PRACTICAL WIRELESS

JUNE 1972

20p

12W RECORD PLAYER

Estelle

& CONSTRUCTING the PW ELECTRONIC IGNITION SYSTEM • TEST BENCH AMP

RSC HIGH-FIDELITY STEREO PACKAGE OFFERS

Four fully wired units ready to 'plug in'.
★ SUPER 30 AMPLIFIER (15 + 15 watt) in veneered housing
★ GARRARD SP25 MK III Turntable on Plinth with cover
★ GOLDRING G850 Magnetic cartridge with diamond stylus
★ PAIR OF STANWAY II Speaker Units

Special Total Price **£87·75** Carr. £1·50

Terms: Deposit £12·75 and 9 monthly payments £9·37 (Total £97·08).

★ Super 30 Amplifier (15 + 15 watt) in veneered housing
★ Goldring GL69 II Transcription Turntable on Plinth as illustrated
★ Goldring Magnetic P.U. Cartridge.
★ Pair of Stanway II speaker units.

Special Total Price **£99·75** Carr. £1·50

Terms: Deposit £14·75 and 9 monthly payments £10·52 (Total £110·33).

ATTRACTIVE TEAK OR AFRORMOSIA VENEERED CABINETS AND PLINTHS

Send S.A.E. for coloured brochure showing other money saving offers.

Matching as recommended for optimum performance. Package prices apply providing all individual units are purchased from any branch within 3 months. See leaflet.

★ TA12 AMPLIFIER 6·5 + 6·5 watt in veneered housing
★ GARRARD SP25 MK III Player unit on Plinth
★ GOLDRING CS90 Ceramic P.U Cartridge with diamond stylus
★ PAIR OF DORCHESTER Loudspeaker Units

Special Total Price **£59**

Or Deposit £9 and 9 monthly payments £6·25 (Total £65·25). Carr. £1·25

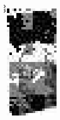
Trans. Plastic Cover £3·15 extra.

PACKAGE AS ABOVE but with Garrard 3000 Autochanger and Sonotone 9TA Ceramic Cartridge in lieu of SP25 and CS90 Carr. £1·25 **£51·75**

Or Deposit £8 and 9 monthly payments £5·58 (Total £58·22)

Trans. Plastic cover £3·15 extra.

'YORK' HIGH-FIDELITY 3 SPEAKER SYSTEM



★ Moderate size only 25×14×10in.
★ Response 30-20,000 c.p.s. Impedance 15 ohms

COMPLETE KIT **£23** Carr. 65p

★ Performance comparable with units costing considerably more.

Consists of (1) 12in. 15 watt Bass unit with cast chassis, Roll rubber cone surround for ultra low resonance, and ceramic magnet. (2) 3-way quarter section series cross-over system (3) 8×5in. 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: Dep. £4·60 and 9 monthly payments £2·47 (Total £26·83).

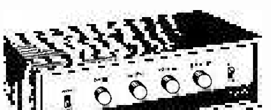
DEMONSTRATIONS AT ALL BRANCHES

HIGH FIDELITY LOUDSPEAKER UNITS

Cabinets latest style Satin Teak veneer. Acoustically lined or filled acoustic damping. Ported where appropriate. Credit terms available.

DORCHESTER (Illustrated) Size 16×11×9in. appr. Range 45-15,000 c.p.s. Rating 8-10 watts. Fitted High flux 13×8in. Dual Cone speaker. Imp. 3 or 15 ohms. **£9·45** Carr. 40p.

STANWAY II Size 20×10¾×9⅞in. approx. Rating 10 watts. Inc. 13×8in. speaker with highly flexible cone surround, long throw voice coil and 10,000 line magnet. High flux tweeter. Handsome Scandinavian design cabinet. Range 35-20,000 c.p.s. Imp. 8 ohms. Gives smooth realistic sound output. See 'package offers' for illustration **£17·85**



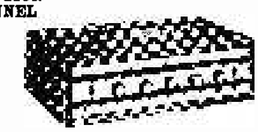
Individual Ganged Controls: Bass, Treble, Volume and Balance. Printed circuit construction employing 10 Transistors plus Diodes. Output rating I.H.F.M. Frequency range 20–20,000 c.p.s. Bass Control ± 12db. Treble Control ± 13db. Selector switch for P.U. or Tape/Radio. For loudspeaker output impedances of 3 to 15 ohms. For standard 200–250v. A.C. mains operation. Attractive Black and Silver finished metal facia plate and matching control knobs.

COMPLETE KIT OF PARTS INCLUDING FULLY WIRED PRINTED CIRCUIT and comprehensive wiring diagram and instructions **£11·50** Carr. 40p

Or FACTORY BUILT IN TEAK VENEERED CABINET as illustrated £14·99 or dep. £2·20 and 9 monthly payments £1·70 (Total £17·50).

R.S.C. TA12 MKIII 6·5+6·5 WATT STEREO AMPLIFIER

FULLY TRANSISTORISED, SOLID STATE CONSTRUCTION
HIGH FIDELITY OUTPUT OF 6·5 WATTS PER CHANNEL

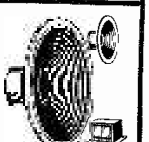


Designed for optimum performance with any crystal or ceramic Gram. P.U. cartridge, Radio tuner, Tape recorder etc. ★ 3 separate switched input sockets on each channel ★ Separate Bass and Treble controls ★ Slide Switch for mono use ★ Speaker Output 3-15 ohms ★ For 200-250v. A.C. mains ★ Frequency Response 20-20,000 c.p.s. −2dB ★ Harmonic Distortion 0·3% at 1,000 c.p.s. Hum and Noise −70dB ★ Sensitivities (1) 50mV (2) 400mV (3) 100mV. Output rating I.H.F.M. ★ Handsome finish Facia plate & Knobs.

COMPLETE KIT OF PARTS WITH FULL WIRING DIAGRAMS & INSTRUCTIONS. **£15·50** Carr. 40p. Factory built with 12 mths. guarantee **£19·50**

Deposit £3 and 9 mthly pymts £2·15 (Total £22·35). Or in Teak veneer housing Dep. £3 & 9 mthly payments £2·55 (Total £25·95). Send S.A.E. for leaflet. **£23**

AUDIOTRINE HI-FI SPEAKER SYSTEMS



Consisting of matched 12in. 11,000 line 15 Watt 15 ohm high quality speaker, cross-over unit and tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction. **£5·95** Carr. 30p

OR SENIOR 15 WATT INCLUDING HF126 15,000 LINE SPEAKER **£6·95** Carr. 35p

HI-FI SPEAKER ENCLOSURES MODERN DESIGN

Teak veneer finish. Acoustically lined. All sizes approx. Carr. 35p. per enclosure.

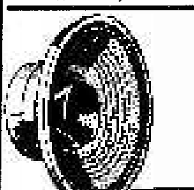
JE8 Size 16×11×9in. Pressurised. Gives pleasing results with any 8in. Hi-Fi speaker. **£5·35**

SE8 For optimum performance with any 8in. Hi-Fi speaker. Size 22×15×9in Ported. **£6·47**

SE10 For outstanding results with 10in. Hi-Fi spkr. Size 24×15×10in. P'td. **£6·74**

SE12 For exclnt prfmcne with 12in Hi-Fi speaker and Tweeter. Size 25×16×10½in. **£7·87**

AUDIOTRINE HIGH FIDELITY SPEAKERS



Heavy construction. Latest high efficiency ceramic magnets. Treated 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.

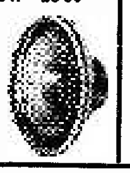
HF808T	8"	10W	£2·88	HF120D	12"	15W	£4·75
HF102D	10"	10W	£3·40	HF126	12"	15W	£5·50
HF120	12"	15W	£4·25	HF126D	12"	15W	£5·90

R.S.C. BATTERY/MAINS CONVERSION UNITS

TYPE BM1. An all-dry battery eliminator. Size 5½×4½×2in. approx. Completely replaces batteries supplying 1·5v and 90v. to battery radio where A.C. mains 200/250v. 50c/s is available.

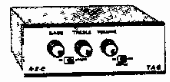
COMPLETE KIT WITH DIAGRAM **£3·25** ASSEMBLED READY FOR USE **£3·75**

FANE 807 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. STATE WHEN ORDERING **£3·85**

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, 9½×2¾×5¼in. Attractive brushed silver finish facia plate 10½×3½in. and matching knobs.

Complete kit of parts with full wiring diagrams and instructions. **£7·50** Carr 40p

OR FACTORY BUILT WITH 12 MONTHS' GUARANTEE £9·75

R.S.C. MkIII SUPER 30 HIGH FIDELITY STEREO AMPLIFIER

A COMPLETELY NEW DESIGN FURTHER IMPROVED IN BOTH APPEARANCE and PERFORMANCE. REPRESENTING VALUE FAR HIGHER THAN THE PRICES SUGGEST.

Only high grade components by leading manufacturers.

COMPLETE KIT OF PARTS **£25** Carr. 65p

Or FACTORY BUILT with 12 months guarantee. Dep. £5·75 and 9 monthly payments £3·50 (Total £37·25.) **£33·75**

Or FACTORY BUILT in cabinet as illustrated. Dep. £7 and 9 monthly payments £3·99 (Total £42·91) **£38·75**

PRINTED CIRCUITRY
TWENTY SILICON TRANSISTORS.
FOUR DIODES,
FOUR RECTIFIERS

★ SATIN SILVER METAL FACIA with black lettering. Black edged knobs with bright silver centres.
★ PUSH-BUTTON SELECTOR SWITCHING
★ NEON INDICATOR
★ JACK SOCKET FOR HEADPHONES
★ CABINETED MODEL VENEERED IN SATIN TEAK. SUITABLE FOR ANY MODERN PICK-UP CARTRIDGE CERAMIC or MAGNETIC, REGARDLESS OF PRICE. WE RECOMMEND USE WITH THE BEST ANCILLARY EQUIPMENT THAT CAN BE AFFORDED.

TECHNICAL DETAILS (Applying to each channel where appropriate)

CONTROLS: PUSH-BUTTON SELECTOR (1) Disc (2) Radio (3) Tape (4) Mono L (5) Mono R (6) SPEAKER DIS. (7) Mains on/off. Bass, Treble and Balance. Plus Ceramic Mag P.U. Switch.

OUTPUT: 15 watts R.M.S. (Continuous) into 8 ohms. 10 watts R.M.S. (Continuous) into 15 ohms.
HUM & NOISE −75dB Min. Vol. −65dB Full Vol. **HARMONIC DISTORTION** 0·1% at 1000 Hz 10 Watts
FREQUENCY RESPONSE: −3dB 7Hz to 70kHz
TREBLE CONTROL: +16dB to −12dB at 14kHz
BASS CONTROL: +17dB to −16dB at 40Hz **CROSS TALK** −58dB
SENSITIVITIES: Disc Mag. 2·5 mV. Ceramic 35mV. Radio 120mV. Tape 120mV.
REAR PANEL SOCKETS ARE FOR 3 PAIRS OF INPUTS (1) P.U. (2) Radio. (3) Tape Amp. Plus pair for tape recorder signal take off and 2 pairs for speaker connections.

CN.240/2 Miniature soldering iron 15 watt 240 volts, fitted with nickel plated 3/32" bit and packed in transparent display box. Also available for 220 volts. **Price £1.70**

CN.240 Miniature soldering iron 15 watt 240 volts, fitted with iron coated 3/32" bit. Up to 18 interchangeable spare bits obtainable. This iron can also be supplied for 220, 110, 50 or 24 volts. **Price £1.70**

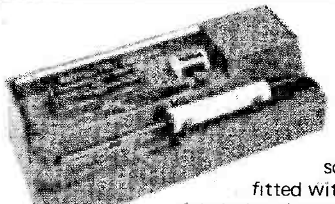
G.240 Miniature soldering iron 18 watt 240 volts extensively used by H.M. Forces. Suitable for high speed soldering and fitted with iron coated 3/32" bit. Also available for 220 volts. Spare bits 1/8", 3/16" and ¼" are obtainable. **Price £1.83.**

CCN.240 New model 15 watt 240 volts miniature soldering iron with ceramic shaft to ensure perfect insulation (4,000 v A.C.). Will solder live transistors in perfect safety: fitted with 3/32" iron coated bit. Spare bits 1/8" 3/16" and ¼" available. Can also be supplied for 220 volts. **Price £1.80**

CCN.240/7 The same soldering iron fitted with our new 7-star high efficiency bit for very high speed soldering The triple-coated bits are iron, nickel and chromium plated. **Price £1.95**

E.240 20 watt 240 volts soldering iron fitted with ¼" iron coated bit. Spare bits 3/32", 1/8" and 3/16" available. Can also be supplied for 220 and 110 volts. **Price £1.80.**

ES.240 25 watt 240 volts soldering iron fitted with 1/8" iron coated bit. Spare bits 3/32", 3/16" and ½" available. Can also be supplied for 220 and 110 volts. **Price £1.83**



SK.1 SOLDERING KIT

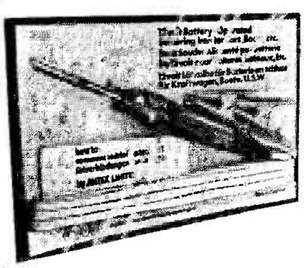
The kit contains a 15 watt 240 volts soldering iron fitted with a 3/16" bit, nickel plated spare bits of 5/32" and 3/32", a reel of solder, heat sink, cleaning pad, stand and booklet "How to Solder". Also available for 220 volts.

Price £2.75

SK. 2 SOLDERING KIT

This kit contains a 15 watt 240 volts soldering iron fitted with a 3/16" bit, nickel plated spare bits of 5/32" and 3/32", a reel of solder, Heat Sink, 1 amp fuse and booklet "How to Solder"

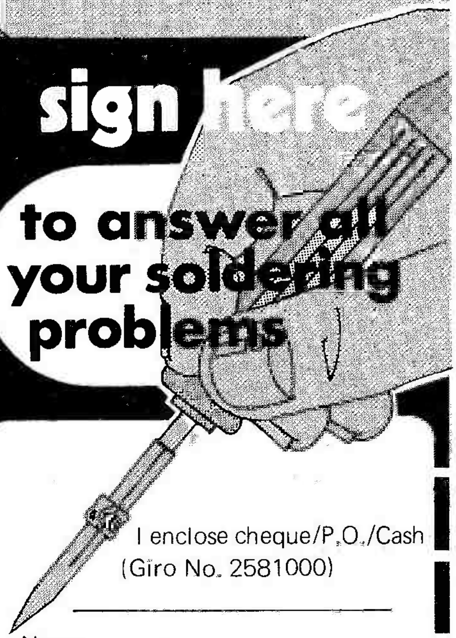
Price £2.40.



MES. 12

A battery operated 12 volts 25 watt soldering iron complete with 15' lead, two crocodile clips for connection to car battery and a booklet "How to Solder" packed in a strong plastic wallet.

Price £1.95.



sign here to answer all your soldering problems

I enclose cheque/P.O./Cash (Giro No. 2581000)

____

Name ____________________

Address ____________________

PW6

☐ Please send the Antex colour catalogue.

Please send the following:

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ANTEX

from electrical, radio or car accessory shops or from **Antex Ltd., Freepost** (no stamp required) **Plymouth PL1 1BR** Telephone 0752 67377/8

The largest selection

NEW LOW PRICE TESTED S.C.R.'s

PIV	1A TO-5 £p	3A TO-66 £p	7A TO-66 £p	10A £p	16A TO-48 £p	30A TO-48 £p
50	0·23	0·25	0·47	0·50	0·53	1·15
100	0·25	0·33	0·53	0·58	0·63	1·40
200	0·35	0·37	0·57	0·61	0·75	1·60
400	0·43	0·47	0·67	0·75	0·93	1·75
600	0·53	0·57	0·77	0·97	1·25	—
800	0·63	0·70	0·90	1·20	1·50	4·00

SIL. RECTS. TESTED

PIV	300mA £p	750mA £p	1A £p	1·5A £p	3A £p	10A £p	30A £p
50	0·40	0·05	0·05	0·07	0·14	0·21	0·47
100	0·04	0·06	0·05	0·13	0·16	0·23	0·75
200	0·05	0·09	0·06	0·14	0·20	0·24	1·00
400	0·06	0·13	0·07	0·20	0·27	0·37	1·25
600	0·07	0·16	0·10	0·23	0·34	0·45	1·85
800	0·10	0·17	0·13	0·25	0·37	0·55	2·00
1000	0·11	0·25	0·15	0·30	0·46	0·63	2·50
1200	—	0·33	—	0·33	0·57	0·75	—

TRIACS

VBOM	2A TO-1 £p	6A TO-66 £p	10A TO-88 £p
100	30	50	76
200	50	60	90
400	70	75	1·10

DIACS
FOR USE WITH TRIACS BR100 (D32) **37p** each

UNIJUNCTION
UT46. Eqvt. 2N2646, Eqvt. TIS43. BEN3000 **27p** each, 25–99 **25p** 100 UP **20p.**

NPN SILICON PLANAR
BC107/108, **10p** each; 50–99 **9p**; 100 up, **8p** each; 1,000 off, **7p** each. Fully-tested and coded TO-18 case.

FREE
One **50p** Pak of your own choice free with **orders valued £4 or over.**

SPECIAL OFFER
2N2926 (Y) (O) 10 for **50p**, 25 for **£1** 20,000 TO CLEAR

CADMIUM CELLS
ORP12 **43p**
ORP60, ORP61 **40p** each

GENERAL PURPOSE NPN SILICON SWITCHING TRANS. TO-18 SIM. TO 2N706/8. BSY-27/28/95A.
All usable devices no open or short circuits. ALSO AVAILABLE in PNP Sim. to 2N2906, BCY70. When ordering please state preference NPN or PNP.

		£p
20	For	0·50
50	For	1·00
100	For	1·75
500	For	7·50
1000	For	13·00

PHOTO TRANS.
OCP71 Type. **43p**

SIL. G.P. DIODES £p

300mW	30	0·50
40PIV(Min.)	100	1·50
Sub-Min.	500	5·00
Full Tested	1,000	9·00

Ideal for Organ Builders.

D13D1 Silicon Unilateral switch 50p each.
A Silicon Planar, monolithic integrated circuit having thyristor electrical characteristics, but with an anode gate and a built-in "Zener" diode between gate and cathode. Full data and application circuits available on request.

FULL RANGE OF ZENER DIODES VOLTAGE RANGE
2-33V. 400mV (DO-7 Case) 13p ea. 1½W (Top-Hat) 18p ea. 10W (SO-10 Stud) 25p ea. All fully tested 5% tol. and marked. State voltage required.

10 amp POTTED BRIDGE RECTIFIER
on heat sink.
100PIV. 90p each

JUMBO COMPONENT PAKS
MIXED ELECTRONIC COMPONENTS Exceptionally good value

Resistors, capacitors, pots, electrolytics and coils plus many other useful items. Approximately 3lbs in weight. Price incl. P. & P. **£1.50 only**

Plus your satisfaction or money back guarantee.

BRAND NEW TEXAS GERM. TRANSISTORS
Coded and Guaranteed

Pak No.			EQVT
T1	8	2G3713	OC71
T2	8	D1374	OC75
T3	8	D1216	OC81D
T4	8	2G381T	OC81
T5	8	2G382T	OC82
T6	8	2G344B	OC44
T7	8	2G345B	OC45
T8	8	2G378	OC78
T9	8	2G399A	2N1302
T10	8	2G417	AF117

All **50p** each pak

2N2060 NPN SIL. DUAL TRANS. CODE D1699 **TEXAS. Our price 25p each.**

120 VCB MIXIE DRIVER TRANSISTOR. Sim. BSX21 & C407, 2N1893 FULLY TESTED AND CODED ND 120. 1-24 17p each. TO5 N.P.N. 25 up 15p each.

Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 **5p** each. Any Qty.

NEW LINE
Plastic Encapsulated 2 Amp. BRIDGE RECTS.

50 v RMS	**32p** each
100 v RMS	**37p** ,,
400 v RMS	**46p** ,,

Size 15 mm × 6 mm.

KING OF THE PAKS — Unequalled Value and Quality

SUPER PAKS — NEW BI-PAK UNTESTED SEMICONDUCTORS

Satisfaction GUARANTEED in Every Pak, or money back.

Pak No.		£p
U1	120 Glass sub-min. general purpose germanium diodes	0·50
U2	60 Mixed germanium transistors AF/RF	0·50
U3	75 Germanium gold bonded diodes sim. OA5, OA47	0·50
U4	40 Germanium transistors like OC81, AC128	0·50
U5	60 200mA sub-min. Sil. diodes	0·50
U6	30 Silicon planar transistors NPN sim. BSY95A, 2N706	0·50
U7	16 Silicon rectifiers Top-Hat 750mA up to 1,000V	0·50
U8	50 Sil. planar diodes 250mA, OA/200/202	0·50
U9	20 Mixed volts 1 watt Zener diodes	0·50
U11	30 PNP silicon planar transistors TO-5 sim. 2N1132	0·50
U13	25 PNP-NPN sil. transistors OC200 & 2S104	0·50
U14	150 Mixed silicon and germanium diodes	0·50
U15	25 NPN Silicon planar transistors TO-5 sim. 2N697	0·50
U16	10 3-Amp silicon rectifiers stud type up to 1000 PIV	0·50
U17	30 Germanium PNP AF transistors TO-5 like ACY 17-22	0·50
U18	8 6-Amp silicon rectifiers BYZ13 type up to 600 PIV	0·50
U19	25 Silicon NPN transistors like BC108	0·50
U20	12 1·5 Amp silicon rectifiers Top-Hat up to 1,000 PIV	0·50
U21	30 A.F. germanium alloy transistors 2G300 series & OC71	0·50
U23	30 Madt's like MAT series PNP transistors	0·50
U24	20 Germanium 1-Amp rectifiers GJM up to 300 PIV	0·50
U25	25 300 Mc/s NPN silicon transistors 2N708, BSY27	0·50
U26	30 Fast switching silicon diodes like IN914 micro-min	0·50
U29	10 1-Amp SCR's TO-5 can up to 600 PIV CRS1/25-600	1·00
U31	20 Sil. Planar NPN trans. low noise amp 2N3707	0·50
U32	25 Zener diodes 400mW D07 case mixed volts, 3-18	0·50
U33	15 Plastic case 1 amp silicon rectifiers 1N4000 series	0·50
U34	30 Sil. PNP alloy trans. TO-5 BCY26, 2S302/4	0·50
U35	25 Sil. planar trans. PNP TO-18 2N2906	0·50
U36	25 Sil. planar PNP trans. TO-5 BFY50/51/52	0·50
U37	30 Sil. alloy trans. SO-2 PNP, OC200 2S322	0·50
U38	20 Fast switching sil. trans. NPN, 400Mc/s 2N3011	0·50
U39	30 RF germ. PNP trans. 2N1303 5 TO-5	0·50
U40	10 Dual trans. 6 lead TO-5 2N2060	0·50
U41	25 RF germ. trans. TO-1 OC45 NKT72	0·50
U42	10 VHF germ. PNP trans. TO-1 NKT667, AF117	0·50
U43	25 Sil. trans. plastic TO-18 A.F. BC113/114	0·50
U44	20 Sil. trans. plastic TO-5 BC115/116	0·50
U45	7 3A SCR's TO-66 up to 600 Piv.	1·00

Code Nos. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked.

NEW QUALITY TESTED PAKS

Pak	Description	Price £p
Q1	20 Red spot trans. PNP AF	0·50
Q2	16 White spot R.F. trans. PNP	0·50
Q3	4 OC77 type trans.	0·50
Q4	6 Matched trans. OC44/45/81/81D	0·50
Q5	4 OC75 transistors	0·50
Q6	4 OC72 transistors	0·50
Q7	4 AC128 trans. PNP high gain	0·50
Q8	4 AC126 trans. PNP	0·50
Q9	7 OC81 type trans.	0·50
Q10	7 OC71 type trans.	0·50
Q11	2 AC127/128 comp. pairs PNP/NPN	0·50
Q12	3 AF116 type trans.	0·50
Q13	3 AF117 type trans.	0·50
Q14	3 OC171 H.F. type trans.	0·50
Q15	5 2N2926 sil. epoxy trans.	0·50
Q16	2 GET880 low noise germ. trans.	0·50
Q17	3 NPN 1 ST141 & 2 ST140	0·50
Q18	4 Madt's 2 MAT 100 & 2 MAT 120	0·50
Q19	3 Madt's 2 MAT 101 & 1 MAT 121	0·50
Q20	4 OC44 germ. trans. A.F.	0·50
Q21	3 AC127 NPN germ. trans.	0·50
Q22	20 NKT trans. A.F. R.F. coded	0·50
Q23	10 OA202 sil. diodes sub-min.	0·50
Q24	8 OA81 diodes	0·50
Q25	6 IN914 sil. diodes 75PIV 75mA	0·50
Q26	8 OA95 germ. diodes sub-min. IN69	0·50
Q27	2 10A 600PIV sil. rects. 1S45R	0·50
Q28	2 Sil. power rects. BYZ13	0·50
Q29	4 Sil. trans. 2 × 2N696, 1 × 2N697, 1 × 2N698	0·50
Q30	7 Sil. switch trans. 2N706 PNP	0·50
Q31	6 Sil. switch trans. 2N708 NPN	0·50
Q32	3 PNP sil. trans. 2 × 2N1131, 1 × 2N1132	0·50
Q33	3 Sil. NPN trans. 2N1711	0·50
Q34	7 Sil. NPN trans. 2N2369, 500MHZ	0·50
Q35	3 Sil. PNP TO-5 2 × 2N2904 & 1 x 2N2905	0·50
Q36	7 2N3646 TO-18 plastic 300MH2 NPN	0·50
Q37	5 2N3053 NPN sil. trans	0·50
Q38	7 PNP trans. 4 x 2N3703, 3 × 2N3702	0·50
Q39	7 NPN trans. 4×2N3704, 3×2N3705	0·50
Q40	7 NPN amp. 4×2N3707, 3×3N3708.	0·50
Q41	3 Plastic NPN TO-18 2N3904	0·50
Q42	6 NPN trans. 2N5172	0·50
Q43	7 BC107 NPN trans.	0·50
Q44	7 NPN trans. 4 × BC108. 3 × BC109	0·50
Q45	3 BC113 NPN TO-18 trans	0·50
Q46	3 BC115 NPN TO-5 trans.	0·50
Q47	6 NPN high gain 3×BC167, 3×BC168	0·50
Q48	4 BCY70 NPN trans. TO-18	0·50
Q49	4 NPN trans. 2×BFY51, 2×BFY52	0·50
Q50	7 BSY28 NPN switch TO-18	0·50
Q51	7 BSY95A NPN trans. 300MH2	0·50
Q52	8 BY100 type sil. rect.	1·00
Q53	25 Sil. & germ. trans. mixed all marked new	1·50

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PRICE	1–24	25–99	100 up
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M/P COMP GERM TRANS.
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OUR PRICE EACH :

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2N3055
115 WATT SIL POWER NPN 50p EACH

SILICON 50 WATTS MATCHED NPN/PNP
BIP 19 NPN TO-3 Plastic.
BIP 20 PNP. Brand new.
VCBO 100/VCEO 50/ IC 10A. HFE type 100/ft 3mHZ.
OUR PRICE PER PAIR :

1–24 prs.	25–99 prs.	100 prs.
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OC22	30p	OC29	40p	AL102	85p	BD132	80p	BD140	85p
OC23	33p	OC35	33p	AL103	85p	BD135	70p	BD155	75p
OC24	45p	OC36	40p	BD121	60p	BD136	80p	BU105	£3
OC25	25p	AD140	40p	BD123	75p	BD137	70p	2N3054	45p
OC26	25p	AD142	40p	BD124	70p	BD138	80p		

SILICON PHOTO TRANSISTOR. TO-18 Lens end NPN Sim. to BP×25 and P21. BRAND NEW. Full data available. Fully guaranteed.

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PROF. TYPE No.	1–24	25–99	100up.
TSO 14 pin type	**30p**	**27p**	**25p**
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LOW COST No.			
BPS 14	**15p**	**13p**	**11p**
BPS 16	**16p**	**14p**	**12p**

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BI-PAK Order No.	Price and qty. prices 1–24 £p	25–99 £p	100 up £p
BP00=SN7400	0·15	0·14	0·12
BP01=SN7401	0·15	0·14	0·12
BP02=SN7402	0·15	0·14	0·12
BP03=SN7403	0·15	0·14	0·12
BP04=SN7404	0·15	0·14	0·12
BP05=SN7405	0·15	0·14	0·12
BP07=SN7407	0·18	0·17	0·16
BP08=SN7408	0·18	0·17	0·16
BP09=SN7409	0·18	0·17	0·16
BP10=SN7410	0·15	0·14	0·12
BP13=SN7413	0·29	0·26	0·24
BP16=SN7416	0·43	0·40	0·38
BP17=SN7417	0·43	0·40	0·38
BP20=SN7420	0·15	0·14	0·12
BP30=SN7430	0·15	0·14	0·12
BP40=SN7440	0·15	0·14	0·12
BP41=SN7441	0·67	0·64	0·58
BP42=SN7442	0·67	0·64	0·58
BP43=SN7443	1·95	1·85	1·75
BP44=SN7444	1·95	1·85	1·75
BP45=SN7445	1·95	1·85	1·75
BP46=SN7446	0·97	0·94	0·88
BP47=SN7447	0·97	0·94	0·88
BP48=SN7448	0·97	0·94	0·88
BP50=SN7450	0·15	0·14	0·12
BP51=SN7451	0·15	0·14	0·12
BP53=SN7453	0·15	0·14	0·12
BP54=SN7454	0·15	0·14	0·12
BP60=SN7460	0·15	0·14	0·12
BP70=SN7470	0·29	0·26	0·24
BP72=SN7472	0·29	0·26	0·24
BP73=SN7473	0·37	0·35	0·32
BP74=SN7474	0·37	0·35	0·32
BP75=SN7475	0·47	0·45	0·42
BP76=SN7476	0·43	0·40	0·38
BP80=SN7480	0·67	0·64	0·58
BP81=SN7481	0·97	0·94	0·88
BP82=SN7482	0·97	0·94	0·88
BP83=SN7483	1·10	1·05	0·95

BI-PAK Order No.	Price and qty. prices 1–24 £p	25–99 £p	100 up £p
BP86=SN7486	0·82	0·30	0·28
BP90=SN7490	0·67	0·64	0·58
BP91=SN7491AN	0·87	0·84	0·78
BP92=SN7492	0·67	0·64	0·58
BP93=SN7493	0·67	0·64	0·58
BP94=SN7494	0·77	0·74	0·68
BP95=SN7495	0·77	0·74	0·68
BP96=SN7496	0·77	0·74	0·68
BP100=SN74100	1·75	1·65	1·55
BP104=SN74104	0·97	0·94	0·88
BP105=SN74105	0·97	0·94	0·88
BP107=SN74107	0·40	0·38	0·36
BP110=SN74110	0·55	0·53	0·50
BP111=SN74111	1·25	1·15	1·00
BP118=SN74118	1·00	0·95	0·90
BP119=SN74119	1·35	1·25	1·10
BP121=SN74121	0·67	0·64	0·58
BP141=SN74141	0·67	0·64	0·58
BP145=SN74145	1·50	1·40	1·30
BP150=SN74150	1·80	1·70	1·60
BP151=SN74151	1·00	0·95	0·90
BP153=SN74153	1·20	1·10	0·95
BP154=SN74154	1·80	1·70	1·60
BP155=SN74155	1·40	1·30	1·20
BP156=SN74156	1·40	1·30	1·20
BP160=SN74160	1·80	1·70	1·60
BP161=SN74161	1·80	1·70	1·60
BP164=SN74164	2·00	1·90	1·80
BP165=SN74165	2·00	1·90	1·80
BP181=SN74181	2·75	2·60	2·40
BP182=SN74182	0·97	0·94	0·88
BP190=SN74190	3·50	3·25	3·00
BP191=SN74191	3·50	3·25	3·00
BP192=SN74192	2·10	1·95	1·75
BP193=SN74193	2·10	1·95	1·75
BP195=SN74195	1·10	1·05	0·95
BP196=SN74196	1·80	1·70	1·60
BP197=SN74197	1·80	1·70	1·60
BP198=SN74198	5·50	5·00	4·00
BP199=SN74199	5·50	5·00	4·00

PRICE-MIX. Devices may be mixed to qualify for quantity prices.
PRICES for quantities in excess of 500 pieces mixed, on application.
Owing to the ever increasing range of TTL 74 Series, please check with us for supplies of any devices not listed above, as it is probably now in stock. WARE 3442.

LINEAR I.C's—FULL SPEC.

Type No.	Price 1-24	25-99	100 up
BP 201C—SL201C	63p	53p	45p
BP701C—SL701C	63p	50p	45p
BP 702C—SL702C	63p	50p	45p
BP 702—72702	53p	45p	40p
BP709—72709	53p	45p	40p
BP 709P—μA709C	53p	45p	40p
BP 710—72710	53p	45p	40p
BP 711—μA711	58p	50p	45p
BP 741—72741	75p	60p	50p
μA703C—μA703C	43p	34p	27p
TAA 263—	70p	60p	55p
TAA 293—	90p	75p	70p
TAA 350	170p	158p	150p

S.G.S. EA1000 **2·63**

ROCK BOTTOM PRICES LOGIC DTL 930 Series I.C's

Type No.	Price 1–24	25–99	100 up
BP930	12p	11p	10p
BP932	13p	12p	11p
BP933	13p	12p	11p
BP935	13p	12p	11p
BP936	13p	12p	11p
BP944	13p	12p	11p
BP945	25p	24p	22p
RP946	12p	11p	10p
BP948	25p	24p	22p
BP951	65p	60p	55p
BP962	12p	11p	10p
BP9093	40p	38p	35p
BP9094	40p	38p	35p
BP9097	40p	38p	35p
BP9099	40p	38p	35p

Devices may be mixed to qualify for quantity price. Larger quantity prices on application. (DTL 930 Series only).

NUMERICAL INDICATOR TUBES

MODEL	CD66	GR116	3015F Minitron
Anode voltage (Vdc)	170min	175min	5
Cathode Current (mA)	2·3	14	8
Numerical Height (mm)	16	13	9
Tube Height (mm)	47	32	22
Tube Diameter (mm)	19	13	12 wide
I.C. Driver Rec.	BP41 or 141	BP41 or 141	BP47
PRICE EACH	£1·70	£1·55	£1·90

All indicators 0-9 + Decimal point. All side viewing. Full data for all types available on request.

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- ★ Signal to noise ratio 80dB.

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- ★ Supply voltage 10–35 Volts.
- ★ Overall size 63mm × 105mm × 13mm.

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

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (rms) 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 1·5amps at 35volts. 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.

STABILISED POWER MODULE SPM80 £2·95

TRANSFORMER BMT80 £1·95 p. & p. 25p.

SPECIAL COMPLETE KIT COMPRISING 2, AL50's, 1, SPM80 & 1, BMT80 ONLY £11 FREE p. & p.

DTL & TTL INTEGRATED CIRCUITS

Manufacturers' "Fall outs"—out of spec. devices including functional units and part function but classed as out of spec. from the manufacturers' very rigid specifications. Ideal for learning about I.C's and experimental work.

Pak No.			Pak No.		
UIC930 = 12 × μA 930	..	50p	UIC948 = 8 × μA 948	..	50p
UIC932 = 12 × μA 932	..	50p	UIC951 = 5 × μA 951	..	50p
UIC933 = 12 × μA 9₀3	..	50p	UIC961 = 12 × μA 961	..	50p
UIC935 = 12 × μA 935	..	50p	UIC9093 = 5 × μA 9093	..	50p
UIC936 = 12 × μA 936	..	50p	UIC9094 = 5 × μA 9094	..	50p
UIC944 = 12 × μA 944	..	50p	UIC9097 = 5 × μA 9097	..	50p
UIC945 = 8 × μA 945	..	50p	UIC9099 = 5 × μA 9099	..	50p
UIC946 = 12 × μA 946	..	50p	UICX9 25 Assorted 930 Series		£1·50

Packs cannot be split but 25 Assorted Pieces (our mix) is available as Pack UICX9
Data Booklet available for the BP930 Series, PRICE 13p

UIC00=12×7400N	50p	UIC46= 5×7446N	50p	UIC81= 5×7481N	50p
UIC01=12×7401N	50p	UIC47= 5×7447N	50p	UIC82= 5×7482N	50p
UIC02=12×7402N	50p	UIC48= 5×7448N	50p	UIC83= 5×7483N	50p
UIC03=12×7303N	50p	UIC50=12×7450N	50p	UIC86= 5×7486N	50p
UIC04=12×7404N	50p	UIC51=12×7451N	50p	UIC90= 5×7490N	50p
UIC05=12×7405N	50p	UIC53=12×7453N	50p	UIC91= 5×7491N	50p
UIC10=12×7410N	50p	UIC54=12×7454N	50p	UIC92= 5×7492N	50p
UIC13= 8×7413N	50p	UIC60=12×7460N	50p	UIC93= 5×7493N	50p
UIC20=12×7420N	50p	UIC70= 8×7470N	50p	UIC94= 5×7494N	50p
UIC40=12×7440N	50p	UIC72= 8×7472N	50p	UIC95= 5×7495N	50p
UIC41= 5×7441AN	50p	UIC73= 8×7473N	50p	UIC96= 5×7496N	50p
UIC42= 5×7442N	50p	UIC74= 8×7474N	50p	UIC121=5×74121N	50p
UIC43= 5×7443N	50p	UIC75= 8×7475N	50p	UICX1=25×Asst'd 74's	£1·50
UIC44= 5×7444N	50p	UIC76= 8×7476N	50p		
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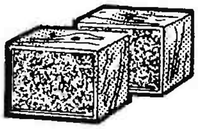
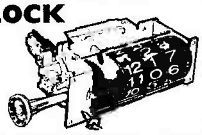


Sold in matched pairs. Each Denton contains an 8in. bass unit with 3in. pressure unit, coupled by a Wharfedale crossover network. Rated input: 18 watts maximum. Frequency response: 65-17,000 Hz. Impedance: 4/8 ohms. Cabinet 9¾in. x 14in. x 8½in.

List Price £39·90 Per Pair C&P £2·00
LASKY'S PRICE £31·00

	List Price	Lasky's Price	C&P
LINTON 2 Pair	£49·90	£38·75	£2
TRITON 3 Pair	£65·00	£51·50	£2
MELTON 2 each	£35·00	£25·50	£1
DOVEDALE 3 each	£45·00	£33·00	£1
ROSEDALE each.	£65·00	£50·00	£1
UNIT 3 each	£12·50	£9·50	50p
UNIT 4 each	£18·00	£12·50	50p
UNIT 5 each	£26·00	£18·50	50p

DIGITAL CLOCK SCOOP



EXCLUSIVELY FROM LASKYS

The lock measures 4¾ W x 1¾ H x 3¾ D (overall from front of drum to back of switch). SPEC.: 210/240V a.c. 50Hz operation; switch rating 250V, 3A. Complete with instructions. **HUNDREDS OF APPLICATIONS COMPLETE WITH KNOBS. FEATURES: ● MAINS OPERATION ● 12-HOUR ALARM ● AUTO "SLEEP" SWITCH ● HOURS, MINUTES AND SECONDS READ-OFF ● FORWARD AND BACKWARD TIME ADJUSTMENT ● SILENT OPERATION ● SHOCK AND VIBRATION PROOF ● BUILT IN ALARM BUZZER**

SPECIAL QUOTES FOR QUANTITIES **LASKYS PRICE £6·50** C&P 25p

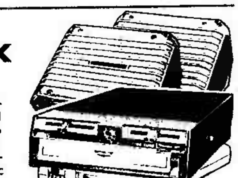
BSR TD8S

8 TRACK STEREO CARTRIDGE PLAYER

The unit is switched on and off by the insertion of the cartridge; The TD8S is suitable for use with most modern stereo amplifiers and delivers a pre-amp output of 125mW. Power requirements: 210/250V AC, 50Hz. Frequency response: 50Hz-10KHz. 4 pole dynamically balanced synchronous motor maintains unwavering speed accuracy - independent of mains fluctuations. Compact in size the TD8S is housed in black and woodgrain plastic cabinet. Size: 8½(W) x 3¾(H) x 10¼ (D) in.

List Price £24·20 LASKYS PRICE £17·95 C&P 35p

BELTEX 8 TRACK



Stereo car Player

Accepts all standard pre-recorded 8 track stereo cartridges and other features include automatic head cleaner. channel select and channel repeat push buttons, slider type volume and tone controls, channel balance control. Tech spec. max output 10W (5 watts per channel), frequency response 50Hz-10kHz. Output imp. 4 ohms. size 4¾(W) x 1⅞(H) x 6¼(D) in. Operates on 12V DC negative earth systems. Beautifully styled with black ivory and chrome trim finish.

