. Most of all its performance and/or limitations must be compatible with your requirements.

There are areas, however, that are either too specialised or require only occasional application of test gear, making the cost of outright purchase too high. This is where the constructor comes into his own.

This issue of *Practical Wireless* takes a look at some test equipment and next month starts a series that will help you to obtain the most from oscilloscopes. Some simple add-on circuitry is often useful and we will be publishing some ideas later with constructional details. Also in this issue is the second part of the "Trouble Tracer" which will be valuable for those who like to cure faults on a wide range of radio and audio equipment.

Of special interest is the stabilised 30 volt power supply, designed for transistor and i.c. circuitry; this is invaluable as a workshop "tool" or as a standby supply in the event of failure in other equipment. We also have a neat little unit that can be used for testing Zener diodes, and next month's issue will include a signal generator providing square, pulse and triangular waveforms.

Test equipment presents an art of its own, the brick wall on which much other equipment likes to lean. It is security to the "home-brew" and peace of mind to the constructor. It has even been described as the difference between furrowed brows and inspired genius—possessing a magical potion that cannot be obtained on doctor's prescription. Probably the greatest asset of test gear is its usefulness as an electronic doctor, diagnosing symptoms and dispensing strange "noises". You, the constructor, are the surgeon.

M. A. COLWELL—*Editor*.

The March issue will include P.W. CRATA; a waveform generator providing square, pulse and triangular waveforms; a second channel interference rejector (or pre-selector) for 10 to 30 MHz; P.W. Datacards nos. 7 and 8; a crystal calibrator and the start of our series on using oscilloscopes. We apologise that this latter feature could not be started in this issue due to an overwhelming demand on our space.

Further details on page 967

NEWS...

Tandy's here!

A massive American operation called Tandy is now installed at their new warehouse premises just north of Birmingham. Tandy aims to acquire retail outlets and issue franchises to sell its own branded audio, electronic components and kits.

Their optimism in the face of the existing competition is to be admired, but has already caused some component suppliers to beware of the power of the financial backing of Tandy. For readers of this magazine, they offer a very wide range of components, and goods in the domestic electronics field were packed in wooden crates originating from Taiwan. The shop at the front of the warehouse was large and a browser's paradise. Our reporter, however, arrived with some degree of concern for the British businessmen; even the launching festivities did not deter him from talking to the Area Sales Manager in the shop. Whilst the components side of the business was our main interest, we were surprised to find that "bubble-pack" cards bearing American prices had also been priced in Sterling. A glossy catalogue shows only a part of the range, and readers who acquire one will be surprised to find component prices so much higher than in most British concerns.

Our reporter concluded that Tandy must belatedly study the British market or think again.

Sonex 74—Latest

THE Sonex, high fidelity exhibition, will be at the Post House Hotel, London Airport, from March 29 to 31st.

The Post House is ideally situated to the M4 Motorway and the airport giving easy access to overseas and British visitors. The organisers, British Audio Promotions Limited, confidently expect that they will be able to provide adequate car parking facilities close by.

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

IMPORTANT MESSAGE TO ALL READERS

Readers of "Practical Wireless" and most other magazines will be aware of the restrictions imposed by the Government and as a result of Trades Union action in various industries. To ensure that you receive your copy of "Practical Wireless" at the earliest possible date, we have to rely on effective communications and delivery through the post and by railway. We also depend on the operation of electrical equipment and printing machinery. Petrol and diesel oil are vital to the needs of our job in quick and effective processing of editorial and advertising material.

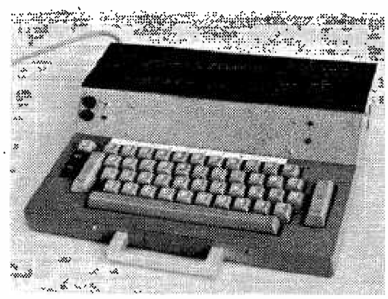
We are sure that you will understand the many problems that confront all of us. We therefore request your patience and understanding during any temporary period when publication may be delayed.

It would help you and us enormously if you make sure of ordering your copy of "Practical Wireless" in advance. We try to help you by telling you a little of what will be published in the next issue and what you can expect in future issues of P.W.

Electronic aid for the disabled

ABOUT five years ago, Toby Churchill—a qualified mechanical engineer working for Lucas—contracted an unidentified virus disease which left him with a number of disabilities. These include a complete loss of the power of speech and a paralysed right arm.

He conceived the idea of a portable electronic device which would enable him to communicate with others easily and set about the task of putting his idea into practice. After reviewing the electronic components available, he knew that his ideas were not just a pipe dream but a practical possibility. The Engineering Department at Cambridge University heard of Toby's ideas and agreed that they would form the basis of a worthwhile project.



Very quickly the ideas became reality. A typewriter-like keyboard was coupled to a Burroughs 'self-scan' display system. Circuits were designed to allow the unit to be powered from rechargeable batteries.

Toby now talks to people using the keyboard: the letters, words and numerals appear in a very easily-read form on the self-scan display panel.

A number of people assisted with the development of the unit —which has been called the Lightwriter—in many different ways. Burroughs, keyboard manufacturers, Cambridge University and Burroughs' UK agents, Walmore Electronics Ltd., all played their parts.

As a result of pressure from friends and acquaintances with similar disabilities, a company—Toby Churchill Ltd.—has been set up to manufacture the Lightwriter. The company has financial backing and production facilities, and it is expected that the first units will become available in the first half of 1974.

The heart of the Lightwriter is the self-scan display panel which is manufactured by Burroughs Corporation in America and available through the UK agents, Walmore Electronics Ltd. It was found that the self-scan display was the only display device available which successfully met all the Lightwriter's requirements.

The display unit consists of a long matrix of special gas-discharge tubes set in cavities. The display used in the Lightwriter has sufficient cavities to form 32 properly spaced alpha-numeric characters, each character being presented in a 5 x 7 dot matrix format.

British quad success

A BRITISH research team has developed a quadrophonic sound recording and reproduction system that could be an answer to the complex requirements of broadcasting quad while being adaptable to existing commercial systems. The work has been carried out at the University of Reading in collaboration with IMF, the broadcast monitor loudspeaker company, under sponsorship of the National Research Development Corporation.

In a communication from John Wright of IMF, the system describes a recording technology compatible with existing disc, tape and f.m. broadcasting and will be publicly demonstrated at the Sonex exhibition at the Post House Hotel, Heathrow Airport, in March. The system, called "ambisonics", is aimed at giving the listener the experience not only of the spacial disposition of the performers, but also of the directional qualities of the reverberant sound, thus extending the stereo medium beyond currently used stereo and quadraphonics.

A full account of information so far available has been written for *Practical Wireless* and appears in this issue.

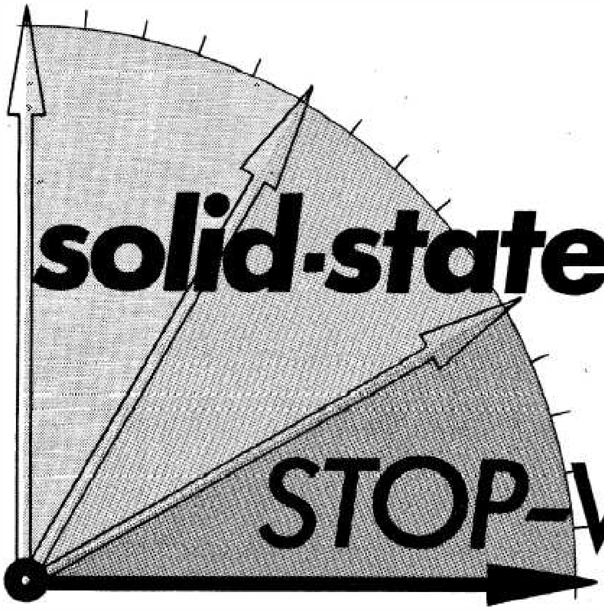
Mid-Lanark A.R.C.

THE Mid-Lanark Amateur Radio Club have sent us details of their future programme. On 4th January they will have a lecture entitled "The Oscilloscope"—how it works and how to use it. A demonstration will be given by GM8DRQ.

On 1st February there will be an Amateur TV demonstration by GM6ADR/T.

Meetings are held at 7.30 p.m. in the Wrangholm Hall Community Centre, Jerviston Road, Motherwell.

Visitors will be made especially welcome and should 'phone D. H. Plumridge (Hon. Sec.) on Hamilton 28759 if further information is required.



solid-state STOP-WATCH

R.JEFFERSON

As its title suggests, this instrument was designed as an electronic alternative to a conventional stop-watch. The main design requirements were:—

(a) Good accuracy and reproducibility
(b) Simplicity
(c) Low cost

The low cost requirement ruled out a digital timer, so an analogue circuit was used. The final circuit gives three ranges, 0-5, 0-15 and 0-50 seconds, and the complete instrument including case and meter can be built for about £7.

THEORY

For a capacitor C charged to a voltage V, the charge Q is given by:—

$$Q=CV \quad \text{.........................(1)}$$

However, assuming the capacitor was previously discharged, the charge Q is also equal to the integral of the current I with respect to time t:—

$$Q=\int I\,dt \quad \text{.........................(2)}$$

If the charging current is held constant, this simplifies to:—

$$Q=It \quad \text{.........................(3)}$$

Combining equations (1) and (3) gives:—

$$It=CV \text{ and, rearranging, } t=\frac{C}{I}\times V$$

If C and I are made numerically equal, the time in seconds can be read directly as a voltage. This forms the basis of the instrument.

CONSTANT-CURRENT GENERATOR

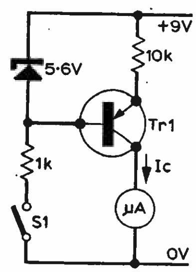
The basic circuit of a constant-current generator is shown in Fig. 1. With S1 open, no base current flows, and the current shown on the meter is the leakage current, which is so low as to be negligible.

When S1 is closed, current flows through the zener diode and the 1kΩ resistor, holding the base 5·6V below the supply voltage. Since Tr1 is now conducting, there is a drop of about 0·6V across the emitter-base junction, so the emitter is held constant at 5V below the supply voltage. This produces a current of 500μA in the 10kΩ resistor and, neglecting the base current, this is also the collector current, which is effectively constant in spite of changes in the supply or collector voltage.

If the meter is replaced by a capacitor, Tr1 will deliver a constant charging current.

HIGH IMPEDANCE VOLTMETER

If the voltage across a capacitor (say 250μF) is measured using a conventional voltmeter (say 20kΩ/V) the capacitor will discharge so rapidly that accurate measurements will be impossible. If a very much larger capacitor is used the discharge is less rapid but leakage currents become a problem. The solution is to use a voltmeter having a very high input impedance.



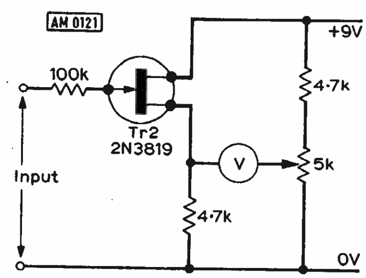


Fig. 1, left: Basic circuit of a constant-current generator. Fig. 2, right: Circuit of high impedance voltmeter.

The circuit is shown in Fig. 2. The FET gives an extremely high input impedance, of the order of 500MΩ so that the time-constant with a 250μF capacitor is about 35 hours! VR1 is used to set the voltmeter to zero when the input is short-circuited.

An interesting feature of this circuit is that the voltmeter does not indicate the absolute value of the input voltage but a proportion of it. However, since all measurements have this constant multiplier (about 0·9 in the prototype) no corrections need be made.

R1 has no effect during normal operation but gives some protection against switching transients.

The capacitor used must be large enough to allow the constant-current transistor to operate at a reasonable collector current but not so large that leakage currents are a problem. In the final circuit a value of 250μF was chosen. Then, with the current at 250μA, the voltage will reach 5V in 5 seconds.

FINAL CIRCUIT

The final circuit is shown in Fig. 3a. S1 is a 3-pole 4-way switch and is used as an on/off switch and a range selector. S1a connects the battery to the circuit while S1b allows three different currents to be preset. S1c, in conjunction with S3, replaces the capacitor C1 with a fixed resistor so that a calibration check may be made.

S2 connects the base circuit of Tr1 and allows a charging current in C1 to flow while it is closed. (Alternative methods of starting and stopping the timer are given later in the text.)

The diodes D1 and D2 act as a low votage zener diode and hold the base of Tr1 at about 1·2V below the supply voltage as part of the constant current generator.

S4 short-circuits the input to the voltmeter circuit and discharges the capacitor C1 if S3 is "Normal". While S4 is operated VR4 is adjusted so that the voltmeter reads zero.

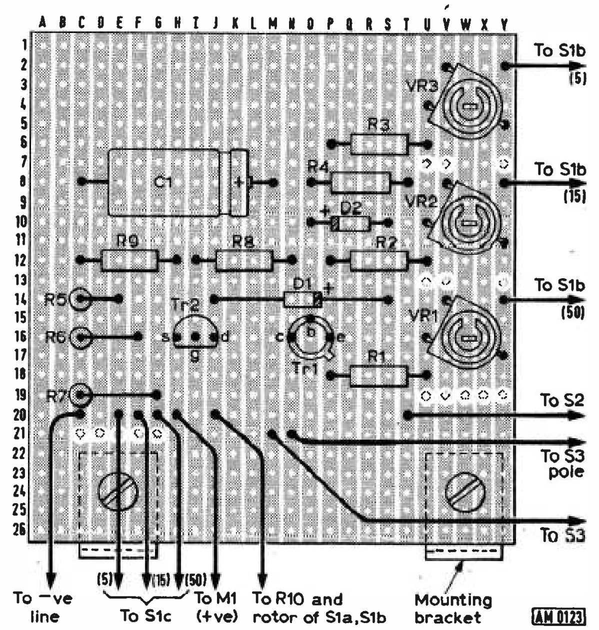


Fig. 3b: Layout of components on 0·1in matrix standard Veroboard. Remainder of components are located on front panel.

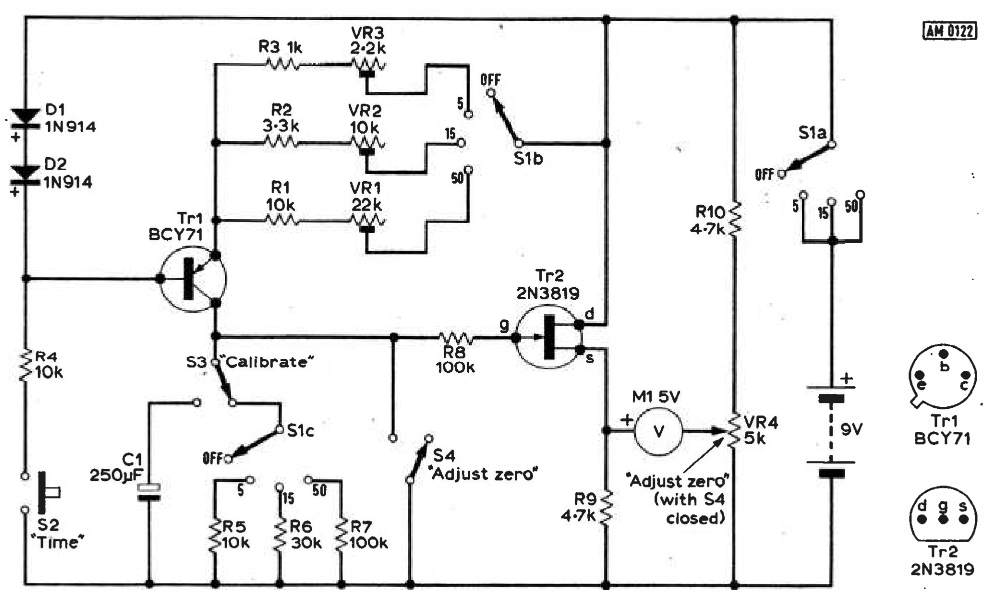


Fig. 3a: Complete circuit of the electronic stop-watch combining the circuits of Figs. 1 and 2.

CONSTRUCTION

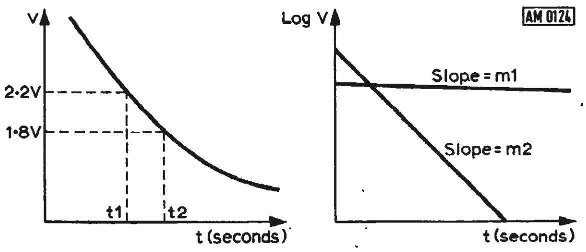
Layout is not critical, and the method of construction may be varied considerably. The prototype used an Elf instrument case which provides a smart and convenient housing.

The meter should be chosen for accuracy and readability. It need not be mounted in the case: a multimeter set to the 5V range and connected by flying leads would work perfectly well, although this arrangement might be rather cumbersome. With a 5V meter, the maximum overload that can occur to the meter is about 50%, which should not cause any damage.

CALIBRATION

C1 must first be checked for an acceptably low leakage current. S1 should be set to range 1 and the capacitor charged to about 4V. S2 should now be released and a note made of the voltage and the time. The voltage should be checked again 15 minutes later: it should be at least 90% of its original value. If the voltage has fallen below 90% the leakage current is too high and C1 must be replaced (although it may still be suitable for other circuits).

There are two methods of measuring the value of C1 given here, as alternatives.



Figs. 4 and 5: Graphs to illustrate the two methods of determining the value of C1.

Simple method

R11 should be temporarily wired across C1, and the capacitor charged to about 4V. When the charging current is stopped the voltage should fall faster than before. Plot a graph of voltage against time, taking readings every 15 seconds for 10 minutes.

Draw a smooth curve, Fig. 4, through the points and note the time in seconds at 2·2V and 1·8V, t_1 and t_2 respectively.

The value of C is given by $C = 5(t_2 - t_1)\mu F$.

Example. If $t_1 = 212$ seconds and $t_2 = 280$ seconds, C is 5 (280−212) = 340μF.

For the mathematically minded, the theory of this method is as follows:—

At any instant t_1 the current through the resistor is given by V/1MΩ = VμA.

For small changes in voltage, the exponential discharge may be considered linear with time, so that if the voltage falls from V_1 to V_2 the average current through R11 is $V_1 + V_2/2\mu A$.

Hence the charge lost by C1 is $V_1 + V_2/2 \times t$.

But this is also equal to $C(V_1 - V_2)$, therefore:—

$$C = \frac{V_1 + V_2}{2(V_1 - V_2)} \times t\,\mu F.$$

Although the purist may note that the average voltage is less than

$$\frac{V_1 + V_2}{2}$$

the effective discharge resistance is rather less than 1MΩ, due to leakage, and these two errors tend to cancel.

★ components list

Resistors:

R1 10kΩ 5% R5 10kΩ 2% R9 4·7kΩ 5%
R2 3·3kΩ 5% R6 30kΩ 2% R10 4·7kΩ 5%
R3 1kΩ 5% R7 100kΩ 2% R11 1MΩ 2%
R4 10kΩ 5% R8 100kΩ 5%

All resistors ¼W. The final calibration depends largely on the accuracy of R5, R6, R7 and R11, so use 2% or better. R11 is used only for calibration so does not appear in circuit diagrams.

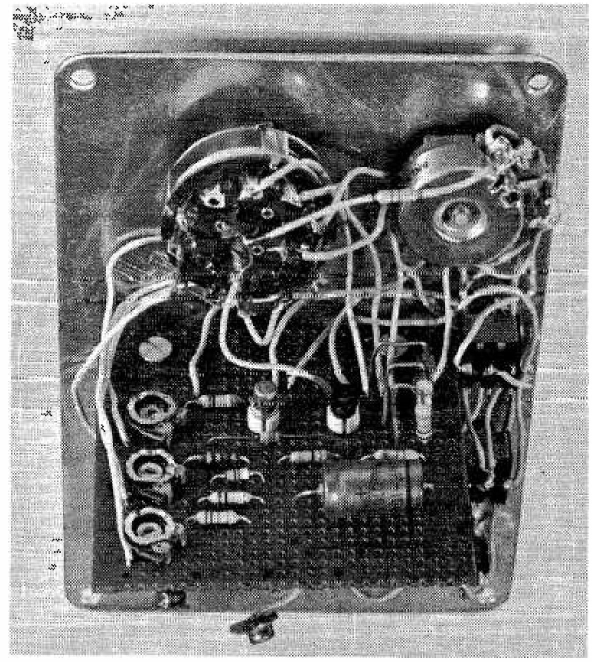
VR1 22kΩ VR2 10kΩ VR3 2·2kΩ
All skeleton pre-sets
VR4 5kΩ potentiometer, linear

Semiconductors

Tr1 BCY71 Tr2 2N3819 D1/2 1N914

Miscellaneous

Capacitor C1, 250μF 16V, see text. Meter, 5VDC FSD (G. W. Smith Model SD640). Switch S1, 4 pole 3 way, break before make. S2 SPST, push-to-make. S3, SPCO biassed toggle. S4, SPST push-to-make. Veroboard. Battery PP3 and terminal clips. Knobs. Instrument case (West Hyde Developments).



Photograph of prototype showing Veroboard bolted to front panel and interconnecting wiring.

Accurate method

For this method a table of natural logarithms is required. If a capacitor C is charged to a voltage Vo and allowed to discharge through its leakage R, the voltage at time t is given by:—

$$V = V_o\, e^{\frac{-t}{CR}}$$

Taking logarithms to the base e:—

$$\log_e V = \log_e V_o - \frac{t}{CR}$$

Plotting $\log_e V$ against t gives a straight-line graph of slope $m_1 = \frac{-1}{CR}$ (see Fig. 5).

R here represents the parallel combination of the capacitor leakage resistance and the input impedance of the FET voltmeter. A second graph is plotted with R11 in parallel with C1.

The effective resistance is now:—

$$\frac{R \times 1M}{R + 1M} \text{ and the slope } m_2 = \frac{-(1+R)}{CR}$$

where R is in MΩ and C is in μF.

Simple algebra shows that $C = \frac{1}{m_1 - m_2}$

(Note that both m_1 and m_2 are negative, and that m_1 is the correction factor for leakage. The value of the leakage resistance is given by $R = (\frac{m_2}{m_1} - 1)$MΩ.

Whichever method is used, at least three "runs" should be plotted and an average taken to give the value of C. R11 should now be removed.

Next the constant-current ranges must be set. If the capacitor was measured as 390μF, as in the prototype, the current on range 3 (0-5 seconds) should be set to 390μA. Switch S3 to CAL and adjust VR3 until the voltmeter indicates 3·90V. Now switch to range 2 and adjust VR2 until the voltmeter again reads 3·90V. Repeat using VR1 on range 1.

Finally operate S4 and check that the meter still reads zero. If the zero has drifted it must be re-adjusted using VR4, when VR1, VR2 and VR3 may all have to be reset.

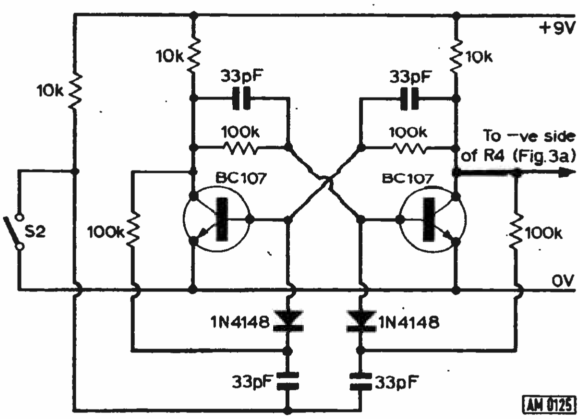


Fig. 6: Additional bistable switch circuit for long intervals, in place of S4.

As it would be rather inconvenient to hold S4 operated during timing, a bistable can be used so that S4 is pressed once to start, and again to stop timing. The circuit is given in Fig. 6.

It is worth remembering that electrolytic capacitors normally have a tolerance range of −50% to +100% so that the nominal 250μF capacitor may have an actual value from 125μF to 500μF

LIGHT OPERATION OF TIMER

Another idea that was used with the prototype was a bistable operated by light-dependent resistors, Fig. 7.

Two LDR's are used, type ORP12. Interrupting the light falling on LDR1 operates the bistable so that Tr2 is conducting, which turns the timer on.

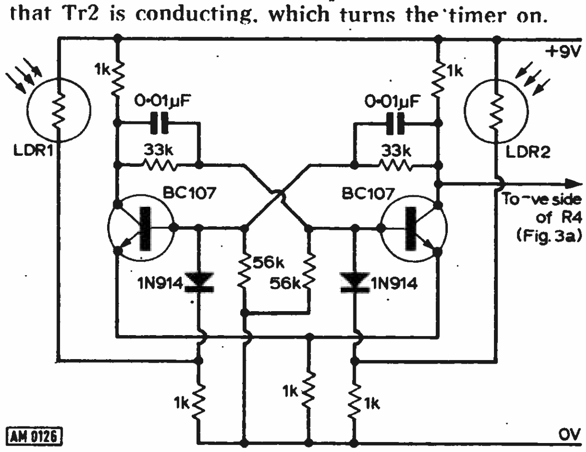


Fig. 7: In this circuit the bistable is operated by LDR's.

Interrupting the light to LDR2 restores the bistable so that Tr2 turns off. R8 may be altered to a lower value which will affect the sensitivity. It may be necessary to increase R6 and R7 to, say 100kΩ if low gain transistors are used. ■

I.C. OF THE MONTH

Number 43 Motorola MC1566L Constant-Current Source

WHEN a constant-current source is required and the various advantages offered by the use of IC's are to be exploited, an input voltage limit of 40 or, possibly, 50V is normally necessary if the IC's are not to be damaged.

Neil Wellenstein, an applications engineer working in Motorola's Arizona laboratories, discovered a means of obtaining a variable constant-current supply with input voltages as high as 750V using a standard regulator IC. In fact, the input voltage is limited only by the breakdown voltage of the series-pass transistors employed.

Development

The IC used by Wellenstein was the MC1566L which has the ability to "float" on its own output voltage. However, when used conventionally, a voltage sensitive error occurs in the constant-current mode which is large enough to prevent the device from being used as a precision constant-current source. Normally the constant-current feature of the MC1566L would only be used to provide short circuit protection when the device is employed as a voltage regulator. The magnitude of the current error is small enough to be of no consequence in this application.

The MC1566 contains a current sensing and a voltage sensing amplifier which "float" on the output voltage and which are supplied from an on-chip regulator. The on-chip regulator receives its input from an auxiliary 25V supply external to the chip.

When used conventionally a constant 1mA flows from pin 3 through a resistor to earth to establish the reference voltage for the voltage sensing amplifier. The error voltage appears between pins 8 and 9. When the device goes into the current limit mode (short circuit conditions) part of the 1mA output from pin 6 can flow through a diode to pin 9 thereby upsetting the error voltage and producing a voltage sensitive output current error.

Practicalities

Wellenstein discovered that by reversing the roles of the voltage and the current sensitive amplifiers, he could eliminate this problem altogether. The accompanying drawing shows the circuit, Fig 1. The net effect is that any portion of the reference current that appears in the load must pass through the current sensing resistor R9 which cannot be bypassed as was previously the case.

The maximum input voltage to the circuit is

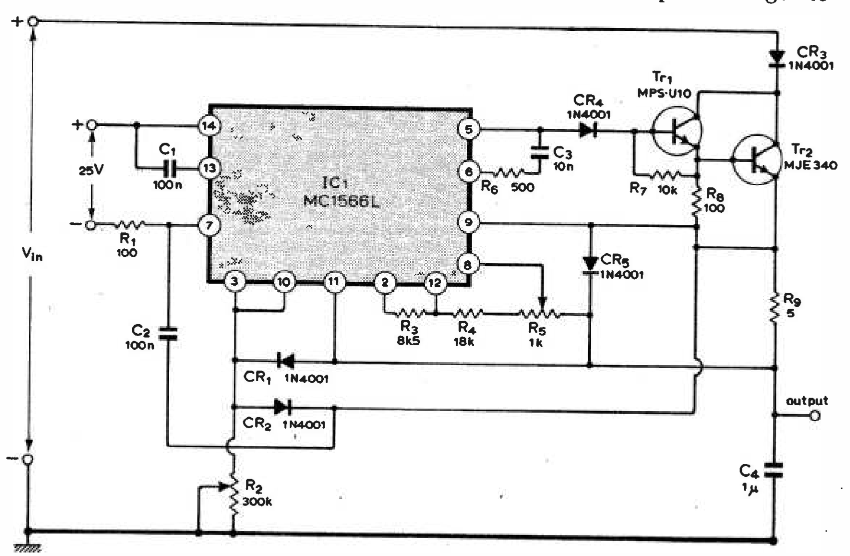


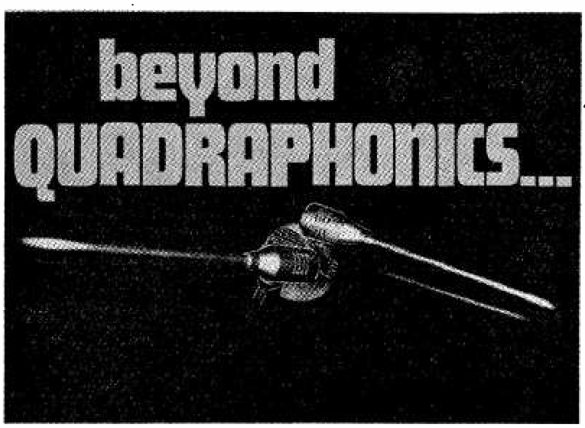
Fig. 1: Practical circuit of the constant-current source fed from a high voltage supply.

—continued on page 950

TO record, without addition or loss, the total directional reverberant information of a live performance inherently needs a microphone technique responsive to the direction of arrival of the sound and capable of delivering this directional information in a format suitable for recording. Such microphones do not at present exist in a commercial form, but have been improvised using tetrahedral arrays of cardioid microphones in promising experiments by Michael Gerzon of the Mathematical Institute, University of Oxford.

An integrated microphone exhibiting these properties is under development with the assistance of Calrec Audio. Such a microphone will sense sounds from all directions, including those from above as well as from all around horizontally.

Sounds having a vertical component cannot be avoided, and the microphone must be designed to respond in a suitable manner so that this vertical information can either be retained or rejected electronically later in the system according to requirements. The signals generated from such a microphone could be amplified and fed directly to four loudspeakers, but *not* with these speakers positioned in the conventional square array.



Similarly the signals, for purposes of information storage, may be fed to a four-channel tape recorder, but again the resultant tape would not be directly suitable for conventional playback.

By the use of suitable decoders such a tape could be replayed through any number of loudspeakers purposefully arranged; these arrangements specifically including the commonly proposed four speaker array or two speaker stereo or even true mono.

This four track tape, or the signals direct from the microphone, may be encoded onto *two* channels of information in such a way that allows the original directional information to be in large measure decoded for multi-speaker playback. The two channel signal, be it on disc, cassette or f.m. radio, is directly suitable without decoding for stereo presentation a la Blumlein and with no more than the usual adverse compatibility to mono when the two channels are directly paralleled.

THREE CHANNEL ENCODING

The original four signals can also be encoded onto the three audio channels potentially available within the bandwidth of f.m. broadcasts, to provide marginal improvement particularly in phase relationship and mono/stereo compatibility. The use of a third channel on disc, possibly of reduced bandwidth, has been advocated by Prof. Duane Cooper of Illinois for similar reasons.

Finally, encoding the four signals onto four tracks of tape or a multiplexed disc such as the JVC-CD4 makes optimal use of the capabilities of four genuine audio channels and enables the full recovery of all information, including that of height, without phase anomalies. Demonstrably there are more versatile ways of employing four independent channels of information than merely feeding them to four loudspeakers.

COMPATIBLE QUAD

Certain of the commercial 'quadraphonic' systems have features consistent with ambisonics, without however exhibiting all its essential properties. Most notably the Nippon-Columbia UMX system of Cooper & Shiga comprises a compatible series of 2-, 3- and 4-channel codings basically consistent with ambisonics although hitherto confined to pan-potting in horizontal angle.

The Japanese 'Regular Matrix' defines a potentially ambisonic 2-channel system, but is vague about the distinction between internal and overhead sounds. Recordings made on any of these systems could be played back through an ambisonic system, with limitations in what could be reproduced but without glaring anomalies, by suitable switching between the basic units of the ambisonic decoders.

It is apparent that true compatibility between different systems, numbers of communication channels, and numbers and configurations of the loudspeakers the listener may use, can come only from the ambisonic approach of considering how to record the directional character of all the sound that may reach the microphone, and then considering how this full directional information can be collapsed down successively to horizontal-only, stereo and mono presentation.

RICHER GAMUT

Experiments with systems aimed at reproducing the true directional quality of original sound shows how restricted are the methods of synthesis and pan-potting in current use. Ambisonics provides a much richer gamut of possibilities.

In so far as it is possible to imitate synthetically the signals due to any sound that the system could record naturally, the possible effects include a previously recorded or synthesised signal being made to appear to recede into the distance or rush up to the listener, changing the character of its reverberance and 'atmosphere', swooping around the listener or even looping the loop.

In addition there is the possibility of creating sounds that never existed in nature, including the so-called 'internal' or 'in-the-head' sounds. At the present stage of development no limits can be placed on the possibilities thus opened up for future developments of the art in synthesised music of 'pop' effects.

In what is called 'serious' music, ambisonics can be the means of reversing the current trend of elaborate recording techniques coming between the listener and the performance. It represents a return to the concept of creating a sound at a good listening position at the live performance, and then recording as accurately as possible the characteristics that give this sound its live quality; surely what 'high fidelity' reproduction is all about.

PARAMETERS

The physical basis of these developments can be expressed in terms of wave-equation of sound. The sound-field at a point is completely determined by knowledge of the pressure p and the three resolved cartesian components of fluid velocity v_x, v_y and v_z. These four parameters can evidently be transmitted along four communication channels each of audio-bandwidth.

A natural way of doing so has been discussed, with much other relevant theory, by Gerzon, in terms of signals representing the four spherical harmonics of order zero and unit, namely 1, x, y, z (where x, y and z are direction cosines and 1 represents an omni-directional component). Note that this or equivalent methods are optimal in the use made of four channels, and are quite distinct from the inferior way the four channels are used in 'quadraphonics'.

If attention is confined to progressive sound-waves, without any standing-wave component, knowledge of the three velocity components v_x, v_y and v_z determines the pressure p uniquely except for an ambiguity of sign caused by the inability to distinguish two waves of opposite phase travelling in opposite directions.

Thus knowledge of p is partially redundant, and this redundancy can be used to compress the information into three channels each of audio bandwidth, if some limitations are accepted. With respect to sounds arriving horizontally, the transformation between four and three channels can be made completely reversible, so that for this application three and four channel systems are strictly equivalent.

TO TWO CHANNELS

The possibility of compression (with some further compromise) into two channels can be expressed in terms of representing the direction of arrival of sound by the two parameters of horizontal angle Θ and vertical angle Φ (i.e. azimuth and altitude angles). Two degrees of freedom are available in a two channel signal, after normalisation to represent the intensity of the sound, namely the relative amplitudes and the relative phases of the signals in the two channels. Thus by using phase information, the three-dimensional sound field can be correctly identified.

Developments in the realisation of the above theoretical possibilities are the subject of current patent applications in the U.K., Canada, Denmark, France, Germany, Italy, Japan, Netherlands, Switzerland and the U.S.A.

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IC OF THE MONTH

—continued from page 948

limited by the series-pass transistor. In the case of the MJE340 shown, the maximum input voltage is 300V. The circuit provides a constant-current output which is adjustable from 200μA to 100mA; above 10mA take care not to exceed the ratings of the MJE340. At both the 200μA and the 1mA settings, output impedance exceeds 200MΩ.

The 1μF capacitor C4 is necessary to ensure circuit stability. However, it limits the rate at which the voltage across the load can change in response to a sudden change in load resistance. This response time can be found by multiplying the capacitor value by the final load resistance. The instantaneous load current is found by dividing the instantaneous output voltage by the final value of load resistance.

The MC1566L is made to a military specification, the 'civilian' equivalent being the MC1466L. The MC1466L costs £3·30, the MPSU10 is 75p and the MJE340 (or BD158) is 41p, all obtainable from Jermyn Home Electronics, 112 Vestry Estate, Sevenoaks, Kent. Add 25p for P/P plus 10% VAT to total cost.

PW TECHNICROSS PUZZLE

Solution to No. 2 presented last month

1 D	2 I	S	3 C	■	4 T	5 W	E	6 E	T	7 E	R	8 S
■	S	■	R	■	■	O	■	L	■	L	■	A
9 R	O	S	Y	■	10 S	O	L	E	N	O	I	D
■	T	■	11 S	E	T	■	■	V	■	P	■	N
12 V	O	L	T	■	R	■	13 D	E	L	E	T	E
■	P	■	14 A	D	A	M	■	N	■	■	■	S
15 B	E	L	L	■	D	■	16 R	■	17 T	A	18 P	S
A	■	■	■	19 L	■	20 T	O	N	E	■	R	■
21 T	A	22 S	S	E	L	■	M	■	23 T	R	I	G
T	■	P	■	N	■	■	24 A	I	R	■	N	■
25 E	L	E	C	T	R	26 O	N	■	27 O	A	T	H
R	■	E	■	I	■	R	■	■	D	■	E	■
28 Y	O	D	E	L	L	E	R	■	29 E	D	D	Y

Two Transistor RECEIVER

R. A. Penfold

ALTHOUGH this receiver uses only two transistors, it is capable of receiving local broadcast stations at reasonable volume from a loudspeaker. In most areas it will also receive several foreign stations after dark. There is also provision for a crystal earpiece.

The set is self contained, having an internal 9 volt battery (PP4), $2\frac{3}{4}$in. dia. loudspeaker and ferrite rod aerial. It tunes the medium wave band only and measures $6 \times 3\frac{1}{8} \times 1\frac{5}{8}$in., excluding control knobs.

As the circuit uses only the minimum of components, it is both inexpensive, and easy to construct and has proved to be stable and reliable. It is a feature of the receiver that once it has been constructed, no special alignment is required before it can be used.

How it works

The circuit consists of a reflexed stage with controlled regeneration, coupled to a single transistor operated as a class A output stage.

The circuit diagram of the receiver is shown in Fig. 1. Tr1 stage provides the majority of the circuit gain. L1 is the tuned winding of the ferrite aerial, and this is tuned by VC1. L2 couples the r.f. signal to the base of Tr1. Tr1 is biased by R1, and C5 plus R2 provide the supply decoupling. R1 is taken to the junction of T1-R2 so that no a.c. negative feedback is introduced, but a certain amount of d.c. feedback is, and this has a stabilising effect on the biasing of Tr1.