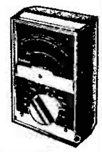
BELTEK C5700 complete with mounting brackets and 8-track pre-recorded demonstration cartridge £19·75 C&P 25p each

BELTEK C5700 8 track player complete with pair SP24 speakers £24·95

Beltek SP24 speakers are available perfectly matching the C5700 in performance and finish specially designed for optimum performance in heavily damped car interior. Size: 7¼in(W) x 6in(D) x 4¾in. rear, 2¼in front (H). Comp with connecting leads.

£5·95 Pair C&P 25p

TM-1 TEST METER

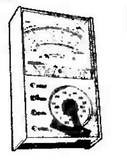


1000 ohms/volt

Lasky's new look top value TM-1 is a really tiny pocket multimeter providing "big" meter accuracy and performance. Precision movement calibrated to +3% of full scale. Click stop range selection switch. Beautifully designed and made impact resistant black case with white and metalic red/green figuring. Ohms zero adjustment. 1000's IN USE. SIZE ONLY 2 7/16 x 3 11/16 x 1 7/16 ● DC/V: 0–10–50–250–1000 at 1K/ohms/V. ● AC/V: 0–10–50–250–1000 at 1K/ohms/V. ● DC Current: 0–1mA, 100mA. ● Resistance: 0–150K ohms. ● Decibels: –10 + 22dB. ● Complete with test leads.

LASKYS PRICE £1.85 C.&P. 15p

TM-5 TEST METER



5000 ohms/volt

Another pocket multimeter from Lasky's. The "slimline" impact resistant case – size 4⅝in x 2½in x 1¼in fitted with extra large 2¾in square meter. Readability is superior on all low ranges, making this an excellent instrument for servicing transistorised equipment. Zero ohms adjustment. Buff finish with crystal clear meter cover. ● DC/V: 3–15–150–300–1,200 at 5K ohms/V. ● AC/V: 6–30–300–600 at 2·5K/ohms/V. ● DC Current: 0–300μA, 0–300mA. ● Resistance: 0–10K/ohms, 0–1M/ohms. ● Decibels: –10dB to 16dB. ● Complete with test leads, battery and instructions

LASKYS PRICE £2.55 C.&.P 35p

BSR McDONALD MP60

High precision low-mass counter-balanced pick-up arm, heavy balanced turntable, simple to operate controls, viscous cueing device, slide in cartridge carrier, 4 pole motor.

LASKYS PRICE £10.95 C.&.P. 50p

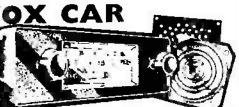
BSR McDONALD UNITS & PACKAGES

A. Chassis only. **B.** Complete with Lasky's plinth and cover. **C.** Complete with Lasky's plinth. cover and AD76K cartridge. **D.** Comp. wired on BSR plinth with cover. **E.** As D plus AD76K cartridge.

MODEL	A	B	C	D	E
MP.60	10·95	15·50	18·50	18·75	22·00
HT.70	15·90	19·90	23·50	23·75	27·00
610	14·50	18·75	23·00	22·25	25·50
510	12·10	16·50	18·85	20·00	22·85
310	9·75	14·00	16·50	17·25	20·25
MP.60 TPD2 Styrene base				17·50	21·00

210 Complete with plinth, cover & BSR cartridge **£9·95**

FANTAVOX CAR RADIO



W1/700 MW/LW

A new two waveband all transistor car radio that covers full medium and long wavebands with slide switch wave change. Large easy to grip controls. Illuminated dial with "easy to read" lining scale. Externally adjustable aerial trimmer ensures maximum output. Powerful output stage gives perfect reproduction through either one or two speakers. Operates on all 12 volt D.C. system. Negative or positive earth. Standard size 6½in (W) x 4¾in (D) x 2in (H). Black with chrome trim. Complete with speaker. baffle. leads, mounting brackets and instructions. Fully guaranteed. Complete with speaker, baffle & mounting bracket.

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STEREO 70 amplifier (cased)

List Price £75·00 **LASKY'S PRICE £55·00** C & P £1·00

LEAK TEAK CASES

Teak case for Stereo 30 or Stereo 70, please state which is required.
List Price £7·37 **LASKY'S PRICE £2·75** C & P 35p

Teak case for Stereofetic tuner only.
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Double case for 30 or 70 and stereofetic tuner.
List Price £10·37 **LASKY'S PRICE £4·95** C & P 35p

LEAK TRUSPEED TURNTABLE SYSTEM
List £69·50 **Lasky's Price £47·50 C & P £1·50**

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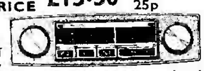
MODEL RN 214/15

RN214 is a triumph of micro-miniaturisation. So compact and light, mounted on its spindles only, it needs no real support. The RN214 can be fixed quickly and easily. **Spec:** Power supply: 13 volt D.C. negative earth operation only. Power output: 5 watts. Wave ranges: Medium wave: 185m-586m (1622-512kHz). Long wave: 1030m-2000m (290-150 kHz). Intermediate frequency: 470kHz. Size: 7in x 1·6in x 3·6in. **EN8893/05 general purpose mounting kit with loudspeaker £2·70 extra.**

List Price £19·25 **LASKYS PRICE £15·50** C.&P. 25p

Model RN 314/15



The RN314 gives you big sound because of the high sensitivity from the tuned RF stage. Due to its compact size it can be mounted without any rear support. Spec: power supply: 12V DC neg earth only. Power output: 5 watts RMS. Wave ranges: Medium 185m-585m (1622-512kHz): Long 1030m-2000m (290–150kHz). Intermediate frequency: 470kHz. Size: 7in x 1·6in x 3·6in. **EN8893/05 general purpose mounting kit with loudspeaker £2·70 extra.**

List Price £25·25 **LASKYS PRICE £21·00** C.&.P. 25p

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100 x 80 mm.

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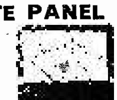
50-0-50μA	£3·45	50V. D.C.	£3·10
100μA	£3·45	300V. D.C.	£3·10
100-0-100μA	£3·35	1 amp. D.C.	£3·10
500μA	£3·20	5 amp D.C.	£3·10
1mA	£3·10	300V. A.C.	£3·10
		VU Meter	£3·75

BAKELITE PANEL METERS

TYPE S-80
80 mm.
square fronts



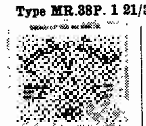
50μA	£3·20	50V. D.C.	£2·60
50-0-50μA	£3·10	300V. D.C.	£2·60
100μA	£3·10	1 amp. D.C.	£2·60
100-0-100μA	£3·00	5 amp. D.C.	£2·60
500μA	£2·75	300V. A.C.	£2·60
1mA	£2·60	VU Meter	£3·37
20V. D.C.	£2·20		

"SEW" CLEAR PLASTIC METERS

Type MR.85P. 4½in. x 4½in. fronts.

		50mA	£2·80
		100mA	£2·80
		500mA	£2·80
		1 amp.	£2·80
		5 amp.	£2·80
		15 amp.	£2·80
		30 amp.	£2·90
		20V. D.C.	£2·80
		50V. D.C.	£2·80
50μA	£3·60	150V. D.C.	£2·80
50-0-50μA	£3·10	300V. D.C.	£2·80
100μA	£3·10	15V. A.C.	£2·80
100-0-100μA	£3·00	300V. A.C.	£2·80
200μA	£3·00	S Meter 1mA	£2·87
500μA	£2·90	VU Meter	£3·60
500-0-500μA	£2·80	1 amp. A.C.*	£2·80
1mA	£2·80	5 amp. A.C.*	£2·80
1-0-1mA	£2·80	10 amp. A.C.*	£2·80
5mA	£2·80	20 amp. A.C.*	£2·80
10mA	£2·80	30 amp. A.C.*	£2·80

Type MR.38P. 1 21/32in. square fronts.



		200mA	£1·60
		300mA	£1·60
		500mA	£1·60
		750mA	£1·60
		1 amp.	£1·60
		2 amp.	£1·60
		5 amp.	£1·60
		10 amp.	£1·60
50μA	£2·10	3V. D.C.	£1·60
50-0-50μA	£1·90	10V. D.C.	£1·60
100μA	£1·90	15V. D.C.	£1·60
100-0-100μA	£1·75	20V. D.C.	£1·60
200μA	£1·75	100V. D.C.	£1·60
500μA	£1·65	150V. D.C.	£1·60
500-0-500μA	£1·60	300V. D.C.	£1·60
1mA	£1·60	500V. D.C.	£1·60
1-0-1mA	£1·60	750V. D.C.	£1·60
2mA	£1·60	15V. A.C.	£1·70
5mA	£1·60	50V. A.C.	£1·70
10mA	£1·60	150V. A.C.	£1·70
20mA	£1·60	300V. A.C.	£1·70
50mA	£1·60	500V. A.C.	£1·70
100mA	£1·60	S Meter 1mA	£1·70
150mA	£1·60	VU Meter	£2·10

Type MR.52P. 2½in. square fronts.

50μA	£3·10	10V. D.C.	£2·00
50-0-50μA	£2·60	20V. D.C.	£2·00
100μA	£2·60	50V. D.C.	£2·00
100-0-100μA	£2·50	300V. D.C.	£2·00
500μA	£2·30	15V. A.C.	£2·10
1mA	£2·00	300V. A.C.	£2·10
5mA	£2·00	S Meter 1mA	£2·10
10mA	£2·00	VU Meter	£3·20
50mA	£2·00	1 amp. A.C.*	£2·00
100mA	£2·00	5 amp. A.C.*	£2·00
500mA	£2·00	10 amp. A.C.*	£2·00
1 amp.	£2·00	20 amp. A.C.*	£2·00
5 amp.	£2·00	30 amp. A.C.*	£2·00

Type MR.45P. 2in. square fronts.

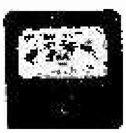
50μA	£2·25	5 amp.	£1·70
50-0-50μA	£2·10	10V. D.C.	£1·50
100μA	£2·10	20V. D.C.	£1·50
100-0-100μA	£1·87	50V. D.C.	£1·50
200μA	£1·87	300V. D.C.	£1·50
500μA	£1·75	15V. A.C.	£1·80
500-0-500μA	£1·70	300V. A.C.	£1·80
1mA	£1·70	S Meter 1mA	£1·85
5mA	£1·70	VU Meter	£2·25
10mA	£1·70	1 amp. A.C.*	£1·70
50mA	£1·70	5 amp. A.C.*	£1·70
100mA	£1·70	10 amp. A.C.*	£1·70
500mA	£1·70	20 amp. A.C.*	£1·70
1 amp.	£1·70	30 amp. A.C.*	£1·70

Type MR.65P. 3½in. x 3½in. fronts.

50μA	£3·37	10V. D.C.	£2·20
50-0-50μA	£2·75	20V. D.C.	£2·20
100μA	£2·75	50V. D.C.	£2·20
100-0-100μA	£2·65	150V. D.C.	£2·20
200μA	£2·65	300V. D.C.	£2·20
500μA	£2·40	15V. A.C.	£2·30
500-0-500μA	£2·20	50V. A.C.	£2·30
1mA	£2·20	150V. A.C.	£2·30
5mA	£2·20	300V. A.C.	£2·30
10mA	£2·20	500V. A.C.	£2·30
50mA	£2·20	S Meter 1mA	£2·37
100mA	£2·20	VU Meter	£3·37
500mA	£2·20	50mA A.C.*	£2·20
1 amp.	£2·20	100mA A.C.*	£2·20
5 amp.	£2·20	200mA A.C.*	£2·20
10 amp.	£2·20	500mA A.C.*	£2·20
15 amp.	£2·20	1 amp. A.C.*	£2·20
20 amp.	£2·20	5 amp. A.C.*	£2·20
30 amp.	£2·30	10 amp. A.C.*	£2·20
50 amp.	£2·50	20 amp. A.C.*	£2·20
5V. D.C.	£2·20	30 amp. A.C.*	£2·20

"SEW" BAKELITE PANEL METER

Type MR.65. 3½in. square fronts.



		1 amp.	£1·95
		2 amp.	£1·95
		5 amp.	£1·95
		15 amp.	£1·95
		30 amp.	£1·95
		50 amp.	£1·95
		5V. D.C.	£1·95
		10V. D.C.	£1·95
		20V. D.C.	£1·95
		50V. D.C.	£1·95
		150V. D.C.	£1·95
25μA	£3·50	300V. D.C.	£1·95
50μA	£2·75	30V. A.C.*	£1·95
50-0-50μA	£2·35	50V. A.C.*	£1·95
100μA	£2·35	150V. A.C.*	£1·95
100-0-100μA	£2·25	300V. A.C.*	£1·95
500μA	£2·20	500mA A.C.*	£1·95
1mA	£1·95	1 amp. A.C.*	£1·95
1-0-1mA	£1·95	5 amp. A.C.*	£1·95
5mA	£1·95	10 amp. A.C.*	£1·95
10mA	£1·95	20 amp. A.C.*	£1·95
50mA	£1·95	30 amp. A.C.*	£1·95
100mA	£1·95	50 amp. A.C.	£1·95
500mA	£1·95	VU Meter	£3·10

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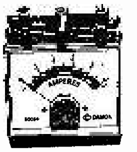

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100μA	£4·65	50V d.c.	£4·40
1mA	£4·40	300V d.c.	£4·40
50-0-50μA	£4·65		
1-0-1mA	£4·40	Dual range	
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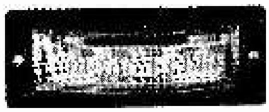
5A d.c.	£4·40	5V/50V d.c.	£4·65
10V. d.c.	£4·40		



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50-0-50μA	£3·00	1mA	£2·45
100μA	£3·00	300V. A.C.	£2·45
100-0-100μA	£2·90		
200μA	£2·90	VU Meter	£3·40

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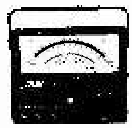
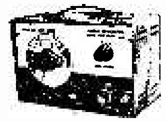


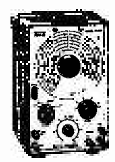
370 WTR MULTI-METER
Features A.C. current ranges. 20,000 o.p.v. 0/·5/2·5/10/50/250/500 1000 V DC. 0/2·5/10/50/250/500/1000 V AC. 0/50uA/1/10/100mA/1/10 Amp DC. 0/100mA/1/10 Amp AC 0/5K/50K/500K/5MEG/50MEG. −20 +62db. £15, P. & P. 25p.

TE22 SINE SQUARE WAVE AUDIO GENERATORS



Sine: 20cps to 200 kc/s on 4 bands. Square: 20cps to 30 kc/s. Output impedance 5,000 ohms, 200/250V. A.C. operation. Supplied brand new and guaranteed with instruction manual and leads. £17·50. Carr. 37½p.

TE-20D RF SIGNAL GENERATOR



Accurate wide range signal generator covering 120 Kc/s-500 Mc/s on 6 bands. Directly calibrated Variable R.F. attenuator, audio output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions. £15. Carr. 37½p. Size 140 × 215 × 170 mm.

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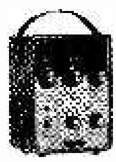
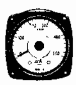


New high quality portable instrument. Sine 1 Hz to 100 kHz. Square 20 Hz to 20 kHz. Output max +10 dB (10 K ohms). Operation 220/240v. A.C. Size 215mm × 150mm × 120mm. Price £27·50. Carr. 25p.



240° Wide Angle 1mA Meters

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MW1-8 80mm square		£4·97½
	P. & P. extra	

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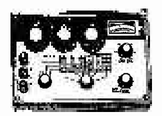

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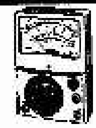

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20,000 O.P.V.
Overload protection
5/25/100/500/1000 VDC.
10/50/250/1000 VAC.
50uA/250mA. 20K/2 meg ohm. −5 to + 62db.
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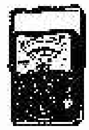
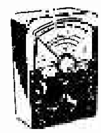
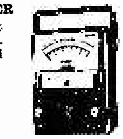
ModelS-100TRMULTIMETER/TRANSISTOR TESTER. 100,000o.p.v. mirror scale/overload protection. 0/·12/·6/3/12/30/120/600 VDC. 0/6/30/120/600 VAC. 0/12/600μA/12/300mA/12 AMP DC. 0/10 K/1MEG/100MEG. −20to+50 db. 0·01–·2 MFD. Transistor tester measures Alpha, beta and Ico. Complete with batteries, instructions and leads. £13·50. P/P 25p.





MODEL 500 30,000 O.P.V with overload protection mirror scale 0/·5/2·5/10/25 100/250/500/1,000/500. D.C 0/2·5/10/25/100/250/500/1,000V. A.C. 0/50μA/5/50/500mA. 12 amp. D.C. 0/60/K/6 Meg./60 Meg Ω. £8·87½. Post paid.

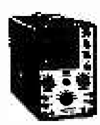
HT100B4 MULTI-METER
Features A.C. current ranges. 100,000 o.p.v. Mirror Scale, Overload protection.
0/·5/2·5/10/50/250/500/1000 V DC.
0/2·5/10/50/250/1000 V AC.
0/10/250uA/2·5/25/250 MA/10 Amp DC.
10 Amp AC. 0/20K/200K/2MEG/20 MEG. − 20 + 62 db. £12·50, P. & P. 25p.



RUSSIAN 22 RANGE MULTIMETER

Model U437 10,000 o.p.v. A first class versatile instrument manufactured in U.S.S.R. to the highest standards. Ranges: 2·5/10/50/250/500/1000v D.C. 2·5/10/50/250/500/1000v A.C. DC Current 100 wA/1/10/100mA/1A. Resistance 300 ohms/3/30/300K/3m Ω. Complete with batteries, test leads, instructions and sturdy steel carrying case. OUR PRICE £5·97 P. & P. 25p.

TO-3 PORTABLE OSCILLOSCOPE



3in. tube, Y amp. Sensitivity 0·1v p-p/CM. Bandwidth 1·5 cps–1·5 MHz. Input imp. 2 meg Ω 25pF X amp. sensitivity 0·9v. p-p/CM. Bandwidth 1·5cps –800kHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10 cps–300kHz. Synchronization. Internal/external. Illuminated scale 140 × 215 × 330 mm. Weight 15½lb. 220/240V. A.C. Supplied brand new with handbook. £40·00. Carr. 50p.

HONEYWELL DIGITAL VOLTMETER VT.100

Can be panel or bench mounted. Basic meter measures 1 volt D.C. but can be used to measure a wide range of AC and DC volt, current and ohms with optional plug in cards. Specification: Accuracy: ±0·2, ±1 digit. Resolution: 1mV. Number of digits: 3 plus fourth overrange digit. Overrange: 100% (up to 1·999). Input impedance: 1000 Meg ohm. Measuring cycle: 1 per second. Adjustment: Automatic zeroing, full scale adjustment against an internal reference voltage. Overload: to 100v. D.C. Input: Fully floating (3 poles). Input power: 110-230v. A.C. 50/60 cycles. Overall size: 5⅞in. × 2 13/16in. × 8 3/16in. AVAILABLE BRAND NEW AND FULLY GUARANTEED AT APPROX. HALF PRICE. £49·97½. Carr. 50p.

G. W. SMITH & CO (RADIO) LTD.
Also see next two pages

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ALL DEVICES BRAND NEW AND FULLY GUARANTEED

Transistors

		2N3415	22p	2N5458	35p	BC114	15p	BFW90	22p	NKT219	30p
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2G301	20p	2N3417	37p	2S102	25p	BC116	15p	BFX12	22p	NKT224	22p
2G302	20p	2N3439	130p	2S103	25p	BC118	15p	BFX13	22p	NKT225	22p
2G303	20p	2N3440	97p	2S104	25p	BC119	30p	BFX29	25p	NKT229	30p
2G306	42p	2N3564	17p	2S301	50p	BC121	20p	BFX30	25p	NKT237	35p
2G308	30p	2N3565	15p	2S302	50p	BC122	20p	BFX37	30p	NKT238	25p
2G309	30p	2N3566	22p	2S303	60p	BC125	15p	BFX44	37p	NKT240	27p
2G371	15p	2N3568	25p	2S304	75p	BC126	20p	BFX68	67p	NKT241	27p
2G374	20p	2N3569	25p	2S501	32p	BC134	12p	BFX84	25p	NKT242	20p
2G381	22p	2N3570	125p	2S502	35p	BC135	12p	BFX85	30p	NKT243	62p
2N388A	49p	2N3572	97p	2S503	27p	BC136	15p	BFX86	25p	NKT244	17p
2N404	20p	2N3605	27p	3N83	40p	BC137	15p	BFX87	25p	NKT245	20p
2N696	15p	2N3606	27p	3N128	70p	BC138	20p	BFX88	20p	NKT261	20p
2N697	15p	2N3607	22p	3N140	77p	BC140	35p	BFX89	62p	NKT262	30p
2N698	25p	2N3638	18p	3N141	72p	BC141	35p	BFX93A	70p	NKT264	20p
2N699	30p	2N3638A	20p	3N142	55p	BC147	10p	BFY11	42p	NKT271	20p
2N706	10p	2N3641	18p	3N143	67p	BC148	10p	BFY18	25p	NKT262	20p
2N706A	12p	2N3642	18p	3N152	87p	BC149	12p	BFY19	25p	NKT274	20p
2N708	15p	2N3643	20p	40050	55p	BC152	17p	BFY21	42p	NKT275	20p
2N709	62p	2N3644	25p	40250	50p	BC153	20p	BFY24	45p	NKT278	25p
2N718	25p	2N3645	25p	40251	32p	BC154	20p	BFY29	40p	NKT281	27p
2N718A	30p	2N3691	15p	40309	32p	BC157	15p	BFY30	40p	NKT401	87p
2N726	30p	2N3692	18p	40310	45p	BC158	11p	BFY41	50p	NKT402	90p
2N727	30p	2N3693	15p	40311	35p	BC159	12p	BFY43	62p	MKT403	75p
2N914	17p	2N3694	18p	40312	47p	BC160	35p	BFY50	20p	NKT404	55p
2N916	17p	2N3702	10p	40314	37p	BC167	11p	BFY51	20p	NKT405	75p
2N918	30p	2N3703	10p	40315	37p	BC168B	10p	BFY52	20p	NKT406	62p
2N929	22p	2N3704	11p	40316	47p	BC168C	11p	BFY53	15p	NKT451	62p
2N930	20p	2N3705	10p	40317	37p	BC169B	11p	BFY56A	57p	NKT452	62p
2N987	40p	2N3706	9p	40319	55p	BC169C	12p	BFY76	42p	NKT453	47p
2N1090	22p	2N3707	11p	40320	47p	BC170	12p	BFY77	57p	NKT713	20p
2N1091	22p	2N3708	7p	40323	32p	BC171	15p	BFY90	65p	NKT717	42p
2N1131	25p	2N3709	9p	40324	47p	BC172	15p	BSX19	17p	NKT734	27p
2N1132	25p	2N3710	9p	40326	37p	BC175	22p	BSX20	15p	NKT736	35p
2N1302	17p	2N3711	12p	40329	30p	BC177	20p	BSX21	20p	NKT773	25p
2N1303	17p	2N3713	187p	40344	27p	BC178	20p	BSX26	45p	NKT781	30p
2N1304	22p	2N3714	200p	40347	57p	BC179	20p	BSX27	47p	OC16	50p
2N1305	22p	2N3715	123p	40348	52p	BC182	10p	BSX28	32p	OC19	37p
2N1306	25p	2N3716	130p	40360	40p	BC182L	10p	BSX60	82p	OC20	75p
2N1307	25p	2N3773	240p	40361	40p	BC183	9p	BSX61	62p	OC22	50p
2N1308	25p	2N3791	206p	40362	50p	BC183L	9p	BSX76	15p	OC23	60p
2N1309	25p	2N3819	34p	40370	32p	BC184	11p	BSX77	20p	OC24	60p
2N1507	17p	2N3820	55p	40406	57p	BC184L	11p	BSX78	25p	OC25	40p
2N1613	20p	2N3823	50p	40407	40p	BC186	25p	BSY24	15p	OC26	25p
2N1631	35p	2N3854	27p	40408	52p	BC187	27p	BSY25	15p	OC28	60p
2N1632	30p	2N3854A	27p	40409	55p	BC212L	12p	BSY26	17p	OC29	60p
2N1637	30p	2N3855	27p	40410	62p	BC213L	12p	BSY27	15p	OC35	50p
2N1638	27p	2N3855A	30p	40412	50p	BC214L	15p	BSY28	17p	OC36	60p
2N1639	27p	2N3856	30p	40467A	57p	BCY10	27p	BSY29	17p	OC41	22p
2N1701	162p	2N3856A	35p	40468A	35p	BCY30	27p	BSY32	25p	OC42	25p
2N1711	24p	2N3858	25p	40528	72p	BCY31	30p	BSY36	25p	OC44	15p
2N1889	32p	2N3858A	30p	40600	57p	BCY32	50p	BSY37	25p	OC45	12p
2N1893	37p	2N3859	27p	40603	50p	BCY33	25p	BSY38	20p	OC46	15p
2N2147	72p	2N3859A	32p	AC107	30p	BCY34	30p	BSY39	22p	OC70	15p
2N2160	57p	2N3860	30p	AC126	20p	BCY38	40p	BSY43	50p	OC71	12p
2N2193	40p	2N3866	150p	AC127	20p	BCY39	60p	BSY51	32p	OC72	12p
2N2193A	42p	2N3877	40p	AC128	20p	BCY40	50p	BSY52	32p	OC73	30p
2N2194	27p	2N3877A	40p	AC151	18p	BCY41	15p	BSY53	37p	OC74	30p
2N2194A	30p	2N3900	37p	AC152	22p	BCY42	15p	BSY54	40p	OC75	22p
2N2217	25p	2N3900A	40p	AC154	22p	BCY43	15p	BSY56	90p	OC76	22p
2N2218	20p	2N3901	97p	AC176	20p	BCY54	32p	BSY79	45p	OC77	30p
2N2219	20p	2N3903	20p	AC187	25p	BCY58	22p	BSY90	57p	OC78	20p
2N2220	25p	2N3904	25p	AC188	25p	BCY59	22p	BSY95A	12p	OC81	20p
2N2221	25p	2N3905	80p	ACY17	27p	BCY60	97p	C424	15p	OC81D	20p
2N2222	20p	2N3906	25p	ACY18	24p	BCY70	15p	C450	15p	OC82	25p
2N2222A	25p	2N4058	12p	ACY19	24p	BCY71	20p	GET102	30p	OC82D	15p
2N2297	30p	2N4059	10p	ACY20	20p	BCY72	15p	GET113	20p	OC83	25p
2N2368	15p	2N4060	12p	ACY21	20p	BCY78	30p	GET114	20p	OC84	25p
2N2369	15p	2N4061	12p	ACY22	10p	BCY79	30p	GET118	20p	OC139	25p
2N2369A	15p	2N4062	12p	ACY28	17p	BCZ10	27p	GET120	25p	OC140	32p
2N2410	42p	2N4244	47p	ACY39	47p	BCZ11	40p	GET873	12p	OC170	25p
2N2483	27p	2N4248	15p	ACY40	20p	BD112	50p	GET880	80p	OC171	30p
2N2484	32p	2N4249	15p	ACY41	15p	BD116	112p	GET887	20p	OC200	40p
2N2539	22p	2N4250	18p	ACY44	25p	BD121	65p	GET889	22p	OC201	60p
2N2540	22p	2N4254	42p	AD140	47p	BD123	80p	GET890	22p	OC202	75p
2N2613	35p	2N4255	42p	AD149	47p	BD124	60p	GET896	22p	OC203	40p
2N2614	30p	2N4284	17p	AD150	62p	BD131	75p	GET897	22p	OC204	40p
2N2646	40p	2N4285	17p	AD161	35p	BD132	80p	GET898	22p	OC205	75p
2N2711	25p	2N4286	17p	AD162	35p	BDY10	125p	MAT100	25p	OC206	95p
2N2712	25p	2N4287	17p	AF109	45p	BDY20	105p	MAT101	25p	OC207	75p
2N2713	27p	2N4288	15p	AF114	25p	BDY61	125p	MAT120	25p	OCP71	42p
2N2714	30p	2N4289	17p	AF115	25p	BDY62	100p	MAT121	25p	ORP12	50p
2N2904	20p	2N4290	12p	AF116	25p	BF115	25p	MJ400	107p	ORP60	40p
2N2904A	25p	2N4291	15p	AF117	20p	BF117	47p	MJ420	80p	ORP61	40p
2N2905	25p	2N4292	15p	AF118	60p	BF152	28p	MJ421	80p	P346A	22p
2N2905A	20p	2N4294	17p	AF121	30p	BF154	20p	MJ430	102p	ST140	15p
2N2906	20p	2N4303	47p	AF124	22p	BF158	15p	MJ440	95p	ST141	20p
2N2906A	25p	2N4964	15p	AF125	19p	BF159	35p	MJ480	97p	TIS34	62p
2N2907	23p	2N4965	18p	AF126	19p	BF163	35p	MJ481	125p	TIS43	40p
2N2923	15p	2N5027	52p	AF127	16p	BF167	18p	MJ490	100p	TIS44	10p
2N2924	15p	2N5028	57p	AF139	28p	BF170	33p	MJ491	137p	TIS45	27p
2N2925	15p	2N5029	47p	AF178	42p	BF173	19p	MJE340	50p	TIS46	11p
2N2926G	10p	2N5030	42p	AF179	45p	BF177	30p	MJE370	80p	TIS47	11p
2N2926O	10p	2N5172	12p	AF180	50p	BF178	25p	MJE371	80p	TIS48	12p
2N2926Y	10p	2N5174	52p	AF181	40p	BF179	30p	MJE520	60p	TIS49	12p
2N3011	20p	2N5175	52p	AF186	39p	BF180	35p	MJE521	70p	TIS50	12p
2N3014	32p	2N5176	45p	AF239	80p	BF181	32p	MPF102	42p	TIS51	10p
2N3053	18p	2N5232A	30p	AF279	47p	BF182	30p	MPF103	35p	TIS52	11p
2N3054	46p	2N5245	45p	AF280	47p	BF184	20p	MPF104	37p	TIS53	22p
2N3055	60p	2N5246	42p	AFZ11	32p	BF185	20p	MPF105	37p	XB112	12p
2N3133	30p	2N5249	67p	ASY26	25p	BF194	15p	MPS3638	32p	XC141	35p
2N3134	15p	2N5265	325p	ASY27	30p	BF195	15p	NKT124	42p	ZTX107	15p
2N3135	25p	2N5305	37p	ASY28	24p	BF196	15p	NKT125	27p	ZTX108	12p
2N3136	25p	2N5306	40p	ASY29	27p	BF197	15p	NKT126	27p	ZTX109	15p
2N3390	25p	2N5307	37p	ASY50	25p	BF198	15p	NKT128	27p	ZTX300	12p
2N3391	20p	2N5308	37p	ASY51	32p	BF200	35p	NKT135	27p	ZTX301	15p
2N3391A	30p	2N5309	62p	ASY54	25p	BF224	14p	NKT137	32p	ZTX302	20p
2N3392	17p	2N5310	42p	ASY67	45p	BF225	19p	NKT210	30p	ZTX303	20p
2N3393	15p	2N5354	27p	ASY86	32p	BF237	22p	NKT211	30p	ZTX304	25p
2N3394	15p	2N5355	27p	ASZ21	51p	BF238	22p	NKT212	30p	ZTX500	15p
2N3402	22p	2N5356	32p	AUY10	150p	BF244	23p	NKT213	30p	ZTX501	15p
2N3403	22p	2N5365	47p	BC107	10p	BFW61	47p	NKT214	20p	ZTX502	20p
2N3404	32p	2N5366	32p	BC108	10p	BFW87	25p	NKT215	22p	ZTX503	17p
2N3405	45p	2N5367	57p	BC109	10p	BFW88	23p	NKT216	35p	ZTX504	40p
2N3414	22p	2N5457	30p	BC113	10p	BFW89	20p	NKT217	40p	ZTX531	25p

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CA3023	126p	FJJ121	60p	SN7474	40p
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CA3028A	74p	FJJ141	125p	SN7476	45p
CA3028B	105p	FJJ181	75p	SN7483	87p
CA3029	87p	FJJ191	65p	SN7486	33p
CA3029A	165p	FJJ211	125p	SN7490	87p
CA3030	137p	FJJ251	125p	SN7492	87p
CA3035	122p	FJL101	125p	SN7493	87p
CA3036	72p	FJY101	25p	SN7495	87p
CA3039	82p	IC10	250p	SN7496	87p
CA3041	109p	IC12	250p	SN74107	52p
CA3042	109p	L900	40p	SN74153	135p
CA3043	137p	L914	40p	SN74154	200p
CA3044	120p	L923	40p	SN74160	180p
CA3045	122p	LM380	122p	SN74161	260p
CA3046	81p	MC724P	60p	SN74164	220p
CA3047	137p	MC780P	247p	SN74165	225p
CA3048	204p	MC788P	146p	SN74192	175p
CA3049	160p	MC790P	124p	SN74193	175p
CA3050	185p	MC792P	66p	TAA241	162p
CA3051	134p	MC799P	66p	TAA242	425p
CA3052	165p	MC1303L	200p	TAA243	150p
CA3053	46p	MC1304P	225p	TAA263	75p
CA3054	109p	MC1305P	386p	TAA293	97p
CA3055	240p	MC838P	549p	TAA300	175p
CA3059	165p	MC1435P	345p	TAA310	125p
CA3064	120p	MC1552G	461p	TAA320	72p
FCH101	85p	MC1709CG	94p	TAA350	175p
FCH111	105p	MFC4000P	55p	TAA435	147p
FCH121	105p	PA222	260p	TAA521	132p
FCH131	50p	PA230	140p	TAA522	360p
FCH141	105p	PA234	92p	TAA530	495p
FCH151	105p	PA237	210p	TAA811	445p
FCH171	105p	PA246	150p	TAB101	97p
FCH181	105p	PA424	235p	TAD100	150p
FCH191	105p	PA264	190p	TAD110	150p
FCH201	130p	PA265	200p	SL403D	15 p
FCH211	180p	SN7400	20p	SL702C	147p
FCH221	180p	SN7401	20p	UA702A	280p
FCH231	150p	SN7402	20p	UA702C	77p
FCJ101	160p	SN7403	20p	UA703C	137p
FCJ111	150p	SN7404	20p	UA709C	45p
FCJ121	275p	SN7405	20p	UA710C	125p
FCJ131	275p	SN7406	80p	UA716	187p
FCJ141	525p	SN7408	20p	UA723C	100p
FCJ201	100p	SN7409	20p	UA730C	160p
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600 PIV 1A	50p	50 PIV 4A	40p
50 PIV 2A	45p	100 PIV 4A	50p
100 PIV 2A	50p	200 PIV 4A	55p
200 PIV 2A	55p	400 PIV 4A	65p
400 PIV 2A	60p	600 PIV 4A	70p
		50 PIV 6A	45p
		100 PIV 6A	55p
		200 PIV 6A	65p
		400 PIV 6A	75p
		600 PIV 6A	85p

SILICON RECTIFIERS MINIATURE WIRE ENDED PLASTIC

SERIES	IN 1 AMP	PL 1·5 AMP	CL 3 AMP
4001 50PIV	7p	8p	19p
4002 100PIV	7p	9p	20p
4003 200PIV	8p	10p	22p
4004 400PIV	8p	10p	25p
4005 600PIV	10p	12p	26p
4006 800PIV	12p	15p	27p
4007 1000PIV	15p	16p	30p

50 + less 15% 100 + less 20%

SILICON RECTIFIERS STUD MOUNTING

	6A	10A	17·5A	35A
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200PIV	25p	50p	55p	£1·42
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50 + less 15% 100 + less 20%

ZENER DIODES

400MW	1·5 WATT	10 WATT
3·3-33 V	2·4—100	3·9—100V
10p each	25p each	40p each

25 + less 15% 100 + less 20%

TRANSISTOR DISCOUNTS:- 12 + 10%; 25 + 15%; 100 + 20% any one type. Postage on all Semi Conductors 7p extra.
S.A.E. FOR FULL LISTS.

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IR5	40p	30C17	90p	EM85	£1·00
IS5	30p	30C18	80p	EM87	70p
IT4	25p	30F5	85p	EY51	40p
IU4	30p	30FL1	75p	EY86	40p
IU5	60p	30FL12	120p	EY87	42p
2D21	35p	30FL14	95p	EZ40	55p
3Q4	50p	30L15	85p	EZ41	50p
3S4	35p	30L17	80p	EZ80	27p
3V4	48p	30P12	80p	EZ81	29p
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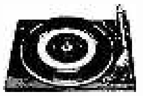

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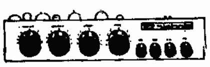

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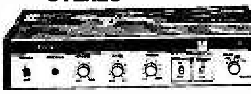

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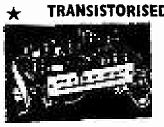

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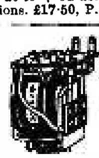

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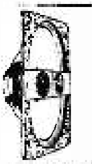

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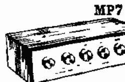

5 microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. 9½" × 5" × 3". Inputs Mics: 3 × 3mV 50K; 2 × 3mV 600 ohm. Phono meg. 4mV 50K. Phono ceramic 100mV 1 meg. Output 250mV 100K.
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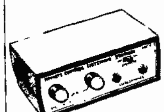

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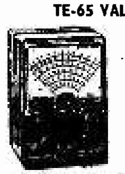

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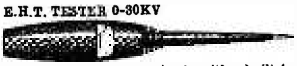

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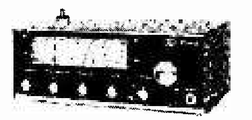

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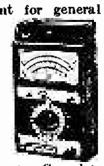

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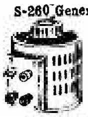

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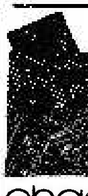

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OC41	0·15	AD149	0·30
OC44	0·13	AUY10	1·25
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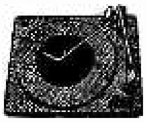

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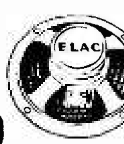

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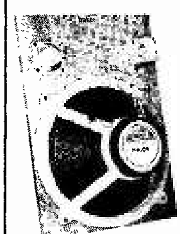

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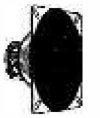

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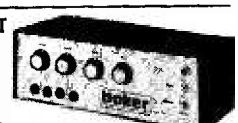

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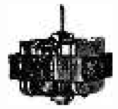

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2 x Duo Type II speakers	£14·00+£2 p&p
Garrard SP25 Mk. III with MAG. cartridge plinth and cover	£23·00+£1·50 p&p
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SPEAKERS Duo Type II
Size approx. 17" x 10¾" x 6¾". Drive unit 13" x 8" with parasitic tweeter. Max. power 10 watts, 3 ohms. Simulated Teak cabinet.
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SPECIFICATION R101
14 watts per channel into 3 to 4 ohms. Total distortion @ 10W @ 1kHz 0·1%. *P.U.1* (for ceramic cartridges) 150mV into 3 Meg. *P.U.2* (for magnetic cartridges) 4mV @ 1kHz into 47K. equalised within ±1dB R.I.A.A. *Radio* 150mV into 220K. (Sensitivities given at full power). Tape out facilities: headphone socket, power out 250mW per channel. *Tone controls and filter characteristics.* Bass: +12dB to −17dB @ 60Hz. Bass filter: 6dB per octave cut. Treble control: treble +12dB to −12dB @ 15kHz. Treble filter: 12dB per octave. *Signal to noise ratio:* (all controls at max) R101—P.U.1 and radio—65dB. P.U.2 −58dB. **R100** same as R101 but P.U.2 (for crystal cartridges) 450mV into 3 Meg. *Cross talk* better than −35dB on all inputs. *Overload characteristics* better than 26dB on all inputs. Size approx 13¾" x 9" x 3¾".

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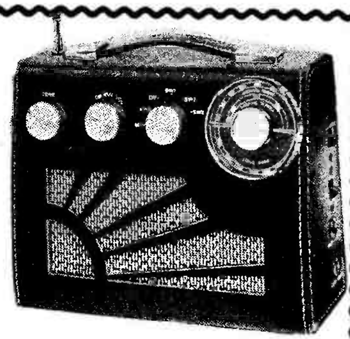

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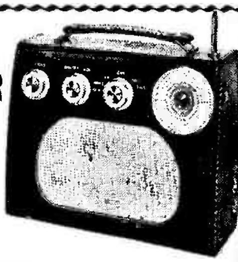

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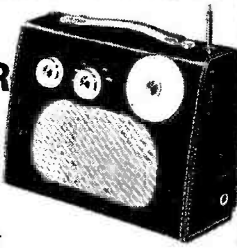

ROAMER SEVEN MK IV

7 Tunable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Extra Medium waveband provides easier tuning of Radio Luxembourg, etc. Built in ferrite rod aerial for MW and LW. Retractable 4 section 24in. chrome plated telescopic aerial for SW. Socket for Car Aerial. Powerful push-pull output. 7 transistors and 2 diodes, including Micro-Alloy R.F. Transistors. 8" × 2½" speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning and wave change controls. Attractive case with carrying handle. Size 9 × 7 × 4in. approx. Easy to follow instructions and diagrams. Parts price list and easy build plans 15p (FREE with parts). Earpiece with plug and switched socket for private listening, 30p extra.

Total building costs £5·98 P. P.& Ins. 41p.
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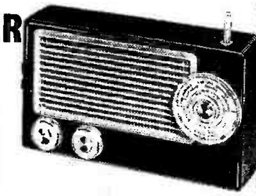

ROAMER SIX

6 Tunable Wavebands: MW, LW, SW1, SW2, Trawler band plus an extra M.W. band for easier tuning of Luxembourg etc. Sensitive ferrite rod aerial and telescopic aerial for Short Waves. 3in. Speaker. 8 stages—6 transistors and 2 diodes including Micro-Alloy R.F. Transistors, etc. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2⅞in. approx. Easy build plans and parts price list 15p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

Total building costs £3·98 P. P. & Ins. 26p
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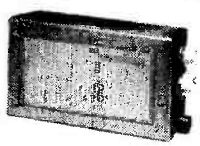
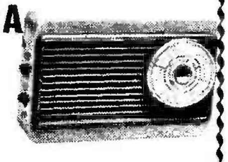


POCKET FIVE

3 Tunable Wavebands: MW, LW, Trawler Band with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker. Attractive black and gold case. Size 5½ × 1½ × 3½in. Easy build plans and parts price list 10p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

Total building costs £2·23 P. P. & Ins. 21p
(Overseas P. & P. 63p)

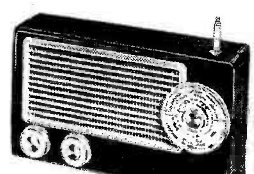


TRANSONA FIVE

5 TRANSISTORS AND 2 DIODES

3 Tunable Wavebands: MW, LW and Trawler Band. 7 stage—5 transistors and 2 diodes, ferrite rod aerial. tuning condenser volume control, fine tone moving coil speaker. Attractive case with red speaker grille. Size 6½ × 4½ × 1½in. Easy build plans and parts price list 10p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

Total building costs £2·50 P. P. & Ins. 22p
(Overseas P. & P. 63p)



TRANS EIGHT

8 TRANSISTORS and 3 DIODES

6 Tunable Wavebands: MW, LW, SW1, SW2, SW3 and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. 3in. Speaker. 8 improved type transistors plus 3 diodes. Attractive case in black with red grille, dial and black knobs with polished metal inserts. Size 9 × 5½ × 2⅛in. approx. Push pull output. Battery economiser switch for extended battery life. Ample power to drive a larger speaker. Parts price list and easy build plans 25p (FREE with parts). Earpiece with plug and switched socket for private listening 30p extra.

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NEW LOW

STEREO AMPLIFIERS

STEREO AMPLIFIERS	Rec. Retail Price	Comet Price
ALBA UA 700	37·93	24·95
ALPHA 212 By Highgate	37·75	25·95
AMSTRAD Stereo 8000 Mk 2	27·95	14·95
AMSTRAD I.C. 2000	42·95	27·50
ARMSTRONG 521	59·00	44·95
DULCI 207	26·00	16·50
DULCI 207M	32·00	19·50
FERROGRAPH F307 Mk. II (cased)	64·00	46·95
FERROGRAPH F307 MII (Metal case)	60·00	42·95
GOODMANS Maxamp	54·00	34·95
LEAK Delta 30 (cased)	65·00	48·25
LEAK Delta 70 (cased)	79·50	58·95
METROSOUND ST20E	39·50	24·95
METROSOUND ST60	70·00	46·25
PHILIPS RH 591	79·00	53·95
PHILIPS RH 590	52·00	35·50
PHILIPS RH 580	29·00	19·95
PIONEER SA500A	58·78	39·95
PIONEER SA600	89·60	58·95
PIONEER SA800	119·85	75·95
PIONEER SA900	133·83	90·95
PIONEER SA1000	147·83	95·95
PIONEER QL600 Quadraphonic con.	94·43	65·55
PIONEER Reverberation 202W	51·05	34·95
RANK Rotel 210	34·90	24·95
RANK Rotel 310	47·50	32·95
RANK Rotel 610	74·50	49·50
ROGERS Ravensbourne	64·50	45·50
ROGERS Ravensbourne (cased)	69·50	49·50
ROGERS Ravensbrook Mk. II	50·50	35·95
ROGERS Ravensbrook (cased) Mk.II	55·50	39·95
SINCLAIR 2000	35·00	24·25
SINCLAIR Project 60/2 x Z30/PZ5	23·90	15·95
SINCLAIR PROJECT 60/2 x Z50/PZ8/trans	34·86	21·95
SINCLAIR PROJECT 605	29·95	20·25
SINCLAIR AFU	5·98	4·25
SINCLAIR Neoteric	61·95	42·93
SINCLAIR 3000	45·00	29·50
TELETON SAQ 206	33·00	19·50
TELETON 307	33·00	20·95
WHARFEDALE Linton Amplifier	60·00	42·95
TELETON GA202 15 watt RMS P.Chan.	Spec Price	28·50

All take both ceramic and magnetic cartridges.

TUNERS

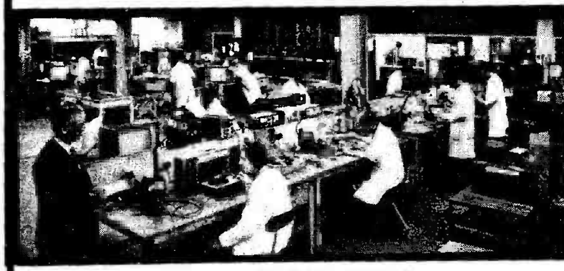
TUNERS	Rec. Retail Price	Comet Price
*ARMSTRONG 523 AM/FM	52·68	39·50
*ARMSTRONG 524 FM	40·97	30·95
ARMSTRONG M8 Decoder	9·50	6·95
*DULCI FMT.7 FM	24·43	17·50
DULCI FMT.7S Stereo	32·89	24·50
GOODMANS Stereomax	75·74	46·95
LEAK Delta FM	73·00	53·95
LEAK Delta AM/FM	87·00	65·95
PHILIPS RH 690	44·15	33·50
PHILIPS RH 691	83·40	67·25
PIONEER TX500 AM/FM	70·93	52·50
PIONEER TX600 AM/FM	100·37	77·95
RANK ROTEL 320	53·38	38·50
ROGERS Ravensbourne chassis	57·95	42·50
ROGERS Ravensbourne in teak case	62·63	47·25
ROGERS Ravensbrook chassis	42·14	31·25
ROGERS Ravensbrook (cased)	48·00	35·25
SINCLAIR 2000	45·00	33·50
SINCLAIR 3000	45·00	34·25
SINCLAIR Project 60 tuner (stereo)	25·00	19·95

All above Tuners are complete with MPX Stereo Decoder except where starred.

TUNER/AMPLIFIERS

TUNER/AMPLIFIERS	Rec. Retail Price	Comet Price
AKAI AA 8500	228·34	169·95
AKAI 6600	145·26	105·50
AKAI 6300	125·83	92·50
AKAI 6200	97·09	72·50
ARENA 2600	111·30	59·95
ARMSTRONG M8 Decoder	9·50	6·95
ARMSTRONG 525	90·14	67·95
ARMSTRONG 526	102·72	77·50
GOODMANS Module 80, 35w. RMS	89·02	67·75
GOODMANS Module 80 Compact	160·38	125·95
GOODMANS Module 110 FM/MW/LW/SW 100W RMS	131·22	104·95
LEAK Delta 75	160·00	127·95
MIDLAND 19/542	49·56	36·75
PHILIPS RH 790	134·00	74·95
PIONEER SX770 AM/FM	135·80	104·95
PIONEER SX440 AM/FM	101·60	79·95
ROGERS Ravensbrook Chassis	96·57	77·95
ROGERS Ravensbrook (cased)	105·35	82·95
ROTEL RX150	67·93	51·95
TANDBERG 1171 MPX	103·03	84·95
TANDBERG TR200 MPX	96·23	79·95
TELETON F2000	51·50	27·25
TELETON CR55	125·26	68·50
TELETON R8000 AM/FM	42·16	21·95

All the above Tuners and Tuner/Amplifiers take both ceramic and magnetic cartridges except Teleton F2000, 8000 which take ceramic only. All include MPX Stereo Decoder with the exception of Armstrong where decoder is extra as listed.



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CARTRIDGES

CARTRIDGES	Rec. Retail Price	Comet Price
AUDIO TECHNICA AT66	6·47	4·20
GOLDRING G850	6·10	3·45
GOLDRING G800	12·21	5·80
GOLDRING G800E	17·67	9·70
GOLDRING G800 Super E	24·41	14·40
*GOLDRING CS90 Stereo	4·88	4·20
*GOLDRING CS91/E	7·33	6·20
EMPIRE 1000ZE/X	59·12	45·95
EMPIRE 999VE/X	42·14	33·25
EMPIRE 999TE/X	24·58	19·50
EMPIRE 999SE/X	19·90	15·60
EMPIRE 999E/X	15·57	11·70
EMPIRE 909E/X	12·12	9·40
EMPIRE 90EE/X	9·37	7·15
ORBIT Magnetic NM 22	SpecPrice	2·85
ORTOFON M15E	27·60	22·95
SHURE M3DM	6·10	4·20
SHURE M31E	11·63	8·50
SHURE M32E	10·73	7·85
SHURE M32-3	9·84	7·65
SHURE M44-5	8·30	5·65
SHURE M44-G	8·30	5·65
SHURE M44-7	7·90	5·40
SHURE M-44G	7·90	5·40
SHURE M44E	8·60	5·80
SHURE M55E	9·70	6·60
SHURE M75G	14·70	9·70
SHURE M75-6	13·60	8·25
SHURE M75EJ	15·40	10·50
SHURE M75E	19·00	12·70
SHURE M75E/95G	20·80	14·60
SHURE V15-11	39·40	26·95
SONOTONE 9TAHC Diam/Saph.	3·75	1·95

Starred cartridges above are ceramic. All others are magnetic.

PICKUP ARMS

PICKUP ARMS	Rec. Retail Price	Comet Price
GOLDRING Lenco 75	13·51	9·30
GOLDRING Lenco L69	9·77	6·40
SME 3009 with S2 Shell	32·34	24·50
SME 3012 with S2 Shell	34·44	26·50

TURNTABLES

The following Turntables are complete with base, plinth, perspex cover and cartridge. Fully wired and ready for use. All at special prices.

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GARRARD AP76 with Goldring G800 Special Price £29·90

GARRARD AP76 with Shure M55E Special Price £32·95

GARRARD AP76 with Shure M75EJ Special Price £34·95

GARRARD 2025 with Sonotone 9TAHC Special Price £13·90

GOLDRING 705/P with G850 £26·00 £10·95

GOLDRING GL75 with G800 Special Price £39·95

THORENS 150 AB complete with TX11 cover Shure M55E cartridge £60·46 £47·95

Turntables	Rec. Retail Price	Comet Price
GARRARD SP25 Mk III	16·17	10·25
GARRARD SL65 B	20·93	13·95
GARRARD SL95 B	49·21	32·75
GARRARD 401	39·04	27·50
GARRARD SL72 B	32·60	22·95
GARRARD Zero 100A	57·42	39·95
GARRARD Zero 100S	52·83	38·95
GARRARD WB4 base Mk IIZ to fit Zero 100 & Zero 100S	6·55	4·95
Base and Cover to fit GARRARD AP25, SL55, SL65B	Special Price	3·60
GARRARD 40B	13·63	10·95
GARRARD AP76	28·44	19·50
GOLDRING GL69 Mk.II	26·86	18·50
GOLDRING GL69P Mk. II	35·23	25·25
GOLDRING GL75	39·06	28·25
GOLDRING GL75P	47·43	35·25
GOLDRING Covers for 69P and 72P	4·36	3·75
Cover for 75P Deluxe	4·88	3·95
GOLDRING C99—plinth and cover for G99	10·75	9·75
GOLDRING G99	27·90	19·50
GOLDRING G101P/C	27·90	22·50
GOLDRING GL72 Chassis	27·90	20·95
GOLDRING GL72P	36·27	29·25
GOLDRING GL85	61·03	46·50
GOLDRING GL85P	70·80	54·75
LEAK Delta	67·50	54·75
McDONALD MP60	14·80	10·25
McDONALD 610	18·79	14·50
McDONALD HT70	20·68	15·25
McDONALD HT70 inc. plinth & cov.	29·89	22·50
Base and Cover for MP60 and 610	Spec Price	3·95
PHILIPS 202 Electronic	64·65	51·75
PHILIPS 308 transcription unit complete with base and cover	36·55	28·25
PIONEER PL12AC with base & cover	47·15	36·25
THORENS TX25 cover	8·26	6·60
THORENS TD125	73·78	58·25
THORENS TD125AB	112·14	91·95
THORENS TD150 Mk. II	33·64	28·25
THORENS TD150A Mk. II	43·09	33·50
THORENS TD150AB Mk. II	46·63	38·25
THORENS TX11 Cover	4·13	3·75
WHARFEDALE Linton with base and cover and Shure M44/7 cart.	34·50	27·25

SPEAKERS

SPEAKERS	Rec. Retail Price	Comet Price
AMSTRAD 138 (pair) 13"×8" twin cone teak	26·00	15·95
AKAI SW 155	59·50	39·95
B & W Model 70	159·50	111·95
B & W DM2	62·50	51·95
B & W DM3	63·00	47·95
B. & W DM1 (pair)	75·20	59·95
CELESTION COUNTY	23·97	19·50
CELESTION Ditton 120 (pair)	56·40	42·95
CELESTION Ditton 15	37·60	26·50
CELESTION Ditton 25	65·00	44·95
CELESTION Ditton 44	54·00	39·95
CELESTION Ditton 66	99·00	74·95
GOODMANS Minister (pair)	46·86	36·95
GOODMANS Havant (pair)	54·42	42·95
GOODMANS Magister	65·63	41·95
GOODMANS Double Maxim	32·07	25·25
GOODMANS Mezzo 3	35·70	23·95
GOODMANS Magnum K2	46·20	30·95
GOODMANS Dimension 8	72·44	49·95
GOODMANS DIN 20NT kit	12·19	9·70
KELETRON KN400 2-speaker System (pair)	15·86	12·50
KN600 3-speaker System (pair)	26·46	17·50
KN800 3-speaker System	15·90	10·25
KN1100 4-speaker System	20·40	13·95
KN1600 3-speaker System	25·20	15·95
KN2100 3-speaker System	30·60	20·45
LEAK 150 (pair)	49·00	37·00
LEAK 250 (pair)	63·00	46·50
LEAK 600	49·50	34·50
METROSOUND HFS 103 (pair)	29·21	23·50
METROSOUND 202	21·50	15·25
METROSOUND Duplex 15	32·00	23·95
METROSOUND Duplex 25	52·00	36·95
PHILIPS RH 411 (pair)	20·60	16·10
PHILIPS RH 402 (pair)	44·70	27·20
PHILIPS 406	34·00	28·20
SINCLAIR Q16	8·98	6·95
STE-MA 450	25·00	16·95
TANDBERG TAN 7	27·22	23·40
TANDBERG Tan 11 (pair)	36·94	31·20
TANDBERG Tan 12 teak (pair)	48·82	43·83
TANDBERG Tan 25 teak (pair)	66·08	56·50
TANDBERG Tan 50 teak	65·00	49·95

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WHARFEDALE Speakers		
Denton Mark II (pair)	39·00	29·50
Linton Mark II (pair)	49·00	37·50
Melton Mark II	35·00	24·45
Dovedale 3 Mark I I	45·00	30·50
Rosedale	65·00	44·95
Triton (III) (pair)	63·00	50·95
Unit 3 Speaker Kit	12·00	9·25
Unit 4 Speaker Kit	18·00	11·95
Unit 5 Speaker Kit	26·00	17·50
CHASSIS SPEAKERS		
GOODMANS Twin-Axiom 8	8·65	7·10
GOODMANS Twin Axiom 10	9·58	7·75
GOODMANS Axiom 401	17·68	12·25
GOODMANS Audiom 8P	5·20	4·15
GOODMANS Audiom 10P	5·67	4·70
GOODMANS Audiom 12P	13·00	9·90
GOODMANS Audiom 15P	21·00	15·75
GOODMANS Audiom 18P	35·70	25·95
GOODMANS Axiom 100 40 watts din	12·00	9·50
GOODMANS ARU 172	4·50	3·20
GOODMANS Axent 100	6·90	4·90
GOODMANS Midax 650	13·59	9·30
GOODMANS Attenuator	3·73	2·70
GOODMANS Crossover Network XO/950	7·77	5·25
WHARFEDALE 8in.Bronze/RS/DD	4·50	3·40
WHARFEDALE Super 8/RS/DD	8·00	6·60
WHARFEDALE Super 10/RS/DD	13·00	11·00
WHARFEDALE WMT1 Matching Transformer	0·84	0·70
HI-FI STEREO SYSTEMS COMPLETE		
ALBA UA552	47·75	34·65
AMSTRAD Stereo 1000	48·00	33·95
DANSETTE Consort Stereo	34·43	24·95
DECCA Sound 613	Special Price	53·95
DECCA Sound 614	Special Price	57·95
DECCA Sound 1204	Special Price	76·95
DECCA Compact 3	Special Price	102·35
DECCA 403	Special Price	47·75
ELIZABETHAN LZ101	58·33	41·85
FERGUSON 3450 with Radio	70·45	5[illegible]·95
FERGUSON 3451 with Radio	96·80	76·95
FIDELITY UA2 Music Master	44·50	33·95
FIDELITY UA1 Music Master with Radio	107·00	78·95
FIDELITY stereo nine	38·50	24·95
GOODMANS Module 80 compact system FM/35 watts. RMS (Less L/S)	165·00	125·75
HMV 2404/5/6 with Radio	194·40	159·00
HMV 2451	115·95	89·95
HMV 2452	63·90	49·95
HMV 2450 with Stereo Radio	130·60	103·00
KB1025 with 657 speakers	49·50	37·95
MURPHY 902 Studio 1, AM/VHF Radio	86·84	65·95
MARCONI 4452	73·95	56·50
PHILCO FORD M1500	97·96	66·75
PHILIPS 808	93·50	71·95
PHILIPS GF824	65·30	49·65
PYE black box unit stereo 1022	90·93	68·25
RIGONDA party time	27·50	21·95
STEEPLETONE stereo system	41·75	31·95
TELETON STP 8 track stereo system	57·50	38·95
ULTRA 6026	36·10	29·95
TAPE RECORDERS AND TAPE DECKS		
AKAI 1720L 4-track Stereo	87·36	66·25
AKAI 4000D 4-track stereo deck	93·65	60·45
AKAI CR80D 8-track stereo tape deck	85·02	58·45
AKAI CR80 8-track stereo recorder	106·39	74·00
AKAI X200D	157·93	100·45
AKAI 1800SD	162·79	102·35
AKAI 2000SD	289·07	223·30

	Rec. Retail Price	Comet Price
AKAI GXC 40D Cassette Tape Deck	92·26	68·25
AKAI GXC 40 Cassette recorder	111·75	83·85
BUSH Discassette DC70	20·62	16·55
BUSH TP 66 Batt./Mains Cassette Recorder	28·18	21·95
BUSH TP70 Cassette, battery/mains tape recorder	28·13	21·95
EKCO 350 Battery/Mains Cassette VHF/MW Radio	37·42	28·75
EKCO 351 Battery/Mains Cassette	23·23	18·45
FERGUSON 3245 Twin track	36·70	25·95
FERGUSON 3246 4-track	42·55	30·95
FERGUSON 3247 4-track	47·95	34·95
FERGUSON 3248 4-track	53·75	39·95
FERGUSON 3252 4-track	100·52	74·95
FERGUSON 3253	43·55	31·95
FERGUSON 3258 4-track	72·40	53·95
FERGUSON 3262	30·15	23·95
FERROGRAPH 702 2-track tape deck	224·43	170·65
FERROGRAPH 704/W 4-track tape deck	224·43	170·65
FERROGRAPH 722	224·43	190·15
FERROGRAPH 724	262·03	190·15
GRUNDIG C200 De Luxe Cassette	37·55	27·95
GRUNDIG TK 121 twin track	56·25	39·95
GRUNDIG TK 141 4-track	62·10	45·75
GRUNDIG TK 146 4-track Auto	66·95	49·95
GRUNDIG TK 147 4-track Auto	93·05	71·95
GRUNDIG C410 Cassette recorder	42·50	32·95
PHILIPS R.R. 392 MW/VHF Radio and Cassette Recorder	49·95	36·55
PHILIPS 2204 cassette, battery/mains	29·10	22·90
PHILIPS 2202 cassette	49·95	36·55
PHILIPS 3302 cassette	20·35	15·95
PHILIPS 4307 4-track	48·65	34·95
PHILIPS 4308 De luxe 4-track	56·85	41·45
PHILIPS 4404 4-track stereo recorder	89·25	65·95
PHILIPS 4407 4-track stereo recorder	108·50	81·85
PHILIPS 4500 4-track stereo tape deck	124·30	91·65
PHILIPS 4408 4-track stereo	130·60	98·95
PHILIPS 2503 Cassette Stereo tape deck	52·05	42·95
PHILIPS 2400 stereo cassette less L/S	66·10	51·95
PYE 9109 cassette	20·37	18·45
PYE 9116 Stereo cassette	66·10	60·95
PYE 9118	29·11	22·95
TANDBERG 1841 4-track stereo tape deck	66·09	48·75
TANDBERG 3021X twin track stereo	104·00	80·85
TANDBERG 3041X 4-track stereo	104·00	80·85
TANDBERG 4021X twin track stereo	174·00	135·50
TANDBERG 4041X 4-track stereo	174·00	135·50
TANDBERG 6041X 4-track stereo	188·00	145·25
TANDBERG 6021X twin track stereo	188·00	145·25
TELETON TC110 cassette battery/mains	26·76	18·50
TELETON TRC 130 cassette with VHF/AM radio battery/mains	41·32	28·00
WHARFEDALE Dolby DC9 cassette stereo tape deck	107·50	87·75
BASES AND COVERS		
GARRARD WB1 Base	3·78	3·20
GARRARD WB4 Base	5·60	4·70
GARRARD SPC1 Cover	3·68	2·90
GARRARD SPC4 Cover	4·38	3·50
Special offer of Base and Cover to fit GARRARD SP25, SL55, SL65B and 3500	Special Price	3·60
GARRARD WB4 base Mk IIZ to fit Zero 100 & Zero 100S	6·55	4·95
GOLDRING Plinth 75	8·37	7·00
GOLDRING Plinth 69	8·37	7·00
GOLDRING Covers for 69P and 72P	4·36	3·75
Cover for 75P De luxe	4·88	3·95
THORENS TX25 (for TD125AB)	8·26	6·60
THORENS TX11 Cover	4·13	3·75
Base and Cover for TD 125	12·39	10·50
SME Plint System 2000 with motor-board	46·20	37·00
MOTORBOARDS only	5·85	3·95

COMPLETE HI-FI SYSTEMS

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GOODMANS AUDIO SUITE, Goodmans Maxamp stereo amplifier. Goodmans stereomax AM/FM Tuner with decoder. Pair of Goodmans Magnum K2 speakers, Garrard AP76 turntable in base, complete with cover and Goldring G800 Cartridge. Beautifully finished in walnut	251·80	182·95
THORENS TD 150AB Mk. II with TX11 dust cover, SHURE M55E Cartridge. LEAK Delta 70 Amplifier, 2 Wharfedale Dovedale 3 Speakers	229·96	174·95
PHILIPS 790 tuner/amp 20 watts RMS per channel. FM/MW/LW/SW & Stereo decoder. Electronic touch tuning. Goldring G175 turntable on plinth with cover and G800 magnetic cartridge, fully wired. 2 Mezzo III speakers	269·19	158·95
GARRARD AP76 with base cover and Shure M55E cartridge Arena 2600 AM/FM and SW Tuner/Amp and 2 Goodmans Havant speakers	214·95	133·95
GOODMANS Module 80 Tuner/Amplifier, Garrard AP76 Turntable with Goldring G800 Cartridge and 2 Goodmans Havant Speakers	192·97	138·95
LEAK Delta 30 amp in teak case. 15 watts RMS channel. Garrard AP76 transcription deck with plinth, cover & G800 magnetic cartridge, fully wired. 2 Ditton 15 speakers	189·36	126·95
LINTON System with Wharfedale Linton Amplifier, Linton Turntable with Shure M44-7 Cartridge and pair of Linton Mk II Speakers	143·50	106·95
AMSTRAD I.C. 2000 integrated circuit 20 watts RMS into 8 ohms per channel amp., Garrard SP 25 turntable with plinth, cover & Goldring G800 magnetic cartridge, fully wired. 2 Wharfedale Denton Speakers	114·95	74·50
AMSTRAD 8000 Mk. II Amplifier, 7 watts RMS per channel. Garrard SP25 with G800 cartridge including base, plinth and cover and pair of Amstrad 138 13" × 8" twin cone teak finish speakers	86·95	48·50
GOLDRING 705P Turntable, fully wired complete with Goldring 850 cartridge. Amstrad stereo 8000 amplifier and 2 Amstrad 138, 13" x 8" twin cone speakers	79·95	39·95

Complete Price List FREE on request!

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PRACTICAL WIRELESS

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JUNE 1972

All the Winners!

BY a unanimous decision, the panel of judges, comprising the Editor and editorial staff of P.W., selected as the winner of the Project Autumn competition the following article:

1. **Digital Frequency Counter/Timer,** by J. Thornton-Lawrence (September-December 1971).

Congratulations are therefore due to author John Thornton-Lawrence for the design, construction and preparation of his most successful project since he started writing for us. Apart from the opinion of the judges, the Digital Frequency Counter/Timer has enjoyed a great success with readers, as confirmed by correspondence. John will soon be travelling to London to officially receive the Designer's Trophy and we hope that he has cleared a prominent space on the sideboard to display the cup!

The selection of runners-up was more difficult. There were twelve nominations to be considered and placed in order of merit. In the event, these were the articles selected:

2. **Linear Ohmmeter,** J. N. Watt (Sept. 71)
3. **Quality Hi-fi System,** C. R. Bradley (Feb.-April 72)
4. **Gate Dip Oscillator,** B. Wood (February 72)
5. **Cube Radio,** R. F. Graham (March 72)
6. **Modular Audio Mixing System,** F. C. Judd (Oct.-Dec. 71)

While congratulating the runners-up, we must also offer our sympathy to the several authors who very nearly squeezed into the final list—some by a very narrow margin.

As mentioned last month, and detailed elsewhere in this issue, our next writer's competition is restricted to those who have never written for P.W. before. This should provide a keen incentive to readers who have hitherto felt that the opposition might be too strong!

We will, of course, continue to publish articles by our established authors, but they will not be eligible for the competition itself. In this way, if we achieve nothing else, it will be seen that the pages of P.W. are open to anyone producing the right kind of material. A study of the winning articles in the last competition will be helpful in assessing chances and will also show that a long and complex article is not necessarily the route to a prize. And for new writers who need a little guidance on preparing articles for publication, some handy notes are available from this office on request. Now it is up to you!

W. N. STEVENS—*Editor.*

NEWS AND COMMENT

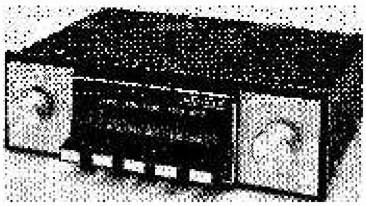
CONSTRUCTIONAL

OTHER FEATURES

JULY ISSUE WILL BE PUBLISHED ON JUNE 2nd

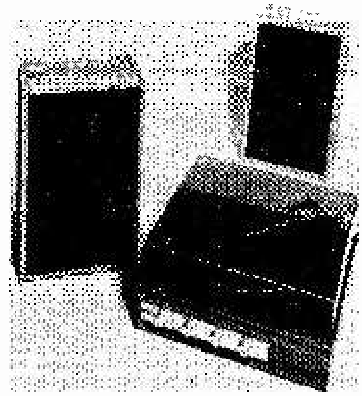
NEWS... NEWS... NEWS...

Push-button wonder



It's a "wonder" because it's a push-button car radio in kit form retailing for only £7! Step-by-step assembly instructions are provided with the kit, and the manufacturers, Radio & TV Components Limited, maintain that anyone with a little experience in wielding a soldering iron can complete the unit in an evening—or if you go to bed very early, two evenings! An integrated circuit and a printed circuit board simplify construction and cut down the number of components to be soldered. The "Tourist" car radio, as it has been called, features five push buttons which can be tuned to four preset medium wave stations. The fifth button is for use on long wave. Spun aluminium knobs are used and the tuning scale is illuminated.

Permeability tuning is employed and r.f. sensitivity is said to be better than 15μV at 1MHz. Power output into an 8Ω speaker is better than 2·5W. The i.f. module and the tuner are pre-aligned and

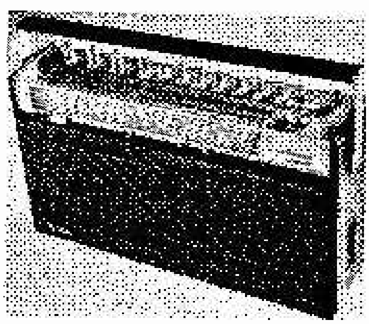


the kit is suitable for 12V positive or negative operation.

Also announced by Radio & TV Components is the £25 stereo system designated Unisound 505. This comprises pre-assembled units which can be wired together in about an hour by means of a screwdriver (no soldering iron being needed). Basically the units used in this system are the Mullard Unilex modules modified by the addition of ATES integrated circuits on the amplifier output stages to provide increased output. The turntable supplied is a Garrard 2025 TC and speakers are dual cone 13×in. elipticals in kit form, manufactured by EMI.

Further information on both of these units may be obtained from *Radio & TV Components, (Acton) Limited, 21 High Street, Acton, London, W.3.*

Saba radio



One receiver in the new Saba range is the Transeuropa Automatic G Radio mains/battery/car portable radio. Waveband ranges are: f.m. 87·5MHz-104MHz, SW1 6·8MHz-18·9MHz, SW2 15MHz-15·5MHz, SW3 5·9MHz-6·23MHz, SW4 2·8MHz-7·5MHz, MW1 510kHz-1220kHz, MW2 1180kHz-1630kHz, LW 150kHz-300kHz.

Twelve transistors are used and the f.m. tuner employs two transistors and vari-cap diode tuning. There are common i.f. stages for a.m. and f.m.: 460kHz 10·7MHz.

A five transistor audio amplifier provides 3·6W and 6W when operating from 12V car battery. There are 2×5 Ohm speakers—7 & 2½in.—the 2½in. speaker is switchable. Treble and base controls are provided amongst many other features. Recommended retail price is £55. U.K. Distributors are *Lampitt Electronics Limited, Manchester.*

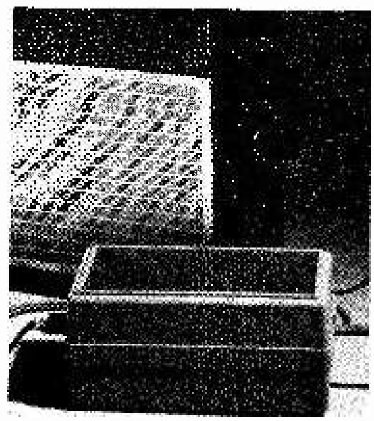
Burnt fingers

We mentioned it once before, and we're mentioning it again because it's useful stuff. Burneze, priced at 39p, is an aerosol preparation which gives instant relief to minor burns. Available through all branches of Boots and most good chemists, it should have a place in every workshop, or home first aid kit, ready for instant action the moment you grab hold of the wrong end of the soldering iron!

Hacker power

The VP408 is a fully-stabilized power unit designed to plug into the mains electricity supply and give a d.c. output adjustable from 6 to 18 volts.

Selection of the voltage required by the equipment to be operated is very simple. Set flush in the underside of the unit is a circular control which may readily be turned by a small screwdriver until the pointer on the control is in line with the voltage indicated on the scale.



The VP408 is intended primarily as an alternative to batteries as the power source for Hacker portable radios, but its wide range of stabilized voltages makes it an ideal power source for portable radios generally, some cassette tape recorders and other equipment requiring low voltage d.c. current within the capabilities of the unit. The VP408 costs £6·90p. *Hacker Radio Limited, Norreys Drive, Cox Green, Maidenhead, Berks.*

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

Record rack

The record rack shown on the front cover was kindly loaned to us by *Civil Service Stores, Strand, London.*

TEAC amplifier

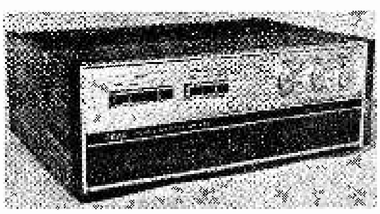
Acoustico Enterprises Ltd., inform us that they now have stocks of Teac equipment and in the picture we show the Teac Amplifier type AS-200S, retailing at £170·48. This is an all silicon transistor stereo amplifier having a rated power of 60W per channel ±0·5dB into a 4Ω load or 50W per channel ±0·5dB in an 8Ω load. Harmonic distortion is under 0·5%, rated output, under 0·1%, 30W output and under 0·1% 100mW. Frequency response is 20-80,000kHz +0dB −1dB and power bandwidth is 20-30,000Hz. Input impedance is 25kΩ or more and sensitivity is 0·7V for rated output.

Elimination of capacitance from the output circuit plus the very stable dual p.s.u. results in an 'unprecedented' flat frequency response which is very noticeable in the low frequency ranges.

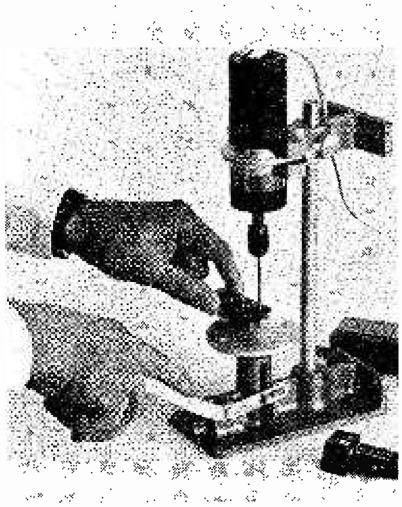
A precision 3dB step selection tone control is employed to eliminate any tonal imbalance between channels.

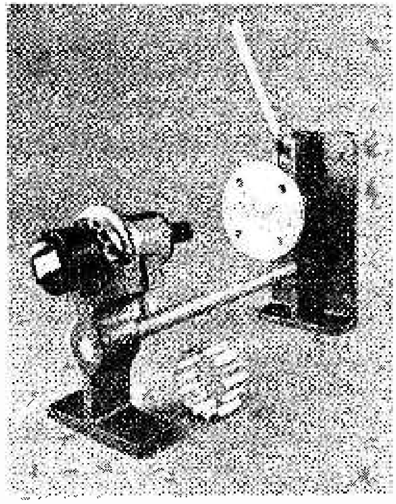
So that the speakers are protected from surge voltage when the unit is first switched on, Teac have included a muting circuit that prevents any current flow to the speakers until the unit has stabilized—usually 3-4 seconds after switch-on.

A matching and very smart looking a.m./f.m. stereo tuner designated AT-200S is also available from Acoustico for £220·41. For further information on Teac equipment contact *Acoustico Enterprises Ltd., 6-8 Union Street, Kingston Upon Thames, Surrey.*



Drills for printed circuit boards





Last October we gave details of two miniature electric drills, made by Expo (Drills) Ltd., which have proven very useful indeed to constructors faced with the problem of drilling a multitude of small holes in circuit boards. The Reliant, and its big brother the Titan Super, are intended to run from a 12V battery or a mains rectifier unit. Now a drillstand-cum-lathe bed is available capable of accommodating either drill. The drill is attached to the stand by a fixed clamp, the work table rising up to the drill by means of a small hand lever against a spring action.

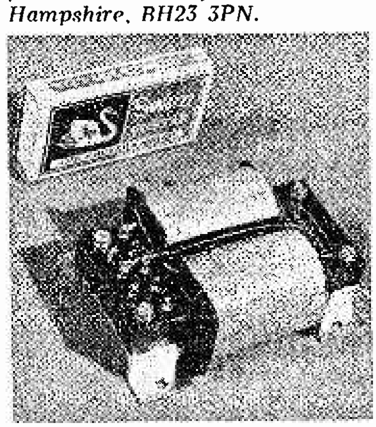
Holes are provided in the stand body to enable it to be screwed down to a bench or to a moveable wooden base. The stand can also be screwed down with the drill and main post horizontal when it may be used as a simple lathe bed for polishing, grinding or cutting. Apart from standard twist drills various cutters, burrs and saws are available as accessories. All these can be accommodated in a set of three collets with a maximum capacity of $\frac{1}{8}$in. A three jaw chuck of unique design is expected to be available in the near future. Details from *Expo Ltd., 62 Neal Street, London, W.C.2.*

Texan transformers

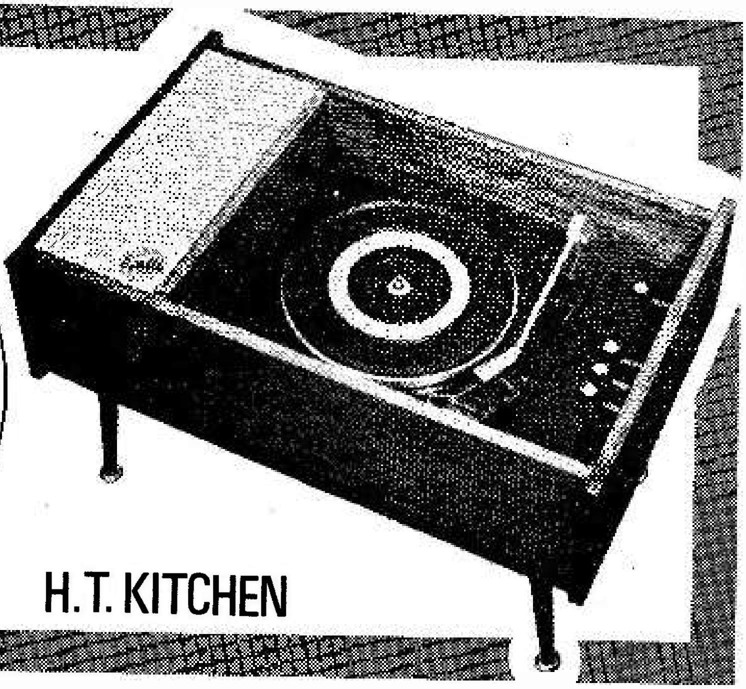
Gardners Transformers Limited announce a new range of low-profile transformers which are designed to overcome the transformer problems associated with the modern tendency towards slimmer electronic equipment.

Use of a Solo Series Transformer (Gardners Type SL 20) in the "Texan" stereo-amplifier designed by Richard Mann, of Texas Instruments, enabled the designer to achieve a remarkably compact design.

Further details of the new SOLO Series (Drawing A.3869) are readily available to industrial users, while a separate Advance Technical Data Sheet (AT.23) describing the Texan 20W transformer will gladly be forwarded upon request to *Gardners Transformers Limited, Christchurch, Hampshire, BH23 3PN.*



12 WATT RECORD PLAYER
Estelle



H. T. KITCHEN

THIS is a project that really got out of hand! Originally I had an old Garrard 4HF turntable that had seen better days and the intention was to put it in a home-made cabinet with a simple mono amplifier and hand it over to my daughter Estelle for her birthday. Her chief criterion of quality is the level obtainable, "the louder the better"!

In the end a second hand Garrard SP25 deck was fitted carrying a ceramic cartridge of unknown history. The "simple" amplifier finished up with ten transistors and at least "mid-fi" performance. The relatively small eliptical speaker in the cabinet has become more of a monitor speaker, the amplifier output being taken to a larger external speaker better able to handle the amplifier output of 12W r.m.s.