The primary winding of T1 forms an a.f./r.f. load for Tr1, and an amplified r.f. signal will appear at Tr1 collector. From here it is coupled via C4 to D1. The r.f. signal is detected by D1. It is important that D1 has the polarity shown.

The audio signal present at the junction of D1-C3 is coupled to the base of Tr1 via L2 winding. Tr1 now operating as an audio amplifier, with T1 primary forming an a.f. load.

In order to increase sensitivity, and also selectivity, regeneration is applied to Tr1 stage. This is the process of feeding some of the r.f. signal at Tr1 collector back to the base of Tr1 (via L1/L2) for further amplification.

Tr1 inverts the r.f. signal, and from Tr1 collector the r.f. signal is coupled via C2 to VR1 slider, and from here via C1 to L1/L2. VR1 controls the regeneration, and maximum sensitivity is obtained with this adjusted just below the point at which the circuit breaks into oscillation. It would appear logical to connect C2 to the top of VR1, and C1 to the slider, but when this was tried the circuit was rather unstable.

Tr1 and Tr2 are coupled by transformer T1, C6 providing the necessary d.c. blocking between the base of Tr2 and the d.c. path to earth through T1 secondary. T1 is a miniature driver transformer for two OC72's. The centre tap on the secondary is ignored. Various transformers were tried and despite differences in impedances and ratios, they all gave virtually identical results.

Tr2 operates as the output transistor. This is biased by R3. The loudspeaker forms the collector load for Tr2 when the loudspeaker is in use, and R4 forms the load when the earpiece is used. The jack socket for the earpiece has a break contact which is used to cut out the loudspeaker from circuit when the earpiece is plugged in. As R4 has a relatively high value it can be left in circuit when the loudspeaker is being used, without having a detrimental effect on performance. C7 introduces a certain amount of negative feedback at the high audio frequencies which helps to improve the audio response.

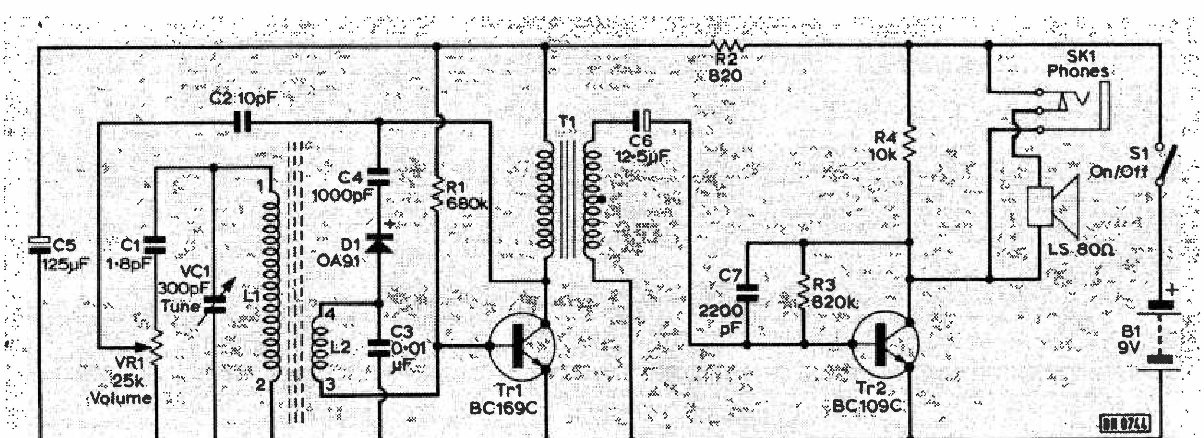

Fig. 1: Circuit of the two transistor receiver.

Ferrite aerial

This is wound on a $4\frac{1}{2} \times \frac{3}{8}$in. ferrite rod. This size should be readily available. Enamelled or d.c.c. wire is used, the exact gauge not being too important. Something in the region of 30-32 s.w.g. is a good choice as this is fairly easy to use, and gives a reasonably compact winding. Fig. 2 shows the construction of the aerial.

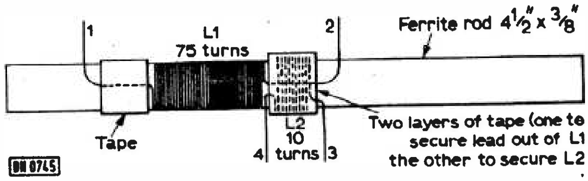

Fig. 2: The ferrite rod aerial.

As can be seen from Fig. 2, L1 winding consists of 75 turns of wire. This wound in a single layer, and should be kept as tidy as possible, avoiding any overlaps. The leads at each end of the coil are taped to the rod, using insulation tape, so as to hold the coil in place. The coil is wound slightly off centre, so that when the aerial is mounted in the case it can be positioned slightly away from the speaker.

L2 winding consists of 10 turns of wire wound over one of the pieces of insulation tape, with a further layer of tape placed on top of this in order to hold it in position. The coil has a single layer, and again it should be free from overlaps.

The case is made from $\frac{1}{16}$in. sheet paxolin, or a similar material. A cut-out for the speaker is made using a coping or fret saw. This and the other holes should be made before the various parts are assembled. The way in which the parts fit together can be ascertained from the diagram. A good quality household adhesive, such as Araldite is recommended.

Two small blocks of wood approx. $\frac{3}{4} \times \frac{5}{8} \times 1$in. are glued to the sides of the case (as shown in Fig. 4). The rear of the case is held in place by two wood screws which pass through two holes already drilled in the back and then screw into the two small blocks of wood.

The method of mounting the ferrite rod can be seen in Fig. 4. The two blocks of wood on which it is mounted measure approx. $1 \times \frac{5}{8} \times \frac{1}{4}$in. and $1\frac{1}{8} \times \frac{5}{8} \times \frac{1}{4}$in. The rod is mounted as far to the rear of the case as possible. A $\frac{3}{8}$in. dia. hole is drilled in each of the blocks of wood, and the rod is pushed into these (it need not be glued). The blocks are then glued to the case.

Some of the initial wiring can now be commenced. This is shown in Fig. 4. This also shows the position of the battery and Veroboard component panel.

Mounting the loudspeaker

A piece of speaker fret is glued behind the speaker cut-out, and the speaker is then in turn carefully glued to this. A sticky backed plastic material is used to cover the case, and so give a smart finish.

VC1, VR1, and the jack socket can then be mounted. VC1 may have a $\frac{3}{8}$in. dia. single hole fixing, but many types have a two or three hole screw fixing. In these cases it is best to glue the capacitor to the front panel.

Veroboard panel

With the exceptions of C1, and R4, all the small components are mounted on a small piece of 0·15in. matrix Veroboard. This has the copper strips running lengthwise. The component layout of this panel is shown in Fig. 3.

If T1 is of a type, which has a mounting clip and flying leads, the clip should be removed and the leads cut short so that it can be treated as a printed circuit type.

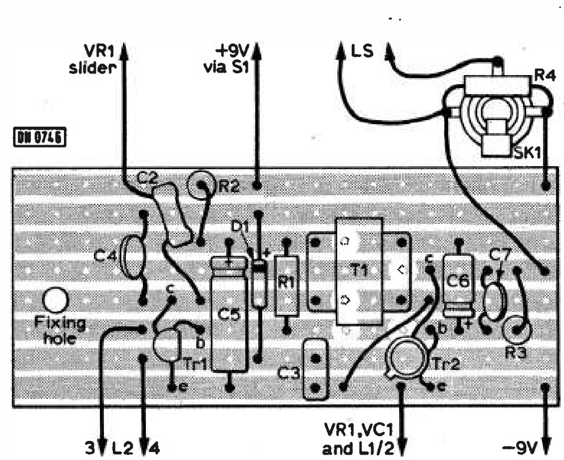

Fig. 3: Veroboard panel component layout.

★ components list

Resistors

R1	680kΩ	R3	820kΩ 5%
R2	820Ω	R4	10kΩ

All ¼ watt, miniature

VR1 25kΩ log or lin with switch

Capacitors

C1 1·8pF ceramic
C2 10pF ceramic
C3 0·01μF polyester
C4 1000pF ceramic
C5 125μF 10 V.W.
C6 12·5μF 25 V.W.
C7 2200pF ceramic

Semiconductors

Tr1 BC169C
Tr2 BC109C
D1 0A91

Miscellaneous

Paxolin, fret, etc. for case; 2¾in, 80Ω L.S. 3·5mm switched jack socket; crystal earpiece with plug (3·5mm); miniature driver transformer (see text); 4½in. x ⅜in. ferrite rod; wire for coils (see text). 250 or 300pF variable capacitor, miniature solid dielectric or air spaced; PP4 battery with clips to suit; Veroboard for component panel; two control knobs, hardware.

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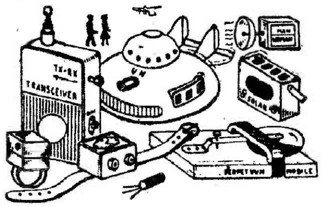

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ECC81	12p	PCL85	20p	6F23	15p
ECC82	12p	PL36	17p	30F5	12p
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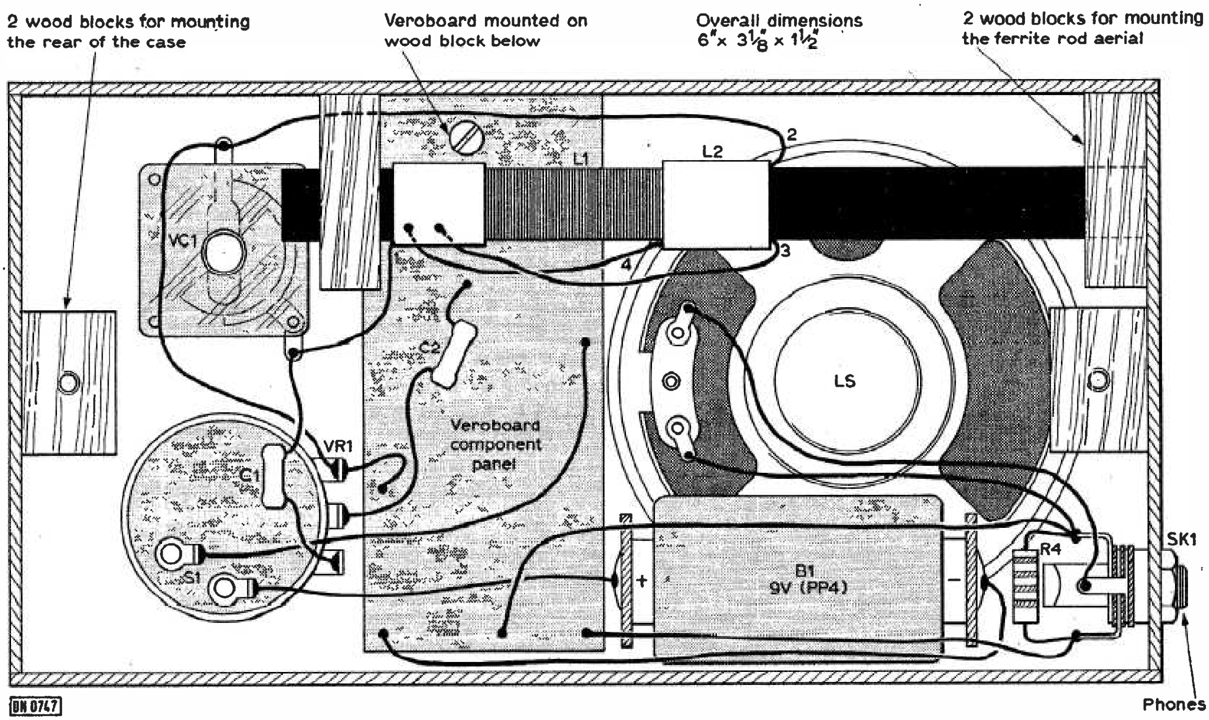

Fig. 4: General construction and layout details.

The 10pF capacitor C2, should have its lead out wires left full length. These can be insulated with sleeving, but this is not essential. The free end of C2 should not be connected to VR1 slider until the Veroboard panel has been mounted

The method of mounting the board is quite simple. A piece of wood approx. $1 \times \frac{3}{4} \times \frac{1}{4}$in. is glued to the inside of the front panel, at the top between the speaker fret and VC1. The Veroboard panel is then positioned as shown in Fig. 4, and a small wood screw is placed through the mounting hole and screwed tight into the block of wood.

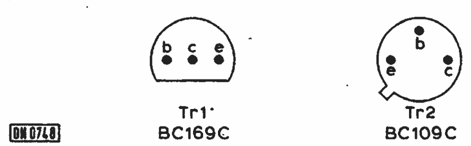

Fig. 5: Transistor base connections.

Using the Set

For initial testing it is suggested that the earpiece is used. If VR1 is adjusted to turn the receiver on, and VC1 is then adjusted, it should be possible to receive two or three stations, although these will probably be rather weak. If VR1 is rotated further clockwise the stations should become louder. If VR1 is turned too far the receiver will begin to oscillate, and whistles will be heard from the earpiece as the set is tuned across the band. If the receiver fails to oscillate, try reversing the connections of L2 winding. The receiver is most sensitive with VR1 set just below the point at which oscillation occurs.

As the ferrite aerial is directional, the set should be rotated for optimum signal.

If the set works properly using the earpiece it can be tried using the speaker. For satisfactory speaker reception it will probably be found necessary to always adjust VR1 for maximum sensitivity and it will need re-adjustment each time the set is retuned.

Conclusion

The receiver may suffer from hand capacity effects. This is where putting ones hand near VC1 tends to slightly alter the tuning. This is a common failing of simple circuits of this type where a single tuning capacitor with a non-metallic chassis is used. It can be eliminated by placing a sheet of aluminium between the front panel and VC1-VR1. The aluminium panel should be connected to the negative supply.

Current consumption of the unit is approximately 11mA when using the loudspeaker and 4mA when using the earpiece. ■

OSCILLOSCOPE TECHNIQUES

Part 1 of this series due to commence in this issue has been held over until the March issue because of pressure on editorial space.

practically wireless commentary by HENRY

No. 102

No noise is . . .

Breathing of a wayward moth.

TELL it not in Gath. Certain of our exalted boffins are dreaming up new ways of overcoming noise. No, not polishing up Dolby—those lads are quite capable of effecting refinements themselves; you should see the latest Japanese version of the Dolby-B circuit, shorn of all but its essentials!

There are alternatives. Now that f.m. broadcasting has become and will continue to become, an everyday part of our lives, some means of bettering signal-to-noise ratio is needed. What we suffered from mono, because we could make a direct and favourable comparison with a.m., is intolerable when we listen to stereo v.h.f. broadcasts.

This is partly psychological. In this country, some parts at any rate, stereo radio is very new: in some parts, still a vague promise. We tend to want our money's worth. We listen more intently. We wait, with bated breath, for some evidence that the studio engineer has his wires crossed and is allowing us to eavesdrop on a prompt from the wrong side of the wings.

The trouble, however, goes deeper. We now have the artistes aware of anti-noise possibilities; feeling they may have been cheated out of their full whack of exposure unless the engineering department has done its damnedest. Can you imagine someone like Arthur Garratt chatting scientifically to us without the full benefit of every decibel available; or James Burke, let alone Raymond Baxter, doing a 'what's to come' piece without the full armoury of technics at their backing?

Evesdrop on a prompt.

Henry was particularly amused by the Larry Adler comment that *Woman's Own* would not let him retain his title for an article: 'What kind of noise annoys an Oistrakh?' They etiolated it to: 'No Noise is Good Noise.'

Beneath the levity is a serious question. What sort of noise *would* annoy an Oistrakh? Certainly not always the same sort of noise that perturbs ordinary mortals like you and me. Noise is a subjective thing. In an iron foundry, Thor could bash on regardless, but while I am tapping out this piece, the clack of a pair of platform soled shoes beneath my window can be utterly distracting. Well, I mean, they have a new *au pair* just down the road . . .

In the middle of the night, noise is the breathing of a wayward moth. To Patrick Moore, 1420MHz is probably the *bête noir* frequency*, while to sundry girl operatives in a factory, constant vibrations at 37Hz caused genuine excuses for sick headaches.

Probably the noise that would annoy an Oistrakh would be a second fiddle slightly out of tune in the opening of the Bach Double Violin Concerto. You can't do much about that with Dolby.

Trouble with the f.m. broadcast situation is that everybody has to be in on the act, or there is no point in applying signal tailoring. The other trouble, less often mentioned, is that current systems act on signals below a certain arbitrary level and within certain frequency bands. Which is all very well, but what about the *background* noise that accompanies some high level sounds and can still be heard?

Studio types will tell you that "compandor" systems carry that particular penalty. Get a few of those big bass drum thwacks in the Panufnik "Heroic Overture" overriding a musing woodwind, and the processing inserts a 'noise swish' that has become so much a familiar phenomenon to us that we think the live performance lacks something.

Just like the old lady who complained after a concert that the orchestra did not sound as 'mellow' as on her pre-transistor radiogram.

Even the best BBC boffins will not be able to reinsert her "lost" frequencies in the right proportion. They cannot even do much to restore power lost to you by your distance from the receiver. It is a point not aired often enough by those hi-fi salesmen who insist (metaphorically) on assuring customers that they can get good stereo on a discarded clothes-line! That is, transmitter power will not of itself determine the range of broadcast reception. This is determined by the height of the aerial, the topography of the earth, humidity, temperature and other atmospheric mysteries. What the extra power does is precisely what we are here concerned with: it improves the signal-to-noise ratio.

* *1420MHz is the radiation frequency of the neutral hydrogen that results from the collision of hydrogen atoms: the intergalactic wavelength.*

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⅛	10%	1 Ω–3·9 Ω	E12	1p	0·8p
⅛	5%	4·7 Ω–1M Ω	E12	1p	0·8p
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Sub-miniature 0·1W, **5p** each. Miniature 0·25W, **7p** each.

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AC126	12p	AF139	32p	BF173	20p	OC44	12p	2N3708	10p
AC127	15p	AF178	32p	BF177	28p	OC45	12p	2N3709	11p
AC128	15p	AF180	40p	BF178	32p	OC70	12p	2N3710	11p
AC131	12p	AF181	40p	BF179	32p	OC71	12p	2N3711	11p
AC132	12p	BC107	12p	BF180	32p	OC72	12p	2N3819	32p
AC176	15p	BC108	12p	BF181	32p	OC81	12p	2N4062	12p
AC187	22p	BC109	12p	BF194	14p	OC82D	12p	2N4286	20p
AC188	22p	BC147	12p	BF195	14p	2N2646	60p	2N4289	20p
AD140	50p	BC148	12p	BF197	15p	2N2904	20p	40360	35p
AD149	45p	BC149	12p	BF200	32p	2N2926	10p	40361	35p
AD161	33p	BC157	14p	BFY50	20p	2N3054	58p	40362	40p
AD162	36p	BC158	14p	BFY51	20p	2N3055	60p	40408	40p
AF114	20p	BC159	14p	BFY52	20p	2N3702	13p	ZTX108	15p
AF115	20p	BC187	22p	BUY105	225p	2N3703	12p	ZTX300	15p
AF116	20p	BD131	75p	OC26	45p	2N3704	13p	ZTX302	20p
AF117	20p	BD132	75p	OC28	50p	2N3705	12p	ZTX500	15p
AF118	38p	BD133	75p	OC35	50p	2N3706	11p	ZXT503	20p

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400mW 5% 3·3V to 30V, **12p.**

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1N4001	50V	1A	7p
1N4002	100V	1A	8p
1N4004	400V	1A	8p
1N4006	800V	1A	10p
1N4007	1000V	1A	10p

SIGNAL

OA85	7p
OA90	5p
OA91	5p
OA202	7p
1N4148	5p
BA114	8p

SLIDER POTENTIOMETERS
86mm x 9mm x 16mm, length of track 59mm.

SINGLE 10K, 25K, 100K log. or lin. **40p.**

DUAL GANG, 10K + 10K etc. log. or lin. **60p.**

KNOB FOR ABOVE, **12p.**

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12in x 6in, **25p**
12 in x 2½in, **10p**
9in x 2in, **7p**

THYRISTORS

2N5060	50V	0·8A	30p
2N5064	200V	0·8A	47p
106F	50V	4A	40p
106D	400V	4A	55p

ALUMINIUM BOXES

AB7	2¾″ x 5½″ x 1½″	50p	AB14	7″ x 5″ x 2½″	84p
AB8	4″ x 4″ x 1½″	50p	AB15	8″ x 6″ x 3″	108p
AB9	4″ x 2¾″ x 1½″	50p	AB16	10″ x 7″ x 3″	122p
AB10	4″ x 5¼″ x 1½″	50p	AB17	10″ x 4½″ x 3″	108p
AB11	4″ x 2½″ x 2″	60p	AB18	12″ x 5″ x 3″	120p
AB12	3″ x 2″ x 1″	44p	AB19	12″ x 8″ x 3″	160p

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2W	24p	4W	45p	TO5 Clip	5p	TO1	Single	5p
3W	36p	6W	60p	TO18 Clip	5p	TO1	Double	8p

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MT60/1	0–24–30–40–48–60V	1A	£2 80
MT60/2	0–24–30–40–48–60V	2A	£3 80

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160V: 0·01μF, 0·015μF, 0·022μF, 0·033μF, 0·047μF, 0·068μF, **3p.** 0·1μF, **3½p.** 0·15μF, **4½p.** 0·22μF, **5p.** 0·33μF, **6p.** 0·47μF, **7½p.** 0·68μF, **11p.** 1·0μF, **13p.**

MULLARD POLYESTER CAPACITORS C280 SERIES
250V P.C. mounting: 0·01μF, 0·015μF, 0·022μF, **3p.** 0·033μF, 0·047μF, 0·068μF, **3½p.** 0·1μF, **4p.** 0·15μF, 0·22μF, **5p.** 0·33μF, **6½p.** 0·47μF, **8½p.** 0·68μF, **11p.** 1·0μF, **13p.** 1·5μF, **20p.** 2·2μF, **24p.**

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(μF/v) 1/63, 1·5/63, 2·2/63, 3·3/63, 4·7/63, 6·8/40, 6·8/63, 10/25, 10/63, 15/16, 15/40, 15/63, 22/10, 22/25, 22/63, 33/6·3, 33/16, 33/40, 47/4, 47/10, 47/25, 47/40, 68/6·3, 68/16, 100/4, 100/10, 100/25, 150/6·3, 150/16, 220/4, 220/6·3, 220/16, 330/4, **6p.** 47/63, 100/40, 150/25, 220/25, 330/10, 470/6·3, **7p.** 68/63, 150/40, 220/40, 330/16, 1000/4, **10p.** 470/10, 680/6·3, **11p.** 100/63, 150/63, 220/63, 1000/10, **12p.** 470/25, 680/16, 1500/6·3, **13p.** 470/40, 680/25, 1000/16, 1500/10, 2200/6·3, **18p.** 330/63, 680/40, 1000/25, 1500/16, 2200/10, 3300/6·3, 4700/4, **21p.**

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0·22μF	35V	4·7μF	35V	33μF	10V
0·47μF	35V	6·8μF	25V	47μF	6·3V
1·0μF	35V	10μF	25V	100μF	3V

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3¾ x 5	27p	27p
17 x 2½	75p	57½p
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17 x 5 (plain)	—	82p
17 x 3¾ (plain)	—	60p
17 x 2½ (plain)	—	42p
2½ x 5 (plain)	—	12p
2½ x 3¾ (plain)	—	11p
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Draw the planned circuit onto a copper laminate board with the P.C. Pen, allow to dry, and immerse the board in the etchant. On removal the circuit remains in high relief.

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		Line Socket	14p
3 Pin	5A	Chassis Plug	16p
		Line Socket	15p
3 Pin	1½A	Chassis Socket	18p
		Line Plug	13p
3 Pin	3A	Chassis Socket	21p
		Line Plug	23p
2 Pin	5A	Line Plug	20p

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VA1026	15p
VA1033	15p
VA1055S	15p
VA1066S	15p
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WAVECHANGE SWITCH 23p
1p 12W, 3p 4W, 2p 2W, 2p 6W, 4p 3W

ROTARY MAINS SWITCH
D.P. 2A **32p**

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741	14 pin DIL	38p
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748	8 pin DIL	45p

DIL Sockets 14 pin and 16 pin **16p**

transistor BIAS & FEEDBACK

G. R. WILDING

TRANSFORMERLESS complementary output stages are widely used in transistor receivers and amplifiers, since they confer the advantage of push-pull operation without the disadvantages of wound components.

The bases of the output pair are directly fed from the collector of the preceding driver stage and it only becomes necessary to include a low value resistive component between driver load and collector to develop the required p.d. for establishing their no-signal forward bias.

When germanium output transistors are used, requiring a base/emitter p.d. of about 0·2V, a silicon diode will develop the voltage to bias them both, but if silicon transistors are employed, two silicon diodes will be necessary.

Alternatively, a low value fixed or variable resistor may be used, and shunted by a miniature thermistor so that as ambient temperature increases, the latter's resistance decreases to reduce forward bias and thus stabilise the mean operating current. In some receivers a diode-connected transistor may be used and, if of similar thermal characteristics to the output pair, will compensate for temperature changes in similar fashion to a thermistor.

Current designs employ diodes, thermistors, fixed and variable resistors in many permutations and some of the more common ones are shown in Fig.1 together with a typical basic transformerless output stage. R1 constitutes the driver collector load with the forward biassed diode developing the required potential for Class B operation, R2 and R3 stabilising output transistor working and minimising their spreads in characteristics.

When the driver collector voltage rises, b/e potential of Tr2 rises to increase its conductance, but the b/e potential of Tr3 is reduced to lower its conductance still further from the Class B position, and into cut-off.

When driver collector voltage reduces, the reverse happens, so that each transistor virtually only amplifies one half-cycle of the applied signal. By carefully selecting the no-signal operating point just above cut-off and therefore the most curved section of the transfer characteristic, highly efficient working with minimum crossover distortion can be achieved.

In the latest GEC 2541/Sobell 1541 portables, the amplifying properties of a transistor are utilised to give particularly good bias compensation against variations in amplifier supply voltage and ambient temperature.

The circuit is shown in Fig.2, with the output from a BC148 pre-amplifier being capacitively fed to audio amplifier Tr64.

This latter stage also DC stabilises the output

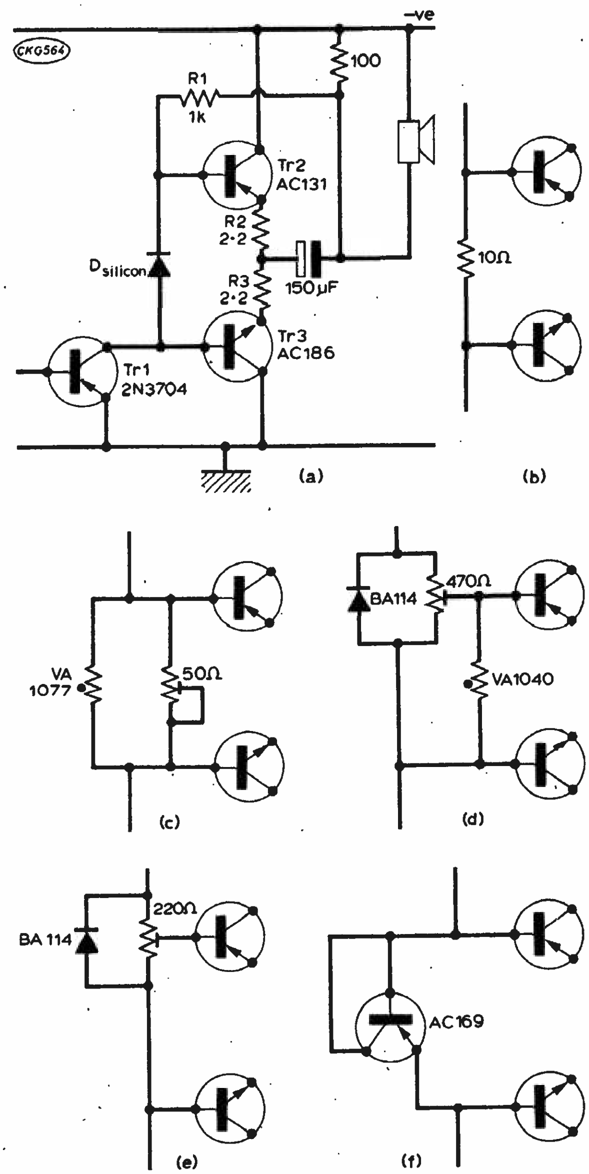


Fig. 1 : (a) Basic complementary push-pull output stage, obtaining bias for the matched transistors from the voltage developed across diode. For germanium transistors, one silicon diode will develop the required p.d., but for silicon transistors, two silicon diodes in series will be necessary. Fig. 1 (b) to (f) : Alternative methods of providing forward bias, showing typical values, exact values depending on transistors used and supply voltage.

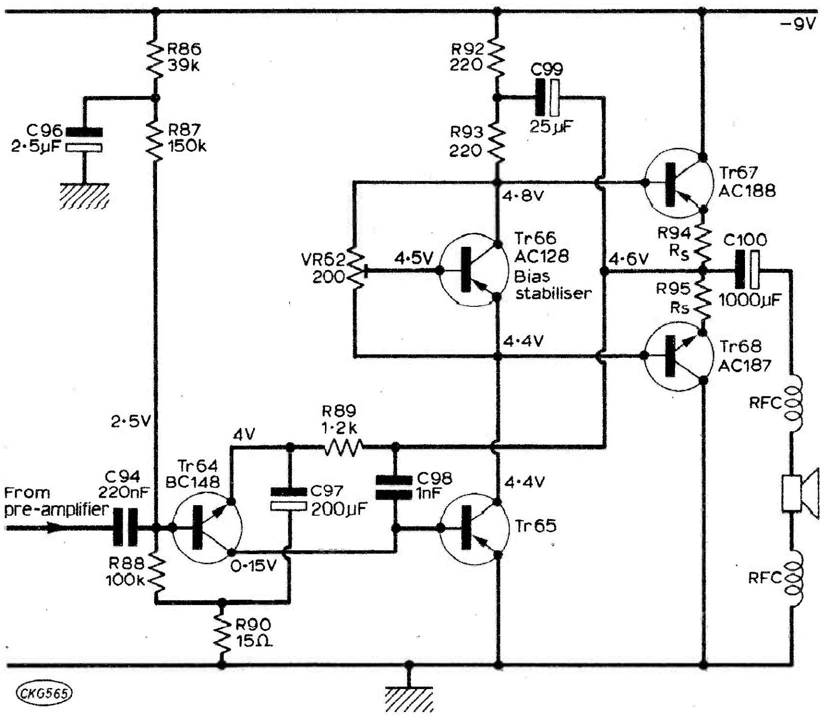
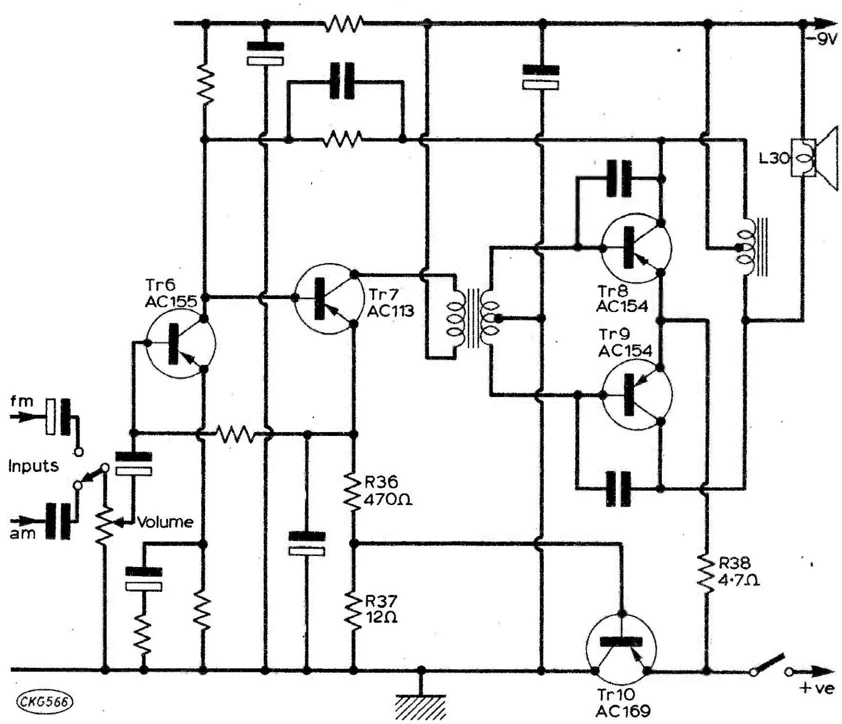


Fig. 2: DC coupled driver and output stages used in GEC 2541/Sobell 1541 six waveband portables. The complementary push-pull output stage is stabilised in two ways, by Tr64 which equalises their mean operating voltages via Tr65, and by Tr66, which compensates their forward bias against variations in supply voltage and ambient temperature.

Fig. 3: AF circuit used in several BRC portables, utilising a saturated transistor Tr10 in series with the supply to provide forward bias to the push-pull output stage. With Tr6 being DC coupled to Tr7, variations in the former's emitter current due to supply or temperature changes produce changes at the junction of R36/37 which effect compensating alterations to Tr10's bias and the voltage developed across it.



transistors, for with its emitter resistor being returned to the junction of their emitter resistors, while its base is held at a fixed potential by the R86/87/88/90 chain, any variation in the voltage at the output transistors emitters produces collector current changes in Tr64, which, due to DC coupling being maintained throughout the circuit, alters the individual biasing of Tr67/68 and equalises their working conditions.

Normally, the voltage at the junction of R94/95 is −4·5V, but if this tends to rise due to inequalities in the conductivity of Tr67/68, the emitter voltage of Tr64 will also be raised to increase its forward bias.

Tr64's collector current will therefore increase and as this is also the base current of driver Tr65, the latter's collector current will increase but decrease its collector voltage applied to the bases of the output transistors.

Net bias to Tr67 will therefore reduce, but increase to Tr68 and result in a lowering of the voltage at the junction of R94/95 to its original value.

Bias compensation is achieved by utilising the voltage developed across Tr66 and VR62 to forward bias the output transistors.

Normally, collector voltage of Tr66 is −4·8V and emitter voltage is −4·4V, and as the junction of R94/95 is −4·6V, ignoring the small voltage drop across resistors, the output transistors are each forward biassed to 0·2V.

Due to the collector current of Tr64 being the base current of Tr65, the latter transistor becomes very sensitive to small changes in supply voltage and temperature. Increases in Tr65's collector current produce proportional increases in the voltage developed between the slider of VR62 and Tr66's emitter to reduce the c/e potential and therefore forward bias to the output stage.

Bias for the transistors in conventional push-pull transformer circuits is usually obtained from a potential-divider across the supply, invariably including a thermistor for compensation against thermal changes.

However, several BRC receivers incorporating this type of circuit employ a transistor specifically for bias compensation whether from changes in temperature or supply voltage.

A typical example of such a circuit is shown in Fig. 3 where the compensating transistor, Tr10, is placed in series with the positive supply line to chassis.

The emitters of the output transistors are returned to positive by the 4·7Ω resistor R38, while the bases are taken directly to chassis via the centre-tapped secondary of the driver transformer.

The chassis is slightly negative to positive supply by the voltage developed across Tr10 which in turn is regulated by the forward bias tapped from the junction of R36/37 in the emitter lead of Tr7.

As Tr6 is DC coupled to Tr7, variations in the former's collector current, due to changes in supply voltage or ambient temperature, become amplified by the latter and produce proportional changes across R37 to vary the bias applied to Tr10 and thus its collector/emitter p.d.

Although worked in a highly saturated condition, Tr10 dissipates only a small wattage since its collector-emitter voltage is only a fraction of 1V.

SINGLE STAGE FEEDBACK

The simplest method of introducing negative feedback to one transistor stage is to omit the emitter resistor's decoupling capacitor, so that as emitter voltage follows base voltage, the effective b/e potential is reduced to reduce stage gain.

When the emitter resistor is fully decoupled, ie, by a capacitor large enough to hold emitter voltage constant at the lowest frequency handled, full gain is obtained.

A less widely used but very effective arrangement is to supply the base bias feed from the transistor's collector instead of from the lt rail.

This can be done whether emitters or collectors stem from chassis, and as well as introducing signal negative feedback, also stabilises the transistors DC working conditions, since an increase in I_c for any reason increases the voltage drop across the collector resistor to reduce forward bias and restore the original position.

For DC stabilisation without signal negative feedback, it is only necessary to split the base bias resistor and decouple the junction with a high value electrolytic capacitor.

An example of such an arrangement is given by both of the low noise audio input stages of the GEC 6+6 stereo unit, as shown in Fig.4.

R312 is the collector load stemming from positive chassis, while R306 and R302 provide forward bias directly from the collector.

Both being of very high value, practically all the

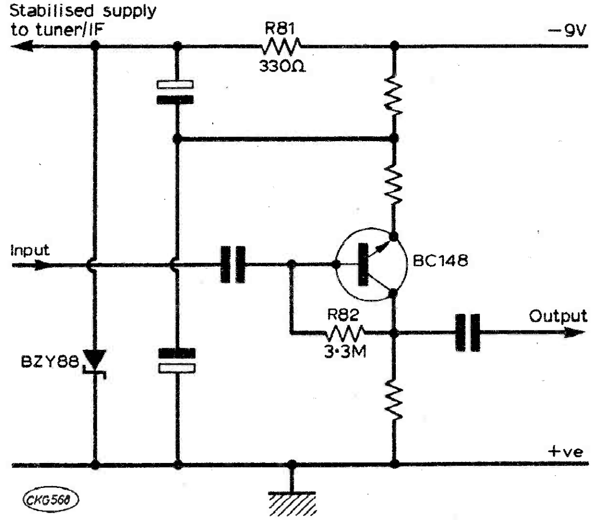


Fig. 5: AF pre-amplifier used in the GEC/Sobell range of portables forward biased by R82 directly from the collector, and applying both negative feedback and DC stabilisation.

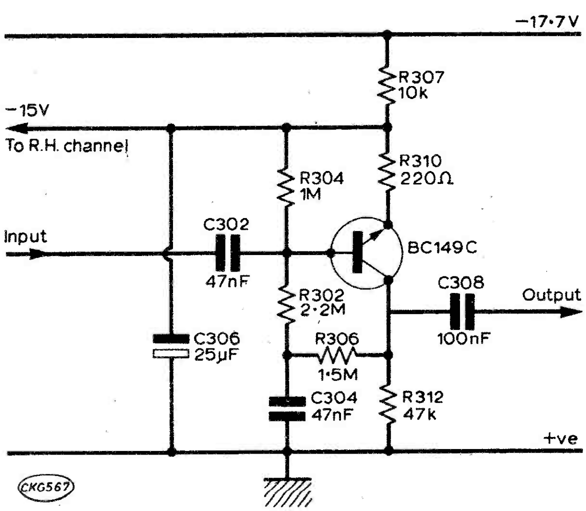


Fig. 4: Low noise audio input stage of GEC six + six stereo unit, forward biased from the collector, but with the AF signal largely filtered out by decoupler C304. R306/302 therefore DC stabilise the transistor while the undercoupled emitter resistor R310 introduces negative feedback.