THE PREAMPLIFIER

A pre-amplifier performs two basic functions. It must raise the usually low voltages fed into it to a level suitable for feeding the power amplifier, and it must be capable of altering the frequency response of the signals passing through it to fulfil two essential requirements. First, to equalise or com-

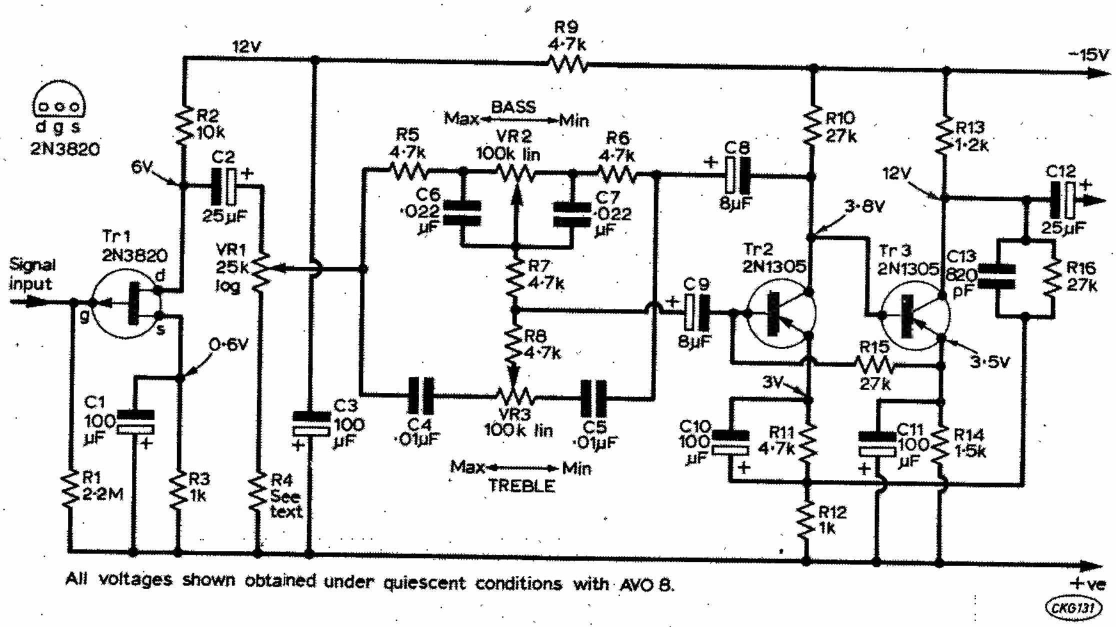


Fig. 1: The circuit of the preamplifier and tone control sections.

pensate the frequency dependent characteristics of the cartridge so that the output from the pre-amp is substantially "flat". This is achieved by providing the pre-amp with a response that is the reverse of the cartridge. Secondly, to provide a variable frequency response so that the flat response can be altered at will. Paradoxical perhaps, but a necessary requirement nevertheless.

The first requirement is a fixed frequency response to the RIAA standard. The second requirement is to provide a variable frequency response, the limits of which follow long established practice. The paradox referred to earlier is a necessary one, for the flat ideal response may result in a sound output from the loudspeaker that is aurally totally unacceptable. The variable frequency response that results from the use of correctly designed tone controls allows the user to modify the response so that a more pleasing sound can be obtained from the loudspeaker, even though a graph of the same response may well depart, perhaps greatly, from the theoretically "correct" flat line response.

Fig. 1. shows the circuit of the pre-amp used in the present design. Considering the various ways possible of loading a ceramic cartridge to provide the required correction, the simplest is by working it into a high resistance, typically 2MΩ, and this is the value of the gate resistor of the f.e.t. used as the input device. R2 is the drain load, the drain current of 600μA being set by the source resistor R3, which is decoupled to a.f. by C1. The low drain current assists in maintaining a low noise level in Tr1, an essential requirement, since the following stages will amplify this noise as well as the wanted signal.

Tr1 feeds the volume control VR1 at the earthy end of which is a low value resistor, R4, allowing a low level signal from the loudspeaker whilst a record is being played with the volume control at minimum. This is purely a safety measure, intended to forestall the user from turning the volume right down when, for example, answering the telephone, and then forgetting all about the record player. The value of R4 is best found experimentally.

The output of the volume control feeds the tone controls which are of the well known and highly regarded Baxandall configuration. A further stage of amplification follows the tone controls before the signal is ready to be passed on to the power amplifier. The degree of amplification required is quite modest but nevertheless two transistors are allotted to this task. The configuration of Tr2 and Tr3 however, allows the overall gain (of the two) to be closely controlled, and is therefore far superior to a single transistor. Direct coupling from Tr2 collector to Tr3 base goes a long way towards eliminating low frequency phase shifts which can occasionally prove troublesome.

Base bias for Tr2 is derived from the emitter of Tr3, improving d.c. stability. Feedback from Tr3 collector to the junction of R11, R12, and C10, controls the a.c. gain and is dependent on the ratio of R16 to R12. Thus, if R16 is, for example, 20kΩ and R12 is 1kΩ, the gain will be 20 times. We can therefore control the gain within wide limits simply by varying the ratio of R12 and R16. This is a most useful facility. Since the output of ceramic cartridges can vary from around 30mV for a better class cartridge, to around a volt for the cheaper "crystal" type, it is clearly useful to be able to vary the gain somewhere in the amplifier to compensate. If this is done, then the gain can be individually "tailored", assuming the cartridge type remains unaltered, so that full output is only available with the volume control fully advanced.

A further advantage of the two transistor circuit is the ability to "tailor" the a.c. feedback such that it becomes frequency selective. This can be effected by

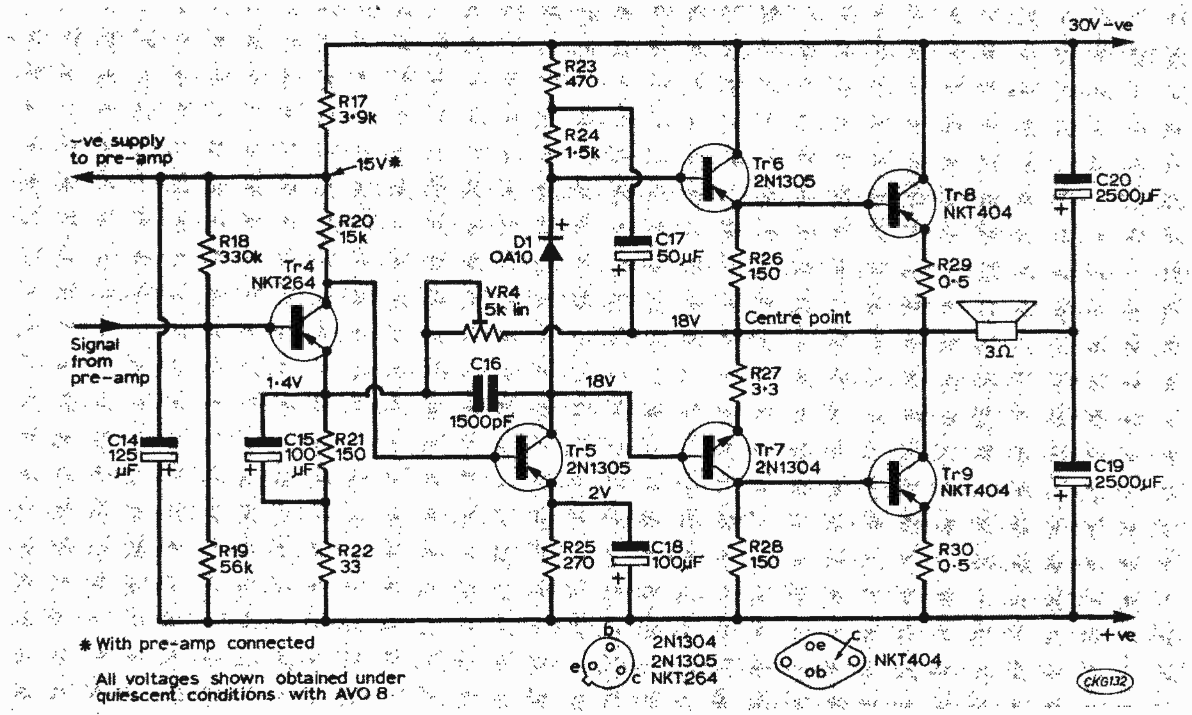


Fig. 2: The circuit of the main amplifier.

shunting R16 with a capacitor, C13. The higher the capacity of C13, the lower the frequency at which it becomes effective. C13 can be selected by purely subjective means, using a cut and try approach in conjunction with listening tests.

THE POWER AMPLIFIER

The circuit of the power amplifier, shown in Fig. 2., is entirely conventional, based upon well established and proven techniques. Several versions, both 3Ω and 15Ω output impedance, having been built and all having performed faultlessly.

Tr4, the input transistor, is a simple voltage amplifying stage with base bias provided by the potential divider R18 and R19. The collector of Tr4 is directly coupled to the base of Tr5. Feedback from the centre point of the amplifier to Tr4 emitter, via VR4, establishes the d.c. working conditions throughout the whole amplifier. Since transistors and other components are subject to manufacturing "spreads", it is necessary to include VR4 to compensate for deviations in the working conditions caused by these "spreads". VR4 is the only component used in setting up the power amplifier.

From Tr5 the signal passes to the bases of an n.p.n.-p.n.p. pair of transistors, Tr6 and Tr7. Diode D1 assists in maintaining correct bias levels. At this junction an emphatic warning must be sounded, if partially or irretrievably damaged transistors are not to be the order of the day. D1 is part of the bias network for the output transistors, *and must be correctly wired into circuit. Suspect or "surplus" diodes must not be used in this application.* Failure to observe these requirements may result in trouble.

Capacitor C16 introduces a degree of high frequency attenuation, in order to protect the output transistors from high level, high frequency, long duration, signals. The h.f. response of the germanium transistors used is very limited, and an excessive continuous h.f. signal can destroy them by overheating the junctions. Under what may be termed normal conditions, these problems should not arise; however, readers possessing a.f. signal generators will no doubt wish to carry out appropriate tests, and then there is a very real danger of an increased mortality rate among power transistors if due care is not exercised.

Cross-over distortion, caused as the output transistors alternately conduct and cut off, can sound most unpleasant if remedial procedures are not taken. The standard remedy is to apply a small forward bias to the output transistors. Emitter resistors R29 and R30 perform this function in the present design.

To reduce the loading on the pre-driver stage, it is customary to increase the input resistance of the driver stage. This is effected by means of a "boot-strap" capacitor, C17 in the amplifier.

A disconcerting, though normally harmless effect found on some power amplifiers, is a loud "plop" when the amplifier is first switched on. The loudspeaker is here fed from a single output capacitor of some 2000μF from the centre point, and the

★ components list

Resistors

R1	2·2MΩ	R12	1kΩ	R23	470Ω
R2	10kΩ	R13	1·2kΩ	R24	1·5kΩ
R3	1kΩ	R14	1·5kΩ	R25	270Ω
R4	see text	R15	27kΩ	R26	150Ω
R5	4·7kΩ	R16	27kΩ	R27	3·3Ω
R6	4·7kΩ	R17	3·9kΩ	R28	150Ω
R7	4·7kΩ	R18	330kΩ	R29	0·5Ω 10% WW
R8	4·7kΩ	R19	56kΩ	R30	0·5Ω 10% WW
R9	4·7kΩ	R20	15kΩ	R31	390Ω 5% 1W
R10	27kΩ	R21	150Ω		
R11	4·7kΩ	R22	33Ω		

All ½W 5% carbon film except as noted.

VR1	25kΩ log.	VR3	100kΩ lin.
VR2	100kΩ lin.	VR4	5kΩ skeleton pre-set

Capacitors

C1	100μF 15VW	C13	820pF polystyrene
C2	25μF 15VW	C14	125μF 15VW
C3	100μF 15VW	C15	100μF 15VW
C4	0·01μF	C16	1500pF polystyrene
C5	0·01μF	C17	50μF 15VW
C6	0·022μF	C18	100μF 15VW
C7	0·022μF	C19	2500μF 25VW
C8	8μF 15VW	C20	2500μF 25VW
C9	8μF 15VW	C21	1500μF 60VW
C10	100μF 15VW	C22	8μF 15VW
C11	100μF 15VW	C23	1000μF 60VW
C12	25μF 15VW	C24	0·1μF 500V

Note: C21 and C23 must have an a.c. ripple rating of 1A for mono or 2A for stereo.

Semiconductors

Tr1	2N3820	Tr5	2N1305	Tr9	NKT404
Tr2	2N1305	Tr6	2N1305	Tr10	NKT404
Tr3	2N1305	Tr7	2N1304	D1	OA10
Tr4	NKT264	Tr8	NKT404	D2	ZL30 30V 1·5W
		D3 to 6	1N4004		

Miscellaneous

T1, mains transformer 240V/30V 750mA (mono). Fuses and holders (2). S1a-b, 2 pole rotary on-off. Knobs etc. PC board 7 x 3 in. Veroboard 0·1in. Matrix 4½ x 3 in. Speaker 7 x 4 in. elliptical 3Ω.

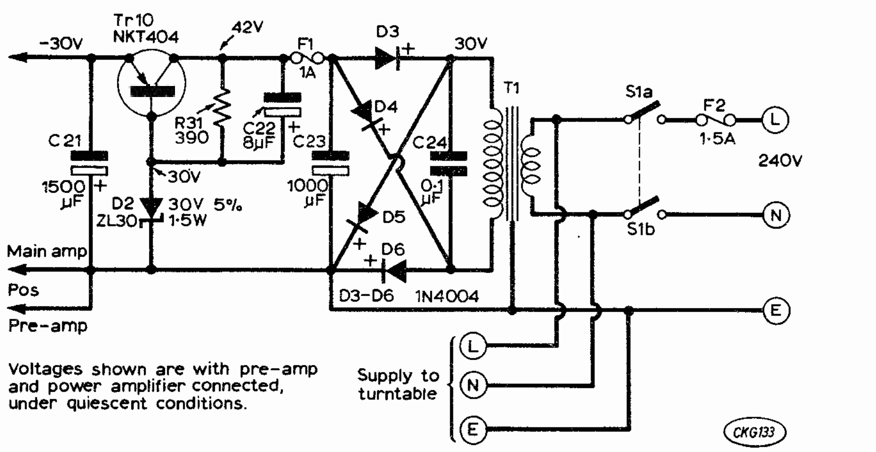


Fig. 3: The power supply circuit.

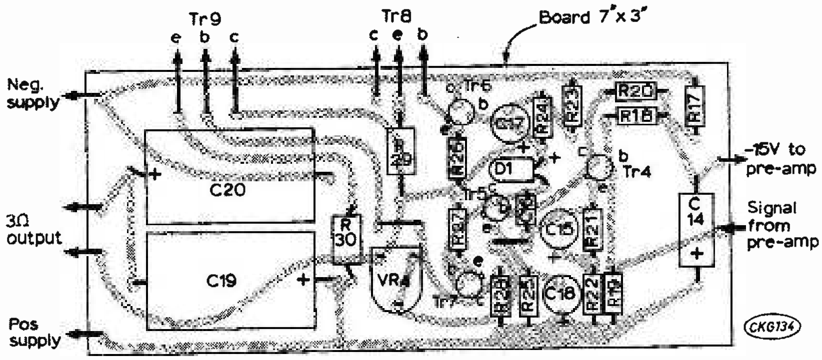


Fig. 4: The circuit board for the main amplifier viewed from the component side.

"plop" is caused by the capacitor charging up to half the supply potential via the "upper" output transistor and the loudspeaker, which are effectively in series.

In the present design this effect is greatly minimised by the use of two output capacitors in series, with the loudspeaker connected from the centre point to the junction of the capacitors. We now effectively have a bridge circuit, in which Tr8 and Tr9 form one side and C19 and C20 form the other. Initial surge currents now tend to flow more symmetrically and steadier nerves should result.

A further important advantage of the symmetrical output configuration, perhaps outweighing the plop reducing properties, is that supply ripple voltages will also flow symmetrically, resulting in a reduced hum level from the 'speaker, not that the hum level requires much reduction!

THE POWER SUPPLY

The amplifier was originally designed for a 15Ω output, as one of a stereo pair. The mains transformer was therefore bought with a 30V secondary to provide a rectified supply, at the quiescent current rating, of 42V. Since the present amplifier requires a supply of 30V, a series transistor in the power supply drops the surplus 12V.

The secondary of the mains transformer feeds a bridge rectifier comprising diodes D3 to D6, Fig. 3. Capacitor C24 is a bypass capacitor, intended to reduce overvoltage spikes and mains-borne noise. C23 is the reservoir capacitor. Tr10 is the series regulating transistor, the base of which is held a constant 30V by the zener diode D2.

CONSTRUCTION

The power amplifier, as already mentioned, was originally conceived as one of a stereo pair, the two amplifiers being laid out on one sheet of copper clad laminate as a mirror image pair. For this application, the sheet was split in half, shown from the component side in Fig. 4. The pre-amp was, to save time, built on a piece of 0·1in. matrix plain Veroboard, shown in Fig. 5, together with its mounting bracket.

Clearly, there is no reason why both units should not be built upon the same type of board either separately, as here, or in an integrated form. The power amplifier is not unduly critical of layout, but the straight line type of construction is undoubtedly best. The pre-amp carries and "processes" some quite low level signals, and if the signal-to-noise ratio and hum level are not to suffer, care in layout must be exercised.

The power supply is integrated to the extent of having all its components mounted on and around the mains transformer. A piece of $\frac{1}{16}$in. aluminium 5×2in. is bolted to one end of the mains transformer, but spaced from it by $\frac{1}{2}$in. by means of $\frac{3}{4}$in. 4BA bolts. In the centre of this panel is

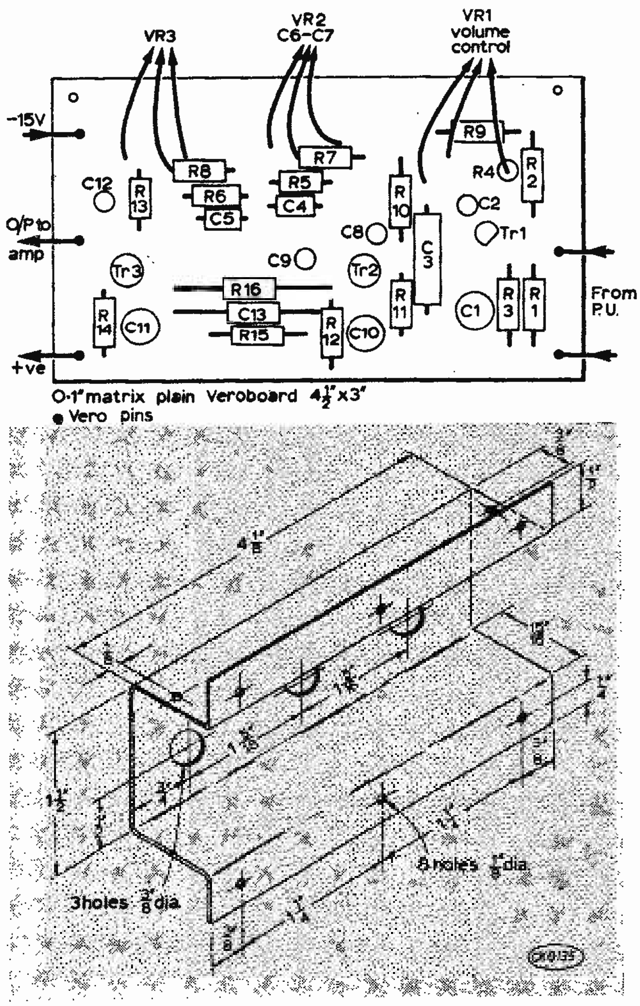


Fig. 5: The component layout and mounting bracket for the preamplifier.

mounted Tr10 with an insulating mica washer. D2, R31 and C22 are grouped round the pins of Tr10. The ends of the aluminium panel protrude either side of the mains transformer body, and carry C21 and C23, one at each end.

The end of the transformer, remote from the power transistor heat sink, Fig. 6, carries a small panel of s.r.b.p. on to which are mounted eight tags.

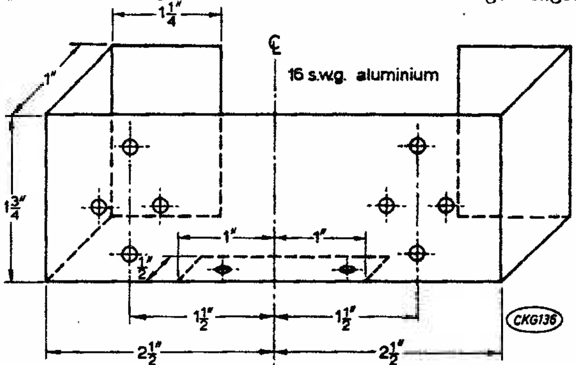


Fig. 6: The heatsink for the output transistors made from 16 s.w.g. aluminium.

Diodes D3 to D6 are soldered to these turret tags, the interconnections being on the reverse side. Since the current demands are heavy (relatively speaking) wire of a suitably heavy gauge must be used such as 14/·01in.

COMPONENTS

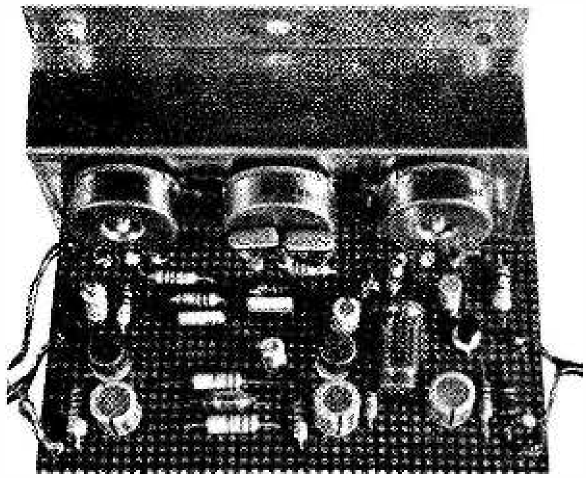
It must be borne in mind that the power amplifier and the latter two transistors of the pre-amp are directly coupled; any faulty transistors, or transistors well outside the published specifications, can lead to fault conditions developing. At best these conditions will prevent correct operation of the equipment; at worst they will cause the destruction of the power transistors. The "cure" is to buy only new transistors from a reputable supplier.

With the exception of R29, R30, and R31, all the resistors used are 5% $\frac{1}{2}$W carbon film types since these are now freely and inexpensively available from many suppliers. The use of these resistors makes subsequent fault finding very much easier, should the need arise, since any deviation from correct operation can almost certainly be attributed to the semiconductors whose manufacturing "spreads" are so much wider than those of the resistors.

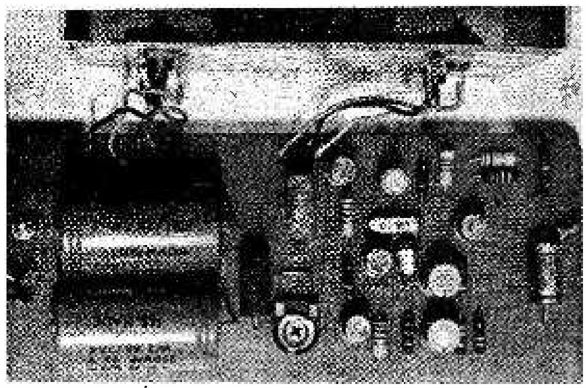
The mains transformer, as already explained, was purchased with a 30V secondary. If the expense of the simple series stabiliser is unacceptable, then the conventional power supply (transformer—rectifier—capacitor) can be used. Under these conditions, the transformer should be rated at 18 to 20V at 800mA for a single amplifier, or at 1·5A for a stereo pair. Since smoothing is now dependent upon C23 alone, it should be increased in value to 2000μF or 2500μF. An anti-surge resistor of about 1Ω should be interposed between the rectifiers and C23.

When the amplifier is delivering its full rated power, transistors Tr8, Tr9. and Tr10 get very hot under sustained drive conditions, and adequately rated heat sinks are necessary. Under normal conditions, when music is being reproduced at a reasonable level, through speakers of average efficiency, the heat generated is very much less, and smaller heat sinks can be used, providing an adequate air flow is ensured.

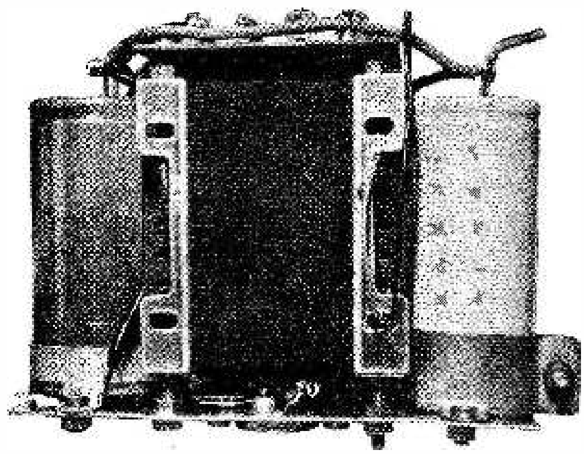
When the various units are completed, they must be thoroughly checked over; wiring errors, shorting wires, etc., can be disastrous, so time spent in careful checking is time well spent.



A view of preamplifier.



The main amplifier. The wires to the output transistors can be seen at the top.



The power supply.

The first item to be checked can be the power supply. Assuming a series stabiliser is used with a transformer having a 30V secondary, the voltages should agree closely with those shown in Fig. 3.

Having allowed C21 ample time to discharge completely, the power amplifier can be connected to the power supply. A fairly high wattage resistor of some 10 to 20Ω should be connected in series with the negative line to limit the maximum current that can be drawn in the event of the power amplifier having a fault condition. Power can now be applied.

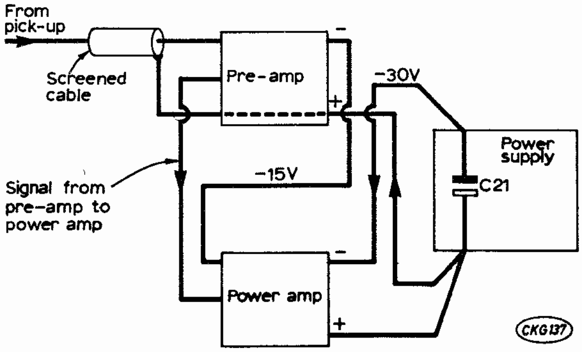


Fig. 7: The interconnection of the individual sections.

An accurate voltmeter should be connected to the centre point and VR4 adjusted to provide a centre-point voltage of approximately 18V. The remaining voltages can also be checked and should agree with those shown in Fig. 2. If voltages differ considerably from those shown, or if the centrepoint cannot be set to 18V, then a semiconductor is the most likely cause, and the easiest course of action is to remove them all from circuit and have them checked on a reliable tester. It is no good pressing on in the hope that the fault will "go away". It won't, it will remain or get worse. If all appears to be well, the series resistor can now be removed.

The centre point voltage, under quiescent conditions, is set to exceed half the supply voltage by a small margin, so that at maximum drive the centre

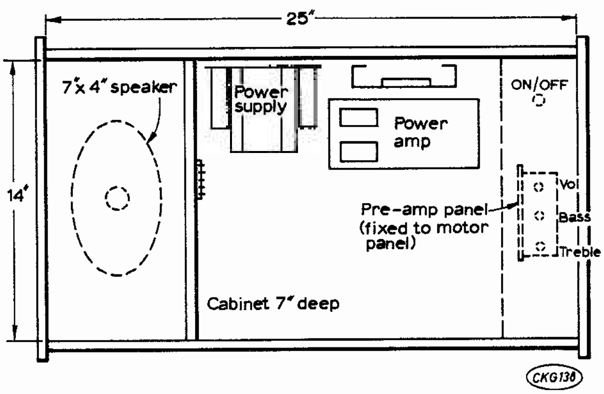


Fig. 8: The general layout employed in the prototype.

point falls to exactly half the supply voltage. Limiting, under conditions of excess drive, will therefore be symmetrical.

If an audio oscillator and oscilloscope are available, VR4 can be set even more accurately. A 1kHz signal is injected into the base of Tr4, and the oscilloscope is connected from the centrepoint to earth. The input from the generator is increased to the point where limiting becomes visible on the oscilloscope. VR4 is then adjusted until the limiting become symmetrical, i.e. positive and negative peaks are evenly clipped. Since VR4 has an effect upon the overall gain of the amplifier, the input signal may require altering to compensate.

As explained earlier, the output transistors are liable to be damaged, or even completely destroyed if indiscriminate high power testing is indulged in. For this reason, sine wave testing at full power *must not be attempted beyond 1 or 2kHz.* High frequency testing can be attempted, but at greatly reduced power outputs. Even then, a series ammeter should be used to continuously monitor the current consumption. If this is done at a carefully chosen output then it will become apparent that I^2R as a function of *actual power output,* and I^2R as a function of *power consumed,* are two very different quantities, the power consumed being, of course, greater than the power output, *the difference increasing with an increase in frequency.*

When the power amplifier has been satisfactorily set up, attention can be turned to the pre-amp. Again, an audio oscillator and oscilloscope are invaluable. A voltage at 1kHz., equal to the peak output of the cartridge to be used, is fed into the input of the pre-amp and R16 is selected such that, with the volume control fully advanced, the output waveform from the power amplifier just starts to limit. This will ensure that distortion due to overloading cannot occur, even at maximum output.

CONNECTING UP

AC currents of over ½A flow through the output stages under maximum drive conditions and incorrect earthing can result in instability or the formation of hum loops. Some thought to interconnections must therefore be given, the circuit of Fig. 7 having been found satisfactory. The pickup lead should only be earthed at the pre-amp, the other end being left disconnected. The turntable should be earthed separately to the main earth.On the prototype, a separate mains on-off switch is used, sited well away from pre-amp to preclude any possibility of mains induced hum. This switches the mains to the player as well as to the amplifier power supply.

Although the amplifier has been described as a mono or single channel unit, reference has occasionally been made to stereo operation. This is, of course, quite possible. All that is required is a doubling up of everything, with a revised physical layout. Separate heat sinks should be used for the two power amplifiers, and if continual high power operation is envisaged, these should be of the commercially produced extruded type.

The power supply will require revision, since a single NKT404 will probably be overrun. Its maximum collector dissipation in the present application is in the region of 8W and this will be doubled for stereo. The easiest course, if a regulator is desired, is to replace the NKT404 with a 2N3055 in the positive side, and to turn the power supply circuit "up side down". The 2N3055 must be mounted on an extruded heat sink to dissipate the heat generated safely, this being mounted in a position where an adequate air flow is possible. ■

MODIFICATIONS TO THE TRANSISTORISED OSCILLOSCOPE

FEBRUARY-MARCH 1972

SINCE publication of the constructional details of the Transistorised Oscilloscope in the February and March editions of *Practical Wireless*, many readers have written in to say that they have had difficulty in obtaining the VCR 139A cathode ray tube. When the unit was first designed, stocks of this tube appeared to be adequate to meet the anticipated demand, but the response to the article has been very much greater than expected and consequently the VCR 139A has become a very rare specimen! In reply to readers' requests several alternative tubes have been tried but, to date, only two which are readily available in quantity have proved to be satisfactory—the surplus 2A P1 and the Mullard DG 7-5.

The 2A P1 can be used as a direct electrical replacement with only one circuit modification (change R12) but suffers from two mechanical disadvantages:

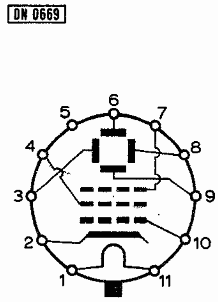
1. The tube face is only 2in. diameter rather than $2\frac{3}{4}$in. of VCR 139A.
2. Some versions are slightly too long to be accommodated into the original chassis design. Early versions of the tube are just over 10in. long and will require extensive modificaion to the metalwork before they can be used. The later, and fortunately much more common version, is $7\frac{1}{2}$in. long and fits perfectly well into the cradle as designed.

The pin connections for the 2A P1 are shown in Fig. 1 together with the corresponding connections for the VCR 139A. The only electrical modification is the changing of R12 (Fig. 5 page 887 of February issue) which should now be 10Ω 5 watt.

The Mullard DG 7-5 is listed by its makers (Philips of Eindhoven) as being obsolete, but, on checking with wholesalers, it still seems to be very widely stocked throughout the country and should be available to special order from any good component retailer. This tube works very well in the revised circuit and gives, if anything, a slightly brighter and better focussed trace than the VCR 139A.

The modified display unit is shown in Fig. 2 and this should be compared with the original circuit (Fig. 5—page 887). As will be seen the main change to the original circuit is the provision of a negative supply for the tube grid. This supply is required because the heater and the cathode of the DG 7-5 are internally connected, so that instead of being able to take the grid to chassis and running the cathode at a positive potential with respect to the chassis, we are obliged to hold the cathode at chassis potential and make the grid negative. The additional components required for this modification are prefixed with the figure 4 in the revised circuit diagram.

The major points concerning construction and testing are unaffected by this modification and the few additional components are easily accommodated on the tag-strips mounted on the back panel.



Tube 2AP1
Base USM11

	2AP1	VCR139A
Heater	1,11	3,4
Cathode	2	1
Grid	10	2
Focus electrode	4	5
Anode	7	9
X plates	3,8	8,10
Y plates	9,6	7,11

Fig. 1 : Pins connections of the 2AP1.

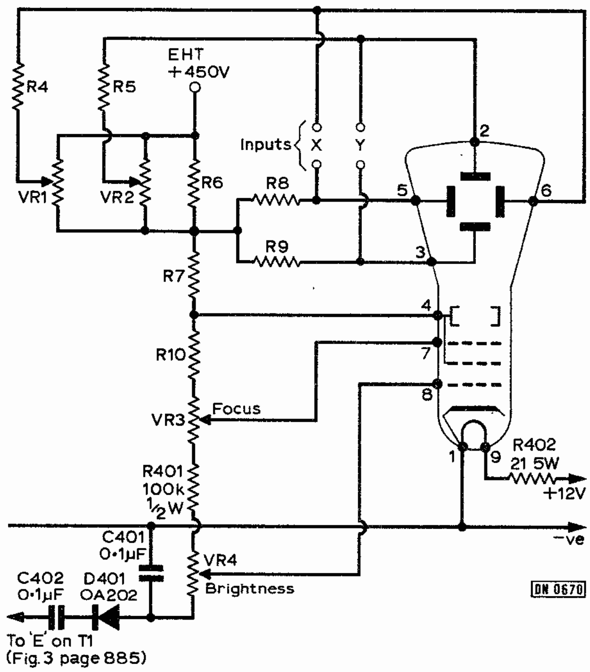


Fig. 2: Circuit changes when using the DG 7-5 tube.

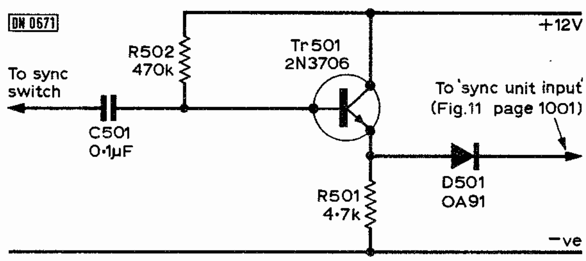
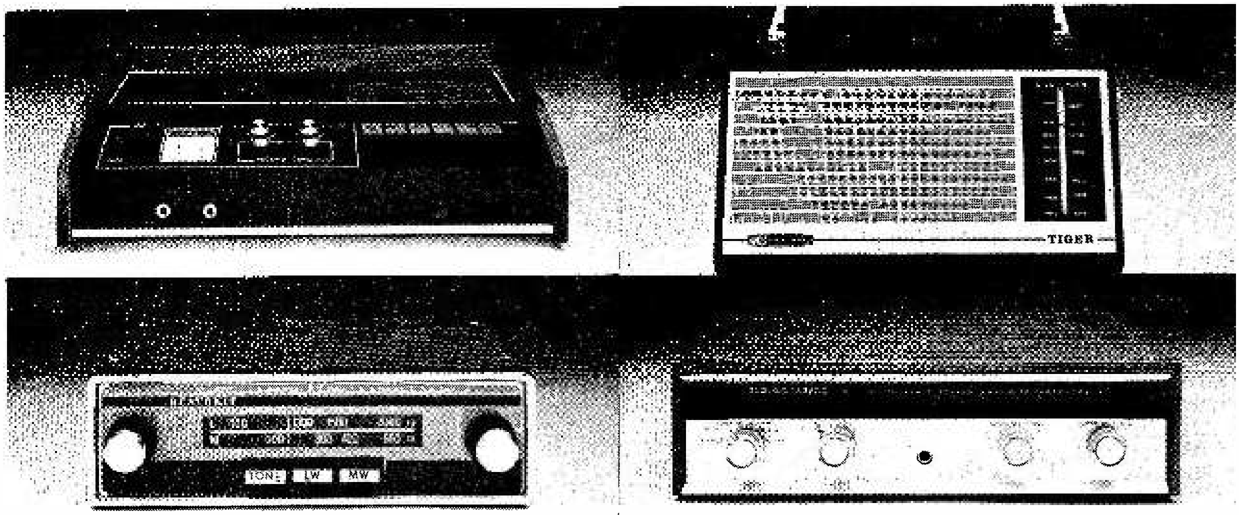


Fig. 3: Modification of the sync circuit.

Many readers have expressed a preference for a more conventional synchronisation circuit than the gated system used in the prototype. The most obvious method is to feed negative going pulses into B_2 of Tr9 (Fig. 11 page 1001) but unfortunately this seems to have a rather distressing effect on linearity. A simple and effective circuit is shown in Fig. 3—the only disadvantage being a lack of sensitivity to very fast pulses. ■



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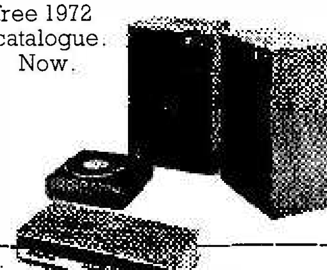

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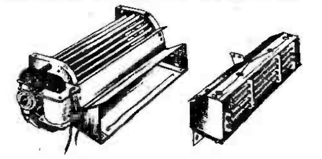

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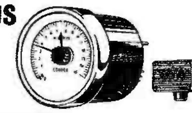

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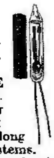

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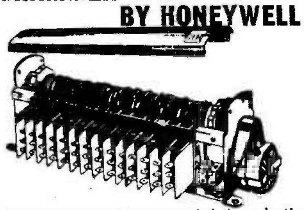

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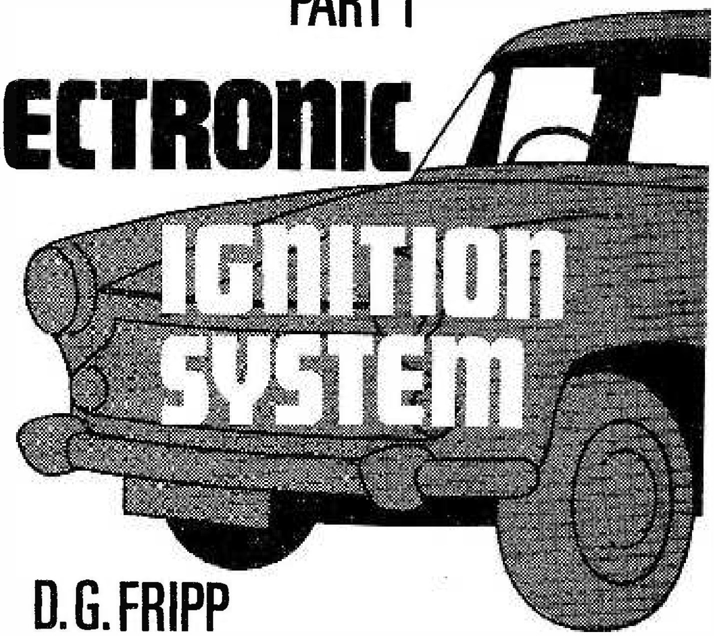
constructing THE PW ELECTRONIC IGNITION SYSTEM

PART 1



Last June we published a short article on the PW Electronic Ignition System little realising the tremendous interest it would arouse. Thousands of these units have been built but many readers wrote in saying "I've got all the parts, what do I do next?" Here is all the information they could possibly need, based on the experiences of a reader.

D. G. FRIPP

THE advantages of an electronic ignition system are now quite well known, and of the various systems available perhaps the "capacitor discharge" system is the most widely popular. This constructional article deals with such a system and follows closely the circuitry as described under this heading in the June 1971 issue in which most of the advantages were fully explained with the exception of one fact of paramount importance to the constructor; as this system uses the contact breaker as already fitted to the car, it in no way alters the timing; thus in the unlikely event of a component failure, a quick rearrangement of the connecting leads taking less than thirty seconds enables the car ignition to be returned to normal and the journey resumed.

Unlike many other systems employing specialised components which are not always readily available even from agents without some delay, this system with its inherent safety factor of easy reversion has much to commend it, as no doubt anyone who has been stranded by an ignition fault would hasten to agree.

SOME ADVANTAGES

Some not quite so obvious advantages not previously mentioned may be of interest to would be constructors, not least of which is the fact that owing to the more powerful spark delivered to the plugs by this electronic ignition unit—this may vary from 20 per cent to 40 per cent depending on the coil used—the firing of the petrol-air mixture is ensured, thus a slightly weaker mixture can often be used to enhance the economy already achieved by this form of ignition due to more complete combustion. This of course means that as up to 25 per cent more of the fuel used is burnt in the engine, where it develops more power, there is a correspondingly significant decrease in the pollution emission in the form of unburnt exhaust gases. In these days of a growing awareness of the desirability of reducing the amount of pollution, as is typified by the lowering of the limits of exhaust emission which must be complied with for the importation of cars into the U.S.A. in the near future, it would seem that the future of electronic ignition may well be assured if only from this one important aspect.

Another advantage of this type of ignition is that because of the faster rise time (as against conventional inductive systems) there is much less time for the current to leak away through any leakage paths which may exist on any of the insulated parts of the ignition components such as plug insulators, leads, distributor cap, rotor arm, and coil h.t. stack, also any conductive deposits which may have accumulated on the plug firing points. Thus plug fouling is virtually eliminated and therefore the heat range grading can be ignored. From this it can be seen that a vehicle using this electronic ignition unit, which is driven under widely varying conditions, should not exhibit any plug trouble even if it were prone to with normal ignition, assuming plugs of reasonable condition.

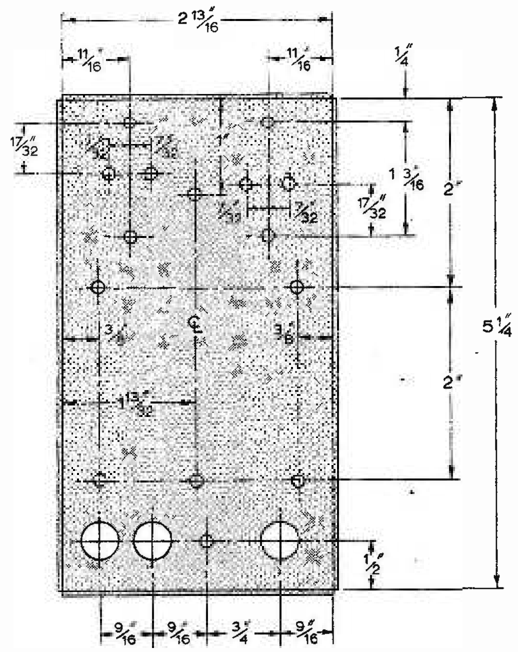
Largely because of the reasons just mentioned at least one well known plug manufacturer has developed a plug specifically for use with electronic ignition. This plug has an annular gap, which has the effect of greatly increasing the mass of the outer electrode, so its erosion should be slower. It should be realised that the effect of a high energy spark is likely to cause more erosion of the electrodes—especially the outer—although this seems to be offset to some degree by using wider gaps as is advocated later in this article, and is probably nullified by the fact that this high energy spark is of much shorter duration—approximately one fifth of a conventional system—and contains nearly equal positive and negative half cycles so that metal migration of the plug firing electrodes should be very much less.

Certainly these conditions would appear to prolong spark plug life, and this is borne out by one such car fitted with new plugs when one of these ignition units was installed, as careful examination of the plugs over 5,000 miles later showed no observable deterioration of the firing electrodes.

From this it can be seen that the normal plugs as quoted by the car manufacturer can be used with confidence, provided that they are in reasonable condition and the gaps are reset.

POLARITY

The unit as shown is the one as used for positive earth supply, but the method of construction and the placing of components is identical for the negative



18 s.w.g. aluminium
Small holes 4 BA clearance. Large holes 3/8 dia.
View looking into box lid

CKG072

Fig. 1 Drilling details for the lid of the box on which all the components are mounted.

★ components list

Resistors
R1 82Ω 3W wirewound
R2 1kΩ ½W
R3 1kΩ ½W
R4 82Ω 3W wirewound
R5 1kΩ ½W
R6 8·2kΩ ½W
R7 39Ω 5W wirewound
R8 2·2 MΩ ½W

Capacitors
C1 0·47μF 600V
C2 0·22μF 250V

Semiconductors
Tr1, Tr2 2N3055 **Positive earth system**
2N3614 **Negative earth system**
D1, 2, 4, 5 1N4001 D3 4 x BY100 or 1N4006
ZD1, ZD2 BZY94C30 SCR TAG1/500 or TAG1/600 (see text)
Semiconductors available from Jermyn Industries, Sevenoaks, Kent

Transformer
T1 Type P1/6 Available from Magtor Ltd., 68 Dale Street, Manchester (£1·50 inc. p/p.)

Miscellaneous
Aluminium box and lid (Type AB7), see text. Tag strips ⅜in. spacing, 8 way with earthing tag each end, 2 way with one earth tag, 3 way with centre earth tag (R.S. Components Ltd.). 4 right angle male push-on connectors (Lucar type).

earth type except for the transistor types and the polarity of the associated diodes as has been explained in the original article. The actual connections from the unit to the coil and contact breaker remain the same in both models as the polarity of the pulse fed to the ignition coil is identical.

When wiring in the unit see that the pulse feed from the discharge capacitor is connected to that terminal on the coil marked positive, as this terminal should correspond to the single end of the primary winding whilst the terminal marked negative should be the end of the primary winding which is common with the earthy end of the secondary on a correctly marked coil.

CONSTRUCTION

This unit has been designed to be as compact as possible without undue cramping of the specified components, but there is little room to spare; high voltage points are adequately spaced and their positions relative to other components considered so the constructor is urged to follow the layout as closely as possible.

Having made a box and lid to the required dimensions, Fig. 1 or purchased a ready made one the lid is marked out to the dimensions given in Fig. 1 and all the holes drilled. Extra holes may be required in the box and lid if extra self tapping screws will be needed to hold the unit together when the box is mounted in the car owing to the possible inaccessibility of the one screw top and bottom provided on the ready made box.

At this stage it is prudent to ascertain the mounting position of the unit and the method to be adopted. Pan head self-tapping screws straight through the back of the box, or alternatively small pieces of aluminium angle may be affixed to the sides of the box to secure fixing points. Whichever

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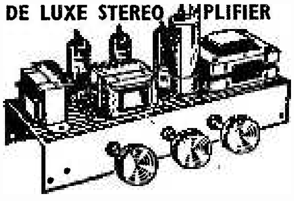

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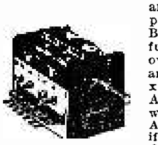

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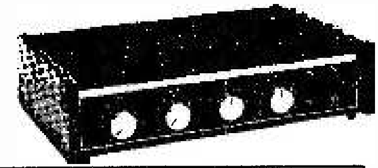

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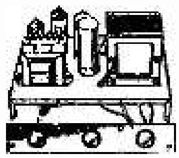

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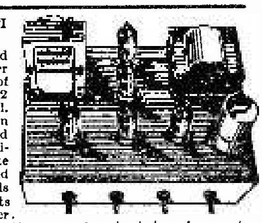

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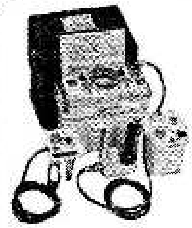

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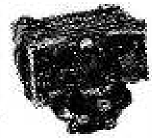

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way is used, remember that any metal protrusions in the shape of screw or rivet heads must be shallow and positioned only in close proximity to earthed parts of the circuit, and also that the unit relies on its mounting for earth return operation which keeps the number of leads to a minimum and the reversionary facility less confusing.

The three heat sink fins, having been made to the sizes given in Fig. 2, are then mounted by means of $\frac{3}{8}'' \times$ 4BA screws as is also the transformer (five leads toward transistors), the two-way tag strip, the three-way centre earth leg tag strip and the discharge capacitor clip which is made from a piece of thin scrap aluminium. The eight-way tag strip is not mounted at this stage as it is more easily fitted after the tag panel.

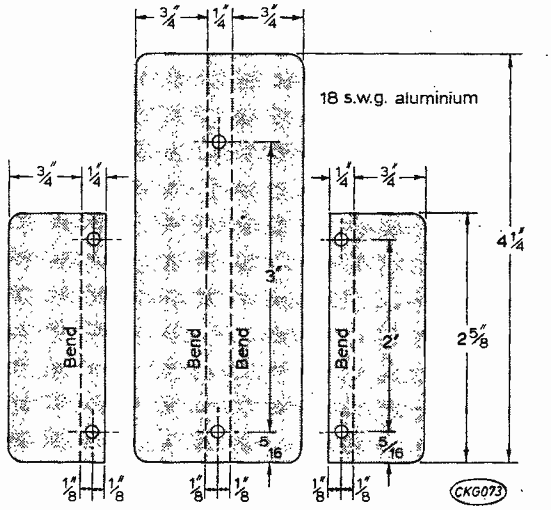


Fig. 2. These three heat sink fins are fitted to the lid of the box.

When mounting the heat sink fins and the transformer it is a sound idea to give those sides which come in contact with the chassis a smear of silicone grease to ensure thermal conductivity. Likewise the transistors when they are mounted.

To obtain a professional finish to the unit now is the time to give it a few coats of matt black paint after masking the transistor mounting positions with two small pieces of masking tape or something similar cut to the required shape using the actual transistors as templates. One of the popular aerosols is ideal for this job and the results are well worth the small effort involved, not only as regards the final appearance of the unit but this process effectively assists the even dissipation of heat besides preventing corrosion.

The paxolin strips and washers are next prepared as in Fig. 3 and assembled to form the tag panel in the manner indicated not forgetting to include a soldering tag under the nuts of connectors marked coil +, −, and CB and the earth tag of the eight-way tag strip under the nut of the remaining connector marked IG/SW., the nut on that side of the transformer being removed to take the other earth tag of the eight-way tag strip which should have the adjacent tag completely removed as reference to Fig. 4 makes clear.

The two transistors of the type required for the particular polarity unit being constructed should next be mounted (with silicone grease on mating surfaces) and also the thyristor heat sink by soldering the doubled over tag in the position indicated in Fig. 4. This heat sink may either be made from thin springy brass or copper 0·020″ thick to the dimensions given in Fig. 5 or it can be formed from a commercial heat sink as supplied for OC81 type transistors as was done in the prototype. It serves as a convenient anchorage for the s.c.r. as well as providing a safety factor which, although not absolutely necessary, is an added precaution.

Wiring can now be begun and is largely achieved with the wire ends of the components. The long wire from the discharge capacitor should be well insulated with plastic sleeving and dressed as in Fig. 4. Careful checks especially on the polarity of the various diodes and the use of a heat sink is strongly recommended whilst soldering operations are in progress.

With regard to the components around the transistors, which were soldered into circuit so as to preclude any intermittent contacts which might occur with spring contacts on transistor holders (imagine an ignition fault impairing performance whilst overtaking), it may be found advantageous to solder the components together one by one so that the final connection to the appropriate transistor pin consists of only one wire end which simplifies construction, replacement of transistors should this ever be necessary, or if the unit is ever altered to the opposite polarity working.

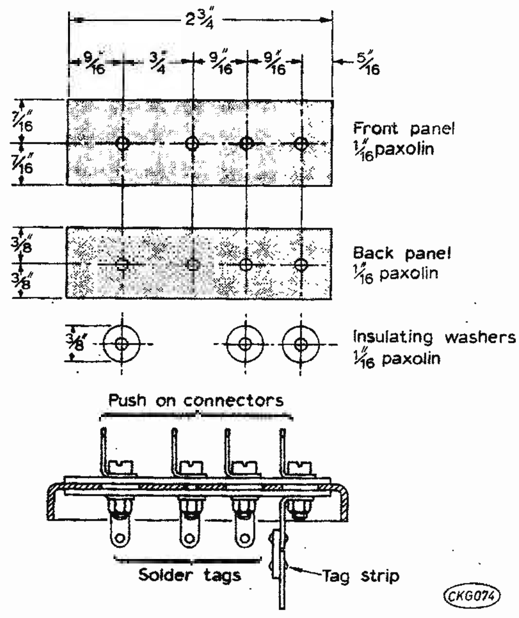


Fig. 3. Assembly details of tag panel.

The next few paragraphs may be ignored by the competent constructor, but are included for those who prefer to work from a step by step outline.

NOTE: The following instructions refer to a unit with a **positive** earthed vehicle. They also apply to the construction of a unit for negative earth use if the reference to polarities of D1, D2, D4, ZD1, ZD2 are reversed, D5 is not required, and of course TR1 and TR2 are of the type specified in the components list. The gate and cathode connections are also reversed for the negative earth unit.

Start by terminating the two black wires of the transformer to the third and fourth tag of the eight-way tag strip (counting earth tags and removed tag from transformer towards IG/SW connector) followed by blue transformer lead and one side of R1 to right tag, and yellow transformer lead and one side of R4 to left tag of three-way strip on transistor side of transformer.

Connect one side of R2, R3 and positive side of ZD1, ZD2 to the central earth tag of the same three-way strip; join free end of R2 to free end of R1 fairly close to R1 body in a T form thus leaving the wire from R1 full length, then using this tee technique again join the positive end of D1 to the R1 wire, the end of this R1 wire is now formed into a small loop to fit on the Base pin of Tr1. By using this method there is only one connection to be made to Tr1 base pin with the advantages already mentioned.

Repeat this process with R3, R4, and D2 to Base pin of Tr2. Connect the free end of D1 (negative) to the free end of ZD1 (negative) and also green lead of T1 using same T method, again forming small loop on the ultimate wire of these junctions for connection to emitter pin of Tr1.

Repeat with D2, ZD2, red transformer lead and emitter pin of Tr2. The four BY100 which form bridge rectifier D3 are next wired in position, Fig. 4. by joining two negative wires of two BY100's together and to the earth tag on strip held by T1 bolt, one positive going to tag 3 where black T1 lead joins. The other positive goes to tag 4 where the other black T1 lead has been soldered and from this point is connected the negative of the third BY100. Its positive wire goes to tag 5 as also does the positive of the fourth BY100 together with one side of R8. The negative of the fourth BY100 is returned to tag 3, upper half of tag. Use the lower half of tags for all previous connections except the earth one.

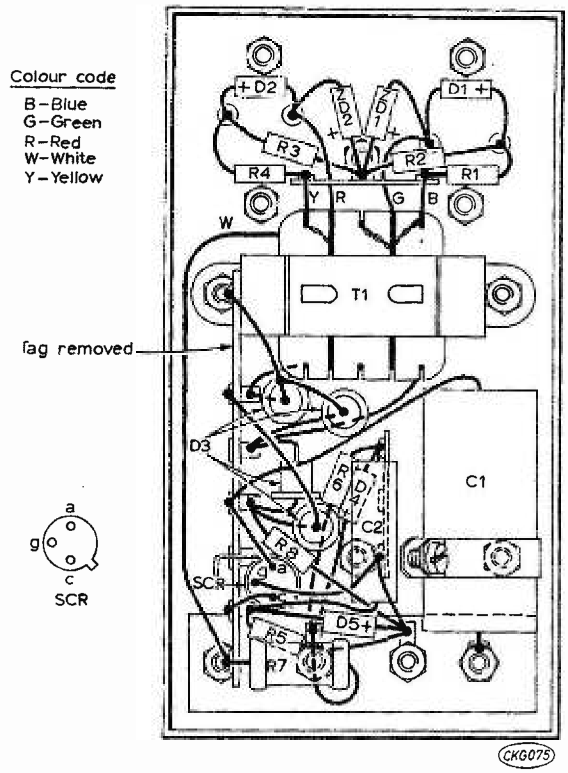
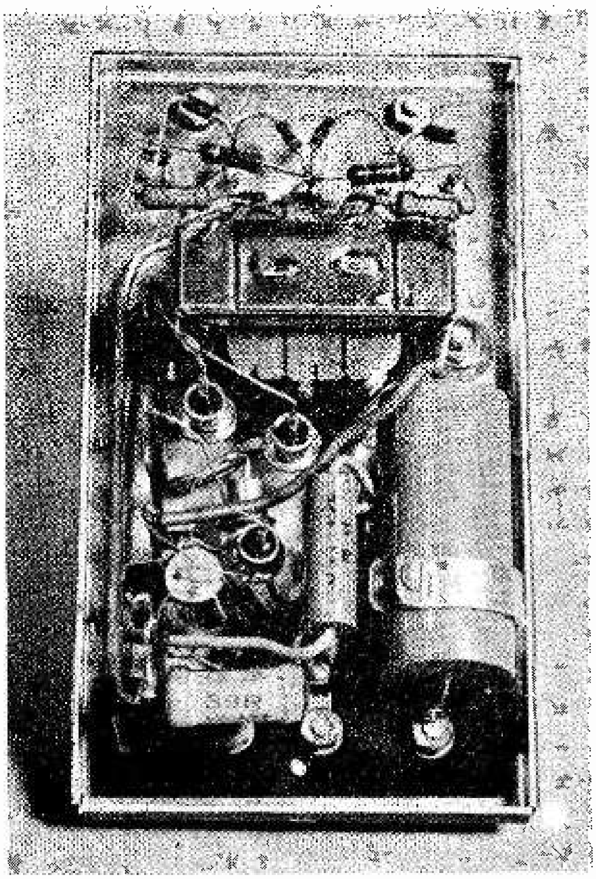


Fig. 4. Complete wiring diagram for a **positive** *earth unit which may be compared with the photograph, below left.*



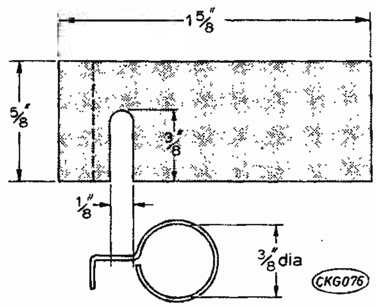


Fig. 5. Heat sink for the SCR made from springy brass or copper.

The two-way tag strip should now be mounted by means of the central heat sink fin fixing bolt and a short piece of wire soldered from the unit tag marked Coil negative to the earth tag on the two-way strip, in the form of a bus bar. Several earth joints can then be comfortably accommodated the first of which is the free end of R8.

To the lower half of tag 7 solder one end of R5 and the negative end of D5, the other end of R5 and the positive end of D5 are then earthed at the bus bar.

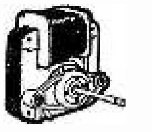
DISTRIBUTION PANELS

Just what you need for work bench or lab. 4 × 13 amp sockets in metal box to take standard 13 amp fused plugs and on/off switch with neon warning light. Supplied complete with 6 feet of flex cable. Wired up ready to work. £2·25 plus 23p P. & I.

MULTI-SPEED MOTOR

Six speeds are available 500, 850 and 1,100 r.p.m. and 8,000; 12,000 and 15,500 r.p.m. shaft is ¼in. dia. 230/240V. Its speed may be further controlled with the use of our Thyristor controller. Very powerful and useful motor, size approx. 2in dia. × 5in long. Price 88p plus 23p postage and insurance.

MAINS MOTOR



Precision made — as used in record decks and tape recorders—ideal also for extractor fan, blower, heaters, etc. New and perfect. Snip at 50p. Postage 15p for first one then 5p for each one ordered.

TELEPHONE HAND SET

Ex-G.P.O.
Perfect order.
50p each plus 20p p. & p.

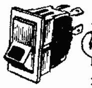
12 VOLT 1½ AMP POWER PACK

This comprises double-wound 230/240V mains transformer with full wave rectifier and 2000 m/f/d" smoothing. Price £1·50, plus 20p post & packing.

NEW LIGHT DIMMER

This uses the latest technique from America, a self triggering device known as the thermo tab and has enabled us to produce a really reliable dimmer at a remarkably low price—namely £2·50 each or 10 for £22·50.

ROCKER SWITCHES



3 new types to offer this month, all snap in fixing into oblong holes. Type 1 S.P. on/off 10 amp 250V. Size approx. 1⅛" × ⅝". Made by Arrow electric. (93 series). Price 12p each. 10 for £1·08.

Type 2 D.P. on/off 10 amp 250V with neon indicator in the lever. Again Arrow 93 series. Price 25p each or 10 for £2·25.

Type 3 Double pole change over spring return, made by the French Russenberg Company. Size approx. 1" × ⅝". Price 15p each. 10 for £1·35.

CARD OPERATED SAFE

All electronic parts to make this £4·50.

AMPLIFIER CASE

Teak veneer on ⅝" ply. modern appearance and design. Size—front 13" × 4½" deep × 8½". Limited quantity £1·25 each plus 25p post and insurance.

MUSIC ON TAPE

A further buy enables us to offer these at an even lower price—namely 65p each or 5 for £2·50. Send for list of titles. We can't repeat when sold out.

PRESSURE SWITCH

Made by Bailey and Macaey Ltd., Type 108R. Adjustable up to 15lb. per square inch. (Instructions included). Set to trip at 8lb. per square inch. Changeover switch rated at 5amp 250V A.C. with re-set button. Electrical connections in box with conduit entry. Price £1·50 each plus 20p post and insurance.

20 WATT INVERTER

Smart and Brown—For van lighting or camping etc. Will light a 2ft. 20 watt standard fluorescent tube from a 12V car battery, current approx. 2A. Very well made unit using die cast chassis. Size 11½" × 2" × 1½". Price £6·50 complete with lamp holders and tube clips.

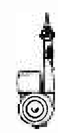
FLEX CABLE SNIP

3 core heavy circular T.R.S. waterproof flex, ideal for running down the garden to pool or shed. 1·5mm cores (5 amp) 100 yard coils £4·25 plus carriage 75p up to 200 miles. £1—300 miles. £1·50—500 miles.

DOOR INTERCOM

Know who is calling and speak to them without leaving bed, or chair. Outfit comprises microphone with call push button, connectors and master intercom. Simply plugs together. Originally sold at £10. Special snip price £3·50 plus 20p postage.

AUTO—ELECTRIC CAR AERIAL



with dashboard control switch—fully extendable to 40in or fully retractable. Suitable for 12V positive or negative earth. Supplied complete with fitting instructions and ready wired dashboard switch. £5·75 plus 25p post and insurance.

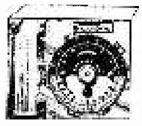
NEED A SPECIAL SWITCH

Double Leaf Contact. Very slight pressure closes both contacts. 6p each, 60p doz. Plastic pushrod suitable for operating, 5p each, 45p doz.

NUMICATOR TUBES

For digital instruments, counters, timers, clocks, etc. Hi-vac XN.3. Price 99p each. 10 for £9.

24-HOUR TIME SWITCH

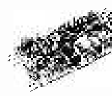


Made by Smiths, these are AC mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with 13A socket. Two completely adjustable time periods per 24 hours, 5A changeover contacts will switch circuit on or off during these periods. £2·50 post and ins. 25p. Additional time contacts 50p pair.

TREASURE TRACER MARK II

Complete Kit (except wooden battens) to make the metal detector similar to the circuit in Practical Wireless August issue. £2·95 plus 20p post and insurance.

MULLARD IF MODULE



This is a fully screened intermediate frequency module for amplification and detection of f.m. signals at 10·7MHz and a.m. signals at 470kHz. The first stage is used as an i.f. amplifier for f.m. and a self oscillating mixer for a.m. operation, in conjunction with an external oscillator coil. 75p each. 10 for £6·75. 100 for £62·50p. With connection dig.

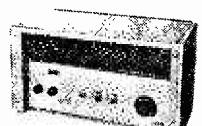
COMPUTER TAPE

2,400ft of the Best Magnetic Tape money can buy—users claim good results with Video and sound. 1in wide £1·00 plus 33p post and insurance with cassette. ¾in wide £1·00 plus 30p post and insurance with cassette. ½in wide 85p plus 25p post and insurance with cassette. Spare spools and cassettes—1in 75p, ½in 75p each plus 20p post and insurance.

ERGOTROL UNITS

These units made by the Mullard Group are for operating and controlling d.c. Motors and equipment from A.C. mains.

Thyristors are used and these supply a variable d.c. resulting in motor speed control and operating efficiency far superior to most other methods.



The units are contained in wall mounting cabinets with front control panel on which are fuses—push buttons for on/off and the variable thyristor firing control.

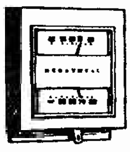
4 models are available—all are brand new in makers cases:

Model 2410 for up to 5 amps £17·50
Model 2411 for up to 10 amps £27·50
Model 2415 for up to 80 amps £95·00

Note: 2415 is a floor mounting 3 phase unit.

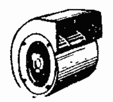
THIS MONTH'S SNIP

HONEYWELL THERMOSTAT



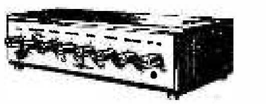
Made by Honeywell for normal air temperatures 40°–80°F (5–25°C). This is a precision instrument with a differential which can be adjusted to better than 1·5°F. A mercury switch breaks on temp. rise—the switch is operated by a coiled bi-metal element and adjustable heater is incorporated for heat anticipation. Elegantly styled and encased in an ivory plastic case with clear plastic windows thermometer above and switch setting scale below-size approx 3·8" × 3·2" × 1·4" deep—can be mounted on conduit box or directly on wall. Price £1·25 each or ten for £11·25.

CENTRIFUGAL FAN



Mains operated, turbo-blower type. Pressed steel Housing contains motor and aluminium impeller. Motor is 1/10th hp giving considerable air flow but virtually no noise. Approx. dimensions 10½" wide by 12" dia. Outlet into trunking 10½" × 4½". £4·95 + £1.

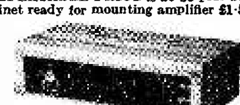
THE FULL-FI STEREO SIX



THE AMPLIFIER SENSATION OF THE YEAR

You will be amazed at the fullness of reproduction and at the added qualities your records or tuner will reproduce. Built into metal chassis ready for mounting on plinth this amplifier uses an integrated solid state circuit with an output power of 6W R.M.S. split over the two channels. The amplifier is ideal for use with normal pick-ups and tuners, it has a double wound mains transformer and ganged volume and tone controls—also switching for Mono to Stereo, tuner or pick-up. UNREPEATABLE PRICE is £6·50 plus 20p post and insurance. Simulated Teak cabinet ready for mounting amplifier £1·50 (posted free when ordered with chassis).

P.E. GEMINI



Dual purpose twin 30 watt stereo amplifier for exceptional performance. Complete kit of parts less case £45 or reprint of data & parts list 55p.

MULLARD. AUDIO AMPLIFIER MODULE

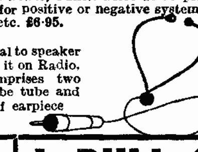
Uses 4 transistors, and has an output of 500mW into 8 ohms speakers. Input suitable for crystal mic. or pick-up 9V battery operated. Size 2in long × 1¼in wide × 1in high.

SPECIAL SNIP PRICE 60p each. 10 for £5·40. 100 for £50.

CAPACITOR DISCHARGE CAR IGNITION

This system which has proved to be amazingly efficient and reliable was first described in the *Wireless World* about a year ago. We can supply kit of parts for an improved and even more efficient version (*Practical Wireless*, June). Price £5·95 plus 20p post. When ordering please state whether for positive or negative systems. De-lux model including printed circuit board etc. £6·95.

RADIO STETHOSCOPE

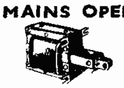


Easiest way to fault find—traces signal from aerial to speaker—when signal stops you've found the fault. Use it on Radio. TV, amplifier, anything—complete kit comprises two special transistors and all parts including probe tube and crystal earpiece. £2—twin stethoset instead of earpiece 75p extra—post and ins. 20p.

QUICK CUPPA

Mini Immersion Heater, 350w. 200/240v. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. £1·25, 12v. car model also available same price. Jug heater £1·50 (mains only)

MAINS OPERATED SOLENOIDS



Model TT2—small but powerful 1" pull—approx. size 1½ × 1½ × 1¼" 60p.
Model 400/1⅞" pull. Size 2¼ × 2 × 1⅞" 75p.
Model TT10 1½" pull. Size 3 × 2½ × 2¼" £1·80 plus 20p post and ins.

MAINS RELAY BARGAIN

Special this month are some single, double and treble pole changeover relays. Contacts rated at 15 amps. Operating coil wound for 240V. A.C. Good British Make. Unused. Size approx. 1½" × 1". Open construction.

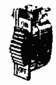
Single pole 25p each 10 for £2·25
Double pole 35p each 10 for £3·15

DRILL CONTROLLER

NEW 1KW MODEL

Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. £1·50 plus 13p post and insurance. Made up model also available. £2·25 plus 13p post & p.

SLIDE SWITCHES

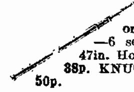


Slide Switch. 2-pole changeover panel mounting by two 6B.A. screws. Size approx. 1in × ⅜in rated 250V lamp. 6p each. 10 for 54p, 100 for £5·10, 500 for £24. Ditto as above but for printed circuit 5p each 10 for 45p, 100 for £4·25. Sub Miniature Slide Switch. DPDT 19mm (¾in approx.) between fixing centres. 12p. each or 10 for £1·08.

LIGHT CELL

Almost zero resistant in sunlight increases to 10 K Ohms in dark or dull light, epoxy resin sealed. Size approx. 1in dia. by ¼in thick. Rated at 500 MW, wire ended. 43p with circuit. Also ORP12 light cell 45p.

TELESCOPIC AERIAL

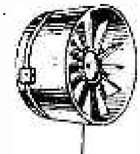


for portable, car radio or transmitter. Chrome plated—6 sections. extends from 7½ to 47in. Hole in botton for 6B.A. screw, 38p. KNUCKLED MODEL FOR F.M. 50p.

0-8 AMMETER

2in square full vision for flush mounting. Moving iron instrument. Ideal for charger. Price 43p each. 10 for £3·90.

EXTRACTOR FAN

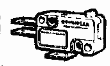


Cleans the air at the rate of 10,000 cubic ft. per hour Suitable for kitchen, bathrooms, factories, changing rooms, etc., it's so quiet it can hardly be heard. Compact. 5⅛" casing with 5¼" fan blades. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector, and fixing brackets. £2 plus 36p post and ins.

DIGITAL CLOCK

As featured this issue, send for parts list.

MICRO SWITCH



5A changeover contacts. 9p each. £1 doz. 15 amp Model 10p each or £1·05 doz.

MINIATURE WAFER SWITCHES

2 pole, 2 way—4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole 6 way—1 pole, 12 way. All at 20p each £1·80 for ten, your assortment.

REED SWITCHES

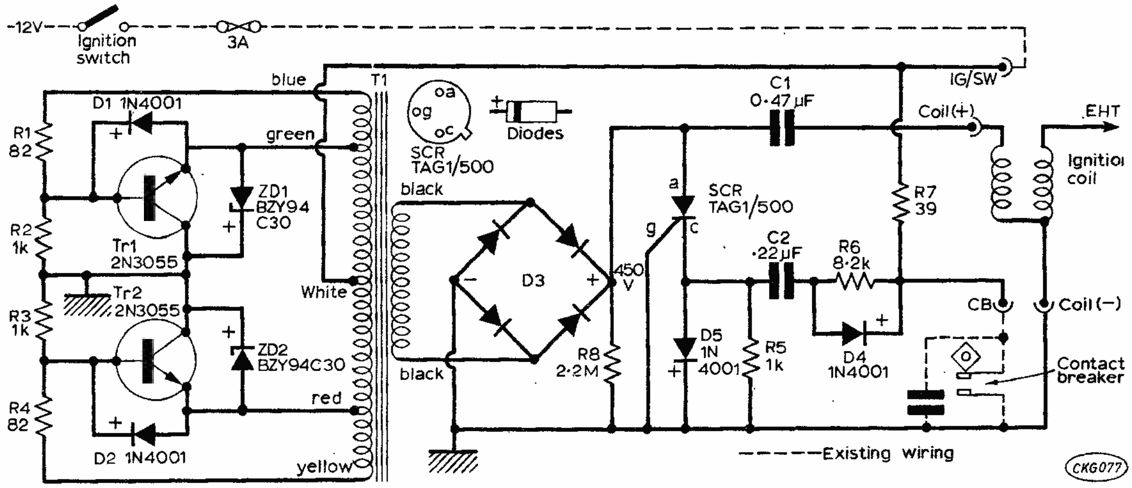
Glass encased, switches operated by external magnet—gold welded contacts. We can now offer 3 types.

Where postage is not stated then orders over £5 are post free. Below £5 add 20p Semiconductors add 5p post. Over £1 post free. S.A.E. with enquiries please.

J. BULL (ELECTRICAL) LTD.

(Dept. P.W.), 7 Park Street, Croydon CRO 1YD

Callers to: 102/3 Tamworth Road, Croydon.



Only minor amendments have been made to the original circuit. This one is for ***POSITIVE*** *earth vehicles.*

One end of R6, the negative end of D4, and one end of C2 are soldered to the free tag on the two-way strip; the free end of R6 and the positive end of D4 are then connected to the unit tag marked CB as is also one side of R7, the other side of R7 and the white T1 lead solder to the earth tag 8 which is unit tag marked IG/SW.

The free end of C2 connects to lower half of tag 7 on eight-way strip.

Capacitor C1 fixing clamp should now be fixed in position and C1 secured by means of the clamping bolt—not forgetting to use a small piece of aluminium as a crush guard. One end of C1 connects to unit tag marked coil positive and the other end covered with good quality plastic sleeving and dressed as in Fig. 4 and connected to tag 5 on eight-way strip.

The thyristor heat sink is then fixed by bending both upper and lower portions of tag 6 (on eight-way strip) in such a manner as to form an almost complete wrap around the strip, the slot in the heat sink is then pushed down centrally over this wrap and soldered in position as shown in Fig. 4.

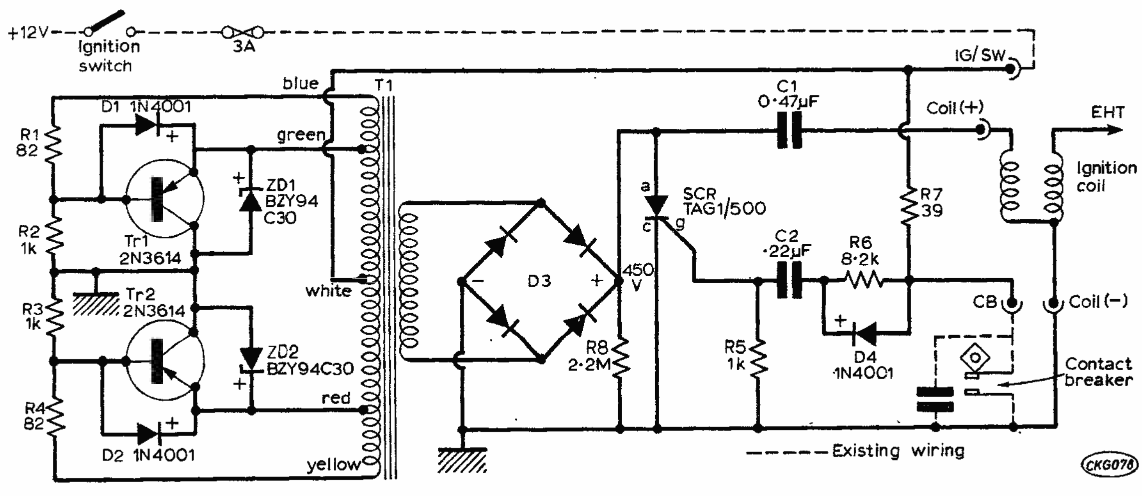
The last component to be fitted is the thyristor SCR and reference to Fig. 4. clearly shows how this is connected, namely anode to tag 5 cathode to tag 7 on eight-way strip whilst the gate is connected to the earth bus bar adjacent to unit tag marked Coil negative.

The TAG 1/500 has proved eminently suitable for use with most ignition coils as fitted to British cars and far superior to those s.c.r.'s obtained from other sources, in freedom from breakdown, but some foreign-made ignition coils require the TAG 1/600 to be used owing to the primary inductance generating excessive oscillatory peaks. However, this subject is too extensive to go into in this article and the foregoing remarks can be taken as a reliable guide.

TESTING

When the unit is complete it should be tested by applying the car battery to connectors IG/SW and −ve (IG/SW to live feed and −ve to that pole of the battery which is earthed on the particular car and unit) when a whistle should be heard indicating that the oscillator section is working. The voltage

This circuit is for ***NEGATIVE*** *earth vehicles. Certain diode polarities are reversed as well as the gate and cathode connections to the SCR. Diode D5 is omitted.*



across the bridge rectifier is then measured and should be approximately 450V, this reading may increase to approximately 480V when the connections to the ignition coil are made but it depends on coil characteristics.

Assuming these initial tests to be satisfactory the unit is then fixed to the car in a suitable place, all connections checked, and the unit is ready for use.

CONNECTING UP

The connections of the ignition unit to the vehicle are quite simple but are given here in full for guidance of any constructor who may be doubtful.

After mounting the unit (preferably on side of wing or bulkhead so as to keep leads from the unit to the ignition coil as short as practicable) remove the existing ignition switch to ignition coil wire—that is the thin lead which does *not* go to the contact breaker—and connect to unit tag marked IG/SW (see notes in text about ballast resistor if cold start coil is fitted).

Remove the thin lead from the ignition coil which connects to the contact breaker, and connect this lead to unit tag marked 'CB'.

Two short extra leads are now required and are connected one lead from unit tag marked 'coil negative' to ignition coil terminal marked 'negative,' the other lead goes from unit tag marked 'coil positive' to ignition coil terminal marked 'positive.' These connections are identical for both negative and positive earthed vehicles.

For coils marked SW and CB, this corresponds to positive and negative respectively—see circuit diagram.

Should the reversionary facility be required—due to component fault, although this should not occur if the recommended components are used—simply remove the two short leads connecting the unit tags marked 'coil positive' and 'negative' to the ignition coil positive and negative.

Remove the lead from the unit tag marked CB and connect it to the ignition coil terminal which is the same polarity as that terminal of the battery which is earthed to the chassis.

The remaining lead which is left on the unit tag marked IG/SW is removed and connected to the remaining free terminal on the ignition coil.

PLUGS

It is recommended that the sparking plug gaps be reset to around 0·050″ instead of the usual gap which is about 0·025″, as the higher resistance load thus presented enables the greater output available from the electronic ignition unit to be used to the fullest advantage.

The prototype of this unit is in use on the writer's car and has proved a worthwhile accessory.

NEXT MONTH Part 2 reviews the various types of ignition coil available today and how they can be used with the PW Electronic Ignition System plus information on using your tachometer with this unit. Finally, a discussion of the various advantages of the PW unit as obtained in actual road tests.

PROJECT Autumn

Practical Wireless Designer's Trophy 1972

To encourage new authors, entries for the 1972 Trophy will be restricted to readers who have not previously had an article published in PW. This leaves the field wide open for those wanting to try their hand at writing technical constructional articles. Contestants will not be in competition with well-known authors, only with other newcomers, so the cup can only be won by a new writer. **It Could Be You.**

TURN YOUR CONSTRUCTIONAL PROJECT INTO CASH—AND MAYBE WIN THE CUP!

RULES

1. The winning entry will be chosen by a panel of judges from among articles published in issues of PW dated September 1972 to August 1973 inclusive. The Editor's decision on all matters arising will be final.
2. The winner of the competition will receive and retain outright the PW Designer's Trophy 1972. Other prizes will be awarded to the best runners-up. Articles will be paid for shortly after publication.
3. The competition is open only to authors who have not previously had any work published in PW.
4. Articles submitted for the competition should conform to the general style of material published in PW and must describe the operation and construction of a piece of radio, audio or test equipment that has been designed and built by the author.
5. Articles should, preferably, be typed using double spacing, leaving wide margins, on one side only of each sheet. Circuit diagrams and any other drawings must be separate and numbered to agree with the text. Author's roughs must be clear enough to permit re-drawing. Components list must also be separate and laid out to the standard PW format.
6. Photographs of the equipment are desirable and should be in black and white, sharp and clear. Photographs may be identified by sticking a label on the reverse instead of writing on the back of the photograph itself.
7. Components used in the design must be readily available from retail sources.
8. Articles should be sent to the Editor, Practical Wireless, Old Fleetway House, Farringdon Street, London, E.C.4. Authors will be advised as soon as possible of the acceptance or rejection of their articles. Equipment, the subject of an article, must not be sent to the Editor until advised to do so.
9. Employees and staff of PW are not eligible for entry to this competition.