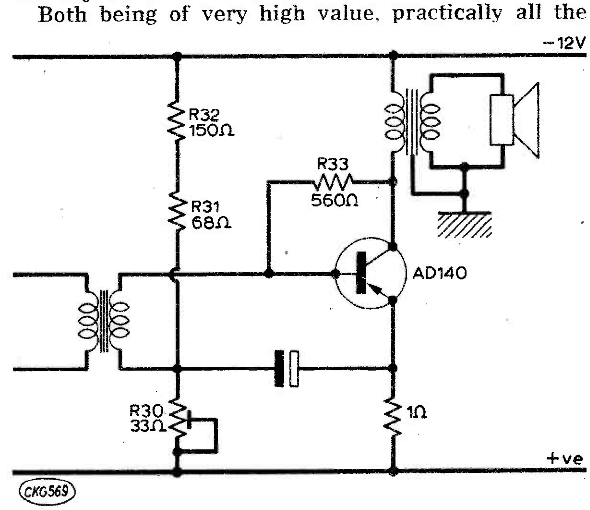


Fig. 6: Single-ended output stage used in many Philips car radio portables. R33 provides signal negative feedback, but not DC stabilisation, due to the primary resistance of the output transformer lonly being one ohm. R30 is set to produce a no-signal collector current of 550 mA.

TAKE 20

DAVID ANDREWS

No. 57
NEON FLASHER

A series of simple transistor projects, using not more than twenty components.

IT must be admitted that the possible applications for this circuit are rather few and far between but it is, nevertheless, offered as a novelty that some readers might like to exploit. The author recalls seeing an advertisement a few years ago for a present for the "man with everything"—it was a heated toilet seat with a built-in flasher to act as a beacon in the dark! This circuit could possibly be used in the latter function without risk of electrocution or perhaps it could be used as a sleep inducer in the child's bedroom!

Operation

The function is to make a small neon tube flash at a rate of about one flash per second, the driving source being a nine volt battery. Current consumption is very small, approximately 1 to 2 mA (average), thus a small battery could power the unit for considerable periods. The unijunction transistor Tr1 Fig. 1 forms a relaxation oscillator that produces a positive-going pulse at base b1 approximately once a second. Frequency of operation is set by R2 and C1. For the above quoted rate R2 ought to be 10kΩ but slower rates can be obtained by increasing its value to 100kΩ. Should faster rates be required C1 can be reduced in value proportionately.

The positive-going pulses from the oscillator are fed to the emitter follower Tr2 that provides suffi-

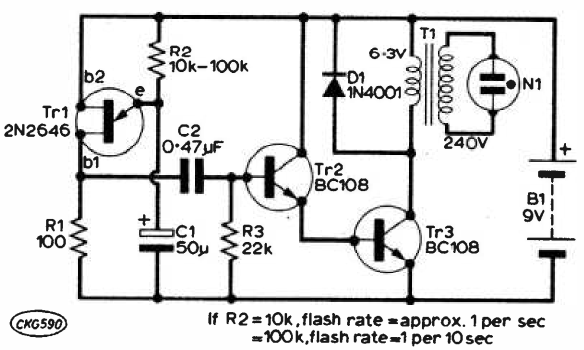


Fig. 1. Circuit of the neon flasher. R2, which, with C1, controls the flash rate could be made variable using a potentiometer. Additionally, C1 could have switched values.

★ components list

R1	100 ohm	Tr1	2N2646
R2	10kΩ (see text)	Tr2	BC108
R3	22kΩ	Tr3	BC108
C1	50μF (6V)	N1	80V neon
C2	0·47μF (polyester)	T1	240V/6·3V
D1	1N4001		

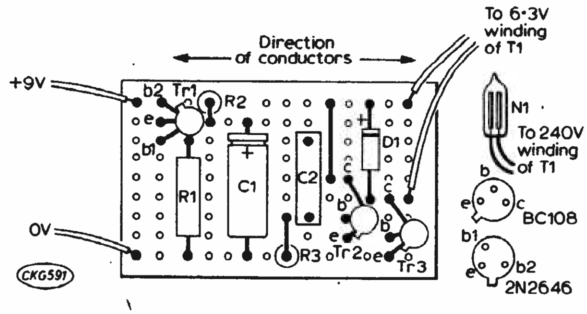


Fig. 2. The circuit can be constructed on veroboard as shown above. The board, transformer and neon lamp could be fitted into a suitable aluminium or plastic box.

cient drive to cause Tr3 to go into saturation. The rapid rise in current through T1's primary induces a high voltage across its secondary windings and this causes the neon to strike. This is repeated every time Tr1 goes through the conductive part of its oscillating cycle.

D1 should not be omitted as it protects the base collector junction of Tr3 from high reverse voltages when Tr3 switches off. The transformer can be any small mains one that has a 6·3V output; note, however, it is connected into the circuit with the 6·3V winding as the collector load and the neon connected across the 240V winding.

TRANSISTOR BIAS & FEEDBACK

—continued from page 963

AF signal is filtered to chassis through the decoupler C304.

In the latest GEC/Sobell 6 waveband portables, negative feedback and DC stabilisation is applied to the pre-amp stage by a 3·3MΩ resistor from collector to base, further feedback being developed across the unbypassed resistor in its emitter lead, Fig. 5.

In common with the other AF stages, this stage is operated from the negative 9V rail, R81 and zener diode BZY88 providing a stabilised supply for the tuner and i.f. stages.

Most transistor receivers employ a push-pull output stage of one form or another, with a feedback loop extending from the speaker to the driver stage, but in some Philips car radio models, a single AD140 is used, signal feedback being provided by a 560Ω resistor from collector to base.

A typical example is shown in Fig. 6, but no DC stabilisation is provided by the resistor in this case since the DC resistance of the output transformer primary is only 1Ω, but effective signal feedback is achieved since the output transformer's impedance to AF is comparatively high.

Forward bias is therefore provided by R32/R31, and to a lesser extent by R33, since it is much higher in value, while R30 sets the correct no-signal collector current at 550mA. ■

ULTRASONIC REMOTE CONTROLLER

PART 2

ROLAND PERRY

THE TRANSMITTER

The transmitter, Fig. 6, consists of just two NE555 IC's and a few resistors plus capacitors. More resistors may be switched in as required to provide more tones.

The transmitter uses four channel tone encoding, but the receiver only employs two of these. One for 'ON', one for 'OFF'—the other two being spare for future use.

As stated earlier, the simplest of the command functions is accomplished by detecting the presence of the ultrasonic carrier. IC2 is programmed to provide the ultrasonic carrier at the frequency of the transducer. In the authors's case, this was 40kHz. The output of the 555 is a square wave fed directly to the transducer.

The next step is to frequency modulate the ultrasonic carrier. This is very simply achieved by IC1 feeding the appropriate tone into pin 5 of IC2. The tone frequencies can again be selected from Table A and switched by means of a multiway push button unit.

The PCB layout is detailed in Fig. 7, and this board fits neatly inside a Norman Rose AB7 aluminium box, along with battery and clips. The transducer is glued on the outside of the case. No doubt a more pleasing arrangement could be evolved without much effort, since aluminium boxes always betray a certain amateurish technique. A multipurpose plastics case will shortly be made available to accommodate this requirement.

When wielding the soldering iron around the circuit there is not much to be said, apart from "put the 555's in the right way round." Experience (bitter), shows that the 555 is not one of the hardier IC's, and can be made defunct with very little effort. The author finds a desoldering tool of some kind is one of the most invaluable items in the constructor's toolkit.

The switch on the tone channel in the prototype was soldered directly to the board so when designing the board, try and accommodate the switch in a similar fashion, since it can save much time, and should mean that wiring mistakes will not occur. Remember that one pole of the switch on each tone channel is used to switch the supply.

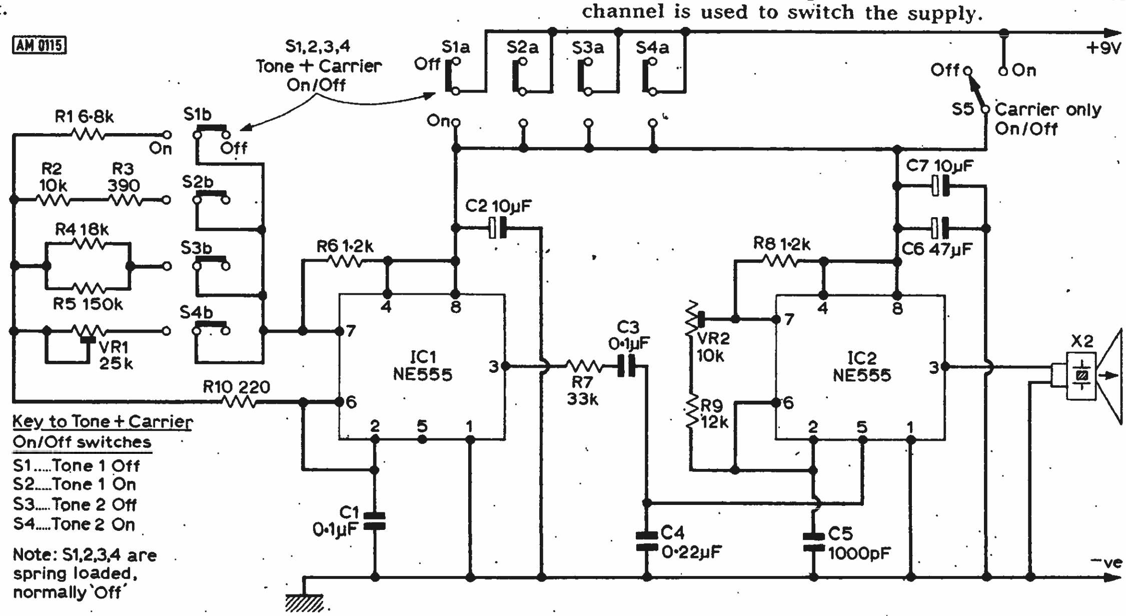


Fig. 6. Circuit of the transmitter or controller, IC1 providing the tones which modulate the carrier produced by IC2 Note:—R10 was inadvertently omitted from components list.

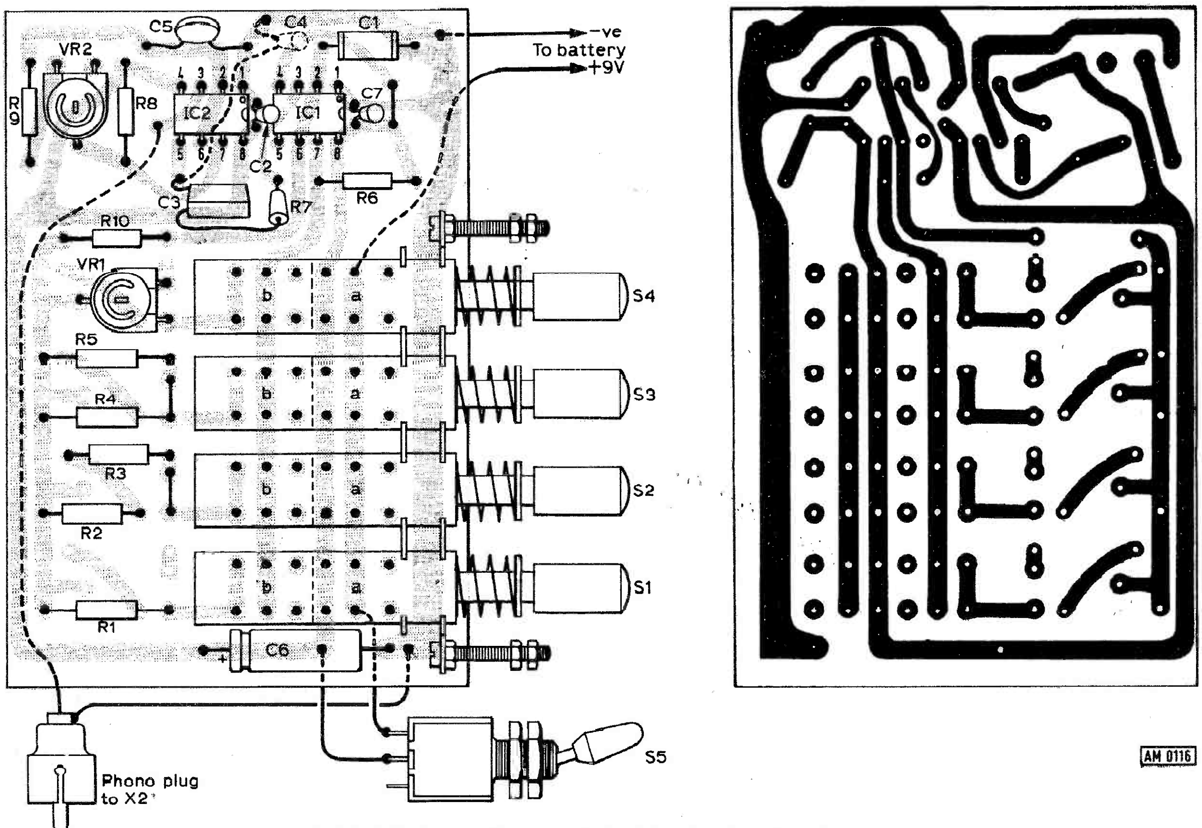
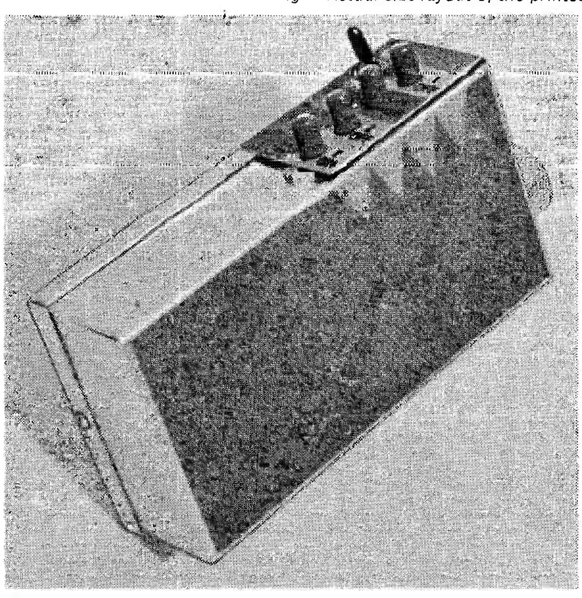
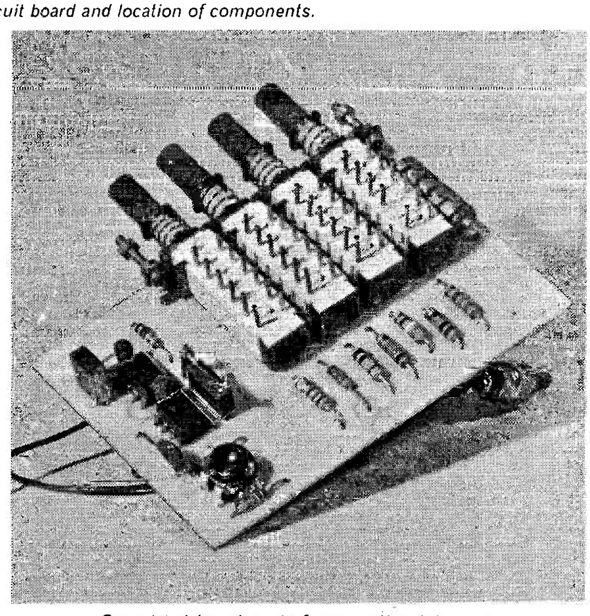


Fig. 7 Actual size layout of the printed circuit board and location of components.



The finished controller, the switch providing "carrier only" control when required.



Completed board ready for mounting into case.

ALIGNING THE TRANSMITTER

1. Operation of the carrier transmitter, IC2, is checked by supplying 9V to the system. Place the transmitter and receiver close together and monitor the output at pin 9 or 7 of the SN76660N. Now tune the transmitter preset on IC2 until the meter reading deflects, indicating the presence of the correct ultrasonic carrier, usually around 40 kHz.
2. Align the ultrasonic tone decoder module as set out in the section on that unit. It may be useful to monitor the output by means of an LED, to indicate output status. The limiting resistor, Rx, should be chosen to suit the available LED, a typical value is 820Ω for a TIL209, Fig. 3.

—continued on page 987

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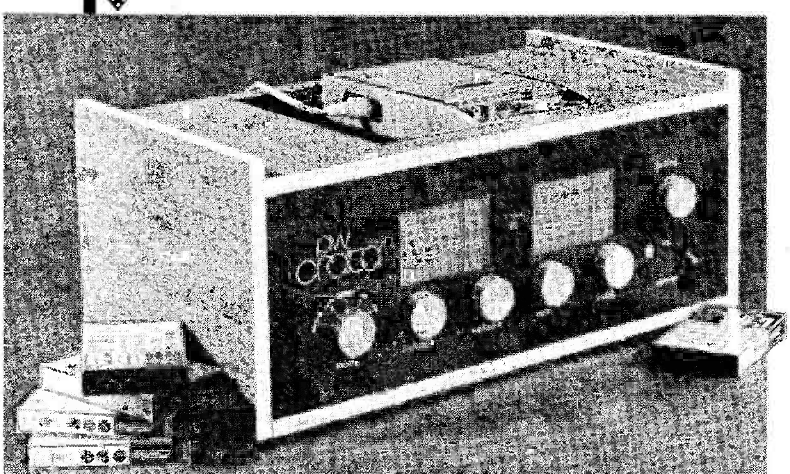

Following the unprecedented success of Project Q4 quadraphonic sound system, Practical Wireless brings you another top design for the home. This is the first British published do-it-yourself domestic high quality tuner amplifier design that includes a built-in cassette recorder, all at a fraction of the cost of commercial equivalents. It is incredibly easy to build if you have basic experience with printed circuit board assembly.

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BENCH STABILISED POWER SUPPLY

DESIGNED AND DEVELOPED BY THE IPC TEC

ALL electronic equipment uses power supplies of one kind or another and so the experimenter needs a variety of DC levels. Power supply stability is unimportant for some circuit designs, but many amplifiers perform better if driven by a stabilised supply and, if it has a really low impedance output, decoupling may be unnecessary. In particular, DC amplifiers require stabilised supplies.

This stabilised supply aims at a professional performance, but uses low cost components readily available to the constructor. The output is fully floating or may be used in twin pack applications (centre-point earthed) described at the end of this article.

BASIC PRINCIPLES

The majority of stabilised power supplies use the emitter follower principle where the emitter takes up a potential slightly less than that applied to the base of a transistor, Fig. 1. A reference voltage from a battery or a zener diode applied to the base of this transistor will yield an output voltage quite well stabilised against load and supply variations. An NPN transistor is shown in Fig. 1, but a PNP will perform equally well in the negative supply line.

Unfortunately, such a simple circuit is seldom adequate, especially if one requires a variable output.

Fig. 1: Basic voltage stabiliser. ▶

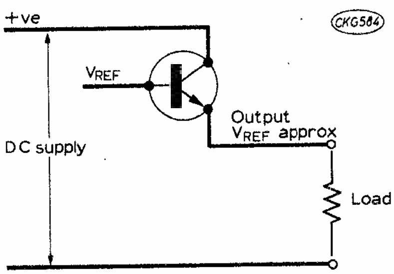


Fig. 2: Improved performance is obtained by use of a difference amplifier. ▼

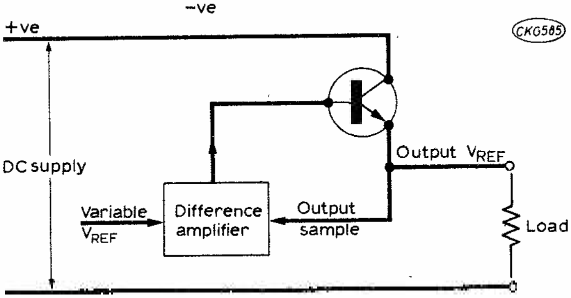


Fig. 3: A 0–30V 1A stabilised supply with overcurrent limiting and voltage and current metering.

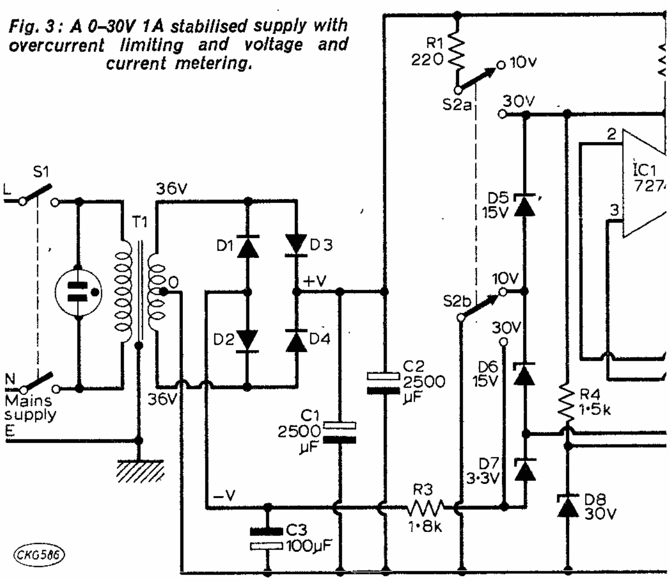


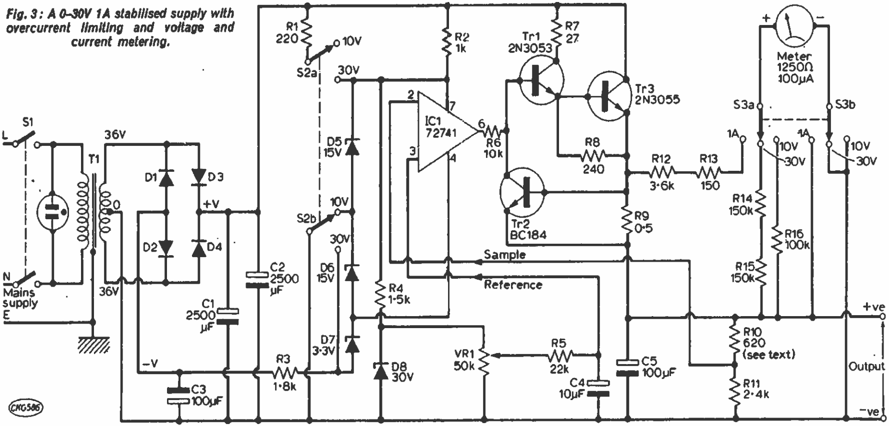
Fig. 2 shows how to modify the basic circuit by adding a difference amplifier to improve stability. A sample of the output voltage passes to the difference amplifier, which compares it with a reference voltage. The difference amplifier has a very high gain, so that if the output voltage increases or decreases compared with the reference, the transistor base voltage immediately moves in a direction which compensates for this change. In addition, because this action is effective up to ripple frequencies, the circuit also provides extra smoothing of the output.

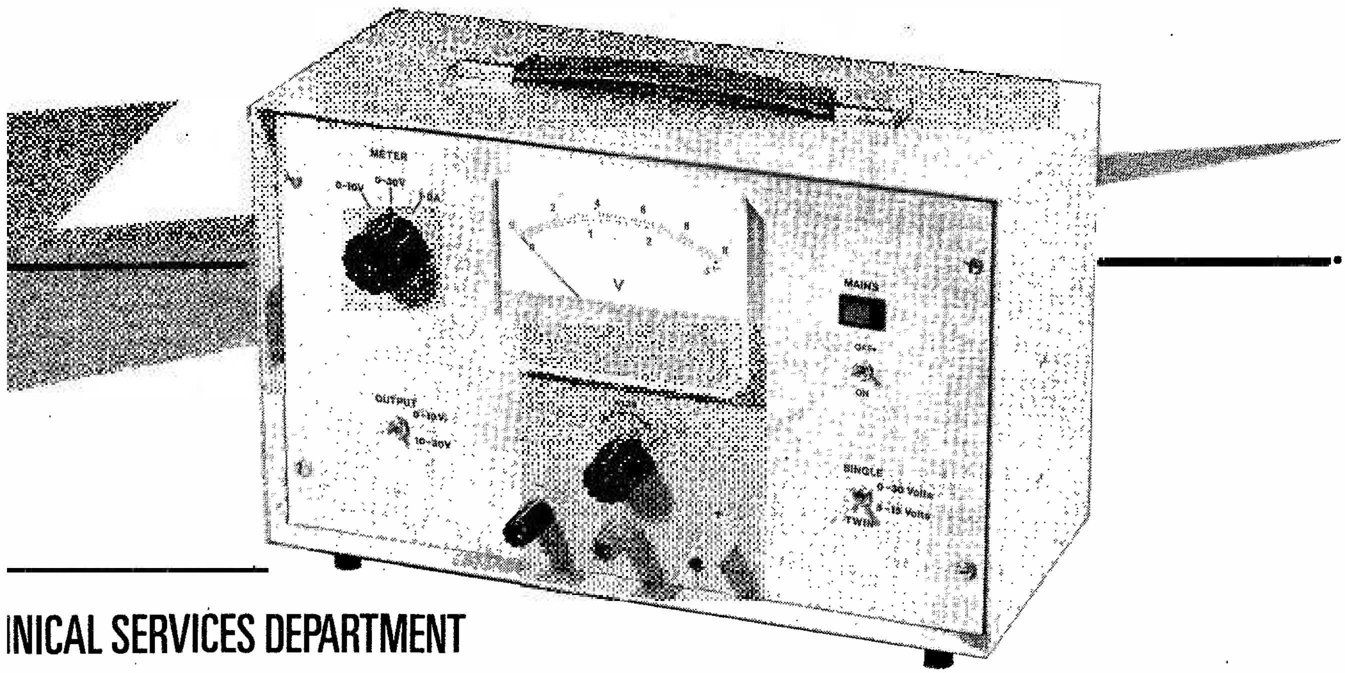
PRACTICAL CIRCUIT

This power supply is based on the circuit of Fig. 2, but incorporates features to overcome practical limitations of the components used. Fig. 3 shows the full

DESIGNED AND DEVELOPED BY THE IPC TECHNICAL SERVICES DEPARTMENT

Fig. 3: A 0–30V 1A stabilised supply with overcurrent limiting and voltage and current metering.





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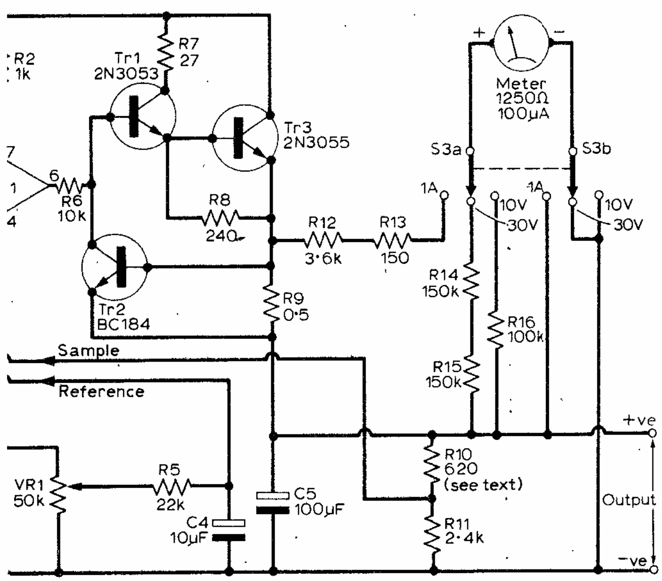


circuit in which a transformer giving 36-0-36V RMS supplies the basic voltage. The transformer voltage is not very critical, windings giving between 32 and 38V would be adequate. For convenience, a bridge rectifier operating as two full-wave rectifiers provides the positive and negative voltage rails, but four separate diodes may be used if preferred. The main positive supply uses two 2,500μF smoothing capacitors, but a single 5,000μF capacitor can be used if available. Negative bias for the reference chain is provided by D1 and D2 and smoothed by C3.

The series regulator (emitter follower) uses a 2N3055 transistor Tr3, connected as a Darlington pair with Tr1 a 2N3053 to reduce the current needed from the difference amplifier IC1. The resistors R10/R11 which sample the output voltage are connected across the output terminals together with C5. R10 may need selecting to ensure that the supply will give its maximum 30-31V output. It is important that R10, R11 and C5 are mounted directly at the output terminals. The output voltage sample from R10/R11 passes to the inverting input of a 741 operational amplifier, which is used because of its low cost and ready availability.

On range 1, which gives 0-10V, the 741 takes its power from ± 15V supplies derived from the main voltage rails by R2, D5 and R3, D6. D7 has no function on this range. The reference voltage is set by potentiometer VR1 which is connected between the ± 15V rails. When switched to range 2, the whole IC1 supply rises positively by 18·3V (D6+D7) and provides a new reference voltage for operating over the 10-30V range. This arrangement is necessary because the 741 integrated circuit will swing between ± 10V satisfactorily, but not reliably outside these limits. However, tests show that the stabilised ranges are in fact rather wider than specified.

Transistor Tr2, whose emitter-base junction is connected across a 0·5Ω resistor R9 in series with the

★ Specification

Voltage ranges

0–10V	range 1
10–30V	range 2
±5–15V twin pack	range 3

Current capability
1A all ranges. Short circuit protection incorporated

Voltage stability
0·3V zero to full load
0·015V per °C
1·5% for 10% mains change

Ripple
1mV off load
3mV full load

Pulse response
Full recovery in 25μS

output, provides current limiting. As the output current rises above 1A, the voltage developed across R9 switches on transistor Tr2. This shunts the control voltage applied to the base of Tr1, reducing the output voltage to a low level. Transistor Tr2 is not critical and a spare lying in the junk box will probably serve for this. One can test the current limiting by supplying 5-10V at 1A and then increasing the voltage until the current stops increasing; if this occurs in the region of 1 to 1·4A the unit will be satisfactory. The current of the design model limits at 1·2A. It is, of course, necessary to use an external ammeter for this test.

METERING

To make a really professional job of this supply, a metering circuit has been incorporated. However, as meters are expensive one can omit this circuit and instead fit a calibrated dial to the potentiometer VR1. This will be suitable for applications not requiring accurate voltage settings. To use a meter which differs from the one specified calculate the appropriate series multiplier resistors.

The following examples, using a 100μA 1,250Ω meter, shows how to calculate the values of the resistors using the formula:—

$$R_{TOTAL} = R \text{ meter} + R \text{ series} = \frac{\text{Voltage range required} \times 1000}{\text{Meter F.S.D. in milliamps}}$$

10 volt range (R16)

$$R_{TOTAL} = \frac{10 \times 1000}{0 \cdot 1} = 100\text{k}\Omega$$

Strictly one should subtract the meter resistance from this figure, but in practice the effect is insignificant and may be neglected.

30 volt range (R14+15)

$$R_{TOTAL} = \frac{30 \times 1000}{0 \cdot 1} = 300\text{k}\Omega$$

The most satisfactory way of producing this resistance is to use two 150kΩ resistors in series; again one may neglect the meter resistance.

Current range. Since R9 is directly in series with the output current (apart from a small load which R10 and R11 take), it will drop 0·5V at 1A. The meter has to read this voltage to measure the current, using a series resistance obtained from the calculation:—

$$R_{TOTAL} = \frac{0 \cdot 5 \times 1000}{0 \cdot 1} = 5{,}000\Omega$$

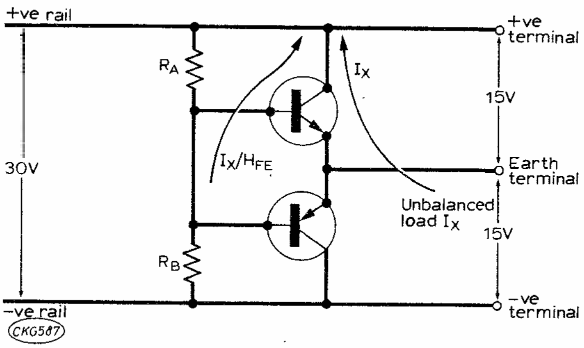
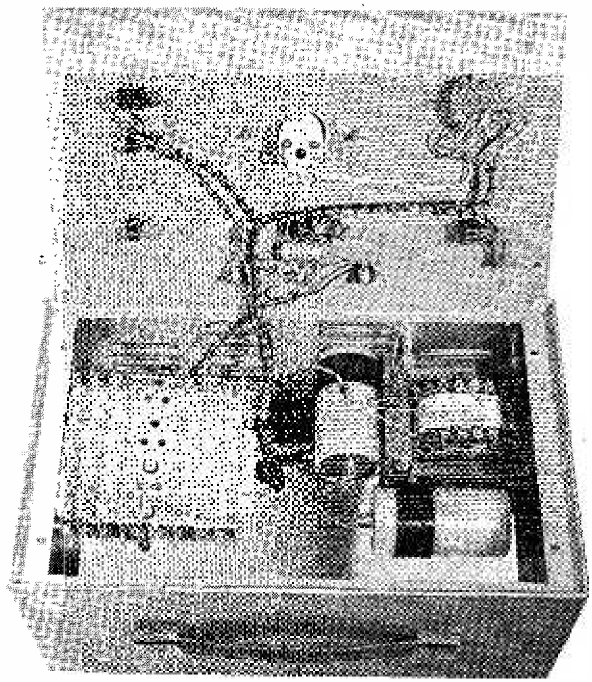


Fig. 4: Basic voltage divider using two emitter-followers.



View with front panel open to show wiring to controls with C5 and R10/11 mounted at the output terminals.

In this case the meter resistance is a significant part of the total and must be subtracted to give the value for R12 & 13 as 3,750Ω. One can make this up from a 3·6kΩ in series with a 150Ω resistor. Close tolerance resistors (2% or better) are essential for the meter circuits.

The current range determines which meter can be used. For example, if one used a 5mA meter the above calculation gives a total resistance of 100Ω, so the internal resistance of the meter would have to be not more than this.

TWIN PACK SUPPLIES

Frequently one needs a positive and a negative supply rail to drive DC amplifiers, operational amplifiers and similar circuits. For these applications one may use two power supplies of the type described, because a floating supply may be connected with either its positive or negative rail earthed. Commercial twin packs usually duplicate the stabiliser circuits and have additional windings on the mains transformer. If a suitable transformer is available, there is no reason why you should not use the same system. However if one is content with lower voltages, then the floating supply can be converted into a twin pack for an additional cost of about £3.

If one connects two equal resistors across the floating output and earths their centre point, the negative rail will be below earth potential and the positive rail will be above earth by an equal amount.

In practice, two resistors are unsatisfactory because the two supply rails will not remain balanced with varying loads, but one can use instead two emitter followers, Fig. 4. In this arrangement the bases of the transistors are connected to a voltage half way across the 30V supply and the emitter follows this voltage. By connecting the emitters to earth one obtains a twin pack supply.

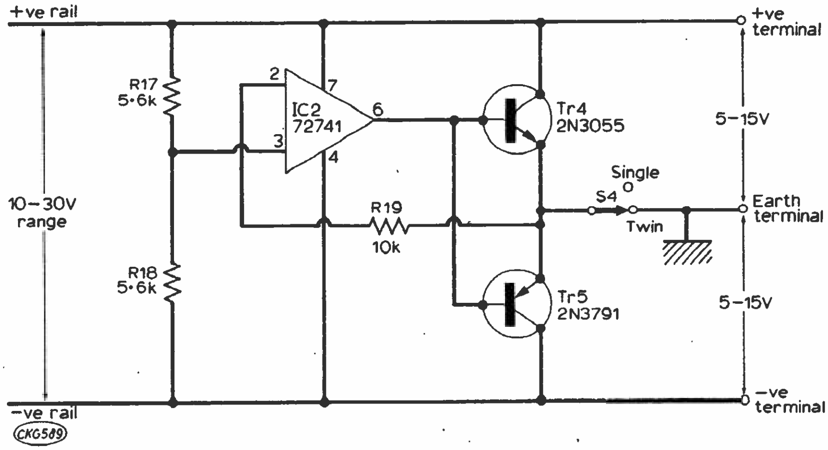
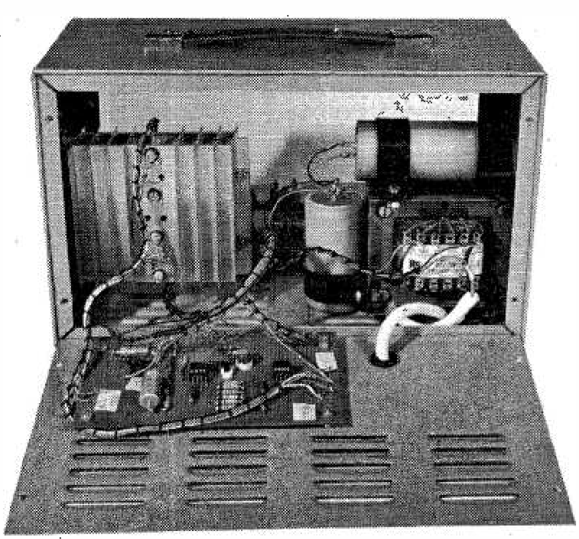


Fig. 5: Adding this circuit across the output of Fig. 3 provides an optional balanced output facility.

The simple circuit shown in Fig. 4 is also unsatisfactory for three reasons. First, short circuits on either of the outputs will 'blow' the opposite transistor. Second, the wattage ratings of the transistors limits the out-of-balance current, so that if one employs low wattage transistors, one must balance the loads carefully. Third, because changes in the out-of-balance current cause an excessive voltage drop in resistor RB, the rails will not be very stable.

Fortunately, one can cure all these faults quite simply by using high power transistors (mounted on a heat sink) driven by a feedback amplifier as shown in Fig. 5. In this arrangement IC2 constantly compares the output of the emitter followers with the reference input, and maintains the balance under all conditions. Because IC2 will not operate at very low levels the voltage range available from this twin pack is limited. However, the range provided (±5-15V) is satisfactory for most applications.

Some difficulty may be experienced in obtaining the 2N3791, used in the prototype. The Motorola MJ2955 (also in a TO3 package) is specified as a PNP complement of the 2N3055 and should be a satisfactory alternative.



View of rear of unit showing circuit board mounted on back panel.

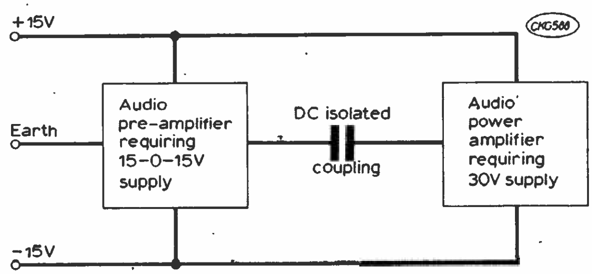


Fig. 6: Powering balanced and unbalanced equipment from a single supply.

In practice, because the very low output impedance makes each rail 'earthy' as far as AC signals are concerned, one can use the full 30V when the supply is wired in this fashion. For example, it is quite in order to connect a 30V amplifier, which is **isolated from earth,** across the terminals and to use a capacitor from a pre-amplifier connected to the ±15V supplies to drive it, Fig. 6.

CONSTRUCTION

A standard instrument case measuring 12¼ x 7½ x 5½in. provides a suitable unit in which to house the power supply. Fig. 7 shows the front panel marked out ready for drilling.

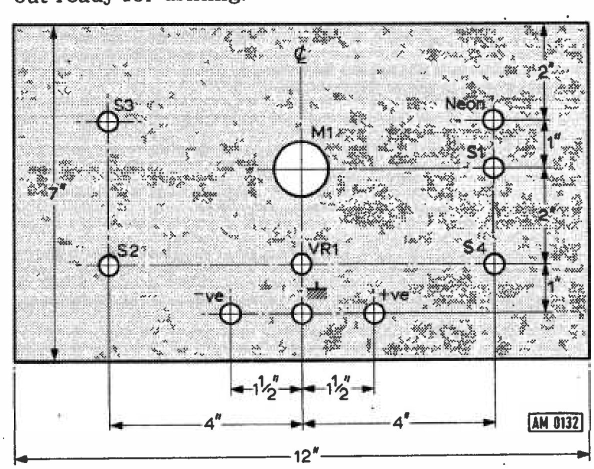


Fig. 7: Drilling dimensions for the front panel. Hole sizes should suit the components used.

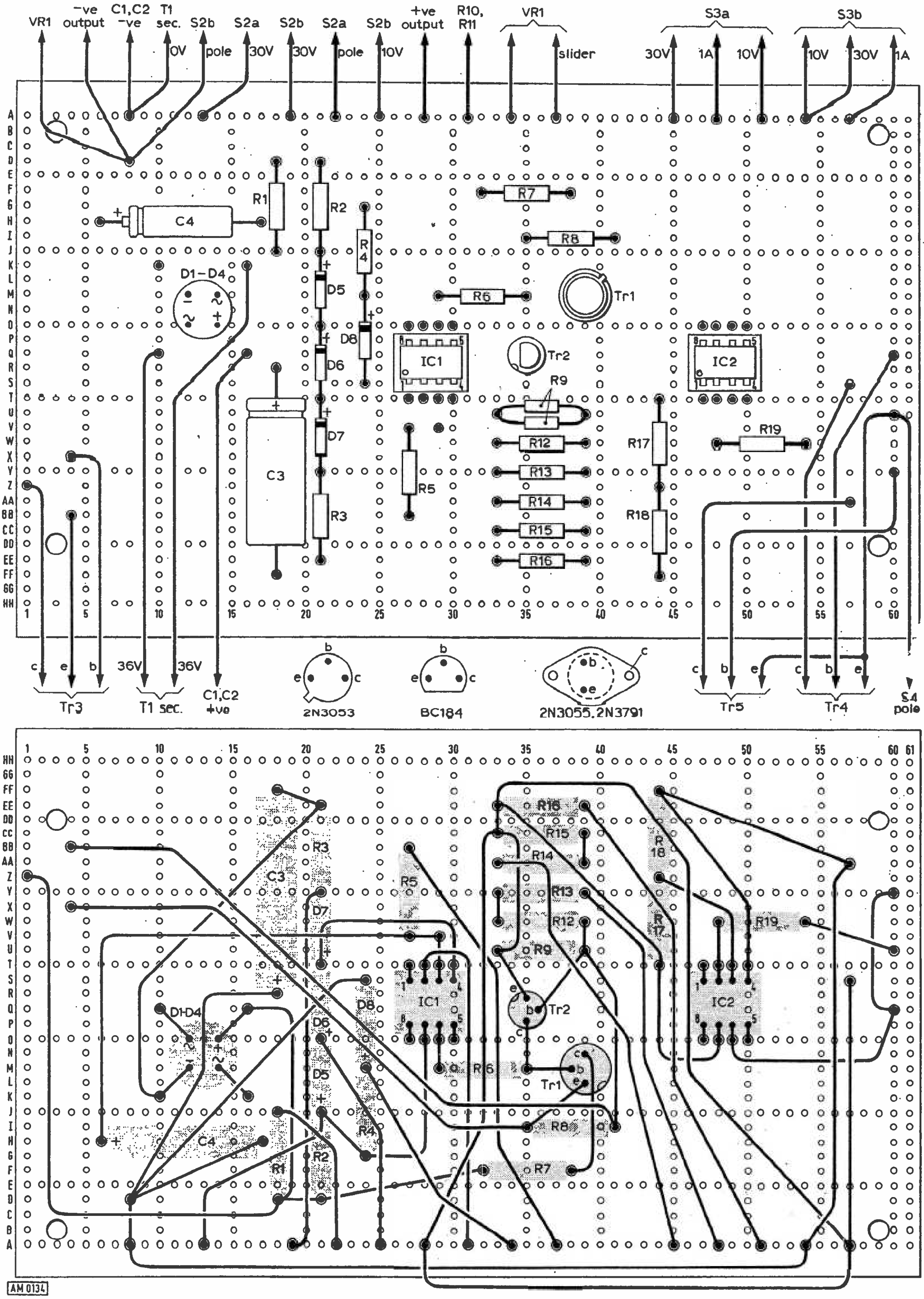


Fig. 8: Layout of component and wiring sides of circuit board. All components are mounted on terminal pins.

★ components list

Resistors

R1	220Ω ½W 5%	R9	0·5Ω 1W 5%
R2	1kΩ 1W 5%	R10	620Ω ½W 5%*
R3	1·8kΩ 1W 5%	R11	2·4kΩ ½W 5%
R4	1·5kΩ ½W 5%	R12	3·6kΩ ½W 2%
R5	22kΩ ½W 5%	R13	150Ω ½W 2%
R6	10kΩ ½W 5%	R14	150kΩ ½W 2%
R7	27Ω ½W 5%	R15	150kΩ ½W 2%
R8	240Ω ½W 5%	R16	100kΩ ½W 2%
VR1	50kΩ ½W Linear		* See text

Capacitors

C1	2500μF 63V	C4	10μF 63V
C2	2500μF 63V	C5	100μF 63V
C3	100μF 63V		

Semiconductors

Tr1	2N3053	D1–D4	1A 100PIV bridge*
Tr2	BC184*	D5	BZY88/C15
Tr3	2N3055	D6	BZY88/C15
IC1	SN72741	D7	BZY88/C3V3
* See text		D8	BZY88/C30

Miscellaneous

S1 DPST Toggle. S2 DPDT Toggle. S3 2 pole 3 way wafer. Meter 100μA 1250Ω (RS Components MR31S). Transformer 36-0-36V 1·1A (RS Components "Univ. Rec. Tr"). Neon panel lamp (250 VAC). Plain Veroboard 0·1 in. matrix, 6 x 3¾in. TO3 heatsink (Chromasonic Electronics). TO3 mica washer and insulating bushes. Transistor and IC sockets. Terminals. Instrument Case Olson 27A (Home Radio). Knobs.

Additional components for Twin Pack output.

Resistors

R17 5·6kΩ R18 5·6kΩ R19 10kΩ
All ½W 5%

Semiconductors

Tr4 2N3055 IC2 SN 72741
Tr5 2N3791 or MJ2955

Note:—The 2N3055 and MJ2955 are available at 63p and 73p respectively, plus VAT, from Jermyn Home Electronics, 112 Vestry Estate, Sevenoaks, Kent. Post and packing 25p per order.

Miscellaneous

S4 SPST Toggle. TO3 heatsink (Chromasonic Electronics). TO3 Mica washers and insulating bushes (2 sets). IC socket.

With the exception of the two 2500μF capacitors, which are attached with insulating "P" clips to the transformer, all other components are assembled on a 6 x 3¾in. 0·1 matrix plain veroboard. This is mounted on the back panel using 6BA spacers to give the required clearance.

The layout of the board Fig. 8 does not pose any problems. One can work logically through the circuit diagram starting with the bridge rectifier at one end of the board, and progressing through to the output of transistor Tr1 at the other end. Links between components on the circuit board and points elsewhere in the unit should be made via terminal pins on the edge of the board. Flexible wiring connects these pins and the external components.

ASSEMBLY

First the transformer and heat sinks are mounted inside the case, Fig. 9. Depending upon its size the transformer may foul the output switch mounted on the front panel, in which case it must be moved back. The two heat sinks carrying the transistors Tr3, Tr4 and Tr5 are bolted together and attached to the side of the case using a simple bracket. Mounting these transistors so that their base and emitter connections are accessible when the front and back panels are removed makes wiring and testing easier.

Finally, the interconnecting leads have to be attached to the panel, transformer and power transistors. The transformer wiring is kept separate and wired directly to the mains switch, indicator neon and bridge rectifier connections. The three wires from the output terminals, namely positive, negative and sample, are critical and are loomed together to run directly to their respective circuit board connections.

The remaining interconnecting wiring is also loomed together for neatness, and in consequence wire identification is necessary. The number of wires involved makes colour coding impracticable, so a simple method of wire identification or masking tape marked with letters can be used instead. As a precautionary measure wire lengths should be kept to a minimum, but they should be long enough to allow the back and front panels to be laid flat. ■

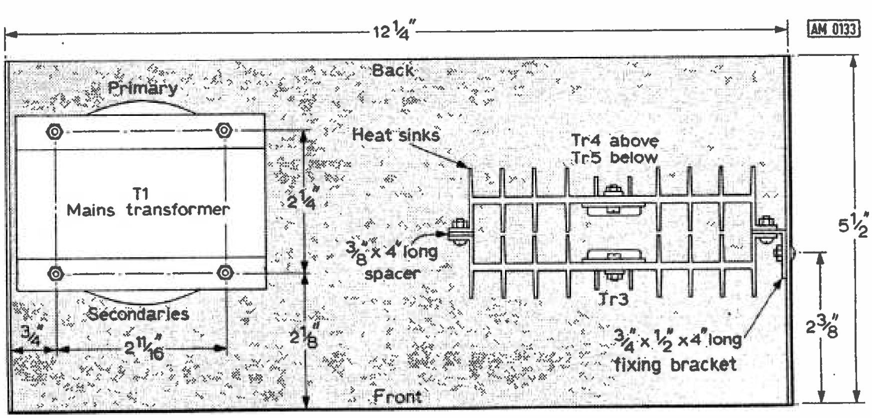


Fig. 9: Plan view showing mounting details of mains transformer and power transistor heatsinks.

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8. Electronic components pack (diodes, resistors, capacitors, transistor).
9. Battery clips and on/off switch.
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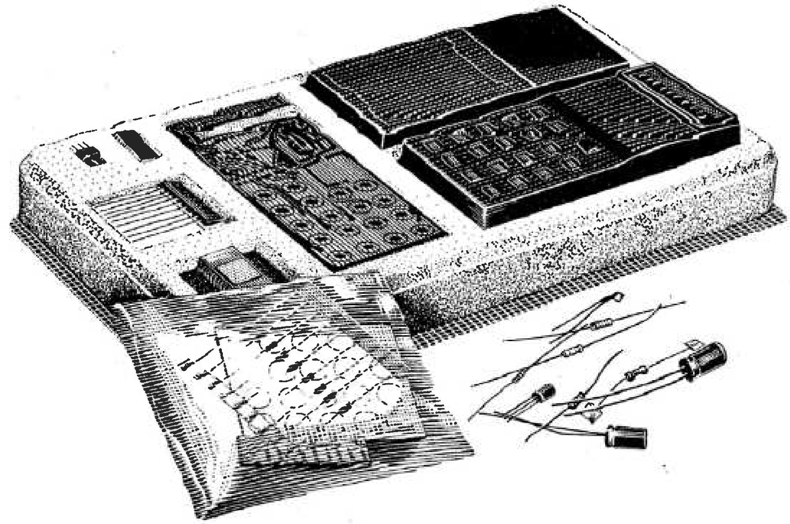

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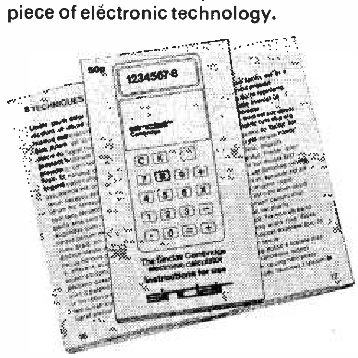

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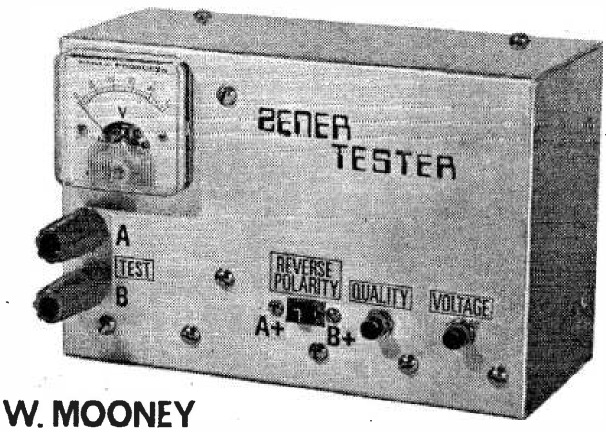
ZENER DIODE TESTER



W. MOONEY

THIS zener diode tester is an inexpensive push-button device which quickly gives the stabilising voltage of a zener diode and an indication of its quality in a matter of seconds. The tester may also be used to determine the polarity of the diode, which is sometimes difficult to establish from visual checks. The instrument may also be used as a "go"-"no-go" tester for normal diodes.

Because of its speed and ease of use, this piece of apparatus is therefore a must for the "Unmarked and untested" device enthusiast and a very useful tool for any electronics workshop.

Although mainly for bench use, battery operation is still desirable so the tester is therefore powered by an internal PP9 battery.

THE CIRCUIT

Most zener diodes in use lie in the range 2V to 30V. Many such diodes will be outside the range of a single 9V battery so some means of high voltage generation must be available. It is possible to obtain the voltage required by the use of two or three 9V batteries in series but this is expensive in the long run and the replacement of batteries can become tiresome. A single transistor/inverter is therefore used to provide the required voltage from a 9V supply.

The inverter consists of a power transistor in an oscillator circuit using a ferrite ring on which is wound a high voltage secondary giving about 200VAC off load. Although the dissipation in the transistor is only about ½W a 2N3055 power transistor is used as these are readily available and will take a lot of abuse during setting up, without failure.

A ferrite ring is used in the transformer resulting in low external radiation and high efficiency. The AC voltage developed across the secondary winding is rectified using a silicon bridge. In the setup described the DC generated can reach around 250V if there is no diode connected to the test terminals.

As can be seen from Fig. 1 the oscillator is very simple in design. On pressing S1, the "Voltage" switch a current flows in the collector winding caused by the bias resulting from R1. The increasing flux in the core causes a feedback current in the base circuit in the correct phase to sustain oscillation. The frequency is a function of the value of R1 and C1 and the collector winding inductance, and greatly depends also on the load applied to the secondary winding. The frequency resulting is in the region of 50kHz and the current in the collector approximates to a squarewave.

The rectified output is applied to C3 via R2, with the zener to be tested connected to terminals A and B. The voltage on C3 builds up until the zener begins to conduct, at its reference voltage. The switch S3 is used to reverse the voltage applied to the zener should it be connected in the forward biased direction. A voltmeter connected across C3 will thus read the zener voltage. Depression of S2, the "Quality" switch, increases the current in the diode to about twice its original value. An increase in the voltmeter reading will result due to the dynamic resistance of

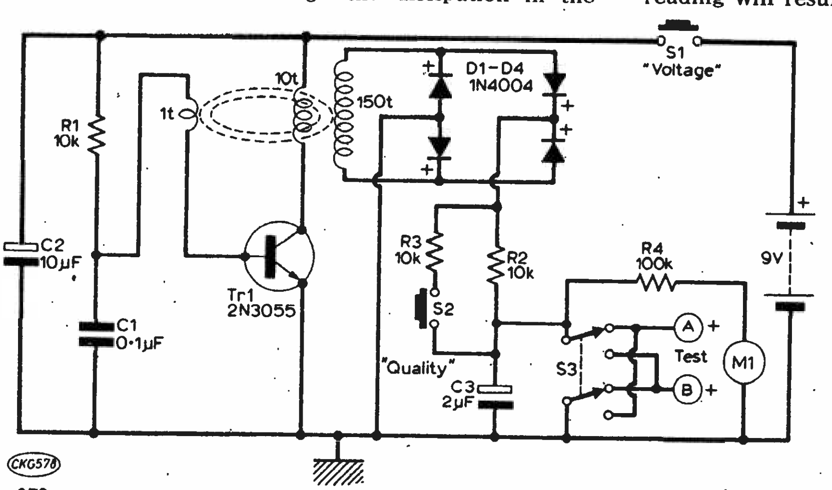


Fig. 1: Circuit of the diode tester. Rectifiers D1/D4 could be a single bridge unit. Layout of components is not critical. Panel layout can follow that used by author, as in the heading photograph.

★ components list

Resistors
R1 10kΩ $\frac{1}{4}$W
R2 10kΩ $\frac{1}{4}$W
R3 10kΩ $\frac{1}{4}$W
R4 100kΩ 5% $\frac{1}{4}$W

Capacitors
C1 0·1μF polyester
C2 10μF 12V
C3 2μF 400V

Semiconductors
D1–D4 1N4004
Tr1 2N3055

Miscellaneous
S1,S2Push-to-make switch. S3 DPDT slide switch. Meter 500μA FSD. Terminals (2). Case, 6 x 4 x 2½in. approx. Battery PP9 (9V) and terminal clips. Tag strips. Ferrite rings (2) FX1593 (Hawnt Electronics Ltd, 112 Pritchett St., Birmingham B6 4EN, 25p a pair inc.). Insulating kit for 2N3055.

the diode but in a good zener diode the increase should hardly be visible on the meter. The voltmeter consists of M1 and Rm giving a FSD of 50V.

COMPONENTS

The oscillator transistor is a 2N3055 and a specimen with a DC current gain of at least 30 should be chosen. Most devices will meet this requirement but the author has come across devices with gains as low as 2.

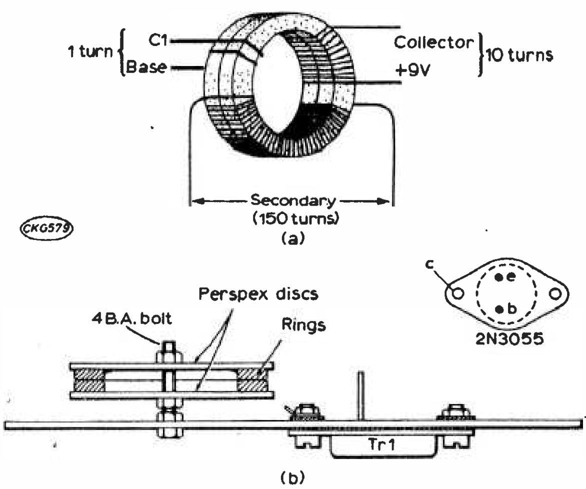


Fig. 2: Details of the construction of the oscillator transformer and its mounting on plate with the transistor. Two ferrite rings are used, taped together.

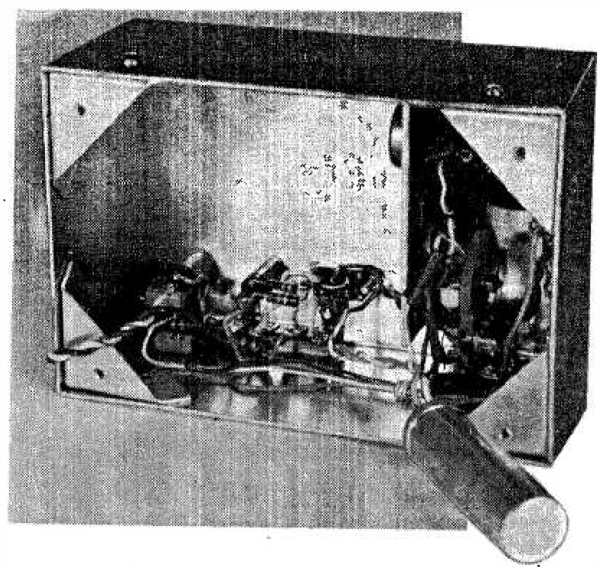
The ferrite rings have plenty of space for easy winding. There are many rings available which are of similar dimensions and although the magnetic properties may not be known, in a simple application like this, most rings will suffice. A little experimentation with the number of turns in the feedback winding should result in success as the setup is far from critical, Fig. 2. The windings on the ring are all pilewound. The feedback and collector windings are made from thin insulated connecting wire. The secondary consists of 150 turns of 30 SWG enamelled copper wire.

CONSTRUCTION

As the layout is in no way critical most constructors will have their own ideas on positioning components. The only important criterion; for right-handed people the "voltage" and "quality" buttons should be on the right hand side of the cabinet and the terminals on the left, the meter being unobscured somewhere in between. In this type of instrument the front panel is best in the horizontal position as in the case of testmeters.

The transistor does not require a heatsink but may be mounted on an aluminium bracket for convenience using the usual insulating mica washer. The transformer may also be mounted on this bracket. A screened cabinet is desirable as severe radio interference can result in the low frequency end of the RF spectrum from harmonics, when the oscillator is running. The original unit was constructed using a ready-made chassis size 6in x 4in x 2½in deep. The front panel layout is shown in photographs. The components were mounted on tagstrips which were bolted to the chassis at convenient points.

A base plate was cut from 1/16in aluminium and four rubber feet attached, the plate held to the cabinet with four self-tapping screws. The battery was held in place with a wad of foam rubber. The PP9 is quite heavy, however, and would best be held in place with an aluminium bracket made for the purpose.



Rectifier diodes D1/D4 are mounted on a tag strip below the oscillator transformer. Remainder of small components are on a tag strip in lefthand compartment.

OPERATION

A zener diode may be considered as a perfect zener in series with a resistor as in Fig. 3. The lower the value of Rd the better the stabilisation will be. A graph of current against voltage for the resistive part, the zener part and a combination of the two is shown in Fig. 4a, b and c. It can be seen that an increase in current from A to B results in an increase in reference voltage from a to b in Fig. 4c. If the

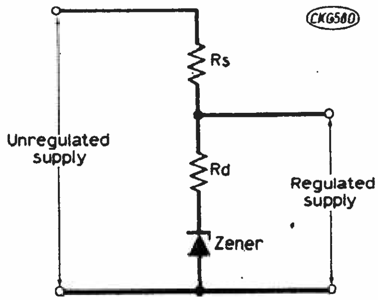
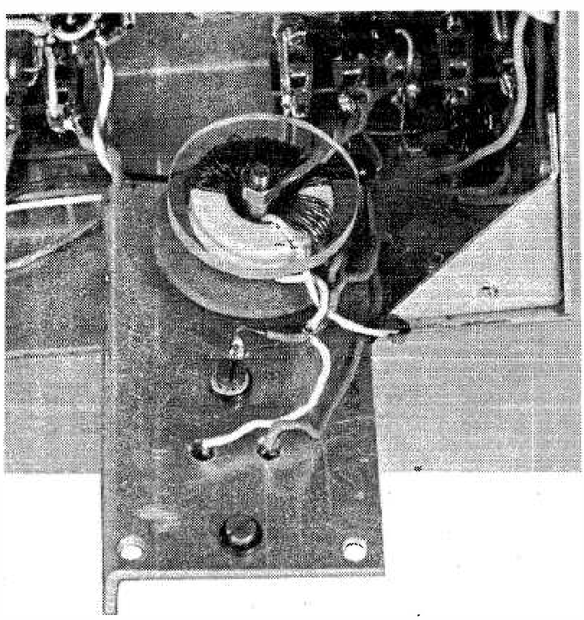


Fig. 3: Circuit of a perfect zener diode with a series resistance approximates the zener diode in practice.

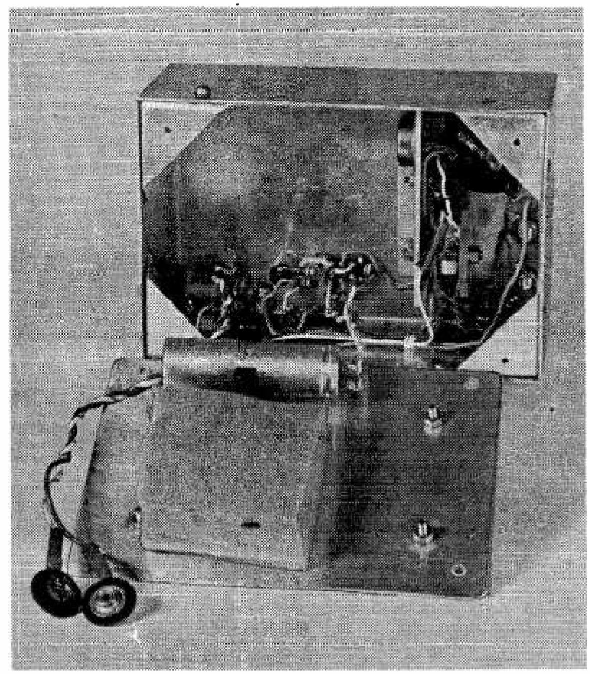
resistive component is very small the plot becomes as in Fig. 4d, a similar increase in current now causes only a small change in reference voltage. In a normal diode the situation is in Fig. 4d.

The portion of the graph marked k in Fig. 4b is called the knee and is usually less than 1mA. The instrument described supplies a current of over 1mA in all cases, therefore this effect should not normally be encountered.



Close-up of the oscillator transformer and its associated transistor removed from case. The one turn base winding is clearly seen.

Assuming that the diode polarity is not known, it is connected across the terminals A and B and the "voltage" button pressed. If the voltmeter reading is very low, say about 0·2V then this is probably the forward biased direction, in which case the polarity should be reversed by operation of S3, and the voltage button pressed again. The meter will (a) rise to the zener voltage, in which case the "quality" button should be pressed, or (b) remain low, in which case the diode is useless, or (c) the voltage will continue to rise and probably go off scale in which case it is an ordinary diode (or a zener with a higher voltage than 50V which is unlikely).



Capacitor C3 is held by a clip to the bottom of the box. A smaller sized capacitor could be fitted inside the box.

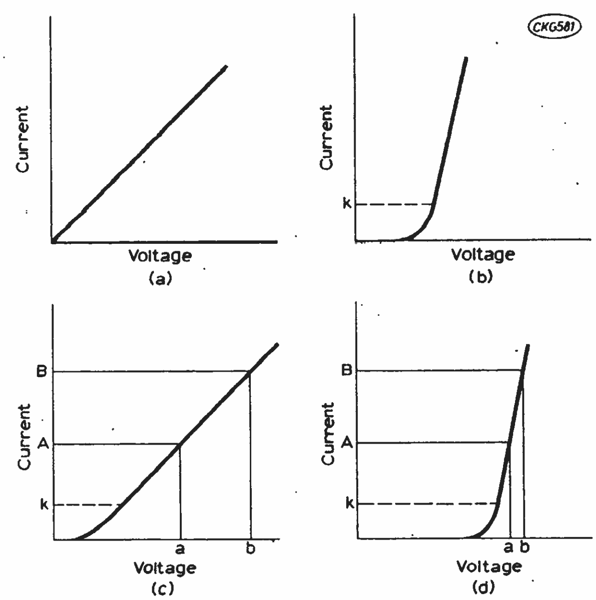
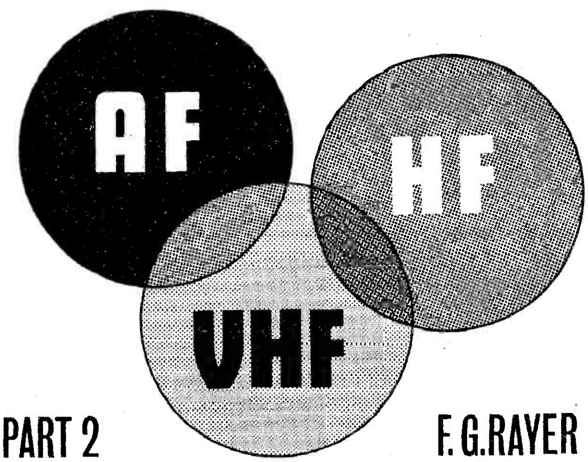


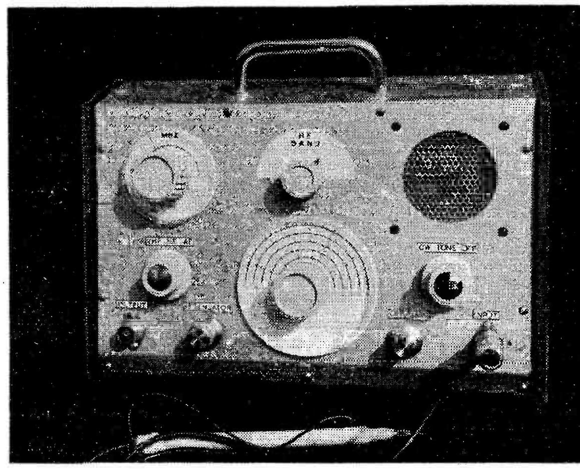
Fig. 4: Four graphs to illustrate the operation of a zener diode as described in the text.

Some diodes which are damaged read a high voltage in both directions, acting as a resistor, pressing the quality button causing a substantial increase in the meter reading.

Base emitter junctions of some silicon transistors have low reverse breakdown voltages, in the region of 5V, and act as excellent zeners. To test these the collector lead is left open circuit and the base and emitter leads connected to the instrument as in the case of a normal diode. ■



PART 2 F. G. RAYER



TROUBLE-TRACER

BRIEF details of the way in which the Trouble-Tracer can be used should prove of help. In some cases a faulty stage may be located with equal speed by using either the generator or the tracer facility. But in other cases one method will be better than the other, so the manner in which faults can be located by either means is outlined. The same general method of working will apply with circuits other than those which are given as examples.

The VHF and HF oscillators produce an unmodulated radio signal which produces no audio output when tuned in with a radio receiver. This unmodulated or CW signal will, however, operate a receiver tuning meter and is used for adjusting some circuits where modulation is not required (e.g., a crystal filter).

For almost all general tests and similar purposes, the tone generator must be switched on. The radio frequency signal, when tuned in with a receiver, then produces an audible tone, which is heard in the receiver speaker. The RF output is also modulated in this way when it is applied to IF stages and an audible indication is required from the radio receiver or equipment being checked.

RF/IF TRACING

Fig. 1 shows typical mixer and IF stages of a receiver. Assuming no results are obtained, a meter has shown that the correct voltage is present from the negative to the positive supply lines, but no audio signal is found at VR1. Therefore the fault must lie in the mixer or IF stages. With the RF probe applied at point 1, one or two local stations ought to be heard on tuning round. If not, the fault is sought in the mixer stage Tr1. Check by testing aerial and oscillator coil windings for continuity and by testing resistors and capacitors as well as Tr1. (More detailed investigation of this stage is possible with the generator.)

If signals are heard at point 2 IFT1 is probably in order. If signals disappear at point 3, Tr2 is not working. So resistors etc. in this stage would be tested. If necessary, a detailed check can be made along any circuit. When transferring the prod from the primary to secondary, such as from 4 to 5 of IFT2, a reduction in volume would be usual, but loss of signals altogether would indicate that IFT2 is probably faulty. Possible localised breaks in a circuit should not be overlooked.

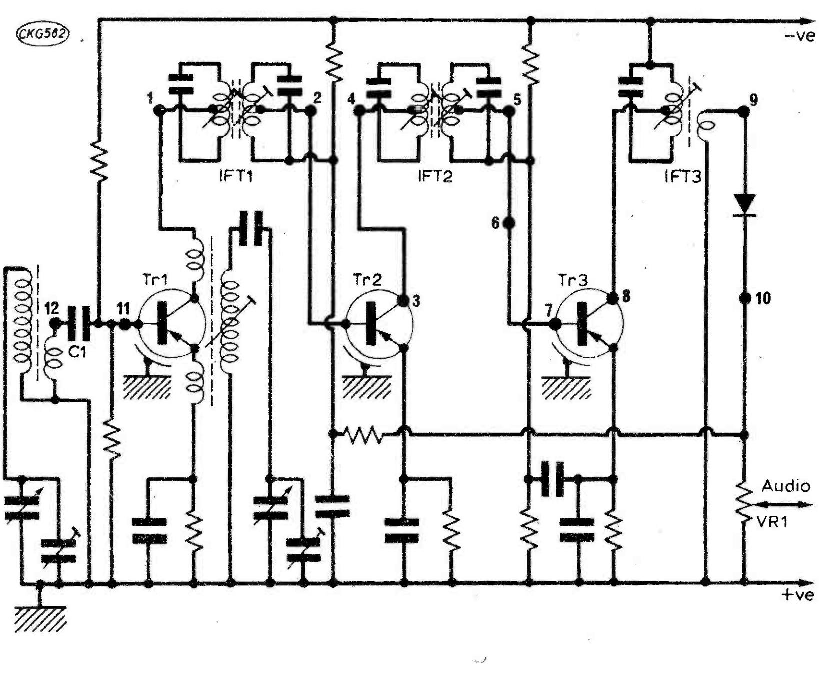


Fig. 1. Essential parts of a circuit comprising a mixer and two IF stages of a receiver to demonstrate fault-finding techniques.

For example, if signals are found at the actual pin of IFT2, point 5, but not at the lead or foil conductor 6, then the soldered joint here needs investigating. Also, if the signal is present at 6, but not at the emitter of Tr3, there is a crack in the foil, or other circuit interruption.

When bringing in a new stage, such as moving from 2 to 3, or from 7 to 8, a considerable increase in volume is to be expected. A test at 9 shows if IFT3 is working. An audio signal should then be found at 10. If not, test D1 and associated circuits.

It will be seen that the method of working is logical and very simple. When the part of the circuit which is defective is brought into use, signals cease.

USING THE GENERATOR

Assuming that the receiver audio section is working, the faulty stage in Fig. 1 may be localised by injecting RF from the generator. In this case, point by point working is carried out **backwards** through the circuit. If the receiver has a 455-470kHz IF, inject at point 8 with a prod from the RF output socket and tune the generator, on the correct range, until the modulated signal is heard. Then transfer the prod to points 7, 5, 4 and 3 systematically. In this way, a stage or IFT can be checked, as well as foil or other conductors. For example, if the generator signal is heard with the prod on IFT2 pin 4, but ceases when the prod is on point 3, the conductor from 4 to 3 needs examining.

Stage by stage checks at intermediate frequency will proceed to point 11, mixer base. With the IF applied here, all the IFT cores (five in Fig. 1) should peak correctly. If not, and results are poor, suspect the IFT which will not tune properly.

For RF tests, tune to the appropriate frequency. Band coverage can be checked with the generator, using very loose coupling from the output lead. Either take it to a loop of a few turns near the ferrite aerial, or place the lead near the aerial. When checking tuned circuits, a prod should not be applied directly to them when they are being trimmed. As an example, a prod can be taken to 4, to check IFT2, but if IFT2 is being adjusted, the prod should be taken to 2, IFT1, or an earlier point. If this is not done, stray capacitance from the prod and lead will upset alignment.

TRACING IN AF CIRCUITS

Fig. 2 is a typical audio amplifier, or audio section of a receiver. With an ordinary prod or preferably a prod on a screened lead with earthing clip taken to point 1, signals should be heard on the tracer speaker. If not, the tuner, pick-up, or other source of audio signals needs investigating.

The signal should similarly be present at 2, and should be much amplified at 3. If not, check Tr1 and associated resistors etc. The source of a trouble, such as distortion, may sometimes be quickly found by this means. For example, if quality is normal at 2, but poor at 3, Tr1 is probably not operating correctly. Its base, emitter and collector resistors should be checked first, including the possibility of a break in the circuit such as at point 4.

Moving to point 5 tests C2 and its conductors and joints. Even more volume should be found with the prod at point 6. If not, check T1 primary, and other items in this stage. Either point 7 should give equal volume. If not, test T1. If the signal is found here, but the set's speaker is not working, check the output stage Tr3/Tr4, T2 and associated items.

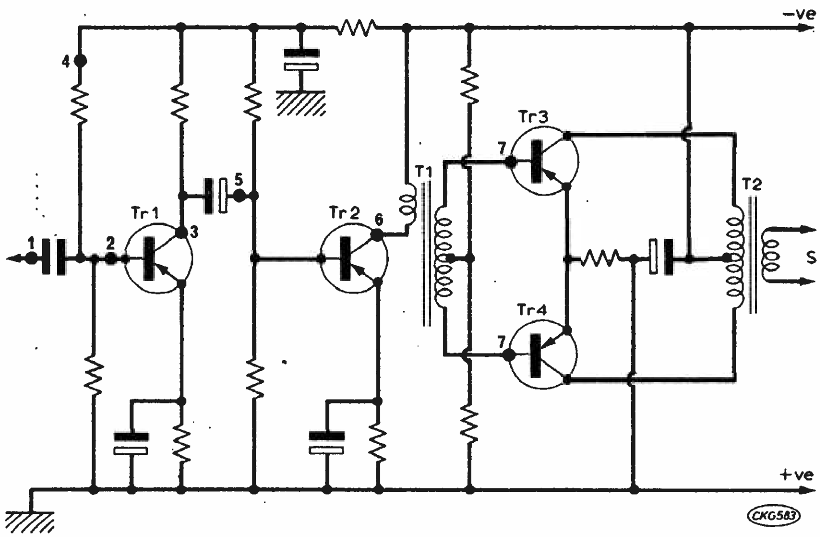


Fig. 2. Basic circuit of a three stage audio amplifier referred to in the text.

GENERATOR TESTS AT AF

Such circuits can be checked also with the audio tone generator. Point by point tests are then made backwards through the equipment, as described for IF circuits. For example, if injecting a signal at 6 Fig. 2 produces an output in the equipment speaker, but not when the prod is moved to 5, then the stage containing Tr2 is faulty.