SUBMIT YOUR ARTICLES NOW

TAKE 20

JULIAN ANDERSON

No. 37
BURGLAR ALARM

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

MAGAZINES such as *Practical Wireless* require a continual supply of new ideas and new articles in order to attract readers; this is not always easy as new and original projects are rare. There is one field however which seems to have been almost ignored—that of burglar and security alarms. A few have been published but I can only recall three in the past ten years.

This is all the more extraordinary when one considers how useful (and how simple) a burglar alarm can be. Admittedly the electronics side is only the tip of the iceberg as the hard part is the fitting and wiring of the alarm circuit rather than the construction of the alarm itself. This can present problems but some guides will be given.

The circuit of the alarm itself is shown in Fig. 1. This is a simple, but reliable audio oscillator whose output is fed to a loudspeaker. The alarm circuit wire is shown as a shorting link between the base and emitter of Tr1; this cuts off the transistor. This link will, of course, be very long; it may be up to 100 yards but even so its resistance will not be more than a few ohms assuming that reasonable quality wire is used. This will have virtually no effect on the circuit and may, for our purposes, be considered as a dead short.

When this link is broken Tr1 will be biased by R1 and when conducting this will in turn provide bias for Tr2 causing a considerable current to be passed through the primary of the transistor output transformer T1 and so to the speaker. However the inclusion of C1 causes this current to appear as a series of pulses and this sounds like an audio note in the speaker.

When the alarm circuit is closed the only current passing will be that through R1 plus the tiny leakage currents through the transistors. This will be below 20μA in total and this sort of current can be taken from a battery almost indefinitely; it will decay of old age before running down.

Note that the output of the speaker, while being more than sufficient to scare off a burglar, is not all that high and so an efficient speaker should be used. This excludes the use of miniature types and the larger the diameter, the greater will be the output.

The construction of this circuit should present few problems but a suggested layout on a small tagboard is shown in Fig. 2.

The alarm circuit comprises a single wire running between the doors and windows to be protected. The contacts can take many forms. Microswitches can be used, most of these have changeover contacts and so can be arranged to break the circuit when a window or door is opened. A springy metal can also be used to make the contacts. All of the switches must be in series of course so that if any one of them is opened the alarm will sound.

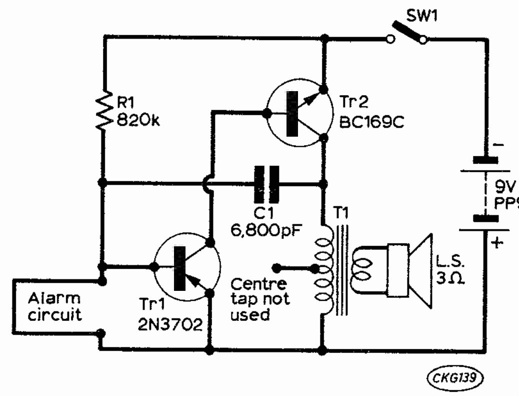


Fig. 1: The circuit of the Take 20 Burglar Alarm.

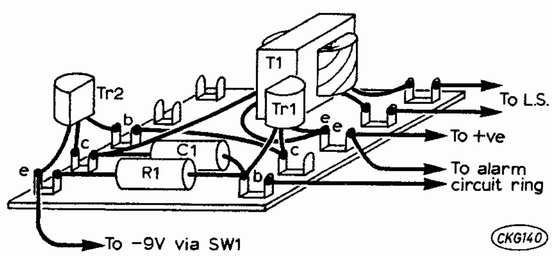


Fig. 2: A suggested component layout on tagboard.

R1	820kΩ, ⅛W, 5%	1p
C1	6,800pF, polystyrene	4p
Tr1	2N3702	13p
Tr2	BC169C	11p
T1	Transistor output transformer (Eagle Type LT700 or similar)	20p
LS	3Ω loudspeaker (ex-TV type)	15p
SW1	On-off switch	5p
	Tagboard	11p
		80p

Prices are those recently advertised in Practical Wireless and may have changed. No allowance is made for minimum order costs or for postage and packing and these should be checked carefully before ordering.

In addition to acting as a burglar alarm, this arrangement will also provide a rapid check to ensure that all the necessary windows and doors are shut. It is also a fail-safe circuit; any faults in the circuit will cause the alarm to sound.

Although battery operation is perfectly satisfactory if the battery is replaced regularly, it is far better to operate this circuit from a mains power supply. In the long run this will be cheaper and more reliable. ■

*

IN NEXT MONTH'S PRACTICAL WIRELESS

AUDIO Test TRIO

Either of these audio signal generators plus the calibrated switched attenuator will enable the constructor to carry out accurate performance tests and measurements on audio equipment. Output amplitude is stabilised using an FET rather than the usual power-consuming thermistor, permitting operation with self-contained batteries. The series starts with a full description of the more sophisticated, full-facility, sine/square-wave version.

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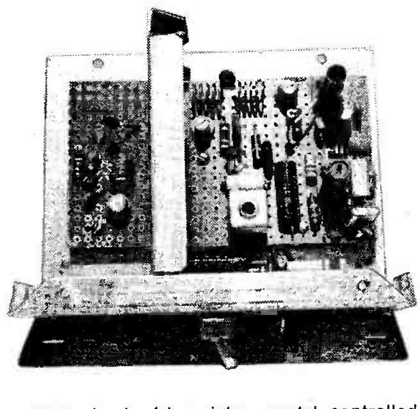
DX'ERS AUDIO AID

This unit will greatly improve the intelligibility of weak DX signals—by filtering the a.f. rather than working at r.f. It incorporates a highly efficient adjustable noise limiter together with an audio filter which will virtually eliminate heterodynes, whatever the strength.

2 METRE F.E.T. CONVERTER



This simple 4-transistor crystal controlled converter permits reception of the entire 2 metre amateur band (144-146MHz) on any receiver capable of covering from 4 to 6MHz. A suitable choice of crystal frequency allows direct frequency read-out on 2 metres from the calibration on the main receiver.

ALL IN THE JULY ISSUE ON SALE 2nd JUNE

The TEXAN

20+20 WATT I.C. STEREO AMPLIFIER

PART 2

RICHARD MANN

Note: Switch section S1A in Fig. 2 (last month) should have been in the closed position. In the specification, the dynamic range should have been given as +38dB and in Fig. 7 the + and − terminals should be reversed. Under the heading "Quiescent Current Setting" on page 56, reference is made in the text to R28. This should have been R24. In the components list the BZY88C15 was specified for ZD1 and ZD2. Although this device is quite suitable for the TEXAN the Texas 1S2150A zener is now specified for ZD1/ZD2.

Equalisation

The input selector switch has three positions—for radio, magnetic pickup and an auxiliary position. The radio position gives a flat response to the input stage from <5Hz to 500 kHz and the input sensitivity is 30mV for 20watts output into 8Ω. This is probably over sensitive for some tuners but the *Texan* has a good overload margin of some 38dB so that even 500mV from the tuner could be handled comfortably.

The pickup equalisation characteristic is shown in Fig. 13. In this position the overall gain of the amplifier is 74dB at 1kHz giving a sensitivity of 2·5mV for full output. Also plotted is the theoretical RIAA curve which is formed from three time constants—3180μS, 318μS and 75μS. Assuming that R6 is 270kΩ (exactly!) this gives the following values for R7, C7 and C8 respectively: 21·76866390kΩ, 3·730376467nF and 10·087777777nF—approximately! The values given last month in Fig. 2 are the nearest standard values and in the prototype gave a maximum error of about 1dB in the audible range. However, these theoretical values are quoted only for the theorist.

The beauty of operational amplifiers, of course, is that given the near-perfect component value you will get a near-perfect response.

This brings up the question of crystal and ceramic pickups which many people will undoubtedly wish to use. There are several ways of tackling this:

For the cheaper cartridge giving an output of several hundred millivolts a high impedance attenuator such as shown in Fig. 14 could be used. With such a high signal there will be little lost in signal/noise performance and the 1MΩ load will give a fairly flat output without further correction. This means that R7, C7 and C8 should be omitted and R6 changed to about 10kΩ.

Cartridges giving outputs of tens of millivolts cannot be treated this way as the signal would be attenuated too heavily since it is necessary to keep the 'earthy' resistance down to about 5kΩ to avoid damping the rumble filter. The rumble filter could be omitted leaving only R2 which would be returned to pin 2 of IC1 instead of ground. It would then be bootstrapped so that the input impedance would rise to several megohms. Again R7, C7 and C8 would be omitted and R6 reduced to

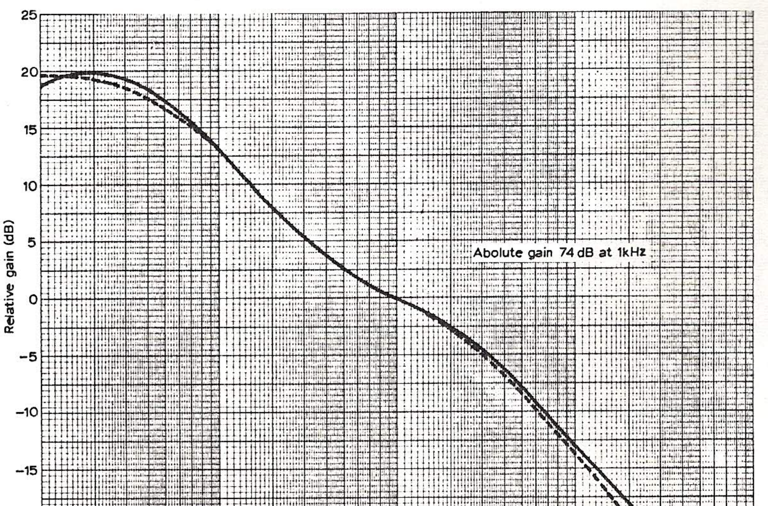
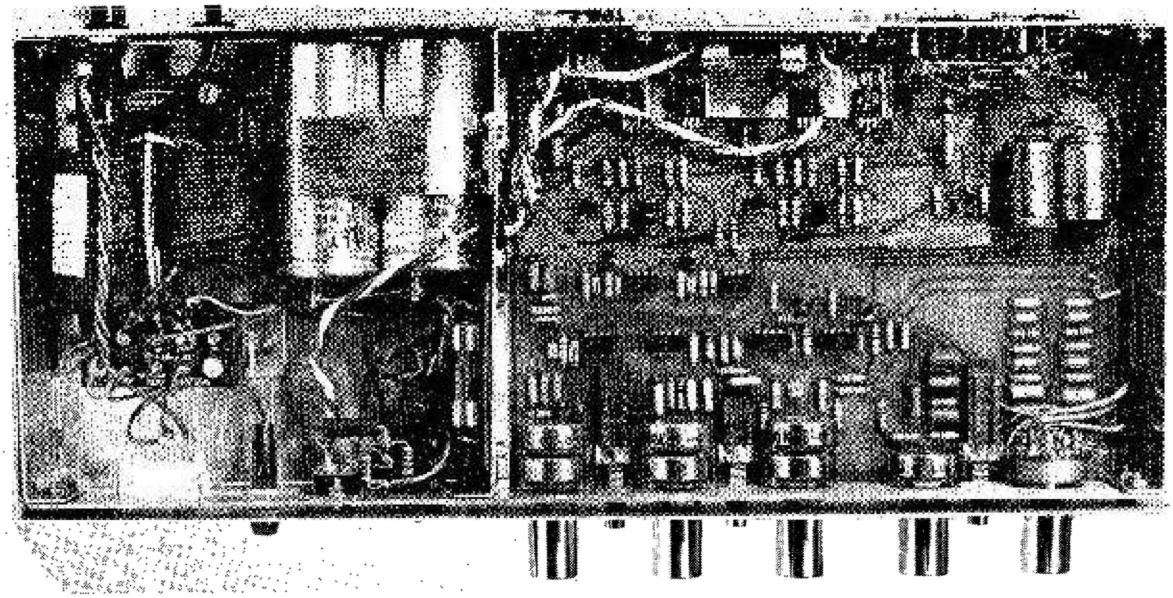


Fig. 13: Magnetic pickup characteristic (measured—solid curve, theoretical—dotted curve).



The complete Texan amplifier. The power supply section is to the left of the dividing screen.

approximately 1kΩ. However it seems a pity to lose the rumble filter especially as ceramic cartridges are more likely to be used with the sort of turntables which require a rumble filter most.

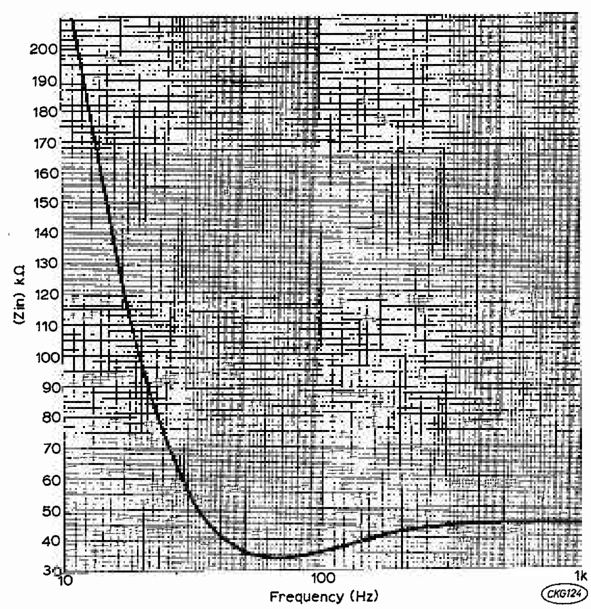
Therefore, the best approach is to use a low impedance loading circuit on the ceramic cartridge such as shown in Fig. 15. This will give a characteristic which approximates to the velocity characteristic of a magnetic cartridge and the output level will also be similar so that the amplifier can be used without modification to its feedback components. This circuit allows some variation of the shunt capacitor to improve the linearity of the response and some manufacturers will quote the circuit values which give the best "magnetic" characteristic from their particular cartridge. If this approach is adopted the constructor can wire the attenuator quite neatly across the pins of the DIN pickup socket.

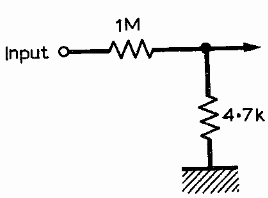
Input Impedance

In the specification the input impedance of the amplifier is quoted as 47kΩ at 1kHz. This nominal figure is modified when the rumble filter is inserted in circuit partly due to the shunting effect of R1 and partly to the series reactance of C1 and C2. This will not normally have any effect on a magnetic pickup cartridge but it may have some loading effect if a ceramic/magnetic conversion network is used so the variation of input impedance is plotted in Fig. 16.

Auxiliary

The *Texan* was originally designed to give an equalized output directly from a tape head without external amplifiers. For this reason the circuit shows R8, R9 and C9 and the printed circuit board is laid out to take these components. However, the present





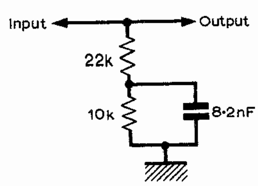


Fig. 14: (far left) Equalisation circuitry for high output crystal/ceramic pickup cartridges.

Fig. 15: (left) Equalisation circuitry for low output crystal/ceramic cartridges.

Fig. 16: (above) Variation of input impedance with frequency (rumble filter in).

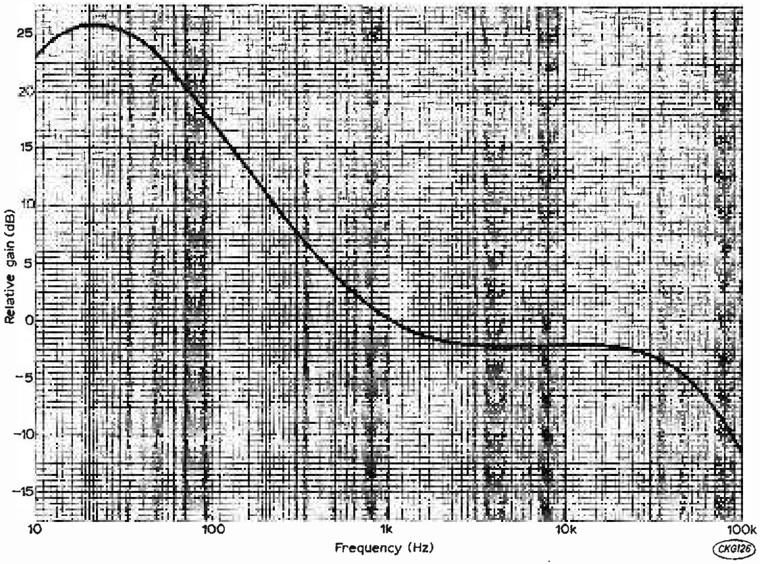


Fig. 17: Tape replay characteristic (direct from head).

day tendency is for a separate tape unit, having internal amplifiers. If it is intended to use such a unit, R8 and C9 should be omitted and R9 reduced to approximately 1·2kΩ giving a flat characteristic and sensitivity similar to that of the radio position.

Nevertheless I feel that many home constructors may be interested in a tape head facility so the following table gives the appropriate values for a few of the standard replay characteristics.

TABLE 1

	R8	R9	C9	Standard time constants
D.I.N. 1⅞ ips	33kΩ	390kΩ	3·9nF	1590μS 120μS
D.I.N. 3¾ ips	33kΩ	820kΩ	3·9nF	3180μS 120μS
D.I.N. 7½ ips	22kΩ	—	3·3nF	— 70μS
N.A.B. 7½ ips	15kΩ	1 MΩ	3·3nF	3180μS 50μS
N.A.B. 3¾ ips	27kΩ	1 MΩ	3·3nF	3180μS 90μS
N.A.B. 1⅞ ips	As for 3¾ ips N.A.B.			

The overall response of the amplifier when using components for DIN 3¾ i.p.s. is shown in Fig. 17. The sensitivity of the amplifier with this characteristic was 1mV approx. Once more the very high loop gain of the operational amplifier is valuable for producing the large amount of bass boost which is required.

Performance

A number of facts and figures have already been quoted regarding the performance of the *Texan* so that distortion is the main topic left for discussion.

Apart from the money the other good thing about writing an article is the opportunity it gives for liberating a few proverbial bees from one's bonnet. My personal "bee" is concerned with the vicious circle of "specmanship" which sets Hi-Fi designers chasing each others' tails (or should it be "tales"). Now I am all in favour of pickups which track, noise reduction systems for tape recorders, f.m. broadcasting and electrostatic loudspeakers—on the whole I am sure that they are worth the money. But I cannot see much point in paying more and more for better and better amplifiers when they are already too good for the transducers coupled to them. When the most experienced ears can barely detect 0·1% distortion on pure tones why spend money struggling for 0·01%, especially when all transducers and recording media introduce about 2 or 3% in themselves. This is a generalisation, of course, and it is always easy to find a specific flaw in such an argument. However, I feel the basic principle is good. Namely, consider the system as a whole and don't spend a lot more money unless you are going to hear the difference. With that said, here are a few more figures:

TABLE 2

Load	Fundamental frequency	Power output (watts)	Harmonic output (dB) 2nd	3rd	4th	T.H.D. %
15Ω	1kHz	15	76	67	—	0·047
		10	74	80	86	0·023
		5	74	80	80	0·024
		0·5	71	77	80	0·033
		0·05	59	61	62	0·164
	10kHz	15	51	48	80	0·488
		10	54	53	70	0·302
		5	56	57	64	0·221
		0·5	57	57	67	0·205
		0·05	61	70	75	0·096
8Ω	1kHz	25	63	61	69	0·114
		20	65	63	—	0·09
		15	66	65	—	0·075
		5	69	75	—	0·04
		0·5	75	75	—	0·025
		0·05	65	68	69	0·077
	10kHz	25	50	43	63	0·779
		20	52	46	69	0·562
		15	54	50	70	0·375
		5	60	56	65	0·196
		0·5	60	77	—	0·101
		0·05	60	—	—	0·10
4Ω	1kHz	25	61	50	75	0·329
		20	63	50	—	0·324
		15	65	52	—	0·257
		10	67	55	90	0·183
		5	68	61	81	0·098
		0·5	66	70	71	0·066
		0·05	55	58	59	0·245

Distortion: Harmonic distortion was measured using a Radford Low Distortion Oscillator and a Hewlett Packard 3590A Wave Analyzer with a 3593A Sweeper.

This measurement technique is far more accurate and gives more useful information due to the subjective nature of harmonic distortion. The harmonics

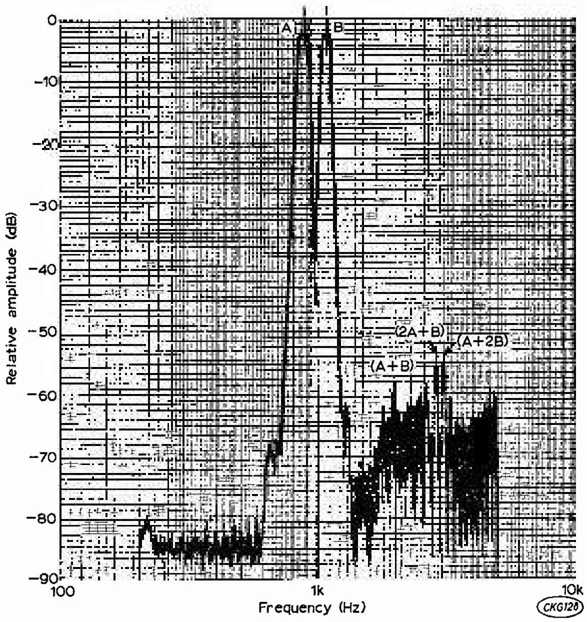


Fig. 18: Wave analysis for input frequencies of 900Hz and 1·1kHz.

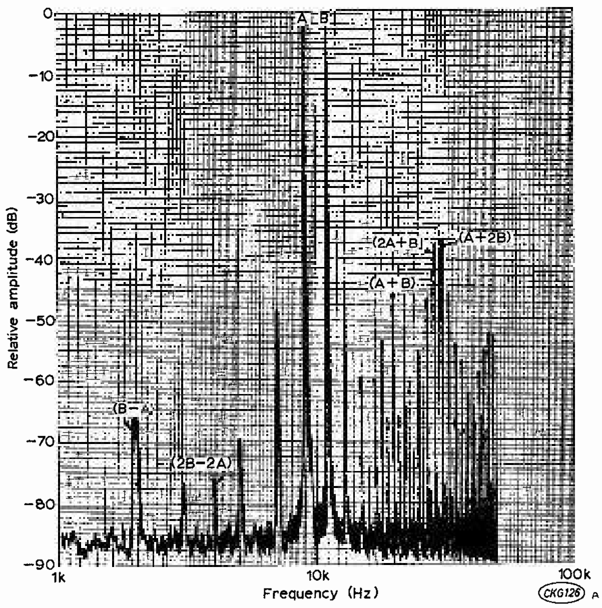


Fig. 19: Wave analysis for input frequencies of 9kHz and 11kHz

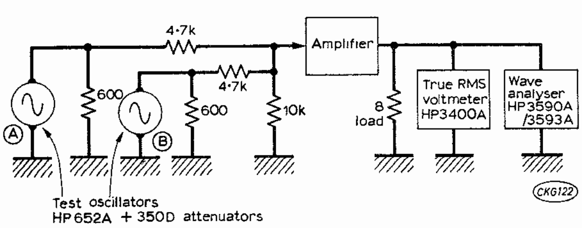


Fig. 20: Test set-up that was used for measurements of intermodulation products (I.P.).

are therefore tabulated in some detail in Table 2 along with total harmonic distortion figures. So you pays your money and you takes your choice. The harmonics are quoted in dB below the fundamental. The total harmonic figures are given as a percentage and calculated from

$$\text{T.H.D.} = \sqrt{V_2^2 + V_3^2 + V_4^2} \ldots.$$

where V_2, V_3, V_4 etc are the percentage values of the harmonic components.

It can be seen that the percentage T.H.D. does not leap up at the levels where crossover distortion would be apparent so the amplifier has a good clean sound.

The *Texan* is primarily designed to work into 15Ω or 8Ω speakers but, for interest, some distortion figures are also quoted for 4Ω loads.

All the measurements were made on the complete amplifiers so they include any distortion due to the preamplifier.

Intermodulation Distortion

The intermodulation products (I.P.) in an amplifier's output result from non linearity of the transfer characteristic which causes multiplication of the components of a complex input waveform so that a spectrum of sum and difference frequencies may be produced across the entire amplifier bandwidth. Thus with only two sinusoidal inputs with frequencies A and B we may get I.P.'s at frequencies of A+B, A−B, 2A+B, 2A−B, A+2B, A−2B etc. If the spectrum is analyzed there will also be components at 2A, 2B, 3A, 3B which are due to harmonic distortion in the signal source and those harmonics produce their own I.P.s resulting in the general mish-mash shown in Figs. 18 and 19.

However, after a bit of mental arithmetic, it is fairly easy to sort out the I.P.s which really count. The total intermodulation distortion is calculated from:

$$\text{I.D.} = \frac{\sqrt{IP_1^2 + IP_2^2 + IP_3^2}}{A+B} \times 100\%$$

where I.P., etc are the amplitudes of the intermodulation products A and B are the amplitudes of the input waveforms.

Therefore any I.P. which is 10 to 20dB below the major I.P. in level can virtually be ignored.

The method of measurement was as follows: With the apparatus shown in Fig. 20, oscillator A was temporarily disconnected and the level from oscillator B was adjusted to give 12·6 volts across the 8Ω load (ie 20 watts). The B attenuator was then set back 3dB. This procedure was repeated for oscillator A alone. The two inputs were then mixed together and the output checked on the true r.m.s. meter to ensure that the power was still 20 watts.

The input frequencies were 900Hz and 1·1kHz in one case (Fig. 18) and 9kHz and 11kHz in the other case (Fig. 19). The analyzer was set to sweep from 200Hz to 5kHz for the low frequency test and from 2kHz to 50kHz for the higher frequency test with an analyzer bandwidth of 100Hz in each case.

Fig. 18 shows that with inputs 900Hz and 1·1kHz the predominant I.P.s occur at 2kHz (A+B), 2·9kHz (2A+B) and 3·1kHz (A+2B). These components give a percentage I.D. of 0·19% approximately.

At the higher frequencies it is easier to pick out I.P.s due to the amplifier and again it can be seen from Fig. 19 that the dominant components are at 20kHz, 29kHz and 31kHz. The difference frequency I.P.s are also clearly seen at 2kHz (B−A), 4kHz (2B−2A) etc but they are insignificant compared with the sum products so that an I.D. figure of 1·0% is obtained.

These distortions may seem rather high but the method of measurement was rather unkind since the *peak* voltage for the combined waveform is $\sqrt{2}$ times greater than the *peak* voltage for a pure sine input due to the beating of the two waves. The peak output voltage is thus 25·2 volts giving a peak power of 80 watts instead of 40 watts.

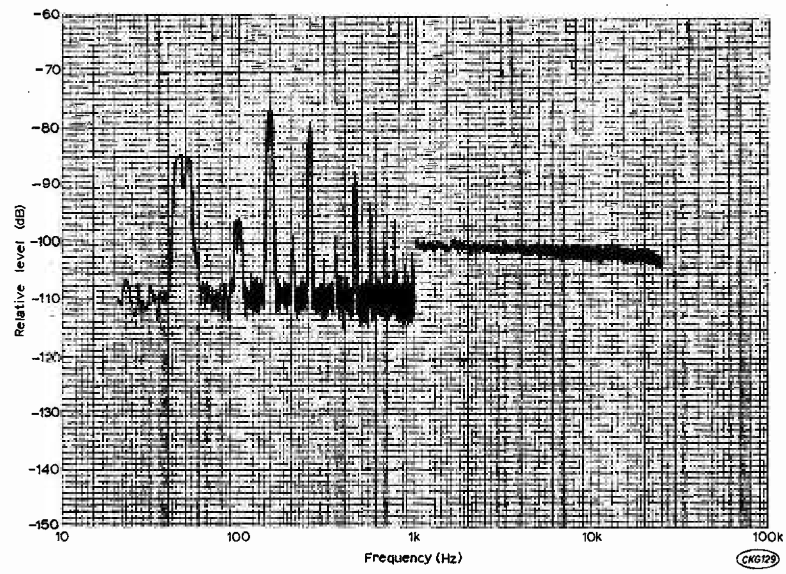


Fig. 21: Noise v. frequency.

Noise and Crosstalk

The wave analyzer which was used for the distortion measurements is also a very valuable instrument for measuring noise and crosstalk. It gives more accurate and meaningful results and since one has only to insert the graph paper and push the button it appeals to my lazy nature.

The noise versus frequency plot shown in Fig. 21 was made with the *Texan* switched to the radio input and the volume control turned up to nearly maximum so that the input sensitivity was exactly 30mV. The input was then grounded via 600Ω and the wave analyzer was connected across the amplifier output.

Between 20Hz and 1kHz an analyzer bandwidth of 10Hz was used, necessitating an automatic sweep rate of 1Hz/Sec. To avoid spending six hours or so completing the plot to 25kHz, the bandwidth was increased to 100Hz after 1kHz. This allowed the sweep rate to be increased to 10Hz/Sec.

The ordinate scaling of the graph is relative to the full output voltage (12·6V) and it can be seen that between 20Hz and 1kHz the mean level is approximately −110dB. Above 1kHz the level jumps by 10dB since noise is proportional to **$\sqrt{\text{Bandwidth}}$**

$$\left(\text{and } 20 \log_{10} \frac{100}{10} = 10\text{dB}\right)$$

However, the absolute noise/root cycle is still the same, about 38μV/$\sqrt{\text{Hz}}$. To get a full bandwidth signal/noise ratio we must add 33dB to the plotted level:

$$\left(\text{i.e. } 20 \log_{10} \frac{20\text{kHz}}{10\text{Hz}}\right) \text{ giving a figure of 77dB.}$$

The wave analyzer allows the hum components to be measured separately since peaks are obvious at 50Hz and particularly at the odd harmonics of 50Hz indicating that they originate in the power supply. Adding these components together gives a separate figure of 75dB for the signal/hum ratio.

More subjectively I have found that for normal listening in domestic surroundings one has to put an ear fairly close to the loudspeaker to decide if the amplifier is switched on or not and that is really the acid test.

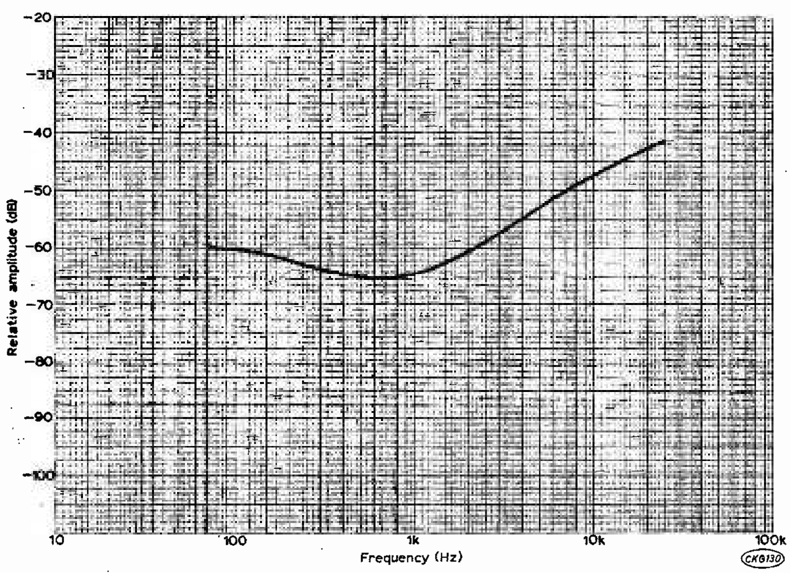


Fig. 22: Interchannel crosstalk v. frequency.

To measure crosstalk versus frequency the b.f.o. output of the wave analyzer was used to provide a 30mV input to one channel of the amplifier. The input of the other channel was grounded via 600Ω and the balance control was set to its mid-way position. The volume control was adjusted to give 20 watts into one load so that any extra coupling via the power supply would be included. The analyzer input was then connected to the output of the other channel. A continuous sweep was made between

60Hz and 25kHz at a bandwidth of 100Hz. The ordinates of the plot are again relative to full output voltage giving an inter-channel crosstalk figure of −65dB at 1kHz and −48dB at 10kHz. The crosstalk figures quoted in the specification were measured with an r.m.s. voltmeter at full bandwidth—hence the difference of 14dB at 1kHz. This shows the merit of using a selective voltmeter at low signal levels if other spurious signals are likely to be present. At 10kHz the crosstalk becomes the predominant signal so that the specification figure is not in error at this frequency.

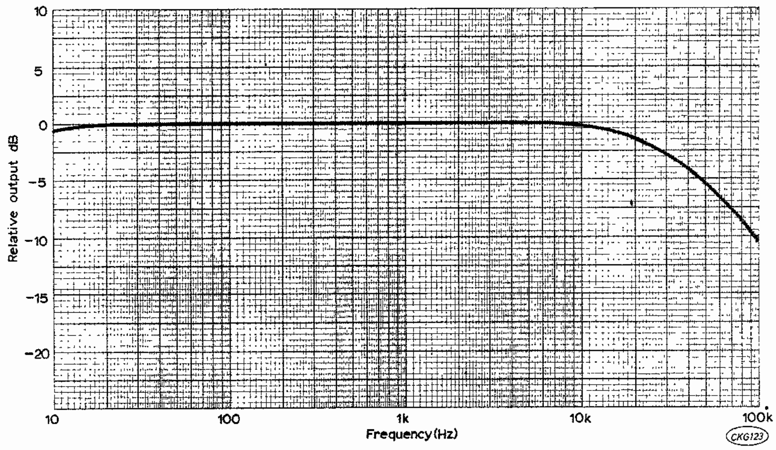


Fig. 23: Power response (20W into 8Ω resistive load).

Power response

The frequency response of the *Texan* was plotted with the selector switch in the flat radio position and with the input and gain adjusted to give a power output of 20 watts at 1kHz into an 8Ω resistive load. The response is almost identical to the low level response shown in Fig. 5 (part 1). This indicates that the gain of the amplifier is still determined by the passive feedback components in the circuit and is not effected by changes in the parameters of the transistors in the power stage. The phase advance capacitor C18 produces a smooth roll-off outside the audio band to eliminate r.f. signals from the output which could cause intermodulation problems with stereo multiplex decoders, tape oscillators and so-forth. In response to numerous enquiries, readers are reminded that all components for the *Texan*—including drilled fibre glass p.c. board, drilled and punched metalwork, finished front panel, will be available from Henry's Radio Limited.

Kits will also contain pre-formed wire packs to facilitate assembly and complete hardwear—in fact everything will be included even down to the last nut and bolt.

A slimline version of the teak sleeve—slimmer than the type shown in the photographs will be available during July/August.

Henry's Radio Limited are the sole U.K. distributors for the *"TEXAN"*, to the trade and retail outlets.

TO BE CONTINUED

MOBILE RALLY DIARY

May 7— Spalding "Tulip Time" at picnic site, Surfleet, 4 miles north of Spalding on the A16 Spalding-Boston road. Talk-in stations will be G3VPR/P on top band (1980kHz). Something for all the family. Free admittance.

May 21— Northern Mobile Rally, at Moore Grange School, Parkstone Avenue, off Ring Road, West Park, Leeds. Refreshments will be available. Further details from D. Binns, G3MGI, 80 Gipton Wood Road, Leeds 8, Yorkshire.

May 28— Chiltern Mobile Rally, organized by the Chiltern Amateur Radio Club, and held in the grounds of Sir Francis Dashwood, at West Wycombe, near High Wycombe, on the same day as an annual steam rally. Talk-in on 160m and 2m. Further details from: P. Perkins, G3OUV, Loakes House, Loakes Park, High Wycombe, Bucks. High Wycombe (0494) 21612.

May 28— Hull & District Amateur Radio Society held in grounds of the East Riding College of Education, Bishops Burton, on the A.1079 York to Beverley. Further information from L. D. Colley, G3AGX, Micasa, Ferry Road. Wawne, Hull, Yorkshire.

June 11— Third Elvaston Castle, Elvaston Castle Countryside Park, Nr. Derby.

June 18— Anglian Mobile Rally, at the Suffolk Show Ground, Ipswich. Further details from D. W. Thomas, G3ZLN, The Old Peoples Home, 9 Burlington Road, Ipswich, Suffolk.

June 25— Bristol City & County RSGB Group, at Longleat, Warminster, Wilts.

June 25— West of England Mobile Rally, at Longleat, near Warminster, Wiltshire. Information from D. Iles, G3COP, 23 Dryleaze Road, Stapleton, Bristol.

July 2— South Shields & District Amateur Radio Club.

July 9— Cornish Mobile Rally, organized by the Cornish Radio Amateur Club, will be held at the Truro Rugby Football Ground. Talk-in stations will be operational on 1·875kHz a.m. and 2m a.m.

July 16— Upton-on-Severn Mobile Rally organised by the Worcester & District Amateur Radio Club. Further information from B. A. Jones, G8ASO, 12 Woodside Road, Larkill, Worcester.

August 6— Woburn Abbey Rally.

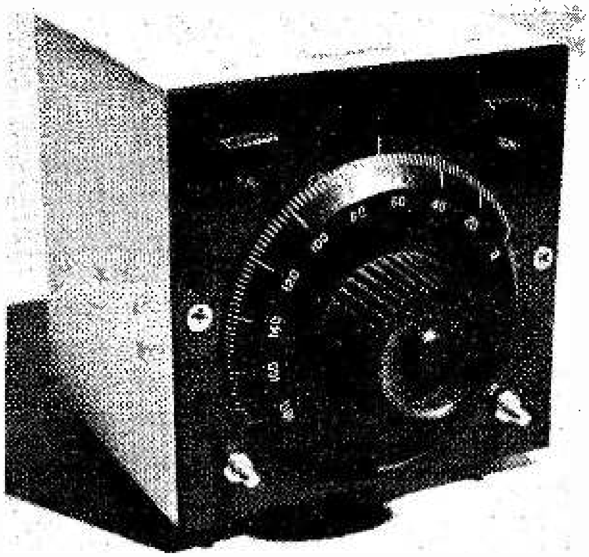
August 13— Torbay Amateur Radio Society Mobile Rally at Newton Abbot Rugby Ground.

August 13— Annual Derby Mobile Rally at Rykneld Schools. Details from T. Darn, G3FGY, 1, Sandham Lane, Ripley, Derby.

August 20— Saltash & District Amateur Radio Club Rally at Saltash Grammar School, with side-shows etc. Ample free parking on site. Details from: 1 Aldridge, G4AJU, 302 St. Peter's Road, Manadon, Plymouth, Devon, PL5 3DU.

August 26-27— Stratford-on-Avon Radio Club Mobile Rally at the National Agricultural Centre, Kenilworth, Warwickshire. Hq. of the Royal Agricultural Society of England. Further details M. J. W. Webb, G3OOQ, 14 Townsend Road, Tiddington, Stratford-on-Avon, Warwickshire. Or ring Stratford-on-Avon 5973.

MW/IF



WOBBULATOR

A.J.BIRKINSHAW

A WOBBULATOR is a signal generating oscillator which is frequency modulated by the sawtooth timebase sweep of an oscilloscope. The band of frequency swept is designed to cover the pass band of tuned radio frequency coupled circuits such as the intermediate frequency transformers of a superhet receiver.

THE REQUIREMENT

The response curve of an i.f. amplifier may be plotted by gradually shifting the frequency of a calibrated signal generator of constant amplitude applied to the amplifier input and recording the detector output voltage relative to input frequency as in Fig. 1.

We could use a pen recorder to trace output voltage on a moving paper chart if there were a mechanical linkage from chart drive to the tuning control of the oscillator with linear rotation relative to frequency.

One would plot many graphs before deciding which give the best or required performance and as preset controls on i.f. transformers are not designed to give an indication of electromechanical value and in some instances a certain amount of hysteresis between electrical and mechanical value may exist, the process of resetting may become somewhat tedious.

Most of us have at some time or other taken the easy way out and tuned for maximum aural response which is reasonably effective under the circumstances because we do not have the manufacturers resources in the way of special equipment

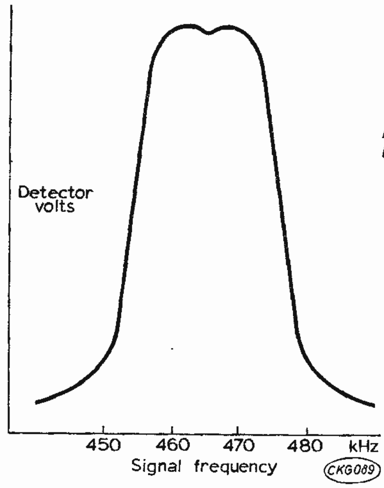


Fig. 1: A typical response of an i.f. amplifier.

designed to set-up a particular model.