When a faulty stage has been located, a more detailed check is made to find the resistor, capacitor, or other defective item or to locate the exact fault. It is possible to use both the generator and tracer simultaneously, to check any stage, and this can be useful when there is more than one fault. As an example, injecting AF at 5 and testing for AF at 6 shows if Tr2 is working. ■

ON THE AIR

AMATEUR BANDS

SHORT WAVES
by DAVID GIBSON, G3JDG

HAPPY New Year, and I trust that there's a goodly crop of Santa-delivered receivers all eagerly swishing their antennae about with a view to sending in a luscious log. AR88 owners will, no doubt, have received a crane for ease of servicing!

Each year, most of the Amateur fraternity make huge numbers of New Year resolutions—how many did you keep from last year? More seriously, 1974 should be a "good" year for Amateur Radio and it really is well worth while making a few resolutions. How many receiving stations, for example, have an oscilloscope? They're not difficult to make, and for an s.w.l. it doesn't have to be a complex instrument. Commercial 'scopes are easily available and they offer an invaluable aid. One useful application is to couple a 'scope into the i.f. of the receiver. In this way, you can actually see the signal you are receiving. If you transmit, say, c.w., then by using the receiver/oscilloscope arrangement as a monitor you can observe the keying waveform.

Perhaps the best resolution for the s.w.l. is simply "Better reports for 1974". An s.w.l. QSL card can look very pretty, but remember that it's the information on it that is of interest to the transmitting Amateur. If your card simply has a rubber stamp approach—RST/date/time/mode/please QSL OM, then your chances of getting a QSL in return are minimal. Put as much information as you can into the report. Don't be afraid to write additional notes or even a letter if the report warrants it. Don't forget the conditions on the band at the time of the report. If you hear a station in, say, Brazil, then it will be of interest if you noted that other stations were fading or that Brazil was (or seemed to be) the only S. American area coming in but that many VE stations had been heard at an average strength of RST 559 or whatever.

Projects; we all build these—at least I hope we do. How about planning your projects this year. Plan it and then do it before you move on to the next thing. A grid dip oscillator (GDO) or a solid state version is invaluable and extremely simple to build—and inexpensive. How about making one and playing antennas this summer? You can plan various types of aerials to experiment with. For a wire antenna, ordinary cheap bell wire will do for summer experiments. You can check the resonance of lengths of coax and numerous other things all with a simple g.d.o.

For the transmitting Amateur the resolution must be "Better use of the Bands". Four metres is a must. Don't forget RAEN (Radio Amateur Emergency Network). This organisation has various Nets and carries out exercises on 70MHz. This might make interesting listening for s.w.ls too. Information on this from the RSGB, 35 Doughty Street, London, WC1N 2AE. While you're at it, why not join the Society?

In answer to impassioned pleas in the post from flat dwellers and unfortunate s.w.l. brothers in "No aerials allowed" environments some words of comfort. A length of flex round the picture rail can work wonders and you don't even need a back garden! In a room only 8ft. square, you can put up a twenty metre dipole (16ft. each half and fed in the middle with coax). Don't forget the loft. Quite ingenious antenna systems have been constructed up there by many Amateurs. A four metre beam can be used in some lofts. Even in the smallest, it's possible to wind some flex round the beams and feed the end with an aerial tuner unit (a.t.u.) on all bands from 160 metres to ten metres. So how about an evening's thought to some serious Amateur Radio New Year resolutions?

Readers' Logs

Stanley Sharred (Birmingham), tells exciting tales of happenings of which the following is passed on; listen 2330hrs for KV4FZ on top band. Stanley's best on 160 metres; DK2QL, DK3BJ, DL0PG, HB9ANW, OE3SGA, PA0HIP all on s.s.b. while on c.w. (same band); OK2PEW, VO1KE, W3ZQW, K1NOL, PY6APM, SV1DO, UQ2GCT, K2ANR, KV4FZ, OH3NB/OHS, OK1AYY, OK1FCW, OK1MCW.

P. Barber (Co. Durham) gives a list of stations who are transmitting slow scan television on 14MHz. Frequency quoted is 14230kHz and callsigns heard include: F3RT, F6AZO, F6BIG, F6BKB, F9IB, G2BAR, G3LIV, I1PRQ, I3HDC, I8PSX, I8TMY, JA7FS, OD5HC, OZ4EDR, VE3FCN, W4LAS, W8BT. Connections to the receiver from the slow scan television monitor are made via the phone jack. How about a resolution to look into s.s.t.v. this year?

Glyn Fisher (Rutland), HRO tuning 4—6MHz m.o.s.f.e.t. converter, sends in a list of goodies heard high up on 144MHz. The antenna is a Vee dipole in the bedroom: DC1EU, DK1IE, DL3TR, F1BCD, F1CBH, F1CCP, F1CEC, GD2HDZ, GW8FTA/P, ON4PB, ON5GF, PA0QC, PA0VV. Glyn wants to know of any modern receiver which covers 4-6MHz continuous. At present he can only think of an HRO or Canadian 52 set—anyone any ideas?

BROADCAST BANDS

Short Wave Reports by 15th of the month to Malcolm Connah, 59 Windrush, Highworth, Swindon, Wiltshire, SN6 7DT.

Medium Waves Logs to Charles Molloy, 132 Segars Lane, Southport, PR8 3JG.

VHF/FM Reports to Simon David, c/o Practical Wireless, Fleetway House, Farringdon Street, London, EC4A 4AD.

AMATEUR BANDS

Short Wave/VHF

Logs in alphabetical order please by 15th of the month to David Gibson, G3JDG, 12 Cross Way, Harpenden, Hertfordshire.

ON THE AIR

BROADCAST BANDS

VHF/FM DXING

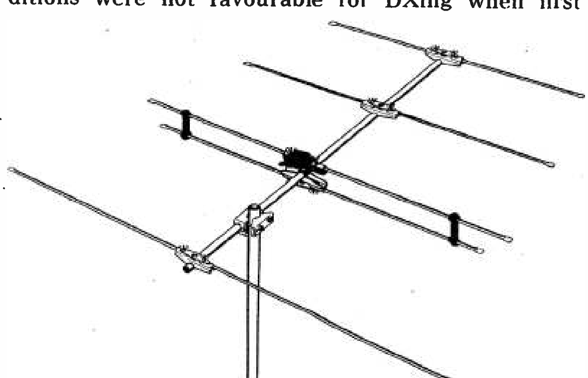
by SIMON DAVID

ENCOURAGING news from the BBC is that more than 99 per cent of the U.K. population can receive v.h.f. broadcasts. Of these, two-thirds are within the service areas of transmitters carrying Radio 2, Radio 3 and Radio 4 stereo programmes. This should provide considerable encouragement for those not yet converted to f.m.

Tuner sensitivities these days are such that you could get by temporarily with the proverbial "wet-string" aerial if you are within good striking distance of the transmitter. One of the *P.W.* authors, Roland Perry, has done this in his second floor apartment room at Cambridge. Roland writes: "The aerial is three feet of wire draped along my desk and at one time or another I have heard BBC Radios Solent, Oxford, London, Nottingham, Humberside, Sheffield, as well as Capital Radio and LBC". Radio 4 transmissions from as far away as Rowridge have also been heard. His cascode f.e.t. preamp is obviously largely responsible.

In Lisburn, Co. Antrim, Mr. R. Montgomery proudly received Radio 3 in stereo for the first time on 91·3MHz. Interesting point here is that he uses a vertically polarised J-Beam 'H' aerial. He also receives stereo from Southern Ireland, Radio Telefis Eirean and Radio Na Gaeltachta.

Talking of "wet-string" aerials I have tried something of this sort with a clip attached to my wall shelving rack. Results some 40 miles North-West of Wrotham were quite good and even produced some surprises from commercial radio. I have been trying out the new FM264T 6-element array from Antiference. This is a combination of the well known "Mushkiller" array with a "Trumatch" dipole. Conditions were not favourable for DXing when first



The FM244T

installed, but the mild spell in early December improved matters considerably.

It is easily installed and when lined up in the direction of South-East I have first-class reception of all the Wrotham and Croydon transmissions plus Radio Medway. Also pulled in were Lille 88·8MHz and 98·1MHz, Rheims 98·7MHz, although the latter was not a very strong stable signal.

Reducing this array to 4-elements had a marked effect on signal strength and the weaker stations tended to be almost impossible to get. On a more sensitive receiver, no doubt a 4-element array would be worthwhile. A photo of the 4-element FM244T array is shown here. The important point about the FM264T and FM244T is the uniform broad-band impedance characteristic, with a claimed variance of ±0·5dB over 88 to 100MHz.

Incidentally the FM264T was fitted in the loft about four feet above the joists. Of course, I have a large loft which is essential, but better results are obtainable when mounted outside on the chimney stack. Incidentally, I found it very useful to run two or three cables up to the loft; I can monitor the receiver output while positioning the aerial. The third (4-core) cable is for a rotator. I tend to prefer loft installations for convenience and certainly to avoid the unsightly clutter of outside installations on top of the roof.

The Editor has told me that *P.W.* is giving a pair of Datacards in the March issue, specially devoted to f.m. reception. I shall certainly make sure I don't miss them.

MEDIUM WAVE BROADCASTS

by CHARLES MOLLOY

BRIAN MURRAY (Edinburgh) has been trying the medium waves with his Astrad VEF204 10 transistor receiver using its internal ferrite rod aerial. He reports hearing programmes in English from the American Forces Network, Frankfurt on 872kHz; Radio Tirana, Albania 1394kHz at 2200hrs; Radio Portugal 755kHz at 2310hrs; Trans World Radio, Montecarlo 1466kHz at 2325hrs. Brian has also logged the BBC local radio station at London on 1457kHz at 1740hrs.

Stephen Mason (Loughton, Essex) has an Ultra 8 transistor receiver which he uses with a 7 metre horizontal wire aerial located 10 metres above ground level. His log includes programmes in English from Radio Sweden on 1178kHz; Radio Portugal 755kHz; Milan, Italy 899kHz; Voice of America, Munich 1196kHz; Radio Berlin International 1511kHz; Radio Tirana, Albania 1394kHz; and in Spanish from Radio Espana de Madrid EAJ2 which is a commercial station on 917kHz. Stephen has received verifications (QSLs) from Sweden, Portugal, Warsaw, Milan, Prague and the Voice of America, for reception on the medium waves.

Ian Gordon (Birmingham) has been busy again with his Codar CR70A, aerial tuning unit and 25m longwire antenna. He reports hearing the Radio Peking relay in Albania on 1457kHz sign-on at 1730hrs with interference from BBC Radio Birmingham on the same frequency and Sud Radio, Andorra in French on 818kHz. Ian reports that the IBA (London) has been heard in Birmingham on 719kHz.

Several readers have asked if the writer would include a log of his own MW DX giving details of the

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DY802	0·45	EF86	0·90	PC900	0·56	PL509	1·55	30F5/PF818	1·10
EABC80	1·00	EF89	0·81	PCC84	0·52	PL802	0·96	30FL1/PCE800	0·75
EB91	0·38	EF91	1·30	PCC88	0·80	PY33	0·66	30FL2	0·75
EBC81	0·75	EF92	1·40	PCC89	0·65	PY81/800	0·50	30FL12	1·05
EBF80	0·60	EF95	1·35	PCC189	0·65	PY82	0·55	30FL14	0·85
EBF83	0·62	EF183	0·60	PCF80	0·51	PY88	0·60	30L1/PCC84	0·52
EBF89	0·58	EF184	0·60	PCF82	1·30	PY500A	1·05	30L15/PCC805	1·05
EC86	0·75	EH90	0·56	PCF86	0·65	PY800	0·50	30L17	0·90
EC88	0·77	EL34	0·95	PCF200	0·85	PY801	0·50	30P4MR	1·30
ECC81	0·45	EL36	1·05	PCF201	0·87	U26	1·00	30P12/PC801	1·05
ECC82	0·43	EL81	0·90	PCF801	0·65	U191	1·00	30P19/PC802	1·00
ECC83	0·45	EL84	0·47	PCF802	0·71	U193	0·50	30PL1/PCL801	0·95
ECC84	0·55	EL85	0·55	PCF806	0·66	UABC80	0·90	30PL13/PCL800	1·20
ECC85	0·53	EL86	0·95	PCH200	0·88	UBC81	0·70	30PL14/PCL88	1·25
ECC88	0·75	EL95	0·70	PCL82	0·54	UBF89	0·60	30PL15	1·05
ECC189	0·71	EL91	1·31	PCL83	0·66	UCC85	0·60		
ECF80	0·56	ELL80	1·80	PCL84	0·59	UCH81	1·00		
ECF82	0·78	EM84	1·18	PCL85	0·63	UCL82	0·70		
ECF86	0·71	EM87	1·18	PCL86	0·63	UCL83	0·70		
ECH81	1·00	EY51	0·83	PCL805/85	0·63	UF89	0·80		
ECH83	1·00	EY86/87	0·42	PD500	1·55	UL84	0·95		
ECH84	0·78	EY88	0·64	PFL200	0·80	UY85	0·50		
ECL80	0·53	EZ80	0·51	PL36	0·88	6/30L2/ECC804	1·00		
ECL82	0·61	EZ81	0·40	PL81	0·75	6F23/EF812	1·05		
ECL83	0·68	GY501	0·90	PL81A	0·88	30C1/PCF80	0·51		
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DAF96	0·50	EF95	0·40	PCC89	0·50
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DF96	0·50	EF184	0·35	PCF82	0·35
DK91	0·45	EL32	0·60	PCF86	0·60
DK92	0·70	EL33	1·75	PCF801	0·50
DK96	0·60	EL34	0·50	PCF802	0·50
DL92	0·40	EL36	0·50	PCF805	0·90
DL94	0·48	EL37	2·50	PCF806	0·75
DL96	0·55	EL41	0·90	PCF808	0·90
DY86/7	0·36	EL42	0·90	PCL82	0·35
DY802	0·37	EL84	0·28	PCL83	0·66
EABC80	0·38	EL95	0·40	PCL84	0·45
EAF42	0·75	ELL80	1·00	PCL85	0·50
EB91	0·22	EM80	0·45	PCL86	0·45
EBC33	1·00	EM81	0·60	PCL805/85	0·50
EBC41	0·75	EM84	0·35	PD500	1·30
EBC81	0·33	EM85	1·00	PEN45	0·75
EBF80	0·40	EY51	0·40	PL36	0·55
EBF83	0·40	EY86	0·40	PL81	0·50
EBF89	0·32	EZ40	0·75	PL82	0·45
EBL31	1·50	EZ41	0·75	PL83	0·45
ECC81	0·40	EZ80	0·28	PL84	0·40
ECC82	0·33	EZ81	0·29	PL500	0·75
ECC83	0·33	GY501	0·80	PL504	0·75
ECC84	0·30	GZ30	0·45	PL508	0·90
ECC85	0·40	GZ32	0·50	PL509	1·55
ECC88	0·40	GZ34	0·65	PL802	0·95
ECH35	1·25	GZ37	1·25	PX4	3·50
ECH42	1·00	HN309	1·50	PX25	3·50
ECH81	0'30	KT61	1·75	PY33	0·63
ECH83	0·45	KT66	2·50	PY81	0·30
ECL80	0·55	KT81 (7C5)	1·30	PY82	0·35
ECL82	0·35	KT81	1·75	PY83	0·38
ECL83	0·70	KT88	2·90	PY88	0·40
ECL86	0·40	KTW61	1·00	PY500	1·00
ECLL800	3·20	MU14	1·00	PY81/800	0·50
EF37A	1·20	N78	2·75	PY801	0·50
EF39	1·20				

SP41	3·00	6J6	0·30
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T41	1·00	6J7G	0·40
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U25	0·85	6K7M	0·45
U26	0·85	6K7G	0·30
U191	0·75	6K8M	0·70
UABC80	0·40	6K8G	0·45
UAF42	0·75	6K25	0·75
UBC41	0·75	6L6G	0·55
UBC81	0·45	6Q7M	0·50
UBF80	0·40	6Q7G	0·50
UBF89	0·40	6SL7GT	0·48
UCC85	0·45	6SN7GT	0·48
UCH42	0·75	6SQ7GT	0·50
UCH81	0·40	6U5G	0·75
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UCL83	0·70	6V6GT	0·45
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UF89	0·40	6X5G	0·40
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UY85	0·40	7C5	1·30
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VR150-30	0·40	7H7	0·70
OA2	0·40	7R7	0·75
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1R5	0·45	7Y4	0·75
1S5	0·30	12AT6	0·40
1T4	0·30	12AT7	0·40
3S4	0·40	12AU6	0·45
3V4	0·70	12AU7	0·33
5R4GY	0·80	12AX7	0·33
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5Y3GT	0·45	30C1	0·80
5Z4G	0·45	30C15	1·05
6/30L2	0·90	30C17	1·10
6AK5	0·40	30C18	0·90
6AM5	0·90	30F5	1·10
6AQ5	0·45	30FL1	0·80
6AS7G	0·85	30FL2	0·75
6AT6	0·45	30FL14	0·90
6AU6	0·30	30L15	1·05
6BA6	0·28	30L17	0·95
6BE6	0·35	30P4MR	1·30
6BH6	0·75	30P12	1·05
6BJ6	0·55	30P19	1·00
6BQ7A	0·55	30PL1	0·95
6BR7	1·00	30PL13	1·20
6BS7	1·35	30PL14	1·25
6BW6	0·90	35W4	0·50
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BC109	0·12	CRS3-40	0·55
BC113	0·16	MJE340	0·50
BC117	0·21	MJE370	0·68
BC143	0·30	MJE520	0·65
BC147	0·12	MJE2955	1·10
BC148	0·10	MJE3055	0·75
BC169C	0·14	MPF102	0·40
BC182	0·12	MPF103	0·36
BC182L	0·12	MPF104	0·35
BC184L	0·13	MPF105	0·46
BCY32	1·20	NKT404	0·60
BCY33	0·38	OA5	0·60
BCY34	0·45	OA10	9·40
BCY70	0·15	OA79	0·10
BCY71	9·20	OA81	0·10
BCY72	0·15	OA91	0·7
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OC25	0·40	ZTX531	0·25	2N2905	0·26
OC28	0·70	ZTX550	0·18	2N2905A	0·23
OC35	0·55	1N914	0·06	2N2906	0·20
OC36	0·65	IN4001	0·6	2N2926	0·10
OC42	0·40	IN4002	0·7	2N3053	0·20
OC44	0·18	IN4003	0·8	2N3055	0·45
OC45	0·18	IN4004	0·8	2N3525	0·80
OC71	0·15	IN4005	0·10	2N3614	0·59
OC72	0·25	IN4006	0·12	2N3615	0·65
OC76	0·40	IN4007	0·12	2N3702	0·11
OC77	0·55	1N4009	0·06	2N3703	0·12
OC81	0·28	1N4148	0·06	2N3704	0·14
OC81D	0·28	1S921	0·07	2N3705	0·12
OC81Z	0·45	IS2033	0·20	2N3706	0·10
OC83	0·25	1S2051A	0·10	2N3707	0·13
OC140	0·65	IS2100A	0·20	2N3708	0·07
OC170	0·25	IS3010	0·25	2N3709	0·10
OC171	0·30	2N696	0·15	2N3710	0·11
OC200	0·55	2N697	0·15	2N3711	0·11
OC201	0·80	2N706	0·10	2N3819	0·35
OC202	0·90	2N706A	0·12	2N3820	0·50
OC203	0·55	2N1131	0·25	2N3823	0·50
OCP71	1·00	2N1132	0·25	2N3903	0·15
ORP12	0·55	2N1302	0·18	2N3904	0·20
ORP60	0·45	2N1303	0·18	2N3905	0·25
T1005	0·20	2N1304	0·22	2N3906	0·16
TIC44	0·29	2N1305	0·22	2N4058	0·15
TIC226D	1·00	2N1306	0·28	2N4059	0·10
TIL209	0·25	2N1307	0·28	2N4060	0·13
TIS43	0·26	2N1308	0·25	2N4061	0·13
ZTX107	0·12	2N1309	0·30	2N4062	0·14
ZTX108	0·10	2N1613	0·20	3N141	0·81
ZTX300	0·14	2N1614	0·45	40360	0·40
ZTX301	0·14	2N2147	0·75	40361	0·45
ZTX302	0·18	2N2160	0·61	40362	0·50
ZTX304	0·24	2N2369A	0·16	40430	0·85

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SN7401	0·20	SN7427	0·37	SN7474	0·48	SN74110	0·57	SN74170	2·88
SN7402	0·20	SN7428	0·43	SN7475	0·59	SN74111	0·86	SN74174	1·80
SN7403	0·20	SN7430	0·20	SN7476	0·45	SN74118	1·00	SN74175	1·29
SN7404	0·20	SN7432	0·37	SN7480	0·80	SN74119	1·92	SN74176	1·44
SN7405	0·20	SN7433	0·43	SN7482	0·87	SN74121	0·57	SN74190	2·30
SN7406	0·40	SN7437	0·45	SN7483	1·20	SN74122	0·80	SN74191	2·30
SN7407	0·40	SN7438	0·43	SN7484	1·00	SN74123	1·44	SN74192	2·30
SN7408	0·25	SN7440	0·20	SN7486	0·50	SN74141	1·00	SN74193	2·30
SN7409	0·33	SN7441AN	0·85	SN7490	0·75	SN74145	1·44	SN74194	1·72
SN7410	0·20	SN7442	0·85	SN7491AN	1·10	SN74150	2·30	SN74195	1·44
SN7411	0·23	SN7450	0·20	SN7492	0·75	SN74151	1·15	SN74196	1·58
SN7412	0·28	SN7451	0·20	SN7493	0·75	SN74154	2·30	SN74197	1·58
SN7413	0·30	SN7453	0·20	SN7494	0·85	SN74155	1·15	SN74198	3·16
SN7416	0·30	SN7454	0·20	SN7495	0·85	SN74156	1·15	SN74199	2·88
SN7417	0·30	SN7460	0·20	SN7496	1·00				
SN7420	0·20	SN7470	0·33	SN7497	4·32				
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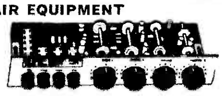

Z40 £4·25 (63p)	Project 605	£19·90	(£2·30)
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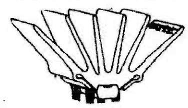

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T-DECS £2·88 (40p)
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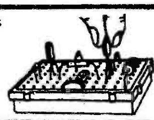

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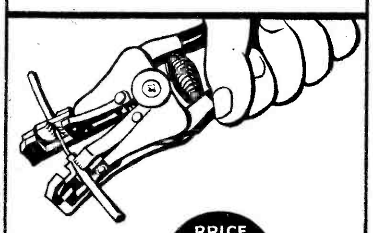

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equipment used. The main receiver is a Marconi Mercury marine communications receiver which covers 15kHz to 4MHz while the standby is a BC946 Medium Wave Command receiver. Two aerials are in use—a standard MW loop antenna and a 90ft longwire at 20ft above the ground. The QTH is Southport in Lancashire. Stations heard regularly in the evening are Radio Na Gaeltachta Conamara, Eire on 539kHz; Baghdad Iraq on 760kHz; Quazvin, Iran 841kHz; Kermanshah, Iran 985kHz; Kuwait 1345kHz. The BBC Eastern Mediterranean relay in Cyprus is now on 1322kHz and is heard relaying the BBC World Service in English at 2305hrs. North American reception has been good this winter with CJON St. John's, Newfoundland, on 930kHz and WNEW New York City 1130kHz conspicuous at 2330hrs. Others heard before midnight are CBN St. John's on 640kHz; CHER Sydney, Nova Scotia 950kHz; WINS New York City on 1010kHz; CBA Moncton New Brunswick on 1070kHz; Radio St. Pierre, St. Pierre et Miquelon (near Newfoundland) in French on 1375kHz. Two South Americans—ZYD66 Rio de Janeiro 940kHz in Portuguese and YVRS Radio Margarita, Venezuala on 1020kHz have been logged frequently along with PJA6 Radio Victoria which is located on the Dutch island of Aruba, near Venezuela and broadcasts religious programmes in English on 925kHz at 2315hrs. On the Longwaves Ankara, Turkey is now heard on 182kHz during the evening along with Azilal, Morocco in Arabic on 209kHz and Tipaza, Algeria on 251kHz in French.

Brian Richardson (Nottingham) asks about Whites Radio Log which gives details of all North American MW stations. This log used to appear in three parts in consecutive issues of an American magazine but it is no longer being published. Currently in the UK there is the Guide to Broadcasting Stations by Butterworth which is available in many bookshops. It lists all MW stations in Europe and a number of the more powerful ones in other parts of the world.

SHORT WAVE DX
by MALCOLM CONNAH

Now that the festivities are over we can all get down to some serious listening, and possibly constructing as well.

This time of year is ideal for trying to catch some of the stations which have eluded you in the past. The only way to catch them is to concentrate all available efforts to the task. One suggestion would be to make a list of all those stations which should be audible on your equipment and then systematically listen for them.

Radio New Zealand, for instance, should soon be audible again. Last year the frequencies were 9540 and 11780 and the time was 0800 GMT.

I wish you all the best with your listening and hope to receive your logs in the near future.

Readers' Logs

A very large number of logs have been received this month and we start with a couple from our overseas readers.

Bruce A. Laird of Greensborough in Victoria, Australia has heard the following stations:

9625 *R. Canada International* in English at 0900.
9675 *Radio Japan* in English at 1100.
9715 *R. Nederland* in English at 0800.
9745 *HCJB, Quito, Ecuador,* English at 0800.
11775 *Swiss B.C.,* in English from 0700 to 0930.
11875 *Radio Japan,* English from 0930 to 1030.
11890 *FEBC, Philippines* in English at 0930.
11940 *R. Japan* in Chinese and Vietnamese at 1000.
15235 *R. Japan* in English at 0930.

Steven Phillips of Durban in South Africa used his Hamerstein Hi-Fi Stereo 30 receiver and 30 odd feet of aerial wire to hear:

6160 *R. Australia* in English at 1500.
11730 *R. Nederland* via Madagascar at 1400.
11770 *BBC, Ascension Is.* relay at 1700.
11815 *NHK, Japan* in English at 1300.
15420 *BBC, East Med.* relay at 0400.
15840 *R. Nederland* in English at 1230.
21600 *Deutsche Welle* noted at 1200.

We return to the U.K. for a log from **Harold Emblem** of Mirfield in Yorkshire who has a Lafayette HA63 receiver and 18 metre long-wire antenna. This combination was used to hear:

9545 *R. Accra, Ghana* from 2104.
11905 *Austrian Radio* at 1900.
15185 *WINB,* Red Lion, U.S.A. at 2115.
15410 *United Nations Radio* noted at 2200.
15440 *WNYN, New York* at 2100.
17855 *United Nations Radio, Tangiers,* 1830.
25790 *RSA, South Africa* noted at 1420.

Simon Auger of Cheshunt in Hertfordshire writes —"After mourning for the injury to my transistor superhet, I blew the dust off my homebrew 2 valve regen.; attached it to my 50 foot end-fed aerial and an A.T.U. and accomplished the following in fourteen afternoons":

4965 *RSA, South Africa* in English at 1330.
6070 *Radio Sofia, Bulgaria* at 1930.
9005 *Voice of Iran, Tehran,* English at 2000.
9630 *Radio Sweden* noted at 1230.
9760 *R. Nacional d'Espana* at 1900.
9912 *AIR, Delhi* in English at 2000.
11775 *Radio Bucharest, Rumania* at 1500.
15340 *Radio Cairo* noted at 1800.

K. Goldsworthy of Hounslow in Middlesex has a Russion-made VEF204 receiver which, when connected to a 10 metre antenna, produced the following:

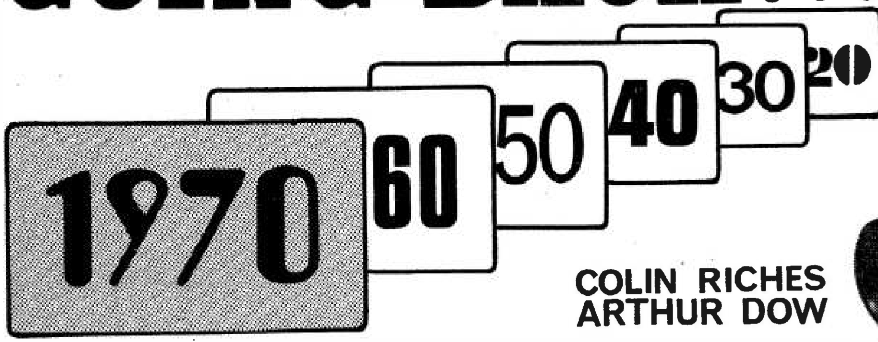
6025 *R. Portugal* in English at 2130.
7185 *RSA, South Africa* in English at 2000.
15185 *Radio Finland* in English at 1200.
17750 *Havana, Cuba* in English at 2130.
17820 *R. Canada International,* English at 2230.
17825 *RSA, South Africa,* English at 1600.

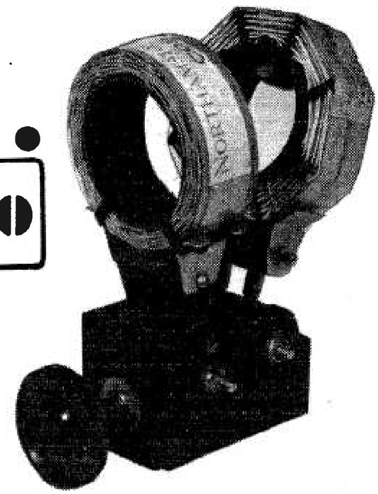
Another point which is worthy of mention at this time of year is the fact that the new edition of the 'World Radio TV Handbook' is due for publication. This book contains details of all Broadcast stations throughout the world. The entry for each station shows a list of all frequencies used; a current programme schedule; details of the Interval Signal; the station announcement; the address of the station and its QSL policy.

The introduction includes general hints on shortwave listening and the last section of the book is a list, by frequency, of all the stations. This list is very useful in identifying particular stations, especially when the frequency to which the receiver is tuned is accurately known.

All in all the handbook is an invaluable asset to all serious DXer's and I would recommend it to anyone regarless of their level of experience.

GOING BACK...





COLIN RICHES
ARTHUR DOW

S-T's Neutrodyne

IN our August 1972 Going Back we gave an all-too-brief account of some of the contributions made to the art of wireless in the early days by John Scott-Taggart. We mentioned, among other matters, that he had sold many patents to the big wireless manufacturing companies including one to the Hazeltine Corporation (USA). Our attention has been drawn to an article published in the July 31st, 1926 issue of "Wireless" wherein much is made of the fact that the Neutrodyne (neutralising) circuit was patented by S.T. on January 2nd 1923 while the date for a practically identical patent by Professor Hazeltine in the USA was April 5th, 1923, some three months later.

"Wireless" sported headlines such as "Who invented the Neutrodyne?", "We should in England call it the Scott-Taggart Neutrodyne" and "New facts about a great invention". We only wish that we could be allowed to reproduce the three pages that "Wireless" published on this most interesting story if only to ensure that present day readers of *PW* are made aware that the British habit of throwing away potential moneymaking inventions is no recent acquisition! Remember the Hovertrain, among others?

To further quote Wireless "The utmost interest is being shown in the whole question of the Neutrodyne circuit. Although such circuits have from time to time been incorporated in various receivers, the extraordinary success of the "Elstree Six" has persuaded the wireless public that for selectivity, range, signal strength and non-radiation the Neutrodyne stands supreme . . . Although in America the manufacturers and public immediately appreciated the merits of the Neutrodyne, yet neither have hitherto fully done so in Great Britain. The wide publicity and dozens of demonstrations of the "Elstree Six" have, after three and a half years, made the Neutradyne 'catch on' ".

Professor Hazeltine himself stated that he did not contemplate a wireless receiver, his idea being to use neutralising in land-line telephony. Only later did he develop the principle in wireless sets. At a luncheon at the Savoy Hotel, in front of over one hundred guests, Professor Hazeltine paid generous tribute to the work of Scott-Taggart and discussing the invention said "I had done some work along those

WHO INVENTED THE NEUTRODYNE?

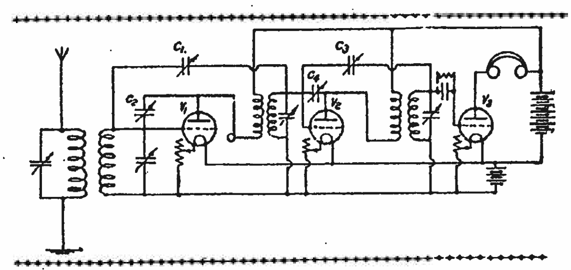
"We should in England call it the Scott-Taggart Neutrodyne"

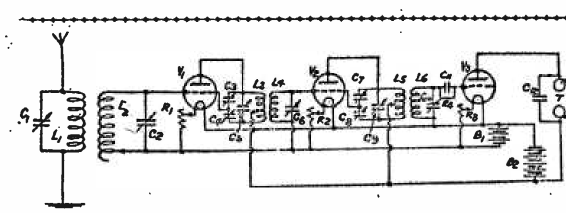
—Professor Hazeltine

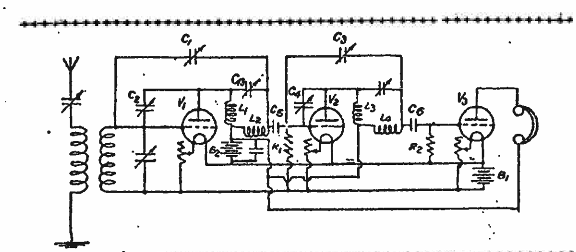
NEW FACTS ABOUT A GREAT INVENTION

How it Came to be Sold to America

Headlines from "Wireless" of July 31st, 1926 exposing the story behind the invention of the Neutrodyne.







Three of the actual circuits included in Patent 217971 of January 2nd, 1923, in the name of Scott-Taggart.

lines generally and the result was the receiver known as the Neutrodyne. Similar work was being done by Mr. Scott-Taggart and I feel that while we in America call it the Hazeltine Neutrodyne we should in England call it the Scott-Taggart Neutrodyne".

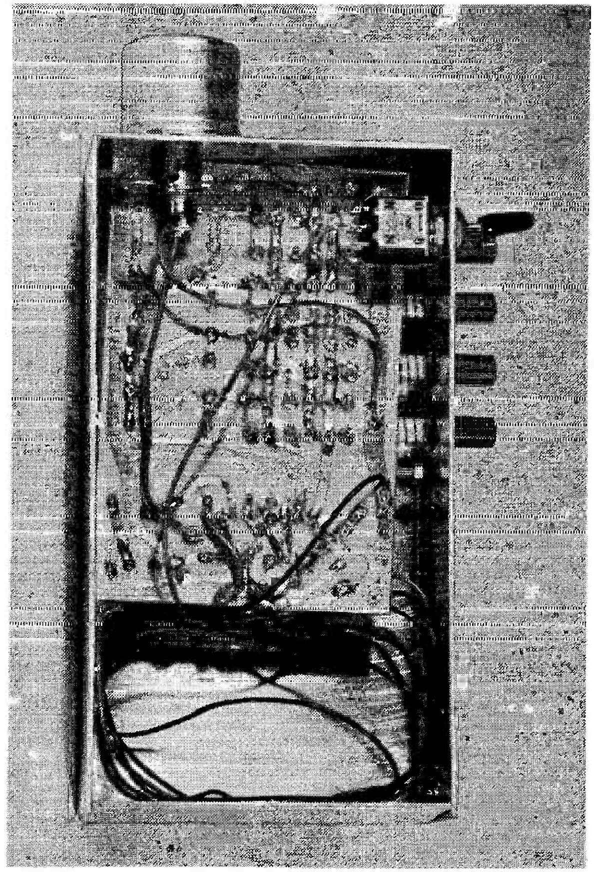
S.T.'s patent had been published in detail in Wireless Weekly in June 1923, and although British industry was fully aware of the inventor's claims not a single firm approached S.T. As Wireless noted "this was not to be wondered at; as recently as a year ago probably the largest manufacturer of broadcast receivers declared publicly that the Neutrodyne was dying out in America and that it could never become popular in this country". After this turn down by the trade here the S.T. patent was bought by the Hazeltine Corporation although S.T. himself was unaware, at the time, of the identity of the purchasers since the arrangements were made through agents.

The ironical position developed in which a first class British patent had been sold to America who exported sets to us here which were licensed under the S.T. patent. The Hazeltine Corporation sold licence rights on the patent to no less than fourteen leading manufacturers in the USA. From Wireless again . . . "The value of the invention was appreciated from the first by the Americans and their enterprise is in striking contrast to our own . . . the Neutrodyne receiver in America has been a colossal success. No other invention has had such an extraordinary vogue. Up to date (1926) £7,000,000 worth of licensed Neutrodyne receivers have been sold. Professor Hazeltine and his associates draw patent licence fees to the extent of £120,000 per annum!"

ULTRASONIC REMOTE CONTROLLER—
continued from page 966

OPERATION AND APPLICATIONS

The prototype system operates at a range of 60 to 80 feet. Bearing in mind the medium of transmission, the best results are obtained under 'line of sight' operation. Ultrasonics behave in a similar fashion to light as far as propagation is concerned, so this means that ultrasonics will be reflected when they strike a hard surface. The prototype system was surprisingly omnidirectional under most conditions, and the user will soon acquaint himself with the possibilities and limitations of ultrasonic command.



The board is fitted into case with the two bolts on the switch unit. The 9V battery fits into the space at the bottom of the case.

Applications are numerous and one that immediately springs to mind is switching lights on and off. This may sound a little mundane to many readers, but how often have you fallen over the garden fork when fumbling about for the garage light switch? With the same transmitter in your pocket, you can turn on entrance lights when you drive in at night, and turn on the radio for the news.

One application of the carrier-only system, that has not been investigated at length in this article, is that of burglar alarms. One American firm now produces a level sensing IC and tone alarm, that will be set off if any one of four inputs indicates a change of state of 25% or so. The change of state can be brought about by interference with the ultrasonic carrier, breaking of light beams etc. ■

HOTLINES ON RECENT DEVELOPMENTS

DODGY FOOD TESTER

EVERY once in a while one reads or hears of a major scare over tinned foods. It's all the fault of those grotty little bacteria and the technical name is Botulism. The "normal" way in which tinned food is tested is to grow a culture and then to turn this over to highly skilled personnel for microscopic analysis. Trouble is that all this culture growing and analysing takes a lot of time and skill.

This is where the "Bactometer" comes into its own. At present it is undergoing various tests, but the great advantages claimed are that the equipment will make the necessary results available in less than an hour, and it doesn't need skilled people to operate it—it's automatic.

How does the Bactometer work? Basically, it is a very sophisticated bridge which measures impedance. The test material is prepared in a liquid culture and a "reference" is made using a medium which is sterile. By putting these two separate cultures into a favourable growing environment the impedance of each is plotted. If there is no growth in the test sample, then the impedance will not differ greatly. However, if growth does take place, indicating contamination, then the impedance drops giving a positive sign. It would appear that bacteria have no resistance to the advance of science! Incidentally, once the samples have been put into the Bactometer, the entire process from that point on is automatic and thus no skill is required to operate the equipment. A chart recorder plots the impedances giving a written printout proof. Perhaps a monitary Bactometer could be devised for bank managers to detect overdrafts?

JAP REPORT

A piece of information which surprised me was that the Japanese home colour television market is approaching saturation point. Apparently some 80% of Japanese households now have colour television and manufacturers are talking about a push to get people thinking about a second set! The scene is an interesting one. Originally, the Japanese manufacturers considered that the smaller colour set was the trend for Japan. Now, Aiwa, a Japanese Company, are to import large screen (24-26in). American models. This has caused quite a stir.

On the Japanese market itself, the accent is now on power saving and this has been underlined with the recent energy availability problems which have become almost international. Meanwhile, Philips, the European-based Dutch giant, have a 26in. colour tube which heats to emmission in only five seconds and yet uses 20% less power than earlier designs. The Japanese finding was that people like to switch on the set and see results almost immediately. The public has been weaned to this by the use of solid state.

VIDEO SYSTEMS

Video recording systems have been in the news, and still are. One favourite method is to record the video signal using a laser beam. On playback, another small laser is used to detect the signal. This approach has been proposed for other markets too, such as mass memories, audio-visual and industrial control. Now, just as everyone is getting used to the idea, a Company has come up with a video playback system which uses the humble 25W light bulb. The bulb needs only about £30 of standard parts to form the basis of the playback system or video record player.

A laser is used to make the video disc by "printing" a series of dots whose individual diameters and densities vary according to the amplitude of the signal being recorded. Some 60 minutes of playing time is provided, the analogue signal being compacted by some 6:1. The train of dots form a spiral which roughly follows the path that a groove would take in an ordinary audio record.

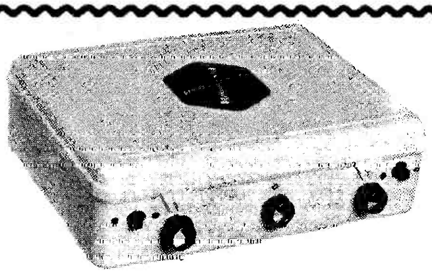
Playback is achieved on a—wait for it—transparent turntable. The 25W light bulb is located beneath the turntable so that it's light shines through both turntable and record. The light is detected by three light sensors or photodiodes. Two of these are responsible for tracking and keeping the lens system in line with the train of dots spiral. The third sensor detects the variations in diameter/density of the dots and this is converted into an amplitude modulated signal. This is mixed with a very small r.f. signal and the resultant a.m. carrier is then fed directly to the aerial terminal of a standard television receiver. Initial experiments have shown that the system should be suitable for digital, audio and analogue recordings.

Please note, the system is experimental and will not be on the market for some time. This column describes state of the art things, and this is one of them.

BOOM TIME

The last year has been a tremendous boom time for the electronics industry. So much so that materials are running out and suppliers just cannot keep pace with the demands of industry. This means that components are becoming scarcer. It is not unusual to find a supplier quoting a 72-week delivery. Couple this with the oil problem and it looks more serious. Plastics are tied in with oil. Although plastic packaged semiconductors are cheaper than ceramic ones, could it be the other way round soon? One thing is easily possible—the price of semiconductors and particularly i.cs may rise soon. It could be the old story of supply and demand, perhaps even a black market. Psst, wanna a buy an OC71 guv?

Ginsberg



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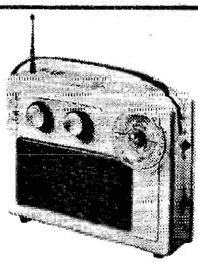
NEW ROAMER NINE



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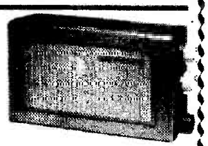

3 Tunable wavebands, M.W. L.W. and Trawler Band. 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, moving coil loudspeaker, attractive black and gold case. Size $5\frac{1}{2}'' \times 1\frac{1}{2}'' \times 3\frac{1}{2}''$ approx. Plans and Parts Price List 15p (Free with parts).

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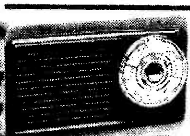

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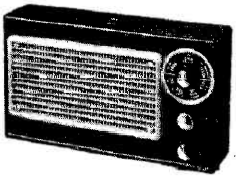

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E.V.7. Case and looks as above. 7 Transistors and 3 diodes. Six wavebands. MW/LW. Trawler Band, SW1, SW2, SW3, powered by 9 volt battery. Push Pull output. Telescopic aerial for short waves. 3" Loudspeaker. Parts Price List and Easy Build Plans 20p. Free with parts. Overseas P & P £1·85.

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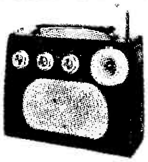

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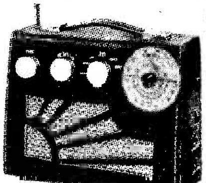

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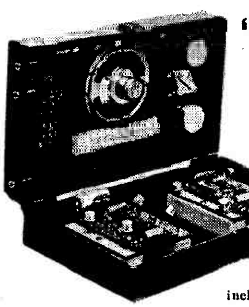

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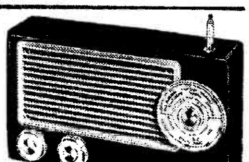

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PART 5—EMITTER FOLLOWER

IT is natural to think that the role of an amplifier is simply to take small voltages and turn them (somehow) into high voltages but this is by no means the end of the story.

Apart from voltage amplifiers we often come across circuits that fulfil some role of amplification that is not always so obvious or, for that matter, easily measurable. To name a few; we have current amplifiers, power amplifiers, impedance converters (sometimes called buffer stages), inverters and operational amplifiers. The transistor can give us all these options in different forms of circuit and we shall explore some of these obvious and not-so-obvious applications.

The transistor is basically a current sensitive device so it would not be unreasonable to look, firstly, at its role as a *current amplifier*. The circuit we shall consider is the *emitter follower* (briefly mentioned in a previous part). The name current amplifier implies that we require a circuit that needs only a very small input current generated by a given voltage to give a larger current in an output circuit with more or less the same sort of voltage swings. If we say that the input and output voltage swings are about the same but impose the condition that the input current is small, it immediately means that the resistances involved in the input circuitry are greater than those we are likely to see in the output (which has larger current variations for the same voltage changes). Fig. 29 is a test circuit that will demonstrate what we mean.

VR1 is used simply to provide a source of variable

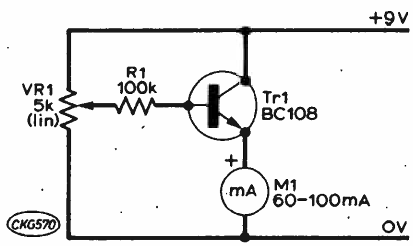

Fig. 29. The emitter current measured is proportional to the base current through R1. The latter is set by VR1.

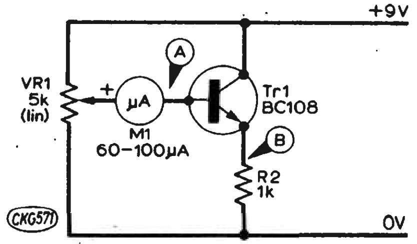

Fig. 30. The transistor draws only the amount of base current necessary to make the potential at B rise to that of A (less the Vbe of the transistor).

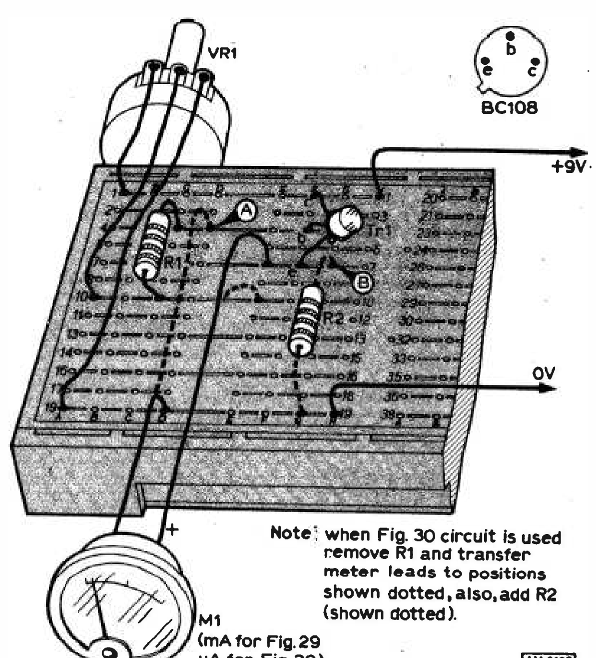

Fig. 31. Layout for Figs. 29 and 30.

voltage that is used to drive base current into Tr1. If you assume the internal resistance of the testmeter (set to current) is zero it is a simple calculation to work out the base current supplied.

The maximum will be when VR1 is set to the top of its track (+9V as a source). The base current is

therefore $\frac{9 - Vbe}{100k\Omega} = \frac{8 \cdot 4}{100}$ mA $= 0 \cdot 084$mA.

The current you will measure in the emitter circuit will be as high as 30mA for this setting of VR1. The increase in current flow is up by a factor of about 300. One could, in fact, have calculated the emitter current from the current gain of the transistor (h_{FE}):

collector current $= h_{FE} \times$ base current

emitter current = collector current + base current

$\therefore\ Ie = (h_{FE} \times Ib) + Ib$

In other words $Ie = Ib \times (h_{FE} + 1)$

Because the h_{FE} for a BC108 is approximately 200 to 300 one can see that the emitter current we measure is about two to three hundred times the base current. An immediate problem that springs out from this calculation is that you can only calculate the result if you know a precise value for h_{FE} but this varies a lot from one transistor to another—even though they may have the same type number. Thus the precise currents you measure in the emitter circuit will be dependent on the particular transistor you are using. Later you will see that steps have to be taken in many circuits to compensate for h_{FE} variations from one transistor to another. It is clear, then, that we can get an amplification of current by using a transistor and if you vary VR1 you should see that to all intents and purposes the emitter current is direcly proportional to the base current supplied.

We can now carry out a variation on the same theme by using the circuit of Fig. 30. At first glance you might think that the base current will be very much greater than 60µA because all that seems to be limiting the base current is R2 in the emitter circuit. Firstly try it out and you should find that by adjusting VR1 the measured base current goes from zero up to a maximum of about 30 to 60µA (depending on your own particular transistor). When VR1 is set to maximum it is tempting to think that the base current is approximately 9V divided by the 1,000Ω of the emitter resistor (about 9mA). If you make this guess you are overlooking the fact that as soon as you start to apply base current into Tr1 we will cause emitter current to flow in R2 and this causes a voltage drop across it. The voltage at B will rise. The

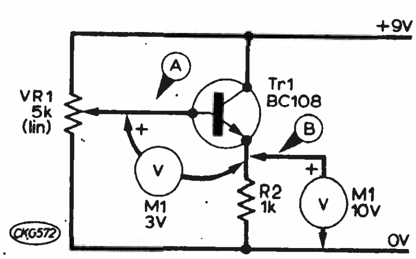

Fig. 32. At all settings of the slider the potential difference between A and B is about 600mV showing that B "follows" A.

base current is thus controlled by the new potential difference between points A and B (NOT between point A and ground!).

You can see the voltage at point B rising by switching the meter to volts (meanwhile connecting point A directly to the base of the transistor, Fig. 32). Notice that there is very little difference between the voltages set at A and those that are given at B. The difference is basically 600mV which is the forward base emitter voltage drop. Return to Fig. 30 and change R2 for a 10kΩ resistor. You will see that the base current drawn by the transistor reduces by a factor of ten. Reduce R2 to 100Ω and the base current increases by about a factor of ten from its original value. The transistor thus gives an output voltage that follows the input voltage and the "following" effect forces the transistor to draw only sufficient base current to make the voltage at B approach that at A.

The input current is self limiting and makes the transistor look as if it has a very high base resistance. We say it presents a high input resistance to the voltage source and the output is more or less the same voltage as the source but the emitter current is very much greater than the input current.

Touch sensitive switch

Another way of looking at this circuit is to consider a limited current coming from a voltage source —Fig. 33—as one might find with a touch sensitive switch where the very small current flowing through the fingers is needed to cause a higher current in another circuit. Bridging the two contacts with the fingers causes base current to flow and the emitter voltage rises towards the voltage of the source (+9V). Depending on how good the skin contact is and how good a conductor you are you may pass sufficient base current to make point B rise to +9V.

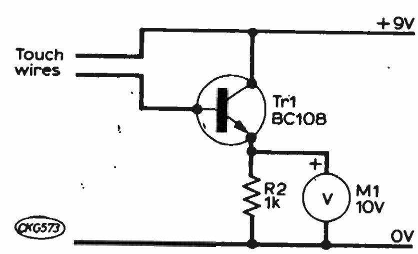

Fig. 33. The small current flowing through the fingers generates emitter current and this is shown as a potential difference across R2.

We have selected a value for R2 so that you may not be able to produce a low enough skin resistance to pass sufficient base current and hence the voltage at B may not follow the base exactly and the voltage you measure will vary depending on how hard you press the contacts with your fingers. To make the voltage at B go to +9V with ease you must reduce the base current requirement and this is done by reducing the amount of emitter current needed to make point B follow the input. This is done by increasing the value of R2 to 10kΩ.

A more precise way of obtaining an output voltage at the emitter of Tr1 proportional to the body's resistance is to make sure that the emitter current, to be controlled, is not limited by the h_{FE} of the transistor. You can then use a circuit that relies on the potential divide effect of the body resistance and R1 (Fig. 34) to give a potential at the base of Tr1 that is reflected in the potential at its emitter (less only the base emitter drop). The current available in the collector/emitter circuit of the transistor is still many times greater than the current flowing through the body and can be used as a signal into other circuits. Fig. 36 is such a circuit. When the contacts are bridged with the fingers a small current flows into the base of Tr1; this produces a higher current in the collector/emitter circuit of Tr1 some, of which, passes into the base circuit of Tr2 where it is further amplified to provide base drive to the inverter Tr3 which needs quite a high base current to turn on the lamp. Bridging the contacts turns on the lamp. If you think about it R2 serves no useful purpose—on the contrary it wastes useful emitter current of Tr1 which could be used as base current for Tr2; thus it can be removed and the circuit still works. The combination of one emitter follower feeding into another emitter follower is often seen when a circuit requires a very high input resistance and the combination is called a *super alpha pair*.

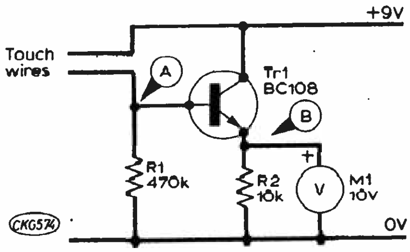

Fig. 34. The potential at A is set by the potential divide of R1 with skin resistance and this is reflected by the potential measured at B in the lower resistance emitter circuit.

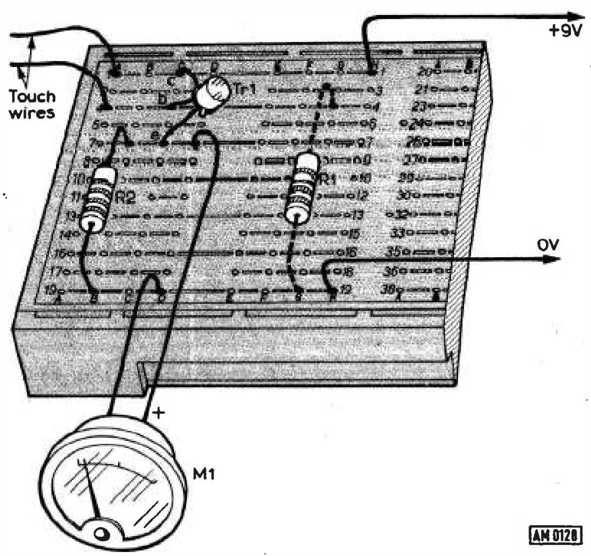

Fig. 35. Layout for Fig. 33. To carry out experiment in Fig. 34 change R2 to 10kΩ and insert R1.

Super alpha pair

The maximum current you can control in the emitter circuit is given by the base current multiplied by the h_{FE} for the transistor. Thus the current gain of a typical single stage using a BC108 is about 200 to 300. For a super alpha pair the gain would be $200\times200=40{,}000$. In our circuit of Fig. 36 the base current required by Tr3 to turn on the lamp is about 0·2mA. We thus need only one fortythousandth of this as base current into the first stage i.e. about 0·005μA. In reality more than this has to flow through the skin because we have the 470kΩ of R1 shunting the base of Tr1 to ground. It is possible to remove R1 and the circuit will become even more sensitive —the only problem is that it may become too sensitive and trigger by capacitively coupled pick up by Tr1's base. In theory R3 could be omitted but this is unwise; it is there to protect the base emitter junction of Tr3 from too high a current.

The emitter follower principle is often used as the active element in voltage regulators where a variable voltage output is needed from a power supply at quite high currents.

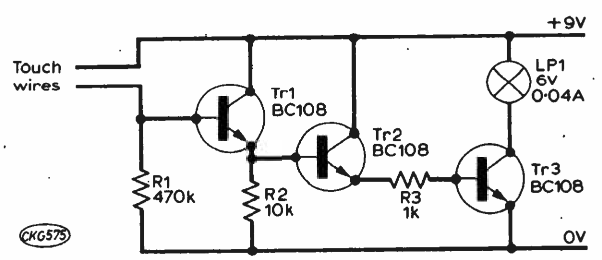

Fig. 36. A touch sensitive light switch. In practice R2 can be omitted as can R1 but removal of the latter might make the circuit over sensitive. R3 should not be omitted.

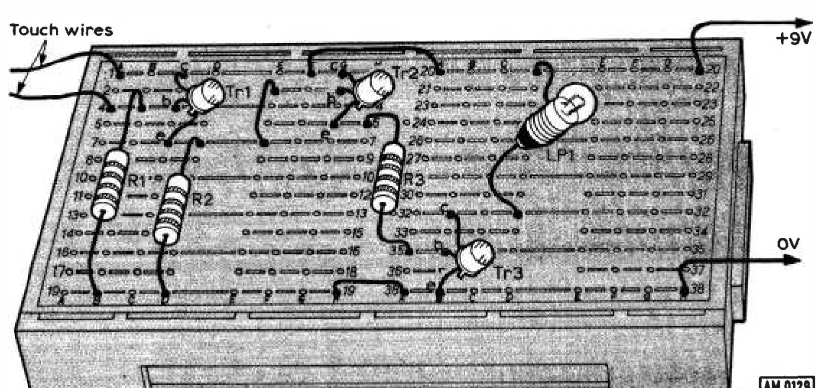

Fig. 37. Layout for Fig. 36.

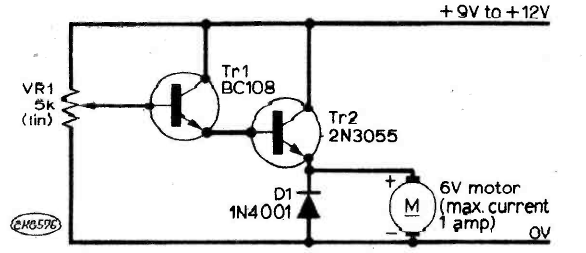

Fig. 38. Simple voltage adjustment to control the speed of low voltage d.c. motors. D1 is included to prevent high reverse voltages from the brushes damaging the transistor. The output is not short circuit protected.

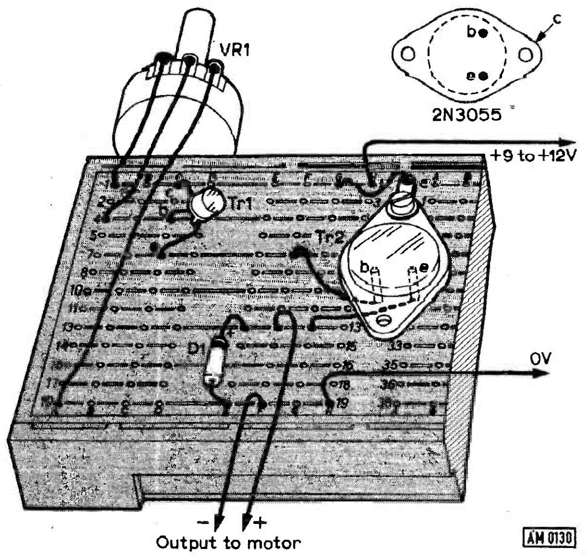

Fig. 39. Layout for Fig. 38. The short leads on Tr2 should be extended to connect to the T-Dec and the collector connection made via a solder tag bolted to Tr2.

It is expensive to use a high power potentiometer but a small potentiometer and a power transistor will do the job very nicely. Provided the output current does not exceed the rating of the transistor and is less than the Ib h_{FE} product the output voltage of Fig. 38 will be approximately equal to the potential set at the wiper of the potentiometer (less the transistors forward voltage drops). With the power transistor shown the circuit would act as a crude speed controller for small model motors. The wiper of the potentiometer provides the reference voltage. This could be generated by means of a zener diode and thus a stabilised power supply could be made to run, say, a cassette tape recorder from a 12V car battery (Fig. 40). C1 is included to suppress ignition noise.

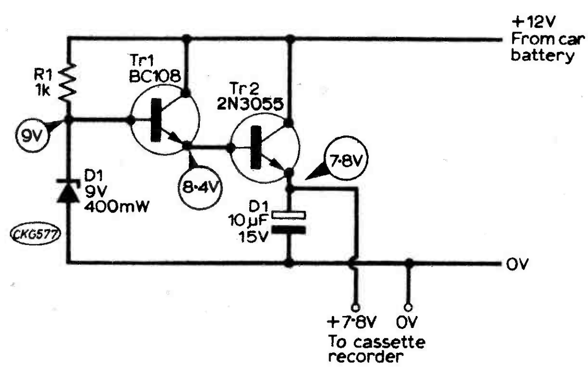

Fig. 40. A simple voltage dropper and regulator for running a cassette recorder from a car battery. Not short circuit protected.

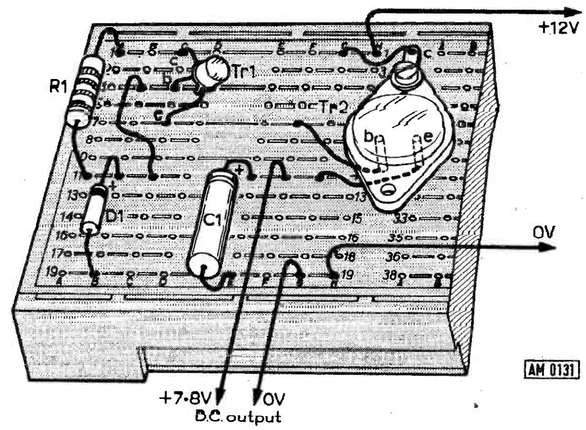

Fig. 41. Layout for Fig. 40.

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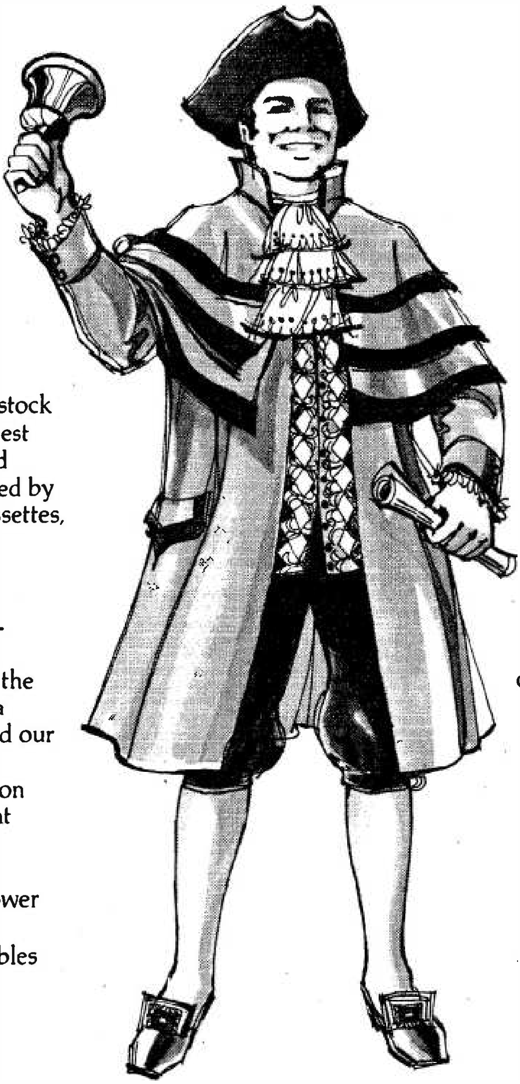

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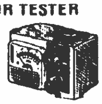

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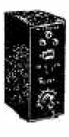

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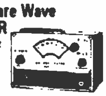

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40A	£103.10	150p

MODEL S260B

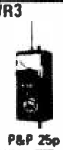
2.5A	£8.75	30p
1A	£10.00	35p

AUTO TRANSFORMERS

0/115/250V. Step up or step down. Fully shrouded.

80W	£2.75	P&P 18p
150W	£3.50	P&P 18p
300W	£4.50	P&P 23p
500W	£6.95	P&P 33p
1000W	£9.50	P&P 38p
1500W	£12.50	P&P 43p
2250W	£20.95	P&P 50p
5000W	£44.95	P&P £1

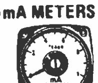
SWR METER Model SWR3



Handy SWR meter for transmitter antenna alignment, with built-in field strength meter. Accuracy 5%, Impedence 52' Indicator 100uA DC. Full scale 5 section collapsible antenna. Size 145 x 50 x 60mm.

OUR PRICE £4.25 P&P 25p

240° Wide Angle 1mA METERS



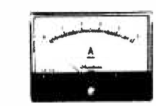
MW 1–6 60x60mm
£3.97 P&P 15p
MW 1–8 80x80mm
£4.97 P&P 15p

SEW

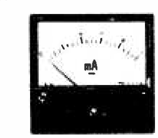
CLEAR PLASTIC PANEL METERS

USED EXTENSIVELY BY INDUSTRY, GOVERNMENT DEPARTMENTS AND EDUCATIONAL AUTHORITIES.

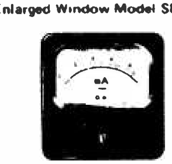
Over 2,000 ranges in stock—other ranges to order. Quantity discounts available. Send for fully illustrated brochure.



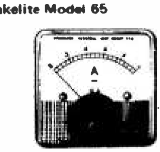
Clear Plastic Model SD830



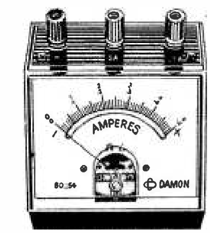
Enlarged Window Model S80



Bakelite Model 65



Clear Plastic Model 45P



Model ED107

RANGE	MR 38P	MR 45P	MR 52P	MR 65P	MR 85P	MR 65	S 80	SW 100	SD 460	SD 640	SD 830	PE 70	ED 107
25uA	–	–	–	–	–	£4.60	–	–	–	–	–	–	–
50uA	£2.55	£2.70	£3.50	£3.70	£4.40	£3.55	£3.50	£4.15	£2.80	£3.05	£3.40	£3.75	£6.90
100uA	£2.45	£2.60	£3.00	£3.15	£4.25	£3.00	£3.40	£3.95	£2.75	£3.00	£3.35	£3.60	£6.40
200uA	£2.40	£2.50	–	£3.05	£4.05	–	–	–	£2.70	£3.00	£3.30	£3.40	–
500uA	£2.25	£2.45	£2.65	£2.75	£3.90	£2.70	£3.05	£3.70	£2.55	£2.95	£3.15	£3.20	–
50-0-50uA	£2.50	£2.85	£3.05	£3.15	£4.25	£3.05	£3.40	£3.95	£2.80	£3.05	£3.40	£3.60	£6.40
100-0-100uA	£2.40	£2.50	£2.95	£3.10	£4.05	£3.00	£3.30	£3.90	£2.75	£3.00	£3.35	£3.50	–
500-0-500uA	£2.25	£2.40	–	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
1mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	£3.20	–
1-0-1mA	£2.25	–	–	–	£3.90	£2.60	–	–	–	–	–	–	–
2mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
5mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	£2.90	£3.10	–	–
10mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	£2.90	£3.10	–	–
20mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
50mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.80	£2.90	£3.10	–	–
100mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	£2.90	£3.10	–	–
150mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
200mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
300mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
500mA	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	£2.90	£3.10	–	–
750mA	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
1A DC	£2.25	£2.40	£2.50	£2.60	£3.00	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	–	£5.95
2A DC	£2.25	–	–	–	–	£2.60	–	–	–	–	–	–	–
5A DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	–	£5.95
10A DC	£2.25	–	–	£2.60	–	–	–	–	£2.60	£2.90	£3.10	–	–
15A DC	£2.25	–	–	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
20A DC	£2.25	–	–	£2.60	–	–	–	–	–	–	–	–	–
30A DC	–	–	–	£2.80	£3.95	£2.60	–	–	–	–	–	–	–
50A DC	–	–	–	£2.90	–	£2.60	–	–	–	–	–	–	–
3V DC	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
5V DC	–	–	–	£2.60	–	£2.60	–	–	£2.60	£2.90	£3.10	–	£5.95
10V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	£2.60	–	£3.10	–	£5.95
15V DC	£2.25	–	–	–	–	–	–	–	–	–	–	–	£5.95
20V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	–	£2.90	£3.10	–	£5.95
50V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	–	£5.95
100V DC	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
150V DC	£2.25	–	–	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
300V DC	£2.25	£2.40	£2.50	£2.60	£3.90	£2.60	£3.00	£3.60	£2.60	£2.90	£3.10	–	£5.95
500V DC	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
750V DC	£2.25	–	–	–	–	–	–	–	–	–	–	–	–
15V AC	£2.30	£2.45	£2.60	£2.80	£2.95	–	–	–	£2.70	£3.00	£3.30	–	–
30V AC	–	–	–	–	–	£2.65	–	–	–	–	–	–	–
50V AC	£2.30	–	–	£2.80	–	£2.65	–	–	–	–	–	–	–
150V AC	£2.30	–	–	£2.80	–	£2.65	–	–	–	–	–	–	–
300V AC	£2.30	£2.45	£2.60	£2.80	£3.95	£2.65	£3.00	£3.70	£2.70	£3.00	£3.30	£3.25	–
500V AC	£2.30	–	–	£2.80	–	£2.65	–	–	–	–	–	–	–
S Meter 1mA	£2.30	£2.50	£2.60	£2.85	£3.90	–	–	–	–	–	–	–	–
VU Meter	£2.65	£2.70	£3.60	£3.70	£4.55	£3.65	£3.70	£4.30	£2.90	£3.15	£3.50	£3.85	–
1A AC	–	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
5A AC	–	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
10A AC	–	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
20A AC	–	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
30A AC	–	£2.40	£2.50	£2.60	£3.90	£2.60	–	–	–	–	–	–	–
50A AC	–	–	–	–	–	£2.60	–	–	–	–	–	–	–
50mA AC	–	–	–	£2.60	–	–	–	–	–	–	–	–	–
100mA AC	–	–	–	£2.60	–	–	–	–	–	–	–	–	–
200mA AC	–	–	–	£2.60	–	–	–	–	–	–	–	–	–
500mA AC	–	–	–	£2.60	–	£2.60	–	–	–	–	–	–	–
50mV DC	–	–	–	–	–	£2.90	–	–	–	–	–	–	–
100mV DC	–	–	–	–	–	£2.90	–	–	–	–	–	–	–
500mA/5A DC	–	–	–	–	–	–	–	–	–	–	–	–	£7.00
1/15A DC	–	–	–	–	–	–	–	–	–	–	–	–	£7.00
5/15V DC	–	–	–	–	–	–	–	–	–	–	–	–	£7.00
5/50V DC	–	–	–	–	–	–	–	–	–	–	–	–	£7.00

SEW PANEL METERS–SIZES AND FIXING INFORMATION

	Front	Panel Hole	Fixing
Model 38P	42 x 42mm	32mm dia.	4 studs
Model 45P	50 x 50mm	38mm dia.	4 studs
Model 52P	60 x 60mm	48mm dia.	4 studs
Model 65P	86 x 78mm	57mm dia.	4 studs
Model 85P	120 x 110mm	98mm dia.	4 studs
Model 65	80 x 80mm	64mm dia	4 studs
Model S80	80 x 80mm	65mm dia.	4 studs

	Front	Panel Hole	Fixing
Model SW100	100 x 80mm	65mm dia.	4 studs
Model SD460	59 x 46mm	38mm dia.	4 studs
Model SD640	85 x 64mm	45mm dia.	4 studs
Model SD830	110 x 83mm	58mm dia.	4 studs
Model PE70	90 x 34mm	70 x 31mm	2 holes

Model ED107 Size: 100 x 90 x 150mm high including terminals.

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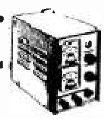
INCORPORATING LASKYS RADIO LTD. & G. W. SMITH & CO. (RADIO) LTD.

PS200 Regulated POWER SUPPLY UNIT



Solid state. Variable output 5—20V DC up to 2 Amp. Independent meters to monitor voltage and current. Output 220/240V AC. Size: 190 x 136 x 98mm.

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PS100B Regulated POWER SUPPLY UNIT

Solid state. Output 6, 9 or 12V DC up to 3 Amp. Meter to monitor current. Input 220/240V AC. Size: 100 x 82 x 159mm.

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MCA220 Automatic Voltage Stabiliser

Input 88—125V AC or 176—250 V AC. Output 120V AC or 240V AC. 200V A rating.

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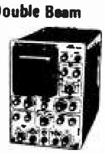
TO3 Portable OSCILLOSCOPE

3" tube. Y amp sensitivity 0.1Vp-p/CM, Bandwidth: 1.5Hz—1.5MHz. Input Impedence: 2 MOhms, 25pF. X amp. sensitivity: 0.9Vp-p/CM. Bandwidth 1.5Hz—800kHz. Input impedence 2 Meg Ohms, 20pF. Time base, five ranges 10Hz. to 300kHz. Synchronisation. Internal or external. Illuminated scale 140 x 215 x 330mm. Weight 15½lbs. 220/240V AC. Supplied brand new with handbook.

OUR PRICE £52.50 P&P 50p

RUSSIAN C116 Double Beam OSCILLOSCOPE



5 MHz pass band. Separate Y1 and Y2 amplifiers. Rectangular 5" x 4" CRT. Calibrated triggered sweep from 0.2usec. to 100 milli-sec/cm. Free running time base, 50Hz—1MHz. Built-in time base Calibrator and amplitude Calibrator. Supplied complete with all accessories and instruction manual.

OUR PRICE £87.00 Carr. paid

C15 PULSE OSCILLOSCOPE

For display of pulsed and periodic waveforms in electronic circuits. VERT. AMP Bandwidth: 10MHz. Sensitivity at 100kHz VRMS/mm: 0.1—25. HOR. AMP. Bandwidth: 500kHz. Sensitivity ay 100kHz VRMS/mm: 0.3—25 Preset triggered sweep 1—3000usec. Free running 20—200 kHz in nine ranges. Calibrator pips. 220 x 360 x 430mm. 115—230V AC.

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LAFAYETTE HA600 Receiver

General coverage 150—400kHz, 550 kHz—30MHz. FET front end 2 mechanical filters, product detector. Noise limiter, variable BFO, S Meter, Bandspread and RF gain. 220/240V AC or 12V DC. Brand new with instructions.

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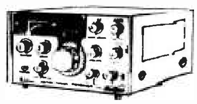
SUPER VALUE TOP QUALITY TRIO communications equipment

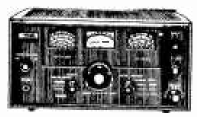
TRIO JR599 RECEIVER



Nine wave-bands covering 1.8—29.7 MHz, 144—146MHz and 10MHz WWV SSB, CW, AM and FM. AF output is more than 1 watt. S Meter. Squelch control. BFO. Variable AF and RF controls. 4—16 ohm output and jack for phones. Power requirement 100/240V AC, 12/14V DC. Size: 270 x 140 x 310mm.

OUR PRICE £132.50 Carr. paid

TRIO 9R59DS RECEIVER



Four bands covering 550kHz to 30 MHz continuous and electrical bandspread on 10, 15, 20, 40, and 80 mtrs. 8 valve plus 7 diode circuit. 4 to 8 ohm output and phone jack. SSB—CW, ANL, variable BFO. S Meter and separate band spread dial. IF frequency 445kHz, audio output 1½ watt. Variable RF and AF gain controls. 115/250V AC, with instructions.

OUR PRICE £42.50 Carr. paid

TRIO JR310 SSB RECEIVER

Covers 3.5, 7, 14, 21, 28, 28.5 and 29.1MHz bands and WWV 15MHz. SSB, AM and CW. AF output more than 1W. Crystal controlled BFO for SSB. S Meter, ANL etc. AC 110/120—220/240V. Size: 330 x 179 x 310mm.

OUR PRICE £75.00 Carr. paid

TRIO TR2200 RECEIVER

Fully transistorised portable VHF transceiver Will transmit and receive on six channels between 144—146MHz. 1 watt transmitter. 12V DC internal or external supply. Built-in charger for Ni-Cad cells. Power/volume switch, squelch control, channel selector, mic. socket, earphone/external speaker socket. Complete with microphone and 144.48, 144.72 & 145.32 crystals. Size: 134 x 58 x 180mm.

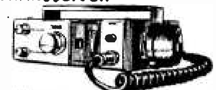
OUR PRICE £79.50 Carr.paid

UNR30 RECEIVER

Four bands covering 550 KHz/30MHz BFO. Built-in speaker. Operates from 220/240V AC. Brand new with instructions.

OUR PRICE £15.75 P&P 37p

BELTEK W5400 CAR TRANSCEIVER



Solid state mobile transceiver for 12 volt DC neg. Transmits and receives on any 12 of 28 channels between 144 and 146MHz. Power output 10W and 1W switchable. Controls: On/off/volume, squelch and channel selector. Internal 3" speaker. Complete with dynamic mic. PTT switch, three sets of crystals for 144.48, 144.6 and 145MHz, mounting bracket and instructions. Size: 160 x 76 x 220mm.

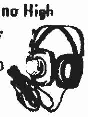
OUR PRICE £75.00 P&P 50p

RUH6 Reflex Horn Speaker

Built-in driver unit. Impedence 16 ohms. Power rating 10W. Response 380—7000Hz. Size app. 6" x 6". Weather and shock protected.