However, because radio receivers depend largely on their i.f. response curves for the quality of reproduction, both bandwidth and amplitude have to be considered. We are in deeper trouble if we have just substituted a transformer of higher Q where maximum amplitude may lead to instability. So we require to see the behaviour of the circuit during adjustment.

We can display the band-pass response on an oscilloscope screen during alignment operations if we automatically sweep the signal in synchronism with the 'scope's time base using the detector output voltage for vertical deflection of the trace, Fig. 2.

Sweep may be obtained if the time base voltage controls the reactance of the oscillatory circuit of the signal generator to swing its resonant frequency a known amount equally above and below a mean value, the mean being the dial frequency setting of the generator.

Frequency modulated signal generators which, with the aid of a cathode ray oscilloscope, were designed for the visual examination of band-pass response curves and the alignment and testing of radio receivers have used various methods to obtain the required sweep as technology advanced. First the motor driven condenser, then the Miller reactance valve and nowadays we have the much

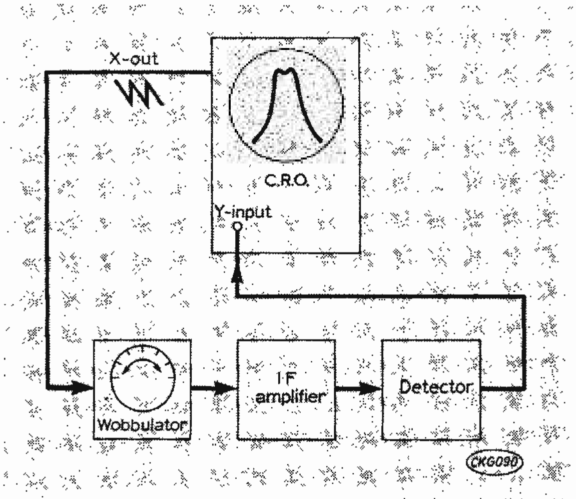


Fig. 2: The arrangement used for displaying the curve shown in Fig. 1.

simpler semiconductor diode whose reverse bias capacitance varies with voltage.

The author is indebted to D. Bollen who described, in the January 1970 issue of *Practical Wireless*, how the common silicon power rectifier shows useful varactor properties. The author has found by experiment that we may dispense with the bias battery for the oscillator application.

For amateur receiver projects the wobbulator to be described will repay its simple cost even if the oscilloscope required as an accessory has to be borrowed. Its output is 100 to 370mV peak to peak over the tuning range of 370kHz to 1·2MHz which covers normal intermediate and medium-wave frequencies.

The minimum requirements of the oscilloscope are moderate, a vertical sensitivity of 0·1 to 1V per centimeter and a time base speed range covering 10mS to 1mS per centimeter being all that is required.

THE CIRCUIT

A single OC44 germanium PNP transistor is used in a circuit configuration popularly employed as a common base oscillator found as part of self-oscillating mixers in medium-wave superhet transistor radios. The emitter resistor is smaller in value than usually employed to allow for greater r.f. output.

The diode requires a negative reverse bias which is not apparent by first examination of the circuit diagram shown in Fig. 3. The bias is provided by rectification of oscillatory power developed across R4 and R5.

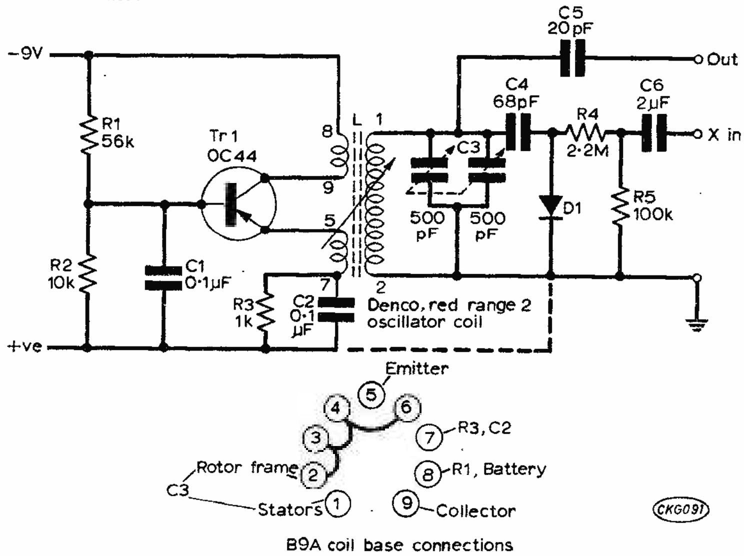


Fig. 3: The circuit of the m.w./i.f. wobbulator.

The X input in a sawtooth waveform is applied via C6 to preserve the waveshape. Sawtooth amplitude should be in the region of 20V peak to peak which is required to swing the diode capacitance and thereby frequency modulate the oscillator.

A lead via a 20pF capacitor connects to the signal input of the receiver being examined. A screened lead from the detector load connects to the Y input of the oscilloscope in use (screening is essential to avoid instability).

With the Denco coil specified, a twin gang 500pf tuning capacitor connected in parallel covers the range depicted in Fig. 4. A twin 365pF unit may be substituted with an acceptable shift of frequency coverage.

★ components list

Resistors

R1	56kΩ	R4	2·2MΩ
R2	10kΩ	R5	100kΩ
R3	1kΩ	All ½W, 10% types	

Capacitors

C1	0·1μF	C4	68pF
C2	0·1μF	C5	20pF
C3	500+500pF variable	C6	2μF 250V polyester

Semiconductors

Tr1 OC44
D1 Silicon diode BY127, FST3/4 AF etc.

Miscellaneous

L1, Oscillator coil, Denco red, Range 2; Veroboard; B9A valve holder

CALIBRATION

The dial can be an engraved knob marked every two degrees from 0 to 180°, an alternative is to use a small protractor and pointer knob. With the case removed, connect the battery and place near a broadcast receiver tuned to the medium wave-band. Select a programme of known frequency and rotate the wobbulator tuning control to obtain a beat whistle. Check with the calibration graph shown in Fig. 4 and adjust the core of the coil to obtain a similar calibration.

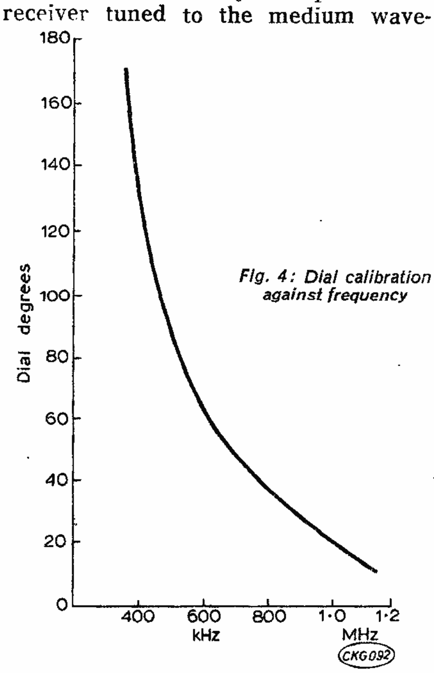
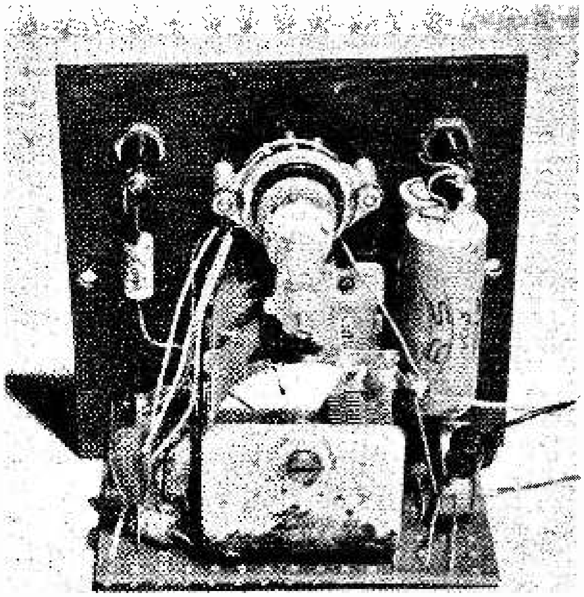


Fig. 4: Dial calibration against frequency

Construction should present no problems and the layout adopted by the author may be seen from the photographs. The Denco coil is best mounted on a B9A valveholder, this will avoid the necessity of soldering directly to the pins.

The simple wobbulator project can be put to further use by the addition of an audio modulating oscillator operating at about 440Hz. We do not of course require modulation when using the wobbulator but there are many occasions where a modulated oscillator with reasonably pure sine wave characteristics is an asset, having successfully



An internal view of the prototype.

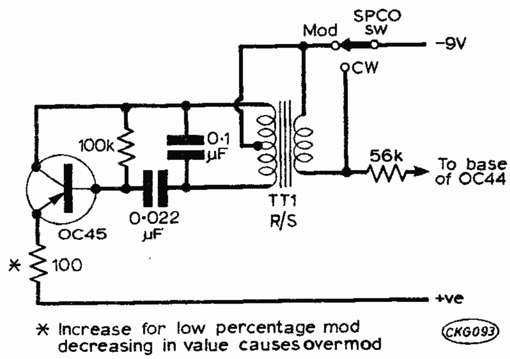


Fig. 5: A simple modulator circuit which may be added.

aligned our receiver i.f. stages we may prefer to adjust the signal r.f. stages and also to note the aural response through the amplifiers driving the loudspeaker. A tunable modulated oscillator enables us to do this, conversion is a simple matter for if we do not apply a sawtooth input, the r.f. oscillator provides c.w. output which may be base modulated by a single transistor oscillator as shown in Fig. 5.

The additional stage may be constructed on a small piece of Veroboard, this and a single pole changeover switch may easily be accommodated in the space at the rear of the cabinet.

Modulation depth may be adjusted by altering the value of the 100Ω emitter resistor but the value given is a reasonable compromise to allow sufficient tolerance in the performance of the component parts. Reducing the value gives overmodulation and poor waveform, increasing the value decreases modulation amplitude but provides a sine wave without distortion. ■

LETTERS...

The Editor does not necessarily endorse the views expressed by correspondents

On the bottle

Like your four correspondents of March '72 "Letters" I, too, was bottle-fed on valves. However, they should try to recapture the spirit of adventure and voyage into the New World of electronics. More than 50 years ago valves were also unreliable (and costly) remember? but we persevered until better days came along. Now transistors and other solid state devices have opened the door very widely indeed. Transistors unreliable? Not any more when properly used and treated. A transistor radio designed and built in 1958 by the writer is still working 100 per cent without any breakdowns. Blame the faults on designers and manufacturers of commercially made equipment built to a price-profit formula; to the lack of a new kind of servicing expertise which many persons cannot be bothered to acquire. The craze for making equipment for ordinary purposes smaller and yet smaller, added to the profit motive regardless, one must expect shoddy goods. No, Valvers, the day of the bottles—good as they were and blessed their memory—is gone forever. Space travel, satellite communications, etc, would not have been possible without solid state devices—nor would there have been any moon walk on television. Greatest boon of all is possibly the contributions these devices have made to Medical electronics.—**A. V. Nash,** *(London, S.W.12).*

N.Z. prices

I have just read a letter in your magazine, from K. B. Moore, dated December, 1971, and I feel I must point out that the prices for the items listed are as follows: BC109 transistor—$0·84c (42np) not $1·85c. BC169C transistor—$1·10c (55np) not $2·25c. 5μF 12V capacitor—·14c (7np) not ·20c. 1·5M resistor—·05c (2½np) not ·10c. If Mr. Moore was actually charged the prices he mentions, I would suggest that next time he buys components, he shops around first.

As you will see from the corrected list, semiconductors are about 4 to 5 times their cost in the U.K., but passive components are very similar in price. The major reason for the difference is that the N.Z. Government places a rather large import duty and sales tax on all semi-conductors.—**A. R. Millar,** *(Auckland 10, New Zealand).*

Fight Back

As a human being, I am open to susceptance, and it is with great reluctance that I resist a tirade against "bottles," induced by the first four letters in your March issue. However, as an unbiased electronics enthusiast it would be wrong to omit to mention that valves have their uses. Indeed, only a fool would suggest using transistors in the output stages of a high power radio transmitter, for example. But semiconductor devices also have a place. Who, for instance, would even consider building a computer of valves, or even of discrete components?

In his letter in the March issue Mr. Martin gives no evidence against transistors, nor any in support of valves; it would be interesting to know the reasons for his electronic reactionism! By comparison, Mr Freeby gives difficulty of servicing as his reason for preferring valves. He mentions "transistor radios which almost fall to pieces when you try to service them," but this is the fault of their physical construction, not the transistors therein. However, he does conclude "or blow up half a dozen transistors when searching for one faulty one", and *this* 'fault' can be cured by practise on the serviceman's part.

"Valves are best for starting people off on electronics," writes Mr. Watton, but here I must beg to differ, for the following reasons:

(i) Transistors are *very* cheap—those used by beginners that is, which can be obtained for less than 1p each (the transistors, not the beginners!)

(ii) There is no risk of electric shock or of burns in beginner's transistors circuits.

(iii) The electrical fragility of transistors encourages care on the part of the constructor, surely an important part of electronics.

Finally, Mr. Wode's only argument seems to be the average size of loudspeakers in transistor radio sets gviing poor tone. I am sure we all agree that large loudspeakers are essential for good quality sound, but where do transistors come in? Admittedly, transistors are electrically fragile, and a transistor class B amplifier needs careful design, for it to be successful, but the fact that all the audio amplifiers I know of on the market today are transistor amplifiers, prove that, in this field at least, transistors are supreme!—**R. D. Broome,** *(Warwickshire).*

U.S.A. — 1940

Further to your Leader in the March issue, your younger readers may be interested to know that prior to 1940, reception of U.S.A. stations in the S.W. Bands was so good that the London evening newspapers used to print the radio programmes of Boston, New York, Schenectady etc. in addition to B.B.C.—**G. Snewin,** *(London, E.17).*

Quality speakers

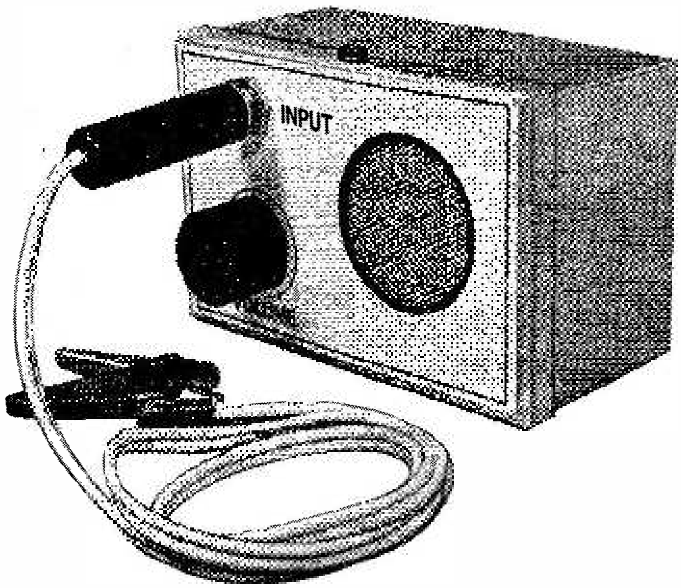
British beaches may soon have no sand judging by the number of people who seem to be building the Quality Hi-Fi speakers! But here's a useful bit of information which may help readers.

The SI-1020A hybrid amplifier specified for the system has been discontinued but may be replaced by the SI-1025A which is for all practical purposes identical in performance and mounting. The plinth specification is unchanged. Amplifers available from Photain Controls Ltd., Randalls Road, Leatherhead. Tel. 2776.—**Caleb Bradley,** *(Essex).*

Company policy

I couldn't agree more with the many views on poor workmanship and bad after-sales service that have been published in *Practical Wireless*. It's about time that high standards of the above were adopted as company policy to ensure value for money.—**Ian Vine,** *(Middlesex).*

test bench amp



E. BUCKLAND

ANYONE who has more than a passing interest in the construction of radio and electronic projects will have acquired a fair number of items of test gear. A multimeter is essential but an r.f. and a.f. signal generator will also be found very useful. These items, plus others which will be required for one's own particular field of interest, are used mainly to test and trouble-shoot finished or partially finished equipment.

One of the most useful items in the author's opinion, however, is none of the above but a simple straightforward audio amplifier; this is rarely considered as an item of test gear. This is surprising when one considers how useful it can be.

A high proportion of the projects published in this magazine are fitted with an amplifier as the final stage; a quick check shows that 30 of the last 36 projects featured on the cover of *P.W.* either used an audio amplifier or were designed to feed one. This gives a rough indication of how often a test bench amplifier could be used for checking that either the early stages of such a project are operating properly or even that an amplifier is working correctly. The circuit shown here can equally well be used as a signal tracer at audio frequencies.

To be of maximum use such an amplifier has to meet certain requirements. Portability was considered important and so the circuit is battery operated. Small size was also high on the list of priorities as this will mean less shelf space and will make it easy to carry around in a brief case for instance. It had to be of reasonable quality, at least good enough to be able to distinguish between correct and incorrect operation of the equipment to which it is coupled. High input impedance and high sensitivity are also desirable features for such a circuit. The output level is of less importance as long as it is to be used mainly as a monitor. The output is in the order of 200mW but small speakers are not very efficient and this output is less than it sounds. Even so, this compares favourably with the output from normal small transistor radios using the same type of battery and has been found to be more than adequate for the intended purpose. In fact many of the design features were controlled by the use of a PP3 battery. This is used to meet the requirements of portability and small physical size. The permissible current drain from this battery limits the output to the level mentioned above.

All the components used are widely available and the cost of this project is not high—certainly not over £2 in total.

THE CIRCUIT

The circuit of the Test Bench Amplifier is shown in Fig. 1. The input is applied directly across the volume control VR1 which is rather higher in value than one would normally encounter in a circuit of this type. This high value has the advantage here of presenting a high impedance input at low volume control settings—this approaches 500kΩ, though this is somewhat reduced for high volume settings where

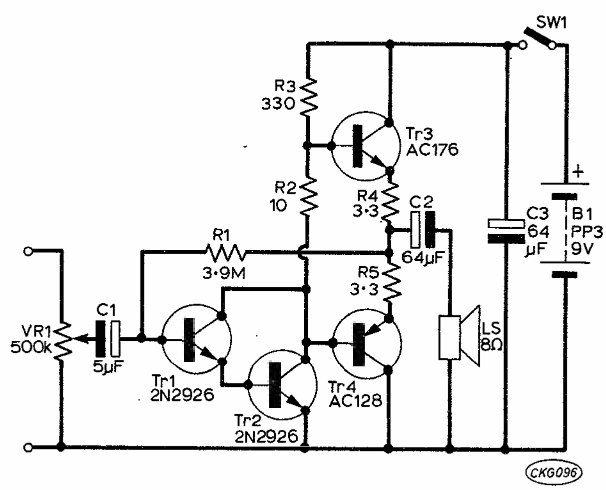


Fig. 1: The complete circuit of the Test Bench Amplifier.

the input impedance of the first transistor is in parallel with the volume control.

The slider connects to the base of the first transistor via the d.c. blocking capacitor C1. Tr1 and Tr2 are connected as a Darlington Pair, a configuration which gives very high gains and also a higher input impedance than a conventional common-emitter amplifier would present.

This stage drives the output pair Tr3 and Tr4. These are conventionally connected as a complementary output pair; one is an NPN and the other a PNP with the bases connected together by R2, a 10Ω resistor. This is necessary to provide a small bias to avoid cross-over distortion.

When Tr2 is conducting heavily (when it is driven on by a positive swing in the signal), Tr4 is driven into conduction. When Tr2 approaches cut-off (due to a negative going swing) the voltage at the base of Tr3 rises (R3 providing the bias) and it conducts. This explanation is far from complete but descriptions of the operation of this type of output stage are described more completely from time to time in other articles.

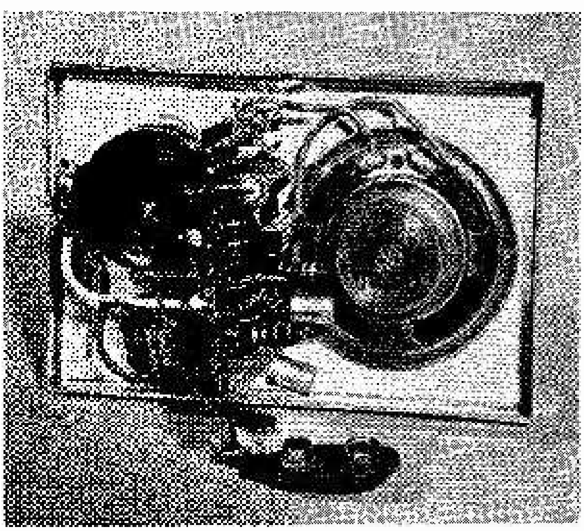
Note that Tr3 and Tr4 must be a matched pair of transistors but are not otherwise critical. Any similar complementary pair of germanium transistors can be substituted without any circuit modifications.

The bias for the Darlington Pair is provided by R1 which also introduces both a.c. and d.c. feedback. If difficulty is experienced in making the circuit work, a slight change in this value may be helpful. However four prototypes have been built of this circuit and this value has proved satisfactory in each case.

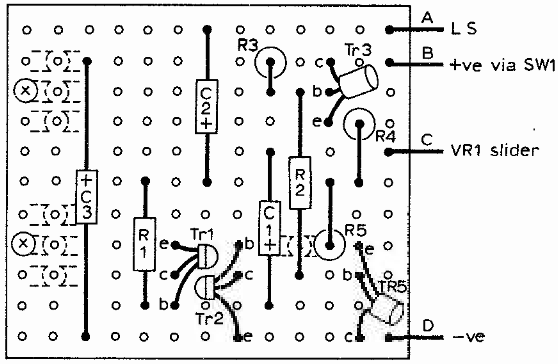
The low value of C2 certainly reduces the bass response but this makes very little difference in practice—miniature loudspeakers are not normally renowned for their good bass response; there seems little point in providing a signal which cannot be handled by the speaker. This smaller value than one would normally find has the added advantage that it is physically small.

CONSTRUCTION

The majority of the components are mounted on



An internal view of the prototype.



Mounting holes

Indicates break in copper strip

Fig. 2: The component layout on Veroboard.

★ components list

R1 3·9MΩ R4 3·3Ω
R2 10Ω R5 3·3Ω
R3 330Ω
All ¼W, 10% types
VR1 500kΩ log. pot. with switch

Capacitors
C1 5μF 10V C3 64μF 10V
C2 64μF 10V

Transistors
Tr1 2N2926 Tr3 AC176†
Tr2 2N2926 Tr4 AC128†
† Matched Pair.

Any "colour" of 2N2926 transistor may be used for Tr1 and Tr2.

Miscellaneous
L.S. Miniature 8Ω loudspeaker
B1 PP3 battery, 9V
Battery clip; Veroboard 0·15in. matrix, 13 x 11 holes; metal or plastic case—see text; Jack plug and socket; Crocodile clips.

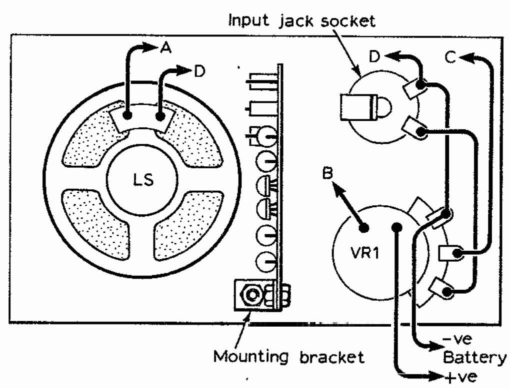


Fig. 3: The wiring details. The wires marked A to D connect to the appropriate points on the circuit board.

a small piece of Veroboard, 0·15in matrix, 13 x 11 holes. One end is left free of components to leave room for a small mounting bracket. The components layout is shown in Fig. 2. The copper conducting strip has to be cut away around the mounting holes for obvious reasons but other than this only one additional break is needed.

Due to the low output and the protection afforded the output pair by R4 and R5, heatsinks are not really necessary on Tr3 and Tr4 when operating from the specified battery.

The circuit can be fitted into almost any small case. The author originally built his into a plastic case but this was dropped several times and eventually broke. For this reason it was replaced by a small metal case which proved much more satisfactory. The one used in the prototype was 4 x 2½ x 2in. fitted with a lid; this is available by mail order from Henry's Radio.

The lid carries the components and a wiring diagram for the final connections is shown in Fig. 3. Of course, any convenient case can be used. The loudspeaker is glued to the face; this method of fixing has been found to be very simple and quite strong enough.

The input to the amplifier is through a jack socket and two wires from the associated jack plug can be fitted with croc clips for rapid connection to any circuit. A band of tape was wound around one of these wires to identify the "earthy" connection.

Proper distortion and frequency response figures have not been taken from this circuit but the amplifier introduces no noticeable distortion and the frequency response has proved to be quite adequate for the designated purpose. ■

CQ!CQ!CQ!CQ!

BOOKS WANTED

...Mullard Circuits for Audio Amplifiers. Second Edn. 1962.—George W. Saunders.

...Any volumes 3 to 10 "Wireless World", RSGB T & R Bulletin, July 1933 (with covers), RSGB 1928 Annual Log Book. "History of Radio Telegraphy & Telephony", Blake, 1927.—Allan Herridge, G31DG, 96 George Street, Basingstoke, Hants.

...Oscilloscope equipment circuits by Easterling buy or borrow.—F. Cosgrove, Rowan Chalet, Lower Road, Postcombe, Oxford, OX9 7DU.

..."Simple Radio Circuits" by A. T. Collins.—J. Wheelton, 41 Chorley Road, Burntwood, Walsall, Staffs.

...Young Schoolboy requires a second-hand copy of the Radio Communication Handbook about £1? Phone Harpenden 5910.—Huw Hallybone, 78 Sauncey Avenue, Harpenden, Herts.

INFORMATION AVAILABLE

...I have in my possession an Italian Magazine dated the Year 1958 called "Bolletino Tecnico Jeloso", it also has English Translation of contents. I would be pleased to send to any reader who may have a need for it, if they send S.A.E. 12" x 4". It has full diagrams, of circuits and components, for the following: TRANS: 9,212-TR, TRANS: 9,222-TR, REC: 9,209-R.—R. Peel, 57 Tangmere Drive, Castle Vale, Birmingham, 35.

EXCHANGE

...P.E. April, 70 to Nov. 70 & March 71 to Dec. 71. Also P.T. Jan. 71 to Oct. 71. 27 issues. All good condition. Would exchange all these for Vol. 43 & 44 P.W.—G. J. David, 32 Trebeferad, Llantwit Major, Glam.

...I have the Aug. 1966 edition of P.W. twice so am willing to exchange one copy for any interesting bit of electronic junk.—L. Cook, 7 Plum Tree Close, Eccleston Park, Prescot, Lancs., L35 7JT.

..."Swap, buy or sell P.W. back issues. Large quantity for disposal. S.A.E. for lists."—R. Forsbert, 123 Harestone Hill, Caterham, Surrey, CR3 6DL.

...June 1968, July and Aug. 1968 issues of P.E.—S. Tucker, 8 Hawkswell Gardens, Oxford, OX2 7EX.

...May 1971 issue of P.W.—C. H. Cheah, 17 Hargrave Road, Archway, London, N19 5SH.

...Aug. 1968 P.W. or photocopy of Portable Keyless Organ.—G. E. Dutton, Buck-ith-Vine-Inn, Burscough Street, Ormskirk, L39 2EG, Lancs.

...P.W. Volume 45 (May 69–April 70), P.W. Volume 47 No. 7 (Nov. 71), P.E. Volume 5 (Jan. 69–Dec. 69 inc.).—M. Ridger, 25 Broomfield Crescent, Leeds, LS6 3DD.

...P.W. for Jan. 1971 with Part 1 of the Stereo Tape Recorder.—R. W. Andrews, 7 Bracken Grove, Wellington, Salop.

...The issue of P.W. containing the circuits, operating info. for the electric organ published circa 1964.—A. J. L. Brown, 9 Ruillon Road, Penicuik, Midlothian.

...The blueprint for the P.W. 35W Guitar Amplifier.—P. Winkley, 96 Leopold Avenue, Handsworth Wood, Birmingham, 20.

...July 1971 issue and any 1969 issues of P.W.—N. A. Dent, Middle House, Lockner Holt, Chilworth, Guildford, Surrey.

CHARLES MOLLOY

THE Medium Wave Column

TOMMY CROSBIE who lives in Broseley, Cheshire writes "I do not think a communications receiver is necessary for a beginner. I only use a domestic receiver (removed from an old radiogram) though some modifications must be made." He then describes how he traced the a.g.c. line and connected it to chassis via a switch. When the switch is operated the a.v.c. is off and the receiver is ready for DXing. Stations heard by Tommy on his modified receiver and MW loop include RNE Tenerife, Canary Islands on 620kHz; Godhavn, Greenland 650kHz; PJB TransWorld Radio, Bonaire 800kHz; EFJ57 Tenerife 890kHz; WINS New York 1010kHz; WBMJ San Juan, Puerto Rico 1190kHz; Radio Afghanistan, Kabul 1280kHz; PJD St Maartin, Netherlands Antilles 1295kHz (this station often broadcasts in English).

DXers will find it an advantage to switch-off the a.v.c. when operating on the medium waves. Two or more stations can often be heard simultaneously on a channel and the slight difference in frequency between them gives rise to a beat. If the a.v.c. is switched on, then the receiver gain will follow this beat, giving rise to an unpleasant flutter which makes reception difficult. The writer invariably has the a.v.c. switched on, then the receiver gain will follow this while the receiver gain is adjusted with the r.f. gain control.

Paul Swain, while on a visit to Tudweilog on the coast of Wales, used his Sanyo 7 transistor portable between 0003hrs and 0330hrs GMT on the 12th February to log CBN St John's, Newfoundland 640kHz; WOR New York 710kHz; CJON St John's 930kHz; WINS New York 1010kHz; WNEW New York 1130kHz; WWVA Wheeling, West Virginia 1170kHz; WHAM Rochester, New York 1180kHz; WOWO Fort Wayne, Indiana 1190kHz; WCAU Philadelphia, 1210kHz; WTOP Washington, D.C. 1500kHz; WMEX Boston 1510kHz; WKBW Buffalo, N.Y. 1520kHz.

Richard Coyle of Glasgow sends a log heard on a Lafayette KT340 and an antenna of 200ft of wire wound round the loft in a triangular coil. R. Caracas, Venezuala 750kHz; WHDH Boston 850kHz; WCBS New York 880kHz; CBM Montreal 940kHz; R. Sutatenza, Colombia 960kHz; WBZ Boston 1030kHz; WHN New York 1050kHz; Radio Globo, Rio 1180kHz; R. Tupi, Rio 1280kHz.

A new high power outlet at Bissau, Portuguese Guinea has appeared on 1070kHz. According to a QSL received by the writer it is on the air daily until 0100hrs GMT and has been heard as a strong signal with deep fading, after 2300hrs. The address for reception reports (which may be in English) is Emissora da Guine Portuguesa, Caixa Postal 191, Bissau, Portuguese Guinea.

Send logs and information about the Medium Waves to the writer at 132 Segars Lane, Southport, PR8 3JG.

Electronotes..

S. GINSBERG

THINGS are hotting up in the television field. Hitachi have launched a 20in. colour tube with 110° deflection angle and with a 29mm neck. The Japanese market version of the tube will have a black matrix but because of Zenith patents the one for Europe will not. Hitachi have plans to follow this tube up with smaller versions in 18in. and 16in. One interesting thing about the Hitachi tubes is a change in the approach to avoid a form of distortion.

A problem with many 110° tubes is that the static convergence at the edges of the tube is upset because of the large convergence angle near the edges of the tube. The electrons passing through the aperture in the shadowmask do not land accurately on the corners of an equilateral triangle and thus colour purity is degraded. While some people might claim that corrective action during tube manufacture tends to eliminate this defect, Hitachi claims that these remedies are inadequate.

Hitachi are fabricating tubes to match this electron distortion rather than trying to correct the placing of the electron beam itself. The resultant tube permits components such as those used with 90° tubes to be used rather than require special deflection coils and special components.

Back to computers. Memories are very much in the news but perhaps the most interesting one is not a semiconductor memory nor a magnetic core. It is a ferroelectric one which, if researchers are right, will pack some 10^{13} bits of information. The idea came originally from holograms. These are three-dimensional images. It was reasoned that perhaps information could be stored in three dimensions, one layer behind the other. Now comes the idea that this could be done with ferroelectric materials and the suggestion is for one called barium titanate which has been doped with impurities. The doping causes the individual crystals to become photosensitive besides being transparent. Thus they could be used to record the interference waves from a holographic image. They could easily be "read out" by using a beam of light and they can also be erased and new information "written" in. So it looks like another twist in the memories stakes with a serious competitor for the memory elements; semiconductor, hologram, plated wire, magnetic core etc.

RCA are recorded as having done some work on ferroelectric crystals but this method used a great deal of heat (some 300°C required for erasure) and there were few problems. The newer method just announced, using barium titanate, uses only an electric filed for erasure and thus looks promising. Experiments, incidentally, are taking place in France.

practically wireless commentary by HENRY

No. 90
Nothing if not Informative

SHATTERED, not a little disabused, Henry sits hunched in the corner of his workshop trying to work out where he went wrong.

No, it is not another classic case of diagnosing power supply, regulator and control circuit malfunction when the heat-fuse in the mains transformer had parted. Not a mere inability to restring a dial drive cord that goes twice round the town hall and back between tuning gang and pointer pulley. Not even, not *especially*, another case of reading *nano* for *micro* or *milli* for *Meg*.

Worse than that, Henry has been accused by a close colleague—nay, a collaborator—of being too literary, not factual enough. 'People pick up *PW*,' he says, 'to be informed, not to be led through the pages of the dictionary.'

Oh dear—I plead guilt. Mea culpa, and all that. Verbal diarrhoea has afflicted your scribe.

There—you see? Put into plainsong, the foregoing should read: Henry talks too much, and to little effect.

'Tis true, 'tis true. Which is why Henry, in this lazy month between Spring and Summer, wants to acquaint you with a few of the facts he has stumbled upon during a recent browse through the trade and enthusiast magazines.

Large frightening sparks.

In the April 1972 issue of *Studio Sound* there are two equipment reviews. First is of a Crown DC 300 amplifier, imported from Indiana, U.S.A. A cool 600 watts into 4 ohms, is all. Or, to be a little more realistic, 150W RMS per channel into 8 ohms. The reviewer, P. A. Lomas, had little to say about it except that it 'exceeded specification' for every test made. And, believe me, those specifications are very impressive, as one would expect for a bit of hardware costing £360.

What interests Henry more is the methods he used to determine how good this amplifier really was. . . . Harmonic distortion of 0·008% at 500Hz, Crosstalk at 10kHz, 95dB below full output, and noise at −113dB, forsooth!

He does report—and Henry applauds the touch of humanity—'Short circuit tests merely produced large frightening sparks, pitted screwdrivers and a shaking hand.'

But the accompanying review was rich. It dealt with the Edison Phonograph, and could have been better if a perfectly straight-faced approach had been maintained. Instead, we read such specifications as:—Wow and Flutter: dependent on alcohol level in blood of operator. (The Phonograph is a cylindrical-scan tinfoil clad machine operated by a hand crank, or hadn't you guessed?)

In fact, the review goes into nice detail about the construction, with diagrams, and nowhere does T. T. Wittering mention April 1. If David Kirk, the Editor of *Studio Sound*, intends to continue with the April Fool insert, as Radio-Electronics used to do (still does?), T. T. W. will have to get together with Henry Scruggs or George Izzard O'Veering and write about the Super-Crown.

On second thoughts, he need only quote from some specifications as boldly published by the makers of system audio equipment. And if he wants more power, what about the Marantz at 250 watts, or the Phase Linear, 750 watts?

The 'ultimate' Hi-Fi system.

Power alone isn't everything, as any owner of an earache generator can tell you. But it does seem to be the tendency for makers of powerful amplifiers to make, also, equipment that performs to the highest standards.

Bert Whyte's piece in the February *Audio* talks about Joe Audiophile, in his seventh heaven because his Aunt Nelly remembered him in her will. He purchases the 'ultimate' hi-fi system, super megawatt amplifiers, preamps with a plethora of controls, which can be corrective or creative, digital readout tuner—naturally, Joe's system is quadrophonic — and ultra-wide range speakers with low frequency response down in the subbasement.

Developing his theme, Bert describes that Joe's aim is to listen to his 15 ips copies of classical masters. 'The first faint susurations (sic) of Ravel's "Daphnis and Chloe" are heard from the speakers . . . *molto pianissimo* . . . and Joe is in a transport of delight.' no tape hiss —but then—WHUMP! RUMBLE'

Joe has been the victim of monitoring techniques. The discs made from those master tapes have been 'rolled off rapidly' below 60Hz.

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					(see note below)		
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C	1/8W	5%	4·7-470K	E24	1	0·8	0·7
C	1/4W	10%	4·7-10M	E12	1	0·8	0·7
C	1/2W	5%	4·7-10M	E24	1·2	1	0·9
C	1W	5%	4·7-10M	E12	2·5	2	1·9
MO	1/2W	2%	10-1M	E24	4	3	2 nett
WW	1W	10% +1/20 Ω	0·22-3·9	E12	7	7	6
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WW	7W	5%	10 Ω-10K	E12	9	9	8

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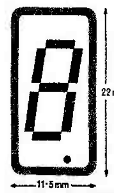

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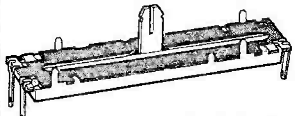

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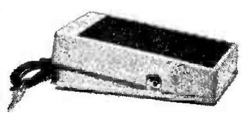

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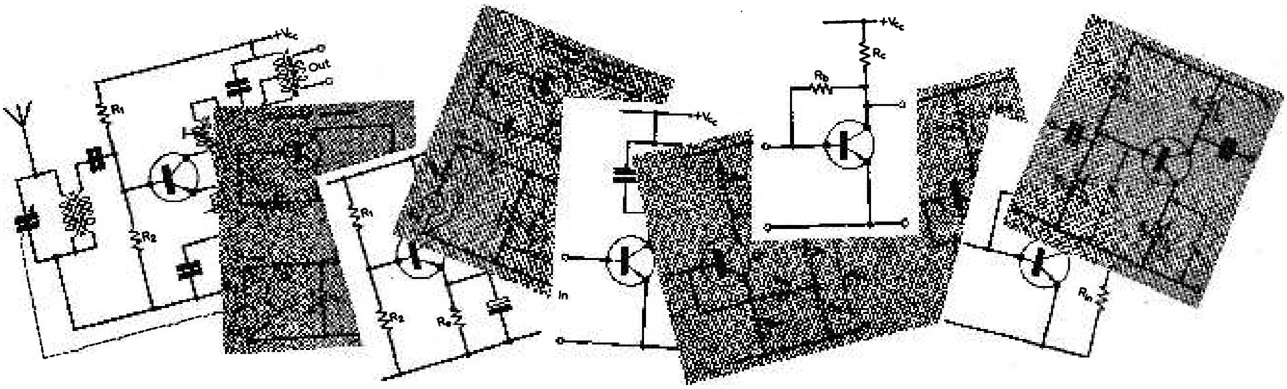


TRANSISTOR CIRCUITRY for beginners

H.W. HELLYER & MICHAEL HOLLIER

PART 8

Buffer links

It has become obvious in recent months, from the polite noises made over the editorial hot-line, and correspondence we have received, that our chosen method of dealing with simple transistor circuitry meets with some approval.

Simplicity can be deceptive. This month, for instance, we have chosen as our subject a single-transistor collector-follower circuit. One transistor, a few components, a little bit of board, and a few moments of your time. But if we were to cover, fully, all the parameters affecting the calculated performance of this 'simple' circuit, half the adverts would be squeezed out of *PW*. More important, such an approach would frighten off the beginner—and he's the chap at whom this series was aimed, remember?