OUR PRICE £4.97 P&P 30p

TE1018 Deluxe Mono High Impedence Headset,



Sensitive magnetic headset with soft ear pads. Impedence 2,600 ohms (600 ohms DC). Frequency response: 200—4,000Hz.

OUR PRICE £2.25 P&P 30p

DH02S STEREO HEADPHONES

Wonderful value and excellent performance combined. Adjustable head band. Impedence 8 ohms 20—12,000Hz. Complete with lead and plug.

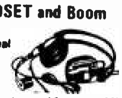
OUR PRICE £2.25 P&P 30p

LH02S STEREO HEADPHONES

Light weight headphones with padded ear pieces. 4/16 ohms 20—20,000Hz. Complete with 6' lead and plug.

OUR PRICE £1.97 P&P 30p

BH001 HEADSET and Boom Microphone



Moving coil. Ideal for language teaching, communications etc. Headphone impedence 16 ohms. Microphone impedence 200 ohms.

OUR PRICE £5.95 P&P 30p

SH628 STEREO HEADPHONES

Outstanding value. With soft ear pads and adjustable headband. 8—16 ohms. 20—20,000Hz. Complete with lead and stereo plug.

OUR PRICE £1.87 P&P 30p

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BSR 8 Track Player Chassis

Famous BSR 8track chassis as used in model TD8S complete with silver and black escutcheon; ready to fit into cabinet. Output 125mV. 240V AC. Overall size app. 185 x 215 x 80mm.

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AF310 Mono amplifier	£5.91
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AT30 Photo cell switch unit	£5.70
AT50 400W Light dimmer/speed control	£4.80
AT55 1,300W Light control/speed control	£5.70
AT56 2,200W Light dimmer/speed control	£6.90
AT60 1 channel light control	£7.80
AT65 3 channel light control	£14.55
HF61 MW transistor radio	£3.33
HF75 FM transistor radio	£2.88
HF310 FM tuner unit	£15.81
HF325 Deluxe FM tuner unit	£24.12
HF330 FM stereo decoder	£9.96
HF395 Aerial amplifier for AM/FM bands I, II, & III	£1.77
GP310 Stereo pre-amplifier	£21.27
GU330 Tremolo unit	£7.50
NT10 PSU 100mA/9—12V	£6.15
NT300 Professional stabilised PSU. 2 x 30V, 2.2A	£12.51
NT305 Transistor converter 12/15V AC/DC to 6V, 7.5V or 9V DC	£4.50
NT310 PSU 240V AC to 2 x 18V DC at 2A	£4.80
NT315 PSU 240V AC to 4.5—15V DC at 500mA	£9.57
AE1 100mW output stage	£1.65
AE2 Pre-amplifier	£1.26
AE3 Diode receiver	£2.00
AE4 Flasher	£1.09
AE5 Astable multivibrator	£1.05
AE6 Monostable multivibrator	£1.02
AE7 RC generator	£1.06
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AE9 Treble filter	99
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Philco Ford 5245 Mains Tape Recorder.

2 track BSR deck with push button controls for easy operation. Tape counter and volume control. Complete with hand microphone. direct recording lead, 1,200' reel of tape and spare reel. 200/250V AC. Fully guaranteed.

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Philco Ford 5248 Mains Tape Recorder.

Four track, two speeds. Piano key type controls, tape counter, recording level meter, volume and tone controls etc. Complete with hand, microphone lead for direct recording 1,800' of tape and spare reel. 200/250V AC. Fully guaranteed.

OUR PRICE £27.50 P&P 75p

BVD5 Vernier TUNING DIAL

App. 7:1 ratio planetary drive vernier dial. Log scale 0—180 degrees. Blank scales 1—5. Dial size 128 x 76mm. Overall size 190 x 117 x 41mm. deep including knob and coupling. ¼" diam. shaft

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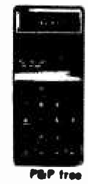

To build yourself. Complete kit of parts with step by step instructions to build a full specification pocket sized calculator.

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OUR PRICE £27.20 P&P 25p

MINUTEMAN MM3 POCKET CALCULATOR

Size only 103 x 77 x 25mm. 8 digit display with overflow and error indicators. Floating decimal. Adds, subtracts, multiplies and divides. Chain and mixed calculations. Constant factor for series multiplication or division. Complete with batteries, instructions and case.

OUR PRICE £23.95 P&P 25p

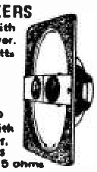
Also available— SINCLAIR EXECUTIVE
Recommended Price £39.00

OUR PRICE £35.45

SINCLAIR EXECUTIVE with MEMORY
Recommended Price £49.00

OUR PRICE £40.75

EMI LOUDSPEAKERS



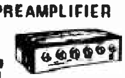
Model 350 13 x 8" with single tweeter/crossover. 20—20,000Hz. 15 watts RMS. Available 8 or 15 ohms.

OUR PRICE £7.25 each P&P 37p

Model 450 13 x 8" with twin tweeter/crossover. 55—13,000Hz. 8 watts RMS. Available 8 or 15 ohms

OUR PRICE £3.62 each P&P 25p

MP7 MIXER-PREAMPLIFIER



5 Microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. Size: 235 x 127 x 76mm. Inputs: Mics. 3 x 3mV 50k; 2 x 3mV 600 ohms. Phono. Mag. 4mV 50k; Phono Ceramic 100mV 1 Meg. Output 250mV 100k.

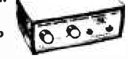
OUR PRICE £8.97 P&P 20p

KE630 3 Station INTERCOM

Master and two sub-stations. Can be used on desk or wall mounted. Complete with cable and batteries

OUR PRICE £5.25 P&P 50p

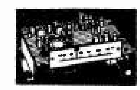
1021 Stereo Listening Station



For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. Two gain controls, speakers on—off slide switch, stereo headphone socket.

OUR PRICE £2.25 P&P 15p

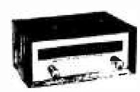
FM TUNER CHASSIS



6 transistor high quality tuner. Size only 153 x 101 x 63mm 3 IF stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Covers 88—108MHz. Ready built, ready for use. Fantastic value for money.

OUR PRICE £5.95 P&P 20p

A1018 FM TUNER



Specification as above FM chassis but complete in cabinet with on/off switch. Size: 184 x 86 x 127mm.

OUR PRICE £9.65 P&P 30p

Stereo multiplex adapter £4.97

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Money saving high performance audio equipment
DIRECT FROM OUR OWN FACTORY

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Better performance
Better value

SAXON HI-FI POWER AMPS FOR DOMESTIC & COMMERCIAL USE

New Versions using 3A "Plastic Power" Driver Transistors now available.

To meet demand, we have included a more powerful module in our well-established and proven range. All these power amplifiers are carefully assembled, tested and guaranteed.
They offer superb value for reliability and versatility.

SA35 35 watts RMS. Uses 7 transistors and 7 diodes Carr. paid. **£4·45**

SA50 50 watts RMS. 7 transistors, 7 diodes. Carr. paid. **£5·65**

SA100 makes an ideal unit in disco assemblies. A real glutton for work. **£10·90**
Reliable, tough and compact, 11 transistors, 6 diodes. Carr. paid.

BRIEF SPEC. FOR ALL THREE MODULES

All modules incorporate OPEN AND SHORT CIRCUIT PROTECTION, plus proof against over-dissipation and faulty inductive loads in the SA.100.

Freq. response	15–40,000 Hz ± 1dB
Distortion	0·2% at 1kHz
Loads	4 to 16 ohms
Quiescent current	15 mA
Noise	Better than −75dB
Supply voltage	SA35 45 volts SA50 45-65 volts SA100 40–70 volts
Size	4½" x 4" x 1" (SA 100) 4" x 3" x 1" (SA35/SA50)

Circuits, connecting instruction and application data are supplied free with all modules.

POWER SUPPLIES
FOR THE SA35, SA50 AND SA100 POWER AMPS. ABOVE

PU.45 Unstabilised supply for 2 SA35's **£4.90**

PU.70 Unstabilised supply for one or two SA50 or SA100 Carr. 40p **£7.75**

PS.45 Stabilised module for two SA35's or one SA50 Carr. free **£3.50**

MT.45 Transformer for above, heavy duty Carr. 20p **£2.85**

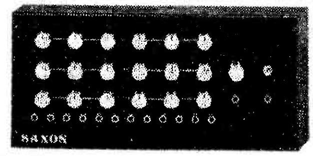
MT.30 Transformer for unstabilised supply complete with rectifier diodes mounted Carr. 20p **£3.50**

PS.70 Stabilised supply module for one or two SA100's Carr. free **£4.90**

MT.70 Transformer for PS70 Carr. 40p **£4.90**

ALL MODULES ARE BUILT ON GLASS FIBRE P.C. BOARD AND SUPPLIED FULLY TESTED

SAXON P/A MIXER CONTROL UNITS



In extra slimline easy-fit case
Using grouped pairs of inputs (high Z and low Z inputs) with individual bass, treble and volume controls on each pair, plus master controls. These low-noise units will feed all makes of amplifiers, making them ideal for clubs, discos etc. Standard jack sockets. Compact design. In strong metal cases. All units guaranteed for 3 years.

- HIGH AND LOW IMPEDANCE INPUTS
- BASS/TREBLE/VOLUME ON EACH PAIR
- MASTER CONTROL ON OUTPUT

● **M4H** 4 high Z, 4 low Z inputs, 4 sets of controls. Case 10" x 8" x 2½". Carr. paid. + V.A.T. **£18·50**

● **M6HL** Case 18" x 8" x 2½" 12 inputs (6 high Z, 6 low Z). Carr. paid. + V.A.T. **£27·50**

Channel section modules, for building your own: gain—16 x (24dB). Tone controls—18dB swing. Carr. paid. + V.A.T. **£3.50**

CONTROL UNITS **£15·80**
Stereo Unit Carr. 30p

Unbeatable for quality & value

Mono (as shown)
For 9v battery operation. As stereo mode less mic. input
Carr. 20p **£6·50**

Two decks, and full headphone monitoring. The unit is mains operated and measures 17½" x 3" x 4" deep and is finished with a smart white on black facia. The controls are: Left/Right deck fader, volume, bass, treble. Headphone Selector and volume. Microphone volume, bass, treble, mains on/off.
COMPARABLE TO UNITS AT OVER TWICE THE PRICE.

AKG MICROPHONES

World famous D.190C—the one the professionals use—at special bargain price of

£19.50 + V.A.T.

120 WATT HEAVY DUTY MODULE

Rugged class A driver stage. This module will run from all our mixers, etc., and most other makes. Delivers 120 watts into an eight ohm load and employs 4 TO3 can (115 watt) output transistors.

SPECIFICATION

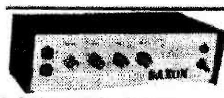
Power output	120 watts into 8 ohms
Freq. response	20-20,000 Hz ± 2dB
Input sensitivity	200 mV into 10K
Construction	Fibreglass board
Size	8" x 4" x 4" (5" with supply)

Low distortion parallel push-pull output stage.

Module & power supply (Carr. 40p) **£18.95**

● 160 watt version with power supply **£27·90** (Carr. 50p)

SOUND AND LIGHT UNITS

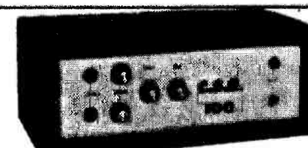


Our popular 3 channel model handles up to 3kW (3000 watts) of lighting and incorporates versatile sound control arrangement to enable professional standards to be achieved. Both units are excellent examples of Saxon quality and value.

3 CHANNEL UNIT
Includes bass, middle and treble as well as master controls. 2 amplifier sockets eliminate need for split leads. Up to 3kW lighting load. Smartly finished steel case. Carr. 30p. **£19·75**

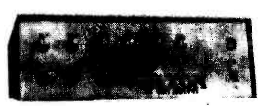
SINGLE CHANNEL UNIT
Operates from 5 to 100 watt amplifiers. Supplied for bass note operation, is easily adapted for treble or mid-range at a cost of about 5p. Carr. pd. **£8·90**

COMPLETE AMPLIFIERS CSE 100



The versatile unit is now available in a black vynide case and so represents even better value than ever delivering speech and music powers of up to 100 watts RMS and continuous signal outputs of 70 watts. Two individually controlled inputs with wide range bass and treble controls.

£34·90 carr. free



SAXON 100 £48·50 carr. free
With an RMS output of 120 watts speech and music, 100 watts continuous power, four individually controlled FET input stages and wide range base and treble controls, this amplifier has established itself as a unit offering quality and reliability at low cost.

LOUDSPEAKERS British made bargains!!
12" 25 watt 8/15 ohms £5·95 carr. 30p 15" 50 watt 8/15 ohm £14·50 carr. 50p.
12" 40 watt 15,000 gauss magnet system 8/15 ohm £11·50 carr. 40p.

Prices subject to alteration without notice. E. & O.E.

V.A.T. Please add 10% to total value of order (inc. carr.) for Value Added Tax.

Please include S.A.E. with written enquiries.

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Telephone 01-684 6385
Hours 9.30 a.m.–5.30 p.m.
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Packed with transistors, diodes, capacitors and resistors—COMPONENT VALUE £1·50. 3 for ONLY 55p + p & p 30p

SPECIAL ONE. As above PLUS Power Transistors ONLY 55p each + p & p 15p

STABILISED POWER MODULES Complete with circuit diagrams, etc. 99p each + p & p 15p

PAXOLINE BOARDS 7¼ × 9″ approx. 4 for 30p + p & p 20p.

FIBRE-GLASS PRINTED CIRCUIT BOARDS

16¼ × 4″ approx. 2 for 55p

DECON-DALO 33PC Marker

Etch resistant printed circuit marker pen 90p each

VEROBOARDS

Packs containing approx., 50sq. ins. various sizes, all ·1 matric 55p

REPANCO CHOKES & COILS

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CH3. 7·5mH 25p CH4. 10mH 25p
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1¼″ and 20mm. 100mA, 200mA, 250mA, 500mA, 1A, 1·5A, 2A
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EARPHONES

Crystal 2·5mm plug 33p
Crystal 3·5mm plug 33p
8 ohms 2·5mm plug 22p
8 ohms 3·5mm plug 22p

DYNAMIC MICROPHONES

B1223. 200 ohms plus on/off switch and 2·5mm and 3·5mm plugs £1·60

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H1012 £1·87

2-WAY CROSSOVER NETWORK

K4007. 80 ohms Imp. Insertion loss 3dB £1·21

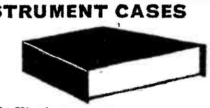
CAR STEREO SPEAKERS

(Angled) £3·85 per pair.

BI-PAK

CATALOGUE AND LISTS
Send S.A.E. and 10p.

INSTRUMENT CASES



(Black Vinyl covered)

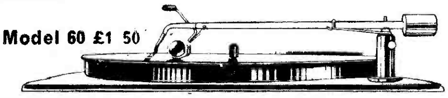
No.	Length		Width		Height	Price
BV1	8″	×	5¼″	×	2″	90p
BV2	11″	×	6″	×	3″	£1·20

ALUMINIUM BOXES

BA1	5¼″	×	2¼″	×	1½″	42p
BA2	4″	×	4″	×	1½″	41p
BA3	4″	×	2¼″	×	1½″	41p
BA4	5¼″	×	4″	×	1½″	47p
BA5	4″	×	2½″	×	2″	41p
BA6	3″	×	2″	×	1″	34p
BA7	7″	×	5″	×	2½″	66p
BA8	8″	×	6″	×	3″	84p
BA9	6″	×	4″	×	2″	54p

BIB HI-FI ACCESSORIES

De Luxe Groov-Kleen
Model 42 £1·84
Chrome Finish Model 60 £1 50



Ref. 36A. Record/Stylus Cleaning Kit 28p
Ref. 43. Record Care Kit £2·35
Ref. 31. Cassette Head Cleaner 54p
Ref. 32. Tape editing Kit £1·54
Model 9. Wire Stripper/Cutter 83p
Ref. P. Hi-Fi Cleaner 31p
Ref. 32A. Stylus Balance £1·36
Ref. J. Tape Head Cleaning Kit 51p
Ref. 34. Cassette Case £1·27
Ref. 56. Hi-Fi Stereo Hints & Tips 32p

ANTEX SOLDERING IRONS

X25. 25 watt £1·93
CCN 240. 15 watt £2·15
Model G. 18 watt £2·15
SK2. Soldering Kit £2·86
STANDS: ST1 £1·21. ST2 77p
SOLDER: 18SWG Multicore 7oz 82p
22SWG 7oz 82p. 18SWG 22ft 28p
22SWG Tube 22p

ANTEX BITS and ELEMENTS

Bits No.		
102	For model CN240 3/32″	38p
104	For model CN240 3/16″	38p
1100	For model CCN240 3/32″	38p
1101	For model CCN240 3/8″	38p
1102	For model CCN240 ¼″	38p
1020	For model G240 3/32″	38p
1021	For model G240 1/8″	38p
1022	For model G240 3/16″	38p
50	For model X25 3/32″	38p
51	For model X25 1/8″	38p
52	For model X25 3/16″	38p

ELEMENTS
ECN 240 £1·16 ECCN 240 £1·32
EG 240 £1·16 EX 25 £1·16

ANTEX HEAT SINKS 10p

V.A.T. included in all prices. Please add 10p P. & P. (U.K. only). Overseas orders—please add extra for postage.

NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C1	250	Resistors mixed values approx. count by weight	0·55
C2	200	Capacitors mixed values approx. count by weight	0·55
C3	50	Precision Resistors 1%, 2% mixed values	0·55
C4	75	⅛th W Resistors mixed preferred values	0·55
C5	5	Pieces assorted Ferrite Rods	0·55
C6	2	Tuning Gangs, MW/LW VHF	0·55
C7	1	Pack Wire 50 metres assorted colours	0·55
C 8	10	Reed Switches	0·55
C 9	3	Micro Switches	0·55
C10	15	Assorted Pots & Pre-Sets	0·55
C11	5	Jack Sockets 3 × 3·5m 2 × Standard Switch Type	0·55
C12	40	Paper Condensers preferred types mixed values	0·55
C13	20	Electrolytics Trans. types	0·55
C14	1	Pack assorted Hardware—Nuts/Bolts, Grommets etc.	0·55
C15	4	Mains Slide Switches	0·55
C16	20	Assorted Tag strips & Panels	0·55
C17	10	Assorted Control Knobs	0·55
C18	4	Rotary Wave Change Switches	0·55
C19	3	Relays 6—24V Operating	0·55
C20	4	Sheets Copper Laminate approx. 10″ × 7″	0·55

PLUGS AND SOCKETS

SOCKETS

PS 35 DIN	2 Pin (Speaker)	0·06
PS 36 DIN	3 Pin	0·10
PS 37 DIN	5 Pin 180°	0·10
PS 38 DIN	5 Pin 240°	0·10
PS 39	Jack 2·5mm Switched	0·09
PS 40	Jack 3·5mm Switched	0·10
PS 41	Jack ¼″ Switched	0·17
PS 42	Jack Stereo Switched	0·26
PS 43	Phono Single	0·06
PS 44	Phono Double	0·10
PS 45	Car Aerial	0·08
PS 46	Co-Axial Surface	0·09
PS 47	Co-Axial Flush	0·14

INLINE SOCKETS

PS 21	D.I.N. 2 Pin (Speaker)	0·13
PS 22	D.I.N. 3 Pin	0·17
PS 23	D.I.N. 5 Pin 180°	0·17
PS 24	D.I.N. 5 Pin 240°	0·17
PS 25	Jack 2·5mm Plastic	0·10
PS 26	Jack 3·5mm Plastic	0·12
PS 27	Jack ¼″ Plastic	0·24
PS 28	Jack ¼″ Screened	0·28
PS 29	Jack Stereo Plastic	0·22
PS 30	Jack Stereo Screened	0·32
PS 31	Phono Screened	0·14
PS 32	Car Aerial	0·15
PS 33	Co-Axial	0·17

PLUGS

PS 1	D.I.N. 2 Pin (Speaker)	0·11
PS 2	D.I.N. 3 Pin	0·12
PS 3	D.I.N. 4 Pin	0·15
PS 4	D.I.N. 5 Pin 180°	0·14
PS 5	D.I.N. 5 Pin 240°	0·15
PS 6	D.I.N. 6 Pin	0·15
PS 7	S.I.N. 7 Pin	0·15
PS 8	Jack 2·5mm Screened	0·10
PS 9	Jack 3·5mm Plastic	0·09
PS 10	Jack 3·5mm Screened	0·12
PS 11	Jack ¼″ Plastic	0·13
PS 12	Jack ¼″ Screened	0·18
PS 13	Jack Stereo Screened	0·29
PS 14	Phono	0·08
PS 15	Car Aerial	0·15
PS 16	Co-Axial	0·10

CABLES

CP 1	Single Lapped Screen	0·06
CP 2	Twin Common Screen	0·08
CP 3	Stereo Screened	0·08
CP 4	Four Core Common Screen	0·23
CP 5	Four Core Individually Screened	0·30
CP 6	Microphone Fully Braided Cable	0·10
CP 7	Three Core Mains Cable	0·07
CP 8	Twin Oval Mains Cable	0·06
CP 9	Speaker Cable	0·04
CP 10	Low Loss Co-Axial	0·10

CARBON POTENTIOMETERS

Log and Lin
4·7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M

VC 1	Single less Switch	0·14
VC 2	Single D.P. Switch	0·26
VC 3	Tandem Less Switch	0·44
VC 4	1K Lin Less Switch	0·14
VC 5	100K Log anti-Log	0·44

HORIZONTAL CARBON PRESETS

0·1 watt 0·06 each
100, 220, 470, 1K, 2·2K, 4·7K, 10K, 22K, 4K7, 100K, 220K, 470K, 1M, 2M, 4·7M

BOOK BARGAIN BUNDLE

8 Books comprising
2 Transistor Equivalent Books
1 Radio and Electronic Colour Code and Data Chart
1 Radio Valve Guide PLUS
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Also 1 General Constructional book

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BP3	Handbook of Tested Transistor Circuits	40p
BP4	International Handbook of the Worlds Short Wave, Medium and Long Wave Radio Stations and FM/TV Listings	35p
BP5	Handbook of Simple Transistor Circuits	35p
BP7	Radio & Electronic Colour Codes and Data Chart	15p
BP8	Sound and Loudspeaker Manual	50p
BP9	38 Practical Tested Diode Circuits for the Home Constructor	35p
BP11	Practical Transistor Novelty Circuits	40p
129	Universal Gram-Motor Speed Indicator	8p
138	How to make FM & TV Aerials, Bands 1, 2 and 3	18p
141	Radio Servicing for Amateurs	20p
146	High Fidelity Loudspeaker Enclosures	87p
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177	Modern Transistor Circuits for Beginners	40p
178	A Comprehensive Radio Valve Guide, Book 5	30p
183	How to Receive Foreign TV Programmes on your set by simple modifications	32p
185	Tested Shortwave Receiver Cuircuits using MAT's	30p
187	The TSL Mark '4' Valved FM Tuner and its construction	20p
196	Reactance-Frequency Chart for Audio & RF use	15p
	Resistor Colour Code Disc Calculator	10p

CARTRIDGES

ACOS GP91-1SC. 200mV at 1·2cms/sec £1·16
ACOS GP93-1. 280mV at 1cm/sec £1·65
ACOS GP96-1. 100mV at 1cm/sec £2·65
TTC J-2005. Crystal/Hi Output 95p
TTC J-20 10C Crystal/Hi Output Compatible £1·10
TTC J-200 CS Stereo/Hi Output £1·60
TTC J-2105 Ceramis/Med. Output £1·64

CARBON FILM RESISTORS

The E12 Range of Carbon Film Resistors, 1/8th watt available in PAKS of 50 pieces, assorted into the following groups:—

R1	50 Mixed 100 ohms–820 ohms	40p
R2	50 Mixed 1K ohms–8·2K ohms	40p
R3	50 Mixed 10K ohms–82K ohms	40p
R4	50 Mixed 100K ohms–1 Meg. ohms	40p

THESE ARE UNBEATABLE PRICES—LESS THAN 1p EACH INCL. V.A.T.

BI-PAK SUPERIOR QUALITY LOW - NOISE CASSETTES

C60, 32p C90, 41p C120, 52p

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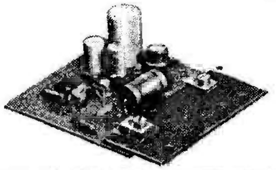
BI-PAK *QUALITY* COMES TO AUDIO!

AL10/AL20/AL30
AUDIO AMPLIFIER MODULES



The AL10. AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.
The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po - 3 WATTS f 1KHz	0·25%
LOAD IMPEDANCE	—	8 - 16 Ω
INPUT IMPEDANCE	f = 1KHz	100 k Ω
FREQUENCY RESPONSE Œ 3dB	Po 2 WATTS	50 Hz - 25KHz
SENSITIVITY for RATED O/P	Vs = 25V. Rl = 8 Ω f 1KHz	75mV. RMS
DIMENSIONS		3" × 2½" × 1"

The above table relates to the AL10. AL20 and AL30 modules. The following table outlines the differences in their working conditions.

Parameter	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power output for 2% T.H.D. (RL = 8 Ω f - 1 KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min

AUDIO AMPLIFIER MODULES

AL 10.	3 watts	RMS	£2·19
AL 20.	5 watts	RMS	£2·59
AL 30.	10 watts	RMS	£3·01

PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20) £4·35
PA 100 (Use with AL30 & AL50) £13·15

POWER SUPPLIES

PS 12. (Use with AL10 & AL20) 88p
SPM 80. (Use with also AL30 & AL50) £3·25
FRONT PANELS SP 12 with Knobs £1·10

TRANSFORMERS

T461 (Use with AL10) £1·38 P & P 15p
T538 (Use with AL20) £1·93 P & P 15p
BMT80 (Use with AL30 & AL50) £2·15 P & P 25p

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA 12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL 10, AL 20 and AL 30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Ceramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm × 84mm × 35mm.

Frequency response
20Hz 50KHz (- 3dB)
Bass control - -
± 12dB at 60Hz
Treble control - -
± 14dB at 14KHz
*Input 1. Impedance
1 Meg. ohm
Sensitivity 300mV
†Input 2. Impedance
30 K ohms
Sensitivity 4mV

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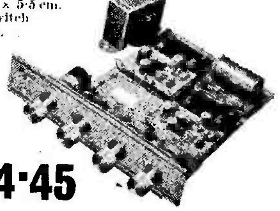
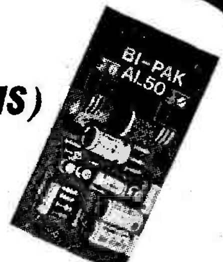
The STEREO 20



The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm × 14 cm × 5·5 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls. Transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ±12dB at 60Hz typically 0·25% at 1 watt. Treble con. ±14dB at 14kHz.

£14·45

50W pk 25w (RMS)



0·1% DISTORTION!
HI-FI AUDIO AMPLIFIER

THE AL50

- ★ Frequency Response 15Hz to 100,000—1dB.
- ★ Load—3, 4, 8 or 16 ohms.
- ★ Distortion—better than ·1% at 1 KHz.
- ★ Signal to noise ratio 80dB.
- ★ Supply voltage 10–35 Volts.
- ★ Overall size 63mm 105mm × 13mm.

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Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and AL50 was conceived to fill the need for all your A.F. amplification needs.
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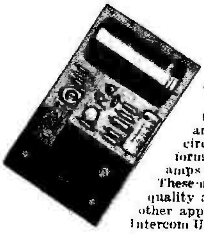
STABILISED POWER
MODULE SPM80



SPM80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1.5 amps at 35 volts. Size: 63mm × 105mm × 30mm.
These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including: Disco Systems, Public Address Intercom Units, etc. Handbook available 10p **PRICE £3·25**

TRANSFORMER BMT80 £2·15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques. Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.
Three switched stereo inputs, and rumble and scratch filters are features of the PA100 which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

SPECIFICATION

Frequency Response	20Hz - 20KHz ± 1dB
Harmonic Distortion	better than 0·1%
Inputs: 1. Tape Head	1·25 mV into 50K Ω
2. Radio, Tuner	35 mV into 50K Ω
3. Magnetic P.U.	1·5 mV into 50K Ω

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB. from 20Hz to 20KHz.

Bass Control	± 15bB at 20Hz
Treble Control	± 15dB at 20 KHz
Filters: Rumble (High Pass)	100Hz
Scratch (Low Pass)	8KHz
Signal/Noise Ratio	better than - 65dB
Input overload	+ 26dB
Supply	+ 35 volts at 20mA
Dimensions	292mm × 82mm × 35mm

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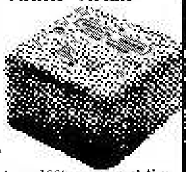
ELECTRONIC MAINS TIMER



A reliable unit ideal for timing Bathroom/Toilet Ventilators Stairway/Cloakroom Lighting etc. Gives up to 30 mins delay before switching off. Delay: 1–30 mins adjustable. Max Load: 400VA or 1000 watts resistive. Ivory Case: 3¾" × 3¾" × 2". Fitting instructions included.
Trade Price: £5·80. Post 20p.

DIMMER SWITCH

Type C1. 300 Watt Light Dimmer for 200/250 Volt A/C operation. Ivory Case: 3¾"×3¾"×1⅝". Fitting Instructions included.
Price: £2·60. Post 20p. 10 for £2·15 each. £5·00 per pair. Post 25p. Post 30p.

POWER UNIT Type P1076

Output switched 3, 4·5, 6, 7·5 9 and 12 Volts at 500mA D.C. Operates from 240 V. mains, suitable for Radios, Tape Recorders, Record Players, etc. Size 7·5 × 5·0 × 14·0 cm Price £3·95. Post 25p.

TRANSFORMERS

SAFETY ISOLATING

Prim. 120/240V. Sec. 120/240V. Centre Tap with screen

VA (watts)	Ref. No.	Price £	P & P £
60	149	2·86	0·38
100	150	3·15	0·52
200	151	5·30	0·52
250	152	7·05	0·65
350	153	9·40	0·80
500	154	13·55	1·00
1000	156	24·97	1·20
2000	158	41·25	*
3000	159	64·54	*

LOW VOLTAGE

Prim:- 200–240V. Sec:- 12 & 24V.

Amps 12V	Amps 24V	Type No.	Price £	P & P £
0·5	0·25	111	1·00	0·22
1	0·5	213	1·23	0·22
2	1	71	1·60	0·22
4	2	18	2·25	0·38
6	3	70	2·70	0·42
8	4	108	3·00	0·52
10	5	72	3·55	0·52
12	6	116	4·50	0·52
16	8	17	5·50	0·52
20	10	115	6·95	0·69
30	15	187	12·90	0·97
40	20	232	18·30	1·00
60	30	226	23·70	1·10

30 Volts

Prim:- 200–240V. Sec:- 12, 15, 20, 24, 30V.

Amps	Type	Price	P & P
0·5	112	1·20	0·22
1	79	1·64	0·38
2	3	2·45	0·38
3	20	3·00	0·42
4	21	3·55	0·52
5	51	4·40	0·52
6	117	5·25	0·52
8	88	6·80	0·67
10	89	8·36	0·67

50 Volts

Prim:- 200–240V.
Sec:- 19, 25, 33, 40, 50V.

Amps	Type	Price	P & P
0·5	102	1·60	0·30
1	103	2·35	0·38
2	104	3·25	0·42
3	105	4·40	0·52
4	106	5·48	0·52
6	107	8·65	0·67
8	118	11·27	0·97
10	119	14·15	0·97

60 Volts

Prim:- 200–240V.
Sec:- 24, 30, 40, 48, 60V.

Amps	Type	Price	P & P
0·5	124	1·60	0·38
1	126	2·25	0·38
2	127	3·55	0·42
3	125	5·40	0·52
4	123	6·98	0·67
5	40	8·46	0·67
6	120	9·20	0·82
8	121	11·60	1·00
10	122	15·25	1·00
12	189	18·43	1·10

MINIATURE AND EQUIPMENT

Prim 240V with screen

Volts Sec. 1	Volts Sec. 2	Milliamps Sec. 1	Milliamps Sec. 2	Type No.	Price £	P & P £
3-0-3	—	200	—	238	1·12	0·10
0-6	0-6	500	500	234	1·18	0·10
0-6	0-6	1000	1000	212	1·28	0·22
9-0-9	—	100	—	13	0·95	0·10
0-9	0-9	330	330	235	1·28	0·10
0-8-9	0-8-9	500	500	207	1·70	0·22
0-8-9	0-8-9	1000	1000	208	2·30	0·30
15-0-15	—	40	—	240	1·28	0·10
0-15	0-15	200	200	236	1·28	0·10
20-0-20	—	30	—	241	1·09	0·10
0-20	0-20	150	150	237	1·28	0·10
0-15-20	0-15-20	500	500	205	2·16	0·38
0-20	0-20	300	300	214	1·36	0·22
20-12-0-12-20		700(D/C)		221	1·21	0·30
0-15-20	0-15-20	1000	1000	206	3·10	0·38
0-15-27	0-15-27	500	500	203	2·38	0·38
0-15-27	0-15-27	1000	1000	204	2·40	0·38

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H8/3A	4μF	50V	4p
H8/4	4·7μF	25V	4p
H8/4A	5μF	64V	4p
H8/5	5μF	10V	4p
H8/5A	5μF	150V	4p
H8/6A	10μF	10V	4p
H8/7	10μF	70V	4p
H8/8	16μF	35V	4p
H8/8A	16μF	16V	4p
H8/9	20μF	6V	2p
H8/9A	20μF	70V	4p
H8/10	22μF	50V	4p
H8/10A	22μF	100V	4p
H8/11	25μF	12V	4p
H8/11A	24μF	275V	4p
H8/12	32μF	15V	4p
H8/12A	30μF	10V	4p
H8/13A	32μF	50V	4p
H8/14	40μF	25V	5p
H8/14A	40μF	16V	4p
H8/15	47μF	50V	4p
H8/15A	40μF	35V	4p
H7/1	50μF	6V	3p
H7/1A	50μF	10V	4p
H7/2A	64μF	2·5V	2p
H7/3A	64μF	25V	4p
H7/4	64μF	15V	4p

Ref. No.	Capacity	Voltage	Price
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H7/7	100μF	25V	4p
H7/8	125μF	16V	5p
H7/8A	100μF	35V	6p
H7/9	100μF	63V	6p
H7/9A	125μF	4V	4p
H7/10	125μF	25V	6p
H7/10A	160μF	2·5V	3p
H7/11	160μF	25V	6p
H7/11A	150μF	16V	5p
H7/13A	200μF	25V	8p
H7/14	220μF	50V	10p
H7/14A	220μF	16V	6p
H7/15	220μF	25V	5p
H7/15A	220μF	35V	10p
H6/1A	250μF	4V	3p
H6/2	250μF	25V	3p
H5/3A	320μF	2·5V	3p
H6/4	320μF	10V	4p
H6/4A	330μF	16V	5p
H6/5	330μF	25V	10p
H6/5A	330μF	35V	15p
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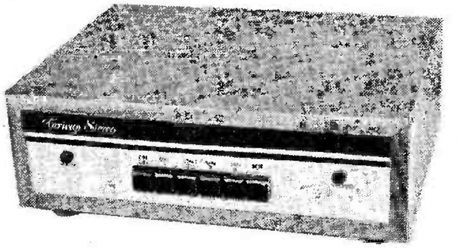

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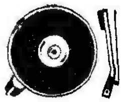

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GARRARD DECCA HI-FI DECK

Single play Stereo/Mono Deram transcription head and arm. Four speeds. 10½in. turntable. Anti-rumble filter. Bias compensation. Laboratory motor.

SPECIAL PRICE **£18·50** Post 25p Ideal for Disco-Deck

METAL PLINTH AND PLASTIC COVER
Cut out for most Garrard or B.S.R. Most will play with cover in position. 12½ × 14¾ × 7¼in. Covered in black leatherette. **£4·95** Post 35p

ALSO AVAILABLE IN SOLID NATURAL MAHOGANY WAX POLISHED FINISH—AT SAME PRICE

COMPACT PORTABLE STEREO HI-FI
Two full size loudspeakers 18½ × 10 × 3½in. Player unit clips to loudspeakers making it extremely compact. Overall size only 18½ × 10 × 8½in. 3 watts per channel, plays all records 33 rpm 45 rpm. Separate volume & tone controls 240v AC mains

Attractive Teak finish Weight 13lbs. Bargain Price **£25** 85p carriage

SPECIAL OFFER! SMITH'S CLOCKWORK 15 AMP TIME SWITCH 0-60 MINUTES

Single pole two-way Surface mounting with fixing screws. Will replace existing wall switch to give light for return home, garage, automatic anti-burglar lights etc. Variable knob Turn on or off at full or intermediate settings. Fully insulated. Makers last list price £4·50. Brand new and fully guaranteed. OUR PRICE **£1·65** or £3 pair. Post 25p.

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 2½in sides 6 × 4in 45p; 8 × 6in 58p; 10 × 7in 65p; 12 × 8in 85p; 14 × 9in 90p; 16 × 6in 90p; 12 × 3in 50p; 16 × 10in £1.

ALUMINIUM BOXES 3 × 3 × 3 in. 60p. 4 × 4 × 4in. 70p. 6 × 4 × 4 in. 80p. 9 × 4 × 4 in. £1. 12 × 4 × 4 in. £1·30.

ALUMINIUM PANELS 18 s.w.g. 6 × 4in 9p; 8 × 6in 15p; 14 × 3in 16p; 10 × 7in 19p; 12 × 5in 20p; 12 × 8in 28p; 16 × 6in 28p; 14 × 9in 34p; 12 × 12in 40p; 16 × 10in 50p.

PAXOLIN PANEL 10 × 8in 15p.

1¼inch DIAMETER WAVECHANGE SWITCHES, 25p. 2 p. 2-way, or 2 p. 6-way, or 3 p. 4-way, 25p each. 1 p.l 2-way, or 4 p. 2-way, or 4 p. 3-way, 25p.

TOGGLE SWITCHES, sp. 18p; dp. 22p; dp. dt. 22p. Sub-miniature, sp. 30p; dp. 37p; dp. dt. 45p.

R.C.S. STABILISED POWER PACK KITS
All parts and instructions with Zener Diode. Printed Circuit Bridge Rectifiers and Double Wound Mains Transformer. Input 200/240V a.c. Output voltages available 6 or 9 or 12 or 15 or 18 or 20V d.c. at 100mA or less. PLEASE STATE VOLTAGE REQUIRED. Details S.A.E. Size 3½ × 1½ × 1¼in. **£2·20** Post 20p

R.C.S. GENERAL PURPOSE TRANSISTOR PRE-AMPLIFIER BRITISH MADE
Ideal for Mike, Tape P.U., Guitar, etc. Can be used with Battery 9-12v. or H.T. line 200-300V. D.C. operation. Size 1¾" × 1¼" × ¾". Response 25 c.p.s. to 25 Kc/s, 26 db gain. For use with valve or transistor equipment. Full instructions supplied. Details S.A.E. **99p** Post 10p

NEW TUBULAR ELECTROLYTICS				CAN TYPES	
2/350V	14p	250/25V	14p	16+16+16/275v	45p
4/350V	14p	500/25V	20p	50+50/300V	50p
8/450V	18p	1000/25V	35p	60+100/350V	85p
16/450V	22p	1000/50V	47p	32+32/250V	20p
32/500V	50p	8+8/450V	22p	32+32/450V	60p
25/25V	10p	8+16/450V	25p	350+50/325V	55p
50/50V	10p	16+16/450V	40p	100+50+50/350V	55p
100/25V	10p	32+32/350V	40p		

LOW VOLTAGE ELECTROLYTICS.
1, 2, 4, 5, 8, 16, 25, 30, 50, 100, 200mF 15V 10p.
500mF 12V 15p; 25V 20p; 50V 30p.
1000mF 12V 20p; 25V 35p; 50V 47p; 100V 70p.
2000mF 6V 25p; 25V 42p; 50V 57p.
2500mF 50V 62p; 3000mF 25V 47p; 50V 65p.
5000mF 6V 25p; 12V 42p; 25V 75p; 35V 85p; 50V 95p.
CERAMIC 1pF to 0·01mF, 4p. Silver Mica 2 to 5000pF, 4p.
PAPER 350V-0·1 4p; 0·5 13p; 1mF 15p; 2mF 150V 15p. 500V-0·001 to 0·05 4p; 0·1 5p; 0·25 8p; 0·47 25p.
SILVER MICA. Close tolerance 1%. 2·2-500pF 8p; 560-2,200pF 10p; 2,700-5,600pF 20p; 6,800pF-0·01, mfd 30p each.
TWIN GANG. "0-0" 208pF+176pF, 65p; Slow motion drive 365pF+365pF with 25pF+25pF, 50p; 500pF standard 65p; small 3-gang 500pF £1·60.
SHORT WAVE SINGLE. 10pF, 30p; 25pF, 55p; 50pF, 55p.

SHORT WAVE SINGLE GANG. Precision Silver Plated Gangable Tuning Condensers. Values up to 100pF. **50p** each. Section Couplers supplied FREE with two or more gangs.

NEON PANEL INDICATORS. 250V AC/DC Amber, 30p.
RESISTORS. ¼ w., ½ w., 1 w., 20%, 1p; 2 w. 5p. 10 Ω to 10M.
HIGH STABILITY. ½ w. 2% 10 ohms to 6 meg., 10p. Ditto 5%. Preferred values 10 ohms to 10 meg., 4p.
WIRE-WOUND RESISTORS. 5 watt, 10 watt, 15 watt, 10 ohms to 100K, 10p each; 2w 0·5 ohm to 8·2 ohms 10p.
TAPE OSCILLATOR COIL. Valve type, 35p.
FERRITE ROD 8" × ⅜" 20p; 6 × ⅜" 20p; 3 × ¼" 10p.

MAINS TRANSFORMERS
ALL POST 25p each

Eagle MT12 12-0-12v 50MA 90p
250-0-250 80 mA. 6·3 v. 3·5 a. 6·3 v. 1 a. or 5 v. 2 a. £2·50
350-0-350 80 mA. 6·3 v 3·5 a, 6·3 v. 1a. or 5 v. 2 a. £3·00
300-0-300 v. 120 mA., 6·3 v. 4 a. C.T.; 6·3 v. 2 a. £3·25
MINIATURE 200 v. 20 mA., 6·3 v. 1 a. 2½ × 2½ × 2in. 75p
MIDGET 220 v. 45 mA., 6·3 v. 2 a. 2½ × 2½ × 2in... 90p
HEATER TRANS. 6·3 v. 3a.................... 60p
GENERAL PURPOSE LOW VOLTAGE. Tapped outputs at 2 amp., 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. £2·80
1 amp., 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £2·80
2 amp., 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £3·80
5 amp., 6, 8, 10, 12, 16, 18, 20, 24, 30, 36, 40, 48, 60 £8·75
5, 8 and 13 v. 5 amp. £1·20. 8 amp., 3, 5, 8, 10, 13 and 5-0-5 v. £1·30. Ditto 5 amp. £1·50; 6-0-6 v. 500 mA 90p. 9 v. 1 amp 95p. 12 v. 300 mA 75p. 12 v. 500 mA 85p. 12 v. 750 mA 95p. 40v. 1 amp £1·75.
AUTO TRANSFORMERS. 115v to 230v or 230v to 115v. 150w. £2·80; 500w. £6·25; 750w. £10; 1000w. £15.
CHARGER TRANSFORMERS. Input 200/250v. for 6 or 12v., 1½ amp. £1·50; 2 amp. £1·80; 4 amp. £2·50
BATTERY CHARGERS. Ready built with leads and clips 1½ amp. £2; 4 amp. £4; 5 amp. £4·50.
FULL WAVE BRIDGE CHARGER RECTIFIERS: 6 or 12v. outputs. 1½ amp. 40p; 2 amp. 55p; 4 amp. 85p.

MAINS ISOLATING TRANSFORMER
Primary 0-110-240v. Secondary 0-240v. 3 amps. 720 watts. Insulated terminals. Varnish impregnated. Fully enclosed in steel case with fixing feet. Famous make. (Value £18) OUR PRICE **£10** Carr. 50p. Can be used as 500 watt auto transformers 240-110V.

SET OF 3 MOTORS FOR COLLARO STUDIO 115 volt TAPE DECK £2·50 Post 50p.

VOLUME CONTROLS
Long spindles. Midget Size 5 K. ohms to 2 Meg. LOG or LIN. L/S 15p. D.P. 25p. STEREO L/S 55p. D.P. 75p. Edge 5K. S.P. Transistor 25p

80 Ohm Coax 4p yd.
BRITISH AERIALITE AERAXIAL-AIR SPACED 40 yd. £1·40; 60 yd. £2.
FRINGE LOW LOSS Ideal 625 and colour. **10**p per yd

Wirewound controls 1¼in. diam. 3 watts. 10 ohms to 100K British made with long spindles ¼in. dia 45p ea.
HELICAL POT 10k LIN List £3, Bargain 75p.
DUAL CONCENTRIC POT 500k LOG + 500k LIN D.P. switch. Inner spindle 3¼in; outer spindle 2¼in. 75p.

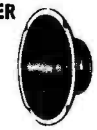
E.M.I. 13½ × 8 in. SPEAKER SALE !

With twin tweeters. And crossover. 10 watt. State 3 or 8 or 15 ohm. As illustrated. **£4·50** Post 25p

With flared tweeter cone and ceramic magnet. 10 watt. Bass res. 45-60 cps. Flux 10,000 gauss. State 3 or 8 or 15 ohm. **£2·75** Post 25p

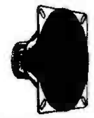
Bookshelf Cabinet
16 × 10 × 9in. Teak Veneer **£5·50** Post 25p

GOODMANS 6½in. HI-FI WOOFER



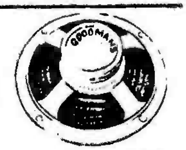
8 ohm, 10 watt. Large ceramic magnet Special Cambric cone surround. Frequency response 30-12,000 cps. Ideal P.A. Columns, Hi-Fi Enclosure Systems, etc. **£4** Suitable cabinet 12 × 8 × 6 £4·00. Suitable Tweeter £2·00.

ELAC CONE TWEETER



The moving coil diaphragm gives a good radiation pattern to the higher frequencies and a smooth extension of total response from 1,000 cps to 18,000 cps. Size 3¾ × 3¾ × 2in. deep. Rating 10 watt, 3 ohm. Crossover £1.25 Post 20p **£1·90**

GOODMANS 8 in. WOOFER



8 ohm 12 watt. Deep cone. Heavy ceramic magnet. Bass resonance 35 cps. Frequency response 30-8,000 cps. Ideal bass unit for Hi-Fi systems **£3·75**

LOUDSPEAKERS P.M. 3 OHMS. 7 × 4in. £1·25; 6½in. £1·60; 8 × 5in. £1·60; 8in. £1·75; 10 × 6in. £1·90; 10in. £2·00.
SPECIAL OFFER! 80 ohm, 2¾ in. 2½in. 35 ohm, 2in.; 3in; 25 ohm, 2½in. dia.; 3in. dia.; 5 × 3 in. 15 ohm. 3½in. dia.; 5in. /6 × 4in.; 7 × 4in.; 8 × 5in 8 ohm, 2½in, 2¾in., 3½in., 5in. dia. **£1** EACH TYPE (6 × 4in., 8 ohm, £1·50).
RICHARD ALLAN TWIN CONE LOUDSPEAKERS. 8in. diameter 4W £2·50, 10in. diameter 5W £2·50; Post 25p. 12in. diameter, 6W, £2·95; 3 or 8 or 15 ohm models.
SPEAKER COVERING MATERIALS. Samples Large S.A.E. Horn Tweeters 2-16Kc/s. 8W 8 ohm or 15 ohm £1·95. De Luxe Horn Tweeters 2-18 Kc/s, 15W, 15 ohm £3·50.
TWO-WAY 3,000 c.p.s. CROSSOVERS 3, 8 or 15 ohm 95p.

TWO-WAY CROSSOVER NETWORK 3,000 c/s
With variable tweeter attenuator giving accurate high/low frequency balance. Mounted on panel 5½in. × 4in. with control knob, tweeter and woofer leads and input terminals. Suitable for 3 to 8 ohm impedance. **£2·20** Post 20p

VALVE OUTPUT TRANSFORMER 25p
MIKE TRANSFORMER MU. metal 100-1 £1·25.
5 WATT MULTI RATIO. 3, 8 and 15 ohms, 80p.
PUSH-PULL VALVE OUTPUT TRANSFORMERS. 50 watt .... £12·50 100 watt £15

ELECTRO MAGNETIC PENDULUM MECHANISM
1·5v d.c. operation over 250 hrs. continuous on SP2 battery, fully adjustable swing and speed. Ideal displays teaching electro magnetism or for metronome; strobe etc. 95p, Post 20p

R.C.S. VALVE AMPLIFIER
2 Stage Triode Pentode valve, 3 watts 3 ohm output. Volume on/off and tone controls AC mains. Complete and tested. £4·50. Post 25p.

WEYRAD COILS
P50/1AC	40p.	RA2W	65p.
P50/2CC	40p.	OPT1	65p.
P50/3CC	40p.	LFDT4.	65p.

Printed Circuit 60p. Twin Gang 75p.

COAXIAL PLUG 10p. PANEL SOCKETS 10p. LINE 18p
OUTLET BOXES, SURFACE MOUNTING 25p.
BALANCED TWIN RIBBON FEEDER 300 ohms, 5p yd.
JACK SOCKET Std. open-circuit 14p, closed circuit 23p; Chrome Lead Socket 45p. Phono Plugs 5p. Phono Socket 5p
JACK PLUGS Std. Chrome 20p; 3·5mm Chrome 13p. DIN SOCKETS Chassis 3-pin 10p; 5-pin 10p. DIN SOCKETS Lead 3-pin 18p; 5-pin 15p. DIN PLUGS 3-pin 18p; 5-pin 25p.
VALVE HOLDERS 5p; CERAMIC 8p; CANS 5p.

BRITISH FM/VHF TUNING HEART
88 to 108 Mc/s British made. 2 Transistors ready aligned—requires 10.7 Mc/s IF. Complete with tuning gang. Connections supplied but some technical experience essential. Our Price **£3·95** Post 20p.

ALL PRICES INCLUDE VAT   MINIMUM POST AND PACKING 20p.   CALLERS WELCOME

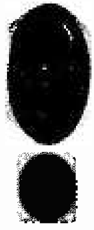
RADIO COMPONENT

Illustrated Colour Brochure, Radio Books & Component Lists 10p. Written guarantee.

ALL OUR PRICES INCLUDE V.A.T.

E.M.I. WOOFER AND TWEETER KIT

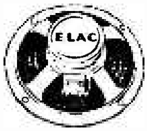
£5·75 THE PAIR. Post 25p. (Available separately. Woofer £4·25; Tweeter £1·90).



Comprising a fine example of a Woofer 10¾ × 6½in. with a massive Ceramic Magnet. 44oz. Gauss 13,000 lines. Aluminium Cone centre to improve middle and top response. Also the E.M.I. Tweeter 3½in. square has a special lightweight paper cone and magnet flux 10,000 lines. Crossover condenser and full instructions supplied.

Impedance Standard 8 ohms
Maximum power 12 watts
Useful Response 25 to 18,000 cps
Bass Resonance 45 cps

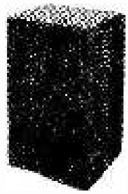
SUITABLE ENCLOSURE 20 × 13 × 9in. MODERN DESIGN. TEAK WOOD FINISH. **£9·90** Post 25p



8in. or 10in. ELAC HI-FI SPEAKER

Dual cone plasticised roll surround. Large ceramic magnet. 50-16,000 cps. Bass resonance 55 cps. 8 ohm impedance. 8in. 10 watts, 10in. 12 watts **£3·75**

TEAK VENEER HI-FI SPEAKER CABINETS
Fluted Wood Fronts



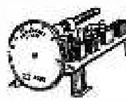
MODEL "A". 20 × 13 × 9in. For 12in. dia. or 10in. speaker. **£9·90** Post 25p

MODEL "B". 16 × 10 × 9in. For 13 × 8in. or 8in. speaker. **£5·50** Post 25p

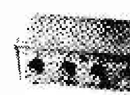
MODEL "B2" ditto. Triangular corner version.

MODEL "C". 16 × 8 × 6in. For 8 × 5in. speaker. **£4·40** Post 25p

LOUDSPEAKER CABINET WADDING 18in. wide, 15p ft.

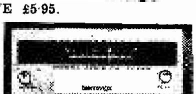


BARGAIN AM TUNER. Medium Wave. Transistor Superhet Ferrite aerial. 9 volt. **£4·95**



BARGAIN 4 CHANNEL TRANSISTOR MONO MIXER. Add musical highlights and sound effects to recordings. Will mix Microphone, records, tape and tuner with separate controls into single output. 9 volt battery operated. **£3·95**

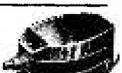
STEREO VERSION OF ABOVE £5·95.



BARGAIN FM TUNER. 88-108 Mc/s Six Transistor. 9 volt. Printed circuit. Calibrated slide dial tuning. Walnut Cabinet. Size 7 × 5 × 4in. **£12·85**

BARGAIN FM TUNER. As above less cabinet. **£8·85**

BARGAIN 3 WATT AMPLIFIER. 4 Transistor Push-Pull Ready built with volume, treble and bass controls. 18 volt battery operated. **£4·50**



THE "INSTANT" BULK TAPE ERASER & HEAD DEMAGNETISER. Suitable for cassettes, and all sizes of tape reels. A.C. mains 200/250V. Leaflet S.A.E. **£3·50** Post 20p

WAFER THIN HEATING ELEMENTS

OFFERING 1001 USES for every type of heating and drying applications in the home, garage, greenhouse, factory (available in manufacturing quantities). Approx. size 10¾ × 8¼ × 1/16in. Operating voltage 200/250V. a.c. 250 watts approx. Printed circuit element enclosed in asbestos fitted with connecting wires. Completely flexible providing safe Black heat. British-made for use in photocopiers and print drying equipment.
Ideal for home handymen and experimenters. Suitable for Heating Pads, Food Warmers, Convector Heaters, etc. Must be clamped between two sheets of metal or asbestos, etc., to make efficient clothes dryers, towel rails—ideal for airing cupboards. Ideal for anti-frost device for the garage—preventing frozen radiators or acting as oil sump heater. Use in the greenhouse for seed raising and plant protection. Invaluable aid for bird houses, incubators, etc., etc. Can be used in series for lower heat. Or in parallel for higher heat applications.

ONLY **40p** EACH (FOUR FOR £1·50)

ALL POST PAID—Discounts for quantity.

BAKER MAJOR 12" £9·90

Post Free

30-14,500 c/s. 12in. double cone, woofer and tweeter cone together with a BAKER ceramic magnet assembly having a flux density of 14,000 gauss and a total flux of 145,000 Maxwells. Bass resonance 40 c/s Rated 20 watts. NOTE: 3 or 8 or 15 ohms must be stated.

Module kit. 30-17,000 c/s with tweeter, crossover, baffle and instructions. **£12·50**

Please state 3 or 8 or 15 ohms. Post Free

BAKER "BIG SOUND" SPEAKERS

Robustly constructed to stand up to long periods of electronic power. As used by leading groups. Useful response 30-13,000 cps. Bass Resonance 55 cps.

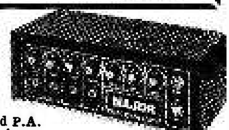
GROUP "25" 12in. 25 watt 3, 8 or 15 ohms. **£8·80** Post Free

GROUP "35" 12in. 35 watt 3, 8 or 15 ohms **£9·90** Post Free

GROUP "50" 15in. 50 watt 8 or 15 ohms. **£22·00**

NEW 12" VERSION 50 watt 8 or 15 ohms **£17·60**

MAJOR 100 WATT ALL PURPOSE TRANSISTOR AMPLIFIER



All purpose transistorised. Ideal for Groups, Disco and P.A. 4 inputs speech and music. 4 way mixing. Output 8/15 ohm. a.c. Mains. Separate treble and bass controls. Guaranteed. Details SAE. **£49** Carr. £1·00

CALLERS ONLY! DE LUXE 100 WATT AMPLIFIER CHASSIS

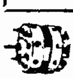
7 valve version, 4 input 10 wide range controls. For mikes, Discos, Organs, Guitars, etc. 4, 8 & 15 ohm loudspeakers matching £69·00.

Q MAX CHASSIS CUTTERS
A die, punch and Allen Screw

Sizes
- 3/8" ... 74p
- 7/16" ... 83p
- Key 'T' for above 6p
- 1/2", 9/16", 5/8" ... 90p
- 11/16", 3/4" ... 92p
- 13/16", 7/8" ... 99p
- Key 'A' for above 6p
- 15/16", 1", 1 1/16", 1 1/8" £1·00
- 1 3/16", 1 7/32", 1 1/4" ... £1·15
- 1 5/16", 1 3/8" ... £1·20
- 1 1/2" ... £1·35
- 1 5/8" ... £1·70
- 1 3/4" ... £1·70
- Key 'B' for above 10p
- 2" ... £2·25
- 2 3/32" ... £2·50
- 2 1/4" ... £3·30
- Key 'C' for above 13p
- 2 5/8" ... £4·50
- 2 3/4" ... £5·75
- 3" ... £9·00
- Key 'E' for above 20p
- 1" Square, with key £2·10

SPECIAL OFFER
100 Ohm 20 watt Rheostat 2¼in diam. Ceramic Former. Screw Terminals ¼in. diam. spindle. 95p. Post 25p.

SPECIAL OFFER
3 inch Panel Meter 50 Microamp, unusual scale require recalibrating. £1·75 post 25p.



REVERSIBLE 4 POLE MOTOR

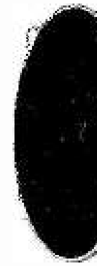
1,400 r.p.m. Reversible 42 Watt, spindle 1¼" × 7/32", size 3½" × 3". As illustrated, 240v. AC mains. **£1·95** Post 25p

E.M.I. GRAM MOTOR

120v. or 240v. A.C. 2,400 rpm. 2-pole 70mA. Size 2⅝ × 2¼ × 2¼in. **£1·00** Post 25p.

BAKER HI-FI SPEAKERS
HIGH QUALITY — BRITISH MADE

REGENT
12in. 15 watts

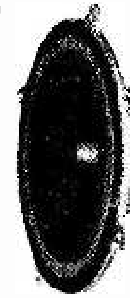


An inexpensive unit for the beginner in high fidelity and for general purposes. May be used to improve any Radio, Amplifier, Hi-Fi or Television receiver.

Bass Resonance 45cps
Flux Density 12,000gauss
Useful response 45-13,000cps
3 or 8 or 15 ohm models.

£8·80 Post Free

DE-LUXE Mk II
12in 15 watts

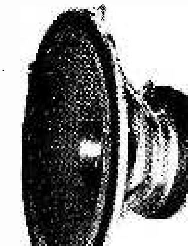


Especially designed to provide full range reproduction at an economical cost. Suitable for use with any high fidelity system. Built-in concentric tweeter cone.

Bass Resonance 30cps
Flux Density 14,000gauss
Useful response 25-16,000cps
8 or 15 ohms models.

£11 Post Free

SUPERB
12in. 20 watts



A high quality loudspeaker, its remarkable low cone resonance ensures clear reproduction of the deepest bass. Fitted with a special copper drive and concentric tweeter cone resulting in full range reproduction with remarkable efficiency in the upper register.

Bass Resonance 25cps
Flux Density 16,500gauss
Useful response 20-17,000cps
8 or 15 ohms models.

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A full range reproducer for high power, Electric Guitars, public address, multi-speaker systems, electric organs. Ideal for Hi-Fi and Discotheques.

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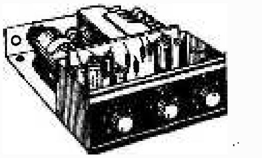
SUPERSOUND 13 HI-FI MONO AMPLIFIER



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

PRICE £11·60. P. & P. 50p.

DE LUXE STEREO AMPLIFIER

A.C. mains 200-240 v. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up:-2 x ECL86 Triode Pentodes. 1 x EZ80 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 300m/v for full peak output of 4 watts per channel (8 watts mono), into 3 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11"w x 4"d. Overall height including valves 5". Ready built & tested to a high standard. **PRICE £9·90.** P.&P. 50p.

POWER SUPPLY UNIT 200/240v. A.C. input. Four switched fully smoothed D.C. outputs giving 6v. and 7½v. and 9v. and 12v. at 1 amp on load. Fitted insulated output terminals and pilot lamp indicator. Hammer finish metal case overall size 6" x 3¾" x 2¼". Suitable for Transistor Radios, Tape Recorders, Amplifiers etc. etc. Ready built and tested. **PRICE £5·00** P. & P. 35p.

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For P.U. Tape, Mike, Guitar, etc. and suitable for use with valve or transistor equipment. 9-18v. battery or from H.T. line 200/300v. Frequency response 15Hz–25KHz. Gain 26dB. Solid encapsulation size 1¾" x 1¼" x ¾". Brand new complete with instructions. Price £1·00. P. & P. 15p.

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A must for servicemen and home constructors. Including many 1000's of British, U.S.A. European and Japanese transistors. ONLY 40p. Post 5p.

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QUALITY RECORD PLAYER AMPLIFIER MK. II
A top quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, and rectifier. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. wide x 3in. deep x 6in. high. Ready built and tested. PRICE £4·40, P. & P. 50p.
ALSO AVAILABLE mounted on board with output transformer and speaker. PRICE £5·85, P. & P. 60p.

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OUR PRICE £9.25 Carr. 75p
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Also available in 8 ohms with EMI 13" x 8" bass speaker with parasitic tweeter £7·15, Carr. 75p.

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A super quality gram amplifier using a double wound fully isolated mains transformer, rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3·5 watts. Volume and tone controls. Chassis size only 7in. wide x 3in. deep x 6in. high overall. AC mains 200/240v. Supplied absolutely Brand New completely wired and tested with good quality output transformer.
P. & P. 40p BARGAIN PRICE **£3·30**

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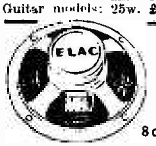
BRAND NEW. 12in. 15w. H/D Speakers. 3 or 15 ohms. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly £7·50. Guitar models: 25w. £7·50, 35w. £9·35, P. & P. 45p.



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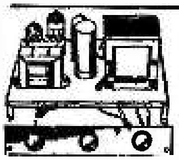
NEW FURTHER IMPROVED MODEL WITH HIGHER OUTPUT AND INCORPORATING HIGH QUALITY READY DRILLED PRINTED CIRCUIT BOARD WITH COMPONENT IDENTIFICATION CLEARLY MARKED FOR EVEN EASIER CONSTRUCTION

A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors including Silicon Transistors in the first five stages on each channel resulting in even lower noise, level with improved sensitivity. Integrated pre-amp with Bass, Treble and two Volume Controls. Suitable for use with Ceramic or Crystal cartridges. Very simple to modify to suit magnetic cartridge—instructions included. Output stage for any speakers from 5 to 15 ohms. Compact design, all parts supplied including drilled metal work, high quality ready drilled printed circuit board, smart brushed anodised aluminium front panel with matching knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Power output: 14 watts r.m.s. per channel into 5 ohms. Frequency response ±3dB 12–30,000 Hz Sensitivity: better than 80mV into 1MΩ. Full power bandwidth: ±3dB 12–15,000 Hz. Bass boost approx. to ±12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 35v. at 1.0 amp. Overall Size 12"w. x 8"d. x 2¾"h.
Fully detailed 7 page construction manual and parts list free with kit or send 18p plus large S.A.E.

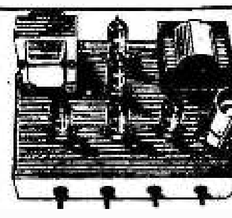
AMPLIFIER KIT	£11·55	P. & P. 25p
(Magnetic input components 33p extra)		
POWER PACK KIT	£3·30	P. & P. 35p
CABINET	£3·30	P. & P. 35p

(Post Free if all units purchased at same time)
Full after sales service
Also available ready built and tested £23·10. Post Free.
Note: The above amplifier is suitable for feeding two mono sources into inputs (e.g. mike, radio, twin record decks, etc.) and will then provide mixing and fading facilities for medium powered Hi-Fi Discotheque use, etc.



3-VALVE AUDIO AMPLIFIER HA34 MK II.
Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½"w. x 4"d. x 4¾"h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker. Separate volume control and now with improved wide range tone controls giving bass and treble lift and cut. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only £5·50. P. & P. 45p.
HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. £4·50. P. & P. 45p.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3–15 Ω speaker and 2 independent volume controls, and separate base and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet 15p + SAE (Free with parts)' All parts sold separately. ONLY £8·80 P. & P. 60p. Also available ready built and tested £12·10 P. & P. 70p.

HI-FI STEREO HEADPHONES
Adjustable headband with comfortable flexifoam earmuffs. Wired and fitted with standard stereo ¼in jack plug. Frequency response 30-15,000Hz. Matching impedance 8-16 ohms. Easily converted for Mono. PRICE £3·30, P. & P. 25p.

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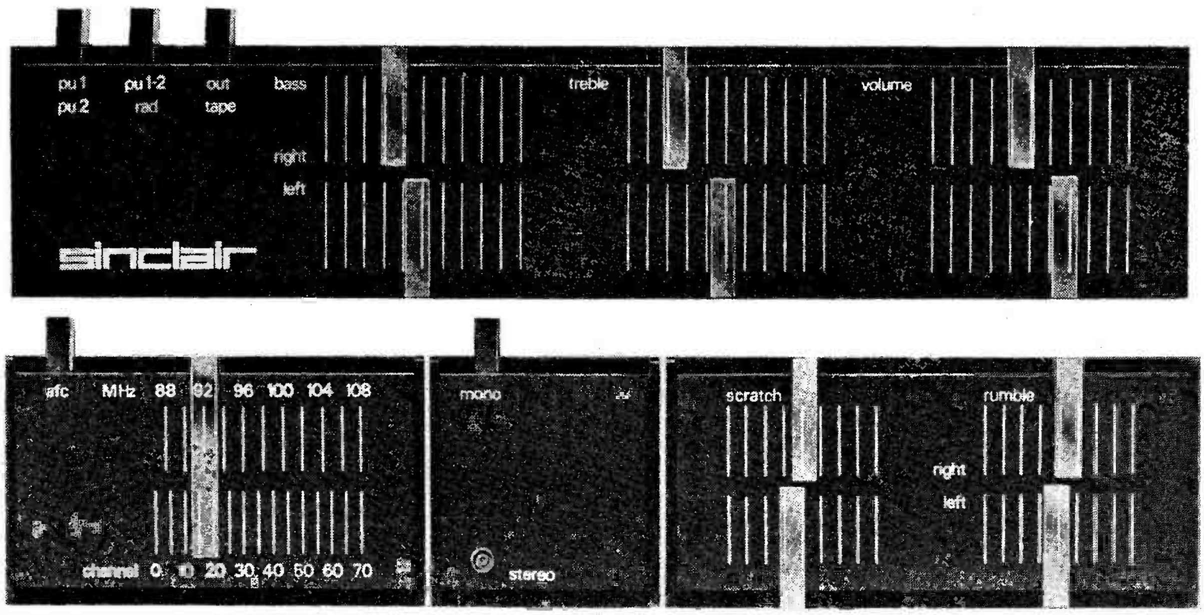


only $\frac{3}{4}$" deep x 2" high

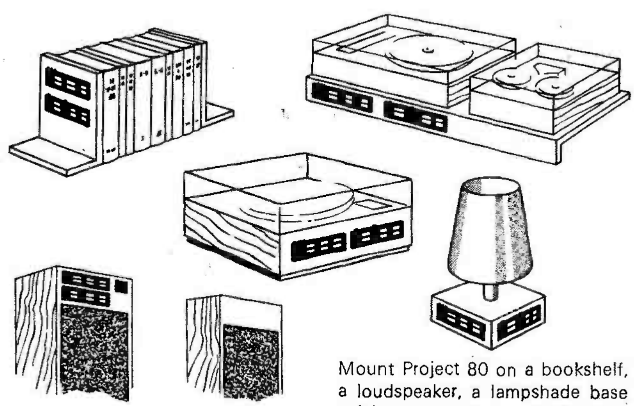
Living with hi-fi takes on new meaning with Sinclair Project 80. The electronics of these revolutionary new modules are all contained within elegantly designed matching cases no more than three-quarters of an inch deep. They are designed for mounting on any appropriate flat surface by means of 6BA bolts extending from the rear of each module and which pass through suitably drilled holes. Connections are taken away out of sight in a similar manner. The possibilities opened up by Project 80 are endless – superb hi-fi systems can be installed in ways hitherto only dreamed about and never before made practical. No more cutting out and shaping to put modules in position. A few holes drilled with the aid of templates supplied and the job is done. Now you need never again be faced with problems of keeping the hi-fi from clashing with carefully thought-out furnishing schemes. (That will surely please wives!) Slider controls have been introduced in place of knobs and all modules in the range incorporate new up-dated circuitry with emphasis on performance standards and built-in protection against overload and shorting. The aim was to re-think modular construction completely – to make it infinitely more versatile, even simpler and more reliable – the result – Project 80 – another triumph for Sinclair, and the most exciting construction modules ever.

the slimmest, most elegant hi-fi modules ever made

Typical Project 80 applications

System	The Units to use	Units cost
Simple battery record player	**Z.40**	**£5·45** +54p V.A.T.
Mains powered record player	**Z.40, PZ.5**	**£10·43** +£1.04 V.A.T.
30W. RMS continuous sine wave stereo amp.	**2 × Z.40s, Stereo 80; PZ.6**	**£30·83** +£3.08 V.A.T.
50W (8 Ω) RMS continuous sine wave de luxe stereo amp.	**2 × Z.60s, Stereo 80; PZ.8**	**£33·83** +£3.38 V.A.T.
Indoor P.A.	**Z.60, PZ.8**	**£14·93** +£1.49 V.A.T.

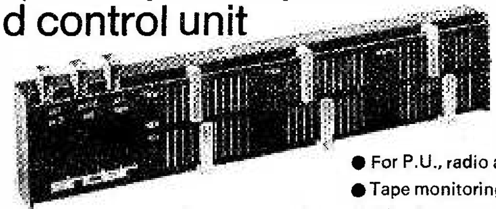
Project 80 FM tuner, decoder, and A.F.U. may be added as required



Mount Project 80 on a bookshelf, a loudspeaker, a lampshade base a false wall with two Q.16 loud-speakers . . . almost anywhere.

new thinking in modular hi-fi

Stereo 80 pre-amplifier and control unit



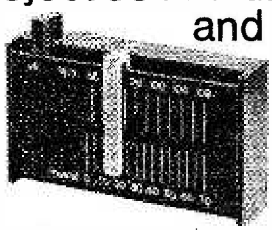
● For P.U., radio and tape
● Tape monitoring switch
● Simplest ever fixing

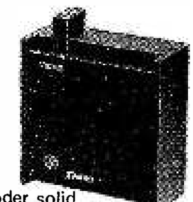
Each channel has its own separate tone and volume controls operated by sliders, enabling ideal environmental matching to be obtained. A virtual earth input stage forms part of the up-dated circuitry that ensures the finest possible quality from all signal sources. Generous overload margins are allowed on all inputs. Clear instructions with template are supplied.

TECHNICAL SPECIFICATIONS
Size – 260 × 50 × 20mm (10¼ × 2 × ¾ins)
Finish – Black with white indicators and transparent sliders
Inputs – Magnetic pick-up 3mV RIAA corrected; Ceramic pick-up 300mV Radio 300mV; Tape 30mV
Signal/noise ratio – 60dB
Frequency range – 20Hz to 15KHz ± 1dB: 10Hz to 25KHz ± 3dB
Power requirements – 20 to 35 volts
Outputs – 100mV + AB monitoring for tape
Controls – Press button for tape radio and P.U Sliders for volume, bass (+ 12dB to – 14dB at 100Hz) treble (+ 11dB to – 12dB at 10KHz)

R.R.P. **£11.95** + £1·19 V.A.T.

Project 80 FM tuner and stereo decoder





● Twin dual varicap tuning: 4 pole ceramic filter: switchable A.F.C.
● On the decoder, solid state stereo indicating beacon.

Making the Project 80 F.M. tuner and decoder available separately gives a wider choice of systems and saves money where stereo reception may not be required. The tuner is a triumph of electronic design and assures excellent performance. The decoder gives a 40dB channel separation with 150mV output per channel. Both units may be used with other than Project 80 systems.

TECHNICAL SPECIFICATIONS OF TUNER
Size – 85 × 50 × 20mm (3¼ × 2 × ¾ins)
Tuning range – 87·5 to 108 MHz
Detector – I.C. balanced coincidence for good A.M. rejection
One I.C. equal to 26 transistors
Distortion – 0·2% at 1 KHz for 30% modulation
4 pole ceramic filter in I.F. section
Aerial impedance – 75 Ω or 240-300 Ω
Sensitivity – 4 microvolts for 30dB quieting
Output – 300 mV for 30% modulation
Power requirements – 23 to 33 volts

R.R.P. **£11.95** + £1·19 V.A.T.

DECODER
Size – 47 × 50 × 20mm (1⅞ × 2 × ¾ins)
One 19 transistor I.C.

R.R.P. **£7.45** + 0·74 V.A.T.

Guarantee

If, within 3 months of purchasing any product direct from us, you are dissatisfied with it, your money will be refunded on production of receipt of payment. Many Sinclair appointed stockists also offer this guarantee. Should any defect arise in normal use, we will service it without charge. For damage arising from mis-use a charge (typically £1·00) will be made.

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Sinclair Radionics Ltd. London Road, St. Ives, Huntingdon PE17 4HJ

Z.40 & Z.60 power amplifiers totally short-circuit proof

Z.40

Z.60

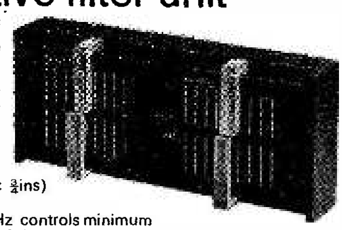
Intended for use in Project 80 installations, these modules readily adapt to an even wider range of applications. Both incorporate built-in protection against short circuiting and risk of damage from mis-use is greatly reduced.

Z.40 TECHNICAL SPECIFICATIONS
Size – 55 × 80 × 20mm (2¼ × 3¼ × ¾ins) 9 transistors
Input sensitivity – 100mV
Output – 15 watts RMS continuous into 8 Ω (35v)
Frequency response – 10Hz – 100KHz ± 1dB
Signal/noise ratio – 64dB
Distortion – at 10 watts into 8 Ω less than 0·1%
Power requirements – 12 to 35 volts

Z.60 TECHNICAL SPECIFICATIONS
Size – 55 × 98 × 15mm (2¼ × 3⅞ × ¾ins) 12 transistors
Input sensitivity – 100-250mV
Output – 25 watts RMS continuous into 8 Ω (45V).
Distortion – typically 0·03%
Frequency response – 10Hz to more than 200KHz ± 1dB
Signal/noise ratio – better than 70dB
Built-in protection against transient overload and short circuiting
Load impedance – 4 Ω min: max. safe on open circuit

Z.40 R.R.P. **£5.45** + 0·54 V.A.T.: **Z.60** R.R.P. **£6.95** + 0·69p V.A.T.

Project 80 active filter unit



Makes a highly desirable part of any worthwhile system where inputs may be from record, radio or tape. As with Stereo 80, separate controls applied to each channel make it easier to obtain ideal stereo balance.

TECHNICAL SPECIFICATIONS
Size – 108 × 50 × 20mm (4¼ × 2 × ¾ins)
Voltage gain – minus 0·2dB
Frequency response – 36Hz to 22KHz controls minimum
Distortion – at 1 KHz – 0·03% using 30V supply
HF cut off (scratch) – 22KHz to 5·5KHz, 12dB/oct. slope
L.F. cut off (rumble) – 28dB at 20Hz, 9dB/oct. slope

● For scratch and rumble control
● Transistorised active circuitry

R.R.P. **£6.95** + 0·69 V.A.T.

Power supply units

PZ.8

Stabilised. Re-entrant current limiting makes damage from overload or even direct shorting impossible. Normal working voltage (adjustable) 45V.

R.R.P. £7·98 + 0·79p V.A.T.
Without mains transformer

PZ.5 30V unstabilised
R.R.P. £4·98 + 0·49p V.A.T.

PZ.6 35V. stabilised
R.R.P. £7·98 + 0·79p V.A.T.

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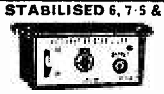

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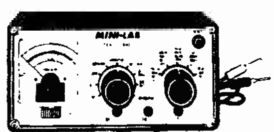

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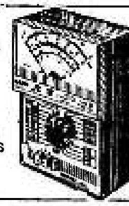

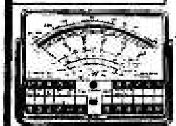

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