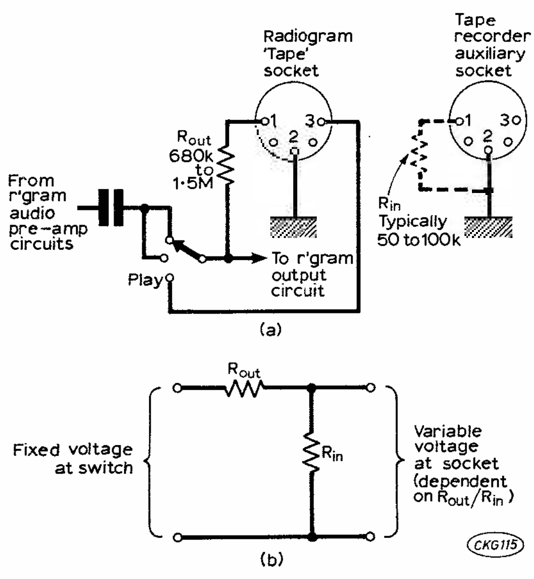


Fig. 39. (a) A single channel of a typical radiogram 'tape' outlet showing the presence of R_{out} which affects the matching. (b) is the equivalent of (a).

The buffer-link can be used between two pieces of equipment when discrepancies of impedance and voltage are such that gain as well as matching is needed. A typical example is the case of the tape recorder connected to the 'Tape' outlet of a radiogramophone. Quite often, specifications make it appear that the simple connecting lead will do the job adequately. The significant point omitted from those specifications (or, at best, skated over), is that the impedance of the load drastically affects the available signal voltage from the radiogram. A glance at Fig. 39 shows why this should be.

To prevent the load (i.e., the tape recorder) from robbing the main equipment of some signal voltage and to save the extra cost of a properly designed feed stage, such as we have already described, a fairly high resistor is used to connect the signal take-off point to the socket.

If a direct connection is now made to the socket, the relatively low impedance of the tape recorder will not affect the performance of the radiogram. But, and it's a big but, a potential devider is now formed, with the smaller resistance section being the tape recorder, so the available voltage is reduced in proportion to the two resistors.

If there is not enough voltage available, we are not going to be able to make a decent recording. No amount of ingenuity with external resistive networks will produce sufficient modulation. What we need is a little amplifier between the radiogram and the tape recorder. We need, in fact, a buffer to prevent interaction of one upon the other and a link to join their circuits together—a buffer-link.

Simple circuit

Emitter-follower circuits make excellent buffers, but do not allow us to obtain any voltage improvement. A two-stage circuit would do the trick, maybe; like the Darlington Pair of Part 6; or even more elaborate circuitry, like the single-double device of Part 7. Here, we can obtain the gain we require and make a suitable match with the very simple circuit of Fig. 40.

This is the single-transistor collector follower stage. If you have read Part 5, page 913, it should not be necessary for me to explain those terms. Such a stage has a medium impedance input, certainly lower than the emitter follower we previously discussed, but still not too low for our purpose. It has a fairly high output impedance, but again, not too high for our purpose. Component changes can modify the performance to suit our requirements, as we shall show. Voltage gain is quite reasonable, and the signal inverts 180° between input and output. All these are conditions that we want.

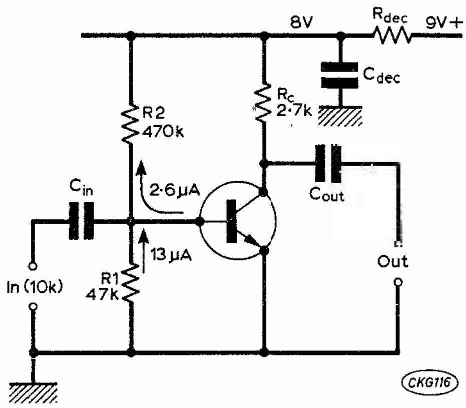


Fig. 40. Basic buffer-link circuit. Essentially a collector-follower the emitter is taken directly to the negative line.

R1 and R2 form the potential divider to give us base bias, just as we have seen in previous months. R_c is the collector load resistor, and this time, our a.c. signal is developed across this load. The emitter in our first example is taken directly to chassis.

The input signal to the base is coupled by C_{in}, with C_{out} performing its coupling function at the other end of the stage, taking the signal to the input of the tape recorder.

Recap

Recapping a little: previous dealings with the emitter follower and Darlington circuits have taught us that the output signal is a little less than the signal voltage fed in to the circuit. In technical terms, the gain is less than unity. This time, we have acquired a bit of gain, and the price we pay is an input impedance lower than before, and an output impedance higher than before. In addition, we now have a phase inversion, which the emitter follower did not have. A signal at the input of the stage is inverted, i.e., receives a phase change of 180°. If the input signal is positive-going, the output signal will be negative-going. This doesn't much matter to us in our present application, but can be quite important for some applications.

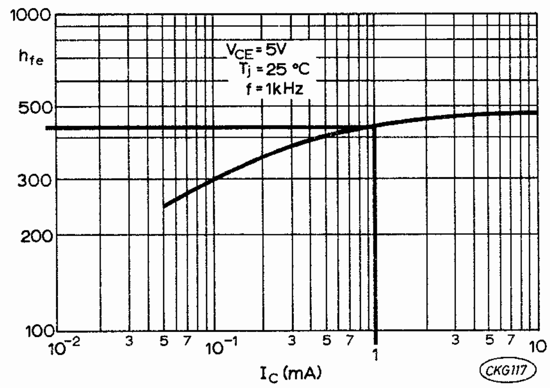
On the subject of impedance, the terms high, low and medium are, of course, only relative. Impedance is the resistance to an a.c. signal, usually at a specified frequency. Where no frequency is specified, as in the case of an amplifier, it is assumed that the impedance is constant over the frequency range of interest: example, 20Hz to 20kHz. A reference frequency of 1kHz is generally assumed, except in the case of microphones and loudspeakers, when 400Hz is more often employed. In general, an a.c. resistance of 1kΩ and below would be called low, up to 100kΩ would be medium and above 100kΩ referred to as 'high impedance'.

Circuit details

We should begin with some modest requirements, bearing in mind that a wide variation of performance can be expected with certain circuit changes. Battery supply—again 9 volts, allowing for 1 volt being dropped across the decoupling resistor, so the stage supply V_{cc} is 8V. The collector current we shall choose is 1mA. And with these simple starters we can choose a transistor.

Our choice is determined by the need more for low noise than high gain, although it is nice to have both. So, to get the best of both worlds, back to old faithful, BC109. Referring to Figs 41 and 42, we can work out the more detailed figures.

The transistor will be operating at a collector current of 1mA, and the voltage between collector and emitter, V_{CE}, will be about 5 volts. (Refer to previous articles in this series for reasons for these quoted figures—an expansion of the argument). From Fig. 41, we can see that the a.c. current gain, h_{fe}, can be determined at somewhere around 450. Similarly, from Fig. 42, we find that the d.c. current gain, h_{FE}, is around 380.



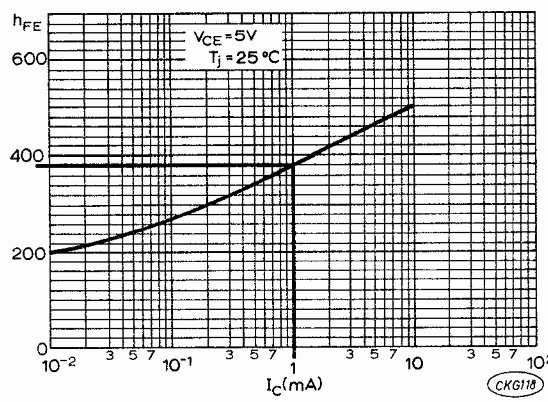


Fig. 41. (top) Graph to determine h_{fe}, the a.c. current gain. Fig. 42 (bottom) is the graph to find the d.c. current gain h_{FE}.

The base current of the transistor is determined by the formula:

$$I_b = \frac{I_c}{h_{FE}}$$

We have determined h_{FE} and the I_c we chose, for best conditions and easy working, to be 1mA. Putting these figures in the above formula, we arrive at the conclusion $I_b = 2{\cdot}6\ \mu A$.

Referring again to our previous arguments, we say that the current flowing in the base bias chain, R1 and R2, should be about five times the base current of the transistor. In our circuit, we have the emitter taken directly to the negative line, and we know that the base-emitter voltage of a silicon transistor is normally 0·6V. So we can calculate the value of R1, since the voltage across it must be 0·6V and the current through it five times the base current of $2{\cdot}6\mu A$. If we do our sums correctly, the answer will be:

$$R1 = \frac{0{\cdot}6V}{5 \times I_b(2{\cdot}6\mu A)} = \frac{0{\cdot}6 \times 10^6}{13} = 46{,}154\Omega.$$

The nearest preferred value in the 5% range will be 47kΩ.

The voltage across R2 will be the supply voltage, 8 volts, minus the base voltage of 0·6V=7·4V. The current will be six times I_b, that is the current in R1 plus the original base current. So:

$$R2 = \frac{V_{cc} - V_b}{6 \times I_b} = \frac{8 - 0{\cdot}6}{15{\cdot}6 \times 10^{-6}} = \frac{74 \times 10^6}{156} = 474{,}359\Omega.$$

The nearest preferred value is 470kΩ.

Input resistance

We have talked before about input resistance and our own experiences in trying to match equipment, about which manufacturers have given inadequate information, show that this is a difficult field. 'Fings ain't always wot they seem ter be!'

The input resistance of the transistor (looking into its base and ignoring R1 and R2) is h_{ie}. Fig. 43 shows that Mullard graph for the BC109, idealised for the conditions under which we are using the transistor—that is, with unnecessary information omitted. We have done this here, at Michael's insistence, because, to the layman, there is nothing more confusing than a graph filled with curves and references he is not called upon to use.

Here, we have indicated that the h_{ie} is a little over 10kΩ. If we had no graph, we should have to calculate:

$$h_{ie} = r_e \times h_{fe} \text{ where } r_e = \frac{25\Omega}{I_c\text{ (mA)}}$$

so $h_{ie} = \frac{25}{1} \times 450$ or 11·25kΩ, which is reasonably near the plotted figure in this case.

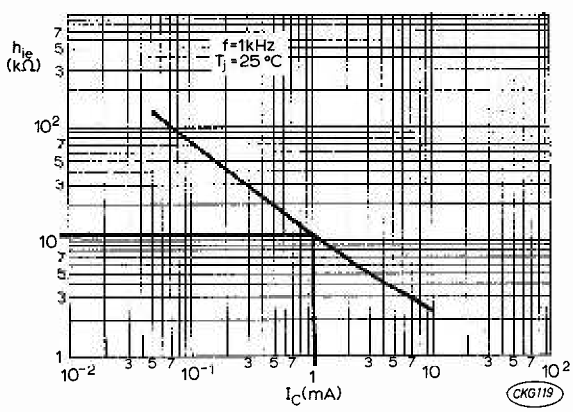


Fig. 43. This graph will give the input resistance, h_{ie}, of the transistor.

The input resistance of the **stage,** and not just the h_{ie}, is the latter shunted by the parallel combination of R1 and R2. This is as far as a.c. is concerned. (In parallel, because to a.c. signals, by reason of the low impedance of C_{dec}, the top of R2 is effectively connected to the bottom of R1.)

So we calculate for h_{ie}, R1 and R2 in parallel, arriving at:

$$\frac{1}{11k\Omega} + \frac{1}{47k\Omega} + \frac{1}{470k\Omega} = 8{\cdot}7k\Omega \text{ approx.}$$

If there are to be 5 volts between collector and emitter, then we must have a voltage drop across R_c of 8−5 ($V_{CC} - V_{CE}$). This works out to 3 volts and if the collector current is chosen to be 1mA, the resistance of the load R_c:

$$\frac{3\text{ volts}}{1mA} = \frac{3{,}000}{1}$$

The nearest preferred value to a 3kΩ resistor we shall get in the 5% range is 2·7kΩ. That's near enough.

Gain

Stage voltage gain (A_v) is equal to R_c divided by the emitter resistance. In this case we are concerned with the **effective internal** emitter resistance, r_e, which you will remember, caused some confusion earlier, and is calculated from the formula:

$$r_e = \frac{25}{I_c\text{ (mA)}} = 25\Omega.$$

The stage gain, A_v, becomes:

$$\frac{R_c}{r_e} = \frac{2{,}700}{25} = 108$$

We made some comment on the principle of selecting transistors so this may be the place to underline the importance of parameter variations on the validity of some associated calculations. In this case, if I_c changes, so does r_e. We chose our collector current and took a 'typical' H_{FE} from the graph. But collector current (actual) depends on base current and actual h_{FE}. So if the selected transistor has an h_{FE} that differs, I_C will differ, r_e will be affected and the stage gain may be quite different from that calculated. Hard world, isn't it?

Adding an external R_e

In the previous case, that of Fig. 40, we had the emitter firmly strapped to 'earth' so the emitter voltage was the same as the negative supply line. What happens to the stage and its performance if we now insert a resistance in this emitter, in the position R_e of Figs 44 (a and b)?

Quite simply, the stage gain is altered and at the same time the input resistance, R_{IN}, is increased.

Basing our calculations on some of the factors we have already, we can choose a convenient value of resistor for R_e and work out what differences it will make. First, V_{cc} is 8V; I_c, 1mA; R_c, 2·7kΩ and our R_e will be, let us say 47Ω. Then $V_e = I_e \times R_e = 1mA \times 47$ ohms $= 0{\cdot}047V$.

The emitter current is the collector current plus base current, or $I_e = I_c + I_b$. Since the base current of the transistor ($2{\cdot}6\mu A$) is very small in comparison with the collector current of 1mA, it is convenient to ignore it, satisfied that there will be only a negligible amount of error. So we can say, effectively,

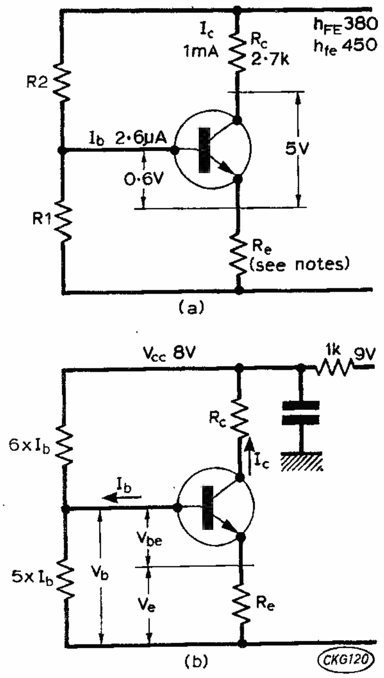


Fig. 44. (a) Theoretical collector follower circuit, showing voltage and current distribution. (b) shows the symbolic representation with R1 and R2 values indicated relative to I_b.

$V_b=V_e+V_{be}$ (Note:—the base-emitter voltage of a silicon transistor, when it is forward biased, as in normal operation, is about 0·6V). Thus, $V_b=0\cdot047+0\cdot6=0\cdot65$V, which is also the voltage across R1.

$$R1=\frac{V_b}{5\times I_b}=\frac{0\cdot65}{5\times2\cdot6\times10^{-6}}=50\text{k}\Omega\text{, approx.}$$

To the nearest preferred value in the 5% range, we can choose 47kΩ.

$$R2=\frac{V_{cc}-V_b}{6\times I_b}=\frac{8-0\cdot65}{15\cdot6\times10^{-6}}=471\cdot154\text{k}\Omega$$

Again, we choose the nearest preferred value, and settle for 470kΩ in the 5% range.

Having added R_e, we now have to take account of its presence in the voltage gain formula, A_v:

$$\frac{R_c}{(R_e+r_e)}=\frac{2{,}700}{47+25}=37\cdot5$$

Input impedance

We were content to deal with h_{ie} previously, the input resistance (impedance) of the transistor, looking into the base with R1 and R2 ignored. Now that we have added R_e, we must allow for it in calculating the input impedance, and we shall be dealing with R_{in}:

$$R_{in}=(R_e+r_e)(h_{fe}+1)=(47+25)(450+1)=32\cdot472\text{k}\Omega$$

The shunting effect of R1 and R2 has to be considered again, as far as a.c. is concerned, so the stage input resistance R_{IN} is calculated as before:

$$\frac{1}{R_{IN}}=\frac{1}{R1}+\frac{1}{R2}+\frac{1}{R_{in}}=\frac{1}{47\text{k}\Omega}+\frac{1}{470\text{k}\Omega}+\frac{1}{32\text{k}\Omega}$$

$$=18\cdot3\text{k}\Omega\text{, approx.}$$

Negative feedback enters into matters at this point. We have not fitted any bypass capacitor across the emitter resistor. This has allowed series negative feedback to take place, and the gain of the stage is reduced by the negative feedback. As it effectively changes the value of R_e+r_e, the stage input resistance is also affected. This feature is widely used in transistor circuitry, where negative feedback is employed to set the stage gain, alter the input impedance, improve the frequency response and reduce harmonic distortion.

To demonstrate the differences that are obtained when R_e is inserted, and then altered, the accompanying table has been prepared. Calculations which back these figures are based on the foregoing formulae, as worked out for an R_e of 47Ω, which we have used. We are assuming a V_{cc} of 8V, and R_c of 2·7kΩ, using a BC109 transistor. We have taken the figures calculated and measured for no R_e and for four different resistive values.

R_e Ω	0	47	100	220	470
Output impedance	<2·7k	2·7k	2·7k	2·7k	2·7k
R1 (kΩ)	47	47	47	56	82
R2 (kΩ)	470	470	470	470	390
R_{IN} (kΩ) measured	8·6	19·5	26	36·3	52
R_{IN} (kΩ) calculated	8·7	18·3	25	34·3	52
A_v (voltage gain) measured	120	35	19	10·5	5·4
A_v calculated	108	37·5	21·6	11	5·74

Table indicating the changes in the circuit characteristics with different values of R_e.

Finally, a paragraph on coupling and decoupling.

We have already stated that R_{dec} is dropping 1V and we know that the approximate current through it will be 1mA so from this we can calculate its value,

$$R_{dec}=\frac{1\text{V}}{1\text{mA}}=1\text{k}\Omega$$

We can take it that the decoupling capacitor, C_{dec} is as before, that is 100μF. C_{out} is similar, at 10μF and C_{in} will vary with the stage input resistance for optimum value. Using the rule-of-thumb method, 1μF into 100kΩ, and applying this to measured values of R_{IN}, we can see that this will vary from a mere 0·1μF (actual value 0·086μF) to greater than 0·5μF.

TO BE CONTINUED

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2G381	22½p	2N3605	27½p	40329	30p	BCY40	50p	BSY24	15p	NKT452	62½p
2N404	22½p	2N3606	27½p	40344	27½p	BCY42	15p	BSY25	15p	NKT453	47½p
2N696	20p	2N3607	22½p	40347	57½p	BCY43	15p	BSY26	17½p	NKT603F	32½p
2N697	17p	2N3702	11p	40348	52½p	BCY54	32½p	BSY27	17½p	NKT613F	32½p
2N698	25p	2N3703	10p	40360	42½p	BCY58	22½p	BSY28	17½p	NKF674F	30p
2N706	12½p	2N3704	11p	40361	47½p	BCY59	22½p	BSY29	17½p	NKT677F	30p
2N705A	12½p	2N3705	10p	40362	57½p	BCY60	97½p	BSY32	25p	NKT713	25p
2N708	15p	2N3706	09p	40370	32½p	BCY70	20p	BSY36	25p	NKT781	30p
2N709	62½p	2N3707	11p	40406	57½p	BCY71	25p	BSY37	25p	NKT10419	30p
2N718	25p	2N3708	07p	40407	40p	BCY72	17½p	BSY38	22½p	NKT10439	
2N726	30p	2N3709	09p	40408	52½p	BCZ10	27½p	BSY39	22½p		37½p
2N727	30p	2N3710	09p	40410	62½p	BCZ11	42½p	BSY40	32½p	NKT10519	
2N914	17½p	2N3711	12p	40467A	57½p	BD116	£1·12½	BSY51	32½p		32½p
2N916	17½p	2N3715	£1·25	40468A	35p	BD121	65p	BSY52	32½p	NKT20329	
2N918	30p	2N3716	£1·30	40600	57½p	BD123	82½p	BSY53	37½p		47½p
2N929	22½p	2N3791	£2·06	AC107	30p	BD124	60p	BSY54	40p	NKT20339	
2N930	27½p	2N3819	35p	AC126	20p	BD131	75p	BSY56	90p		37½p
2N1090	22½p	2N3823	97½p	AC127	25p	BD132	85p	BSY78	47½p	NKT80111	
2N1091	22½p	2N3854	27½p	AC128	20p	BDY10	£1·37½	BSY79	45p		77½p
2N1131	25p	2N3854A	27½p	AC154	22½p	BDY11	£1·62½	BSY82	52½p	NKT80112	
2N1132	25p	2N3855	27½p	AC176	25p	BDY17	£1·50	BSY90	57½p		97½p
2N1302	17½p	2N3855A	30p	AC187	62½p	BDY18	£1·75	BSY95A	12½p	NKT80113	
2N1303	17½p	2N3856	30p	AC188	37½p	BDY19	£1·97½	BSW41	42½p		£1·12
2N1304	22½p	2N3856A	35p	ACY17	27½p	BDY20	£1·12½	BSW70	27½p	NKT80211	
2N1305	22½p	2N3858	25p	ACY18	25p	BDY38	97½p	C111	75½p		92½p
2N1306	25p	2N3858A	30p	ACY19	25p	BDY60	£1·25	C424	27p	NKT80212	
2N1307	25p	2N3859	27½p	ACY20	25p	BDY61	£1·25	C425	55p		92½p
2N1308	30p	2N3859A	32½p	ACY21	25p	BDY62	£1·00	C426	40p	NKT80213	
2N1309	30p	2N3860	30p	ACY22	20p	BF115	25p	C428	37½p		92½p
2N1507	17½p	2N3866	£1·50	ACY28	20p	BF117	47½p	C744	30p	NKT80214	
2N1613	25p	2N3877	40p	ACY40	20p	BF163	37½p	D16P1	37½p		92½p
2N1631	35p	2N3877A	40p	ACY41	25p	BF167	18p	D16P2	40p	NKT80215	
2N1632	30p	2N3900	37½p	ACY44	40p	BF173	19p	D16P3	37½p		92½p
2N1638	27½p	2N3900A	40p	AD140	52½p	BF177	30p	D16P4	40p	NKT80216	
2N1639	27½p	2N3901	97½p	AD149	57½p	BF178	30p	GET102	30p		92½p
2N1671B	£1·00	2N3903	35p	AD150	62½p	BF179	30p	GET113	20p	OC20	75p
2N1711	25p	2N3904	35p	AD161	37½p	BF180	35p	GET114	20p	OC22	50p
2N1889	32½p	2N3905	37½p	AD162	37½p	BF181	32½p	GET118	20p	OC23	60p
2N1893	37½p	2N3096	37½p	AF106	42½p	BF184	25p	GET119	20p	OC24	60p
2N2147	82½p	2N4058	17½p	AF114	25p	BF185	42½p	GET120	52½p	OC25	50p
2N2148	57½p	2N4059	10p	AF115	25p	BF194	17½p	GET873	12½p	OC26	27½p
2N2160	57½p	2N4060	12½p	AF116	25p	BF195	15p	GET880	30p	OC28	62½p
2N2193	40p	2N4061	12½p	AF117	25p	BF196	42½p	GET887	20p	OC29	62½p
2N2193A	42½p	2N4062	12½p	AF118	62½p	BF197	42½p	GET889	22½p	OC35	50p
2N2194A	30p	2N4244	47½p	AF119	20p	BF198	42½p	GET890	22½p	OC36	62½p
2N2217	27½p	2N4285	17½p	AF124	22½p	BF200	52½p	GET896	22½p	OC41	22½p
2N2218	23p	2N4286	17½p	AF125	20p	BF224	14p	GET897	22½p	OC42	25p
2N2219	23p	2N4287	17½p	AF126	20p	BF225	19p	GET898	22½p	OC44	20p
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2N2222	30p	2N4290	17½p	AF178	42½p	BF244	23p	MJ421	£1·12½	OC70	15p
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2N2368	17½p	2N4303	47½p	AF181	42½p	BFX13	22½p	MJ480	97½p	OC74	32½p
2N2369	17½p	2N5027	52½p	AF239	42½p	BFX29	30p	MJ481	£1·25	OC75	22½p
2N2369A	17½p	2N5028	57½p	AF279	47½p	BFX30	30p	MJ490	£1·00	OC76	22½p
2N2410	42½p	2N5029	47½p	AF280	62½p	BFX42	37½p	MJ491	£1·37½	OC77	30p
2N2483	27½p	2N5030	42½p	AF211	32½p	BFX44	37½p	MJ1800	£2·17½	OC81	20p
2N2484	32½p	2N5172	12½p	ASY26	25p	BFX68	67½p	MJE340	62½p	OC81D	22½p
2N2539	22½p	2N5174	52½p	ASY27	37½p	BFX84	25p	MJE520	60p	OC83	25p
2N2540	22½p	2N5175	52½p	ASY28	27½p	BFX85	32½p	MJE521	73p	OC84	25p
2N2613	35p	2N5176	45p	ASY29	27½p	BFX86	25p	MPF102	42½p	OC139	32½p
2N2614	30p	2N5232A	30p	ASY36	25p	BFX87	27½p	MPF103	37½p	OC140	32½p
2N2646	52½p	2N5245	45p	ASY50	25p	BFX88	25p	MPF104	37½p	OC170	30p
2N2696	32½p	2N5246	42½p	ASY51	32½p	BFX89	62½p	MPF105	37½p	OC171	30p
2N2711	25p	2N5249	67½p	ASY54	25p	BFX93A	70p	MPS3638	32½p	OC200	40p
2N2712	25p	2N5265	£3·25	ASY86	32½p	BFY10	32½p	NKT0013	47½p	OC201	60p
2N2713	27½p	2N5266	£2·75	AU103	£1·25	BFY11	42½p	NKT124	42½p	OC202	75p
2N2714	30p	2N5267	£2·62½	ASZ21	42½p	BFY17	22½p	NKT125	27½p	OC203	42½p
2N2865	62½p	2N5305	37½p	BC107	10p	BFY18	32½p	NKT126	27½p	OC204	42½p
2N2904	30p	2N5306	40p	BC108	10p	BFY19	32½p	NKT128	27½p	OC205	90p
2N2904A	32½p	2N5307	37½p	BC109	10p	BFY20	£1·60	NKT135	27½p	OC207	75p
2N2905	37½p	2N5308	37½p	BC113	15p	BFY21	42½p	NKT137	32½p	OCP71	42½p
2N2905A	40p	2N5309	62½p	BC115	15p	BFY24	45p	NKT210	30p	ORP12	50p
2N2906	25p	2N5310	42½p	BC116A	15p	BFY25	25p	NKT211	30p	ORP61	50p
2N2906A	27½p	2N5354	27½p	BC118	10p	BFY26	20p	NKT212	30p	P346A	22½p
2N2907	30p	2N5355	27½p	BC121	20p	BFY29	50p	NKT213	30p	TIS34	62½p
2N2923	15p	2N5356	32½p	BC122	20p	BFY30	50p	NKT214	22½p	TIS43	27p
2N2924	15p	2N5365	47½p	BC125	20p	BFY41	50p	NKT215	22½p	TIS44	10p
2N2925	15p	2N5366	32½p	BC126	20p	BFY43	62½p	NKT216	37½p	TIS45	10p
2N2926		2N5367	57½p	BC140	37½p	BFY50	23p	NKT217	42½p	TIS46	11p
Green	14p	2N5457	37½p	BC147	10p	BFY51	20p	NKT219	30p	TIS47	11p
Yellow	12½p	2S005	75p	BC148	10p	BFY52	23p	NKT223	27½p	TIS48	12½p
Orange	12½p	2S020	£2·00	BC149	12p	BFY53	17½p	NKT224	25p	TIS49	12½p
2N3011	30p	2S102	50p	BC152	17½p	BFY56A	57½p	NKT225	22½p	TIS50	17½p
2N3014	32½p	2S103	25p	BC157	20p	BFY75	30p	NKT229	30p	TIS51	12½p
2N3053	18p	2S104	25p	BC158	11p	BFY76	42½p	NKT237	35p	TIS52	12½p
2N3054	46p	2S501	32½p	BC159	12p	BFY77	57½p	NKT238	25p	TIS53	22½p
2N3055	62p	2S502	35p	BC160	62½p	BFY90	67½p	NKT240	27½p	TIS60	22½p
2N3133	30p	2S503	27½p	BC167	11p	BFW58	27½p	NKT241	27½p	TIS61	25p
2N3134	30p	3N83	40p	BC168B	10p	BFW59	25p	NKT242	20p	TIS62	27½p
2N3135	25p	3N128	70p	BC168C	11p	BFW60	25p	NKT243	62½p	TIP29A	50p
2N3136	25p	3N140	77½p	BC169B	11p	BPX25	£1·85	NKT244	17½p	TIP30A	60p
2N3390	25p	3N141	72½p	BC169C	12p	BPX29	£1·80	NKT245	20p	TIP31A	62½p
2N3391	20p	3N142	55p	BC170	12½p	BPY10	£1·45	NKT261	20p	TIP32A	75p
2N3391A	30p	3N143	67½p	BC171	15p	BRY39	37½p	NKT262	30p	TIP33A	
2N3392	17½p	3N152	87½p	BC172	15p	BSX19	17½p	NKT264	20p		£1·02½
2N3393	15p	R.C.A.	52½p	BC175	22½p	BSX20	17½p	NKT271	20p	TIP34A	£2·05
2N3394	15p	40050	55p	BC182	10p	BSX21	37½p	NKT272	20p	TIP35A	£2·90
2N3402	22½p	40251	32½p	BC183	09p	BSX26	45p	NKT274	20p	TIP36A	£3·68
2N3403	22½p	40309	32½p	BC184	11p	BSX27	47½p	NKT275	20p		

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SN7420	0·20	0·18	SN7450	0·20	0·18	SN7491AN	1·21	1·10
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SN7427	0·48	0·45	SN7453	0·20	0·18	SN7493	0·87	0·84
SN7428	0·80	0·75	SN7454	0·20	0·18	SN7494	0·87	0·84
SN7430	0·23	0·15	SN7460	0·20	0·18	SN7495	0·87	0·84
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IN4007	20p	AAZ15	12p	BAY38	25p	OA9	10p
IS44	7p	AAZ17	10p	BY100	15p	OA47	8p
IS113	15p	BA100	15p	BY103	22p	OA70	7p
IS120	12p	BA102	25p	BY122	47½p	OA73	10p
IS121	14p	BA110	25p	BY124	15p	OA79	7p
IS130	8p	BA114	15p	BY126	15p	OA81	8p
IS131	10p	BA115	7p	BY127	17p	OA82	10p
IS132	12p	BA141	17p	BY164	57p	OA90	7p
IS920	7p	BA142	17p	BYX10	22p	OA91	7p
IS922	8p	BA144	12p	BYZ10	35p	OA95	7p
IS923	12p	BA145	17p	BYZ11	32p	OA200	7p
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ON THE SHORT WAVES

MONTHLY NEWS FOR DX LISTENERS

THE BROADCAST BANDS

Malcolm Connah

Frequencies in kHz • Times in GMT

THE first reporter this month is **Hugh Cocks** of Mayfield in Sussex who has a Unica UNR-30 receiver and a 70 foot long-wire. Hugh sent in a special log of South American stations as follows:

9515 *R. Roquete, Pinto, Brazil* at 2200.
9530 *R. Calendario, Venezuela* at 2230.
9595 *R. Cultura de Bahia, Brazil* at 2130.
9620 *R. Novo de Julho, Brazil* at 2150.
9635 *R. Aparecida, Brazil* at 2225.
9665 *R. Nac. Brasilia, Brazil* at 2230.
9705 *R. Maua, Brazil* at 2100.
11720 *R. Nac. Brasilia, Brazil* at 2100.
11785 *R. Guaiba, Brazil* at 2058.
11795 *R. Nac. Rio, Brazil* at 2100.
11805 *R. Globo, Brazil* at 2100.
11865 *R. Cl. de Pernambuco, Brazil* at 2100.
11875 *R. Soc. de Bahia, Brazil* at 2100.
11915 *R. TV. Gaucha, Brazil* at 2115.
11925 *R. Bandeirantes, Brazil* at 2200.
11950 *R. Min. Educaco, Brazil* at 2130.
15105 *R. Rural Brasileira, Brazil* at 2200.
15145 *R. Jornal do Comercio, Brazil* at 2150.
15155 *R. Dif. de Sao Paulo, Brazil* at 2200.
15190 *R. Inconfidencia, Brazil* at 2230.
15415 *R. Cl. Ribeirao, Brazil* at 2130.

Ian Howes of Lowestoft used a TV antenna with his R209 Mk. 2 receiver to log the following very interesting stations:

4500 *Urumchi, China* with music at 0010.
4665 *Pathet Lao, Laos* in Laotion at 1545.
4790 *R. Ondas Portenas Venezuela* at 0010.
4800 *AIR, Hyderabad, India* at 1545.
4840 *AIR, Bombay, India* at 1510.
4965 *R. Santa Fe, Colombia* news at 0000.
9680 *VLH/R9 ABC, Melbourne, Australia* at 1100.
11875 *R. Dif. Nacional, Nicaragua* at 0000.
11880 *R. Splendid, Argentina* in Spanish at 0045.

Peter Herman of New South Wales, Australia has an equipment line-up which includes a Trio 9R-59DS receiver, a 9MHz. dipole, a 15MHz. dipole, and a Hitachi SCT-1150R 3-band radio/cassette with a telescopic and 12 foot long-wire antenna. Peter's log included:

3322 *R. Bougainville, N. Guin.* at 1143.
4820 *R. Gambia* at 1800.
6145 *AIR, India* at 1540.
7100 *R. Budapest, Hungary* at 1630.
7235 *All India Radio* at 1500.
7285 *R. Berlin International* at 1730.
7290 *R. Kuwait* at 1630.
11920 *R. Abidjan, Ivory Coast* at 1830.

D. A. Hairon of St. Clement, Jersey has sent in another report using the usual equipment, this time he has heard:

9570 *ABC, Australia* in English at 1015.
9625 *Israel B.C.* in English at 2130.
11730 *R. Nederland, Bonaire* at 0525.
11760 *R. Habana, Cuba*, sign off at 0200.
11815 *TWR, Bonaire* in English at 0045.
11860 *BBC, Ascension Is.* relay at 0815.
11875 *R. Nacional, Nicaragua*, Spanish at 0130.
15160 *R. Ankara* in Arabic at 0530.
15532 *R. Bangldesh* in English at 1245.
17855 *NHK, Japan* in English at 0900.
21605 *R. Kuwait* in Arabic at 1100.

Alastair Nimmo is only eleven years old but this extract from his log, using a Meridian 10 transistor portable and 100 foot long-wire shows distinct promise:

5960 *HCJB, Quito, Ecuador*, English at 0830.
6040 *VOA, Rhodes relay* at 2100.
9515 *R. Ankara* in English at 2200.
9525 *RSA, South Africa* in English at 2215.
9530 *AIR, Delhi* in English at 1900.
9530 *VOA, Monrovia* relay, English at 2230.

In order to mention as many reporters as possible I will end this article with a few short extracts from the many received:

Richard Coyle, Glasgow, Lafayette KT340:

4965 *R. Santa Fe, Colombia* at 0550.
4970 *R. Rumbos, Venezuela* at 0345.
4990 *R. Barquisimeto, Venezuela* at 0400.
5038 *R. Bangui, Ident.* in French at 0500.
5075 *R. Sutatenza, Colombia* at 0100.

Adrian Pell, Wareham, Dorset:

12025 *Voice of Vietnam*, English at 2015.
15165 *Danish Radio* in Danish at 1400.
15295 *TWR, Bonaire* in Norwegian at 2145.
15370 *VOA, Greenville* in French at 2200.

Ian Newbold, Birmingham, R209 Mk. 2, 95 foot aerial:

3340 *R. El Mar, Equador* at 2000.
4550 *R. Nacional, Colombia* at 2005.
9735 *NHK, Japan* in Japanese at 2018.
15170 *ELWA, Liberia* in French at 2007.

Fred Wall, E.17, PR155, 20 foot long-wire:

3380 *R. Malawi* in English at 1800.
9510 *R. Barquisimeto, Venezuela* at 2350.
9520 *R. New Zealand* in English at 0900.
11930 *Windward Is. B.S.* cricket at 2120.

Philip Sokell, Barnsley, Romer 10, telescopic antenna:

6125 *VOA* noted at 1610.
6185 *Radio Australia* at 2045.
7215 *Radio Cairo, Egypt* at 0254.
7230 *Radio Kiev, Ukraine* at 0045.

Reports should arrive by the 15th of the month and be addressed to me at 5 Ranelagh Gardens, Cranbrook, Ilford, Essex.

ON THE SHORT WAVES

THE AMATEUR BANDS

David Gibson, G3JDG

Frequencies in kHz • Times in GMT

IN theory, it should have been a very good month for keen listeners since almost every log sent in was for bands which were at either end of the r.f. spectrum. Quite a few queries in the post bag, many asking questions which would require a text book, blackboard and a couple of years at evening classes to answer. Many people who have queries have a very simple way out—join the nearest radio club. You can ask a question and get an immediate answer. There is nearly always someone at the club who specialises in an area where your question is aimed at. If one person doesn't know the full answer, then it is virtually certain that someone else will.

Join the R.S.G.B., too. This organisation will give you all the help you need, and will also tell you the name and address of the secretary of your nearest radio club. The Society also publishes a number of "booklets" especially for the radio enthusiast and some are aimed specifically at the beginner.

Having joined a club, you will get a chance to visit other people's 'stations' and see gear which, at present, is only a number, like PR40 or R107. Better still, you can have a twiddle with the gear and make up your own mind as to whether a particular piece of equipment is very good or just mediocre.

So you don't hear any DX in spite of all those lovely logs you read in *Practical Wireless*? One way to latch on to some DX is to listen for a DX net which has European stations either in it or even running it. Listen for a good European station calling a DX station. Once you have found the right frequency it is highly probable that other stations will come up also calling the DX station. Eighty metres is a common hunting ground for this type of DX net.

Combined efforts of the **Ipswich** and **Colchester** clubs will result in the Anglian Mobile rally to be held at Ipswich on June 18. Talk-in stations on 160, 80, 4 and 2 metres. Colchester club also runs slow morse practice sessions. Anyone in the area might like to drop to Hon. Sec. a line at 26 Pondfield Road, Colchester, Essex. See you at the rally?

An appeal from **Sam Elsdon** for Amateur stations to use "standard" phonetics. I agree. Only way seems to be to make an accepted phonetic alphabet compulsory and written into all Amateur licences throughout the world. Sam has just finished off the CQ2 v.h.f. receiver which appeared in the September edition of *Practical Wireless* back in 1969. He runs a CR70A and PR40 plus a 310ft end-fed. A listen on eighty metres s.s.b. raised: DJ9NW, PJ4AQ, W5ILR/TF, XE1CV, 9H1D. Log for 20 metres reads: BY4AP, EA3AKE, FG7TC, IS1KLO, VE3MR, VK2AVA, VK3OEL, VK5OB, VO4HW, ZS5KY, 4X4DK, 7X2PK, 7X3ORU.

Kevin Lamb has seen thirteen summers pass and resides at Ashford. Gear consists of a two-valve homebrew receiver, a.t.u. (also homebrew) and a 50ft end-fed. Goodies heard on topband include: HB9CM, OK1FT, OK1MAC, OL1APC, 4U1ITU. Twenty metres using an R107 (that's cheating) raised: CX2XA, EA8GZ, EA8DI, HK5ASM, PY7AZQ, VK3ALL, VK4NB, VK4UC, VK5FH, VK6HE, VP9GK, ZL1HD, ZL3AH, ZL3AR, ZL3HA. Kevin asks about some four metre activity. This is a band which the Amateur could so easily lose unless there is a lot more activity. If the two metre addicts would come down, the G8 plus threes take the trouble to learn c.w., and the h.f. DX types go up another band, we might just save it—or is it worth the effort?

One hundred and thirty-two feet of wire stretching into the sunset but anchored to the aerial terminal of an R107 is a feature at a house in Melbourne Road, Chester. **Mike Purcell** loiters thereabouts and heard the following on 3·5MHz s.s.b.: CR4BS, CT1UN, HB9LQS, VE1QM, VP2LAT, VO1CU, WB0FFG/TF, W1AA, 4X4UF.

Another CQ2 v.h.f. receiver builder is **David Lawley** (Gravesend). He has heard a fair number of Amateur two-metre stations already but although he is only ten miles from the beacon station GB3VHF, he can't hear it at all. (V-e-r-y interesting.) Ten metres is the band which has brought a lot of stations in for David using the School Radio Society's B40 plus 500ft long, long, long wire. Log reads: JA8GWA, JR1INC, OD5HI, PZ1DV, VE3DOR, VE7HC, VU2JM, K1BCD, hoards of W stations, ZC4BJ, 4X4GH, 4X4HK, 9X5MS all mostly on s.s.b.

Down on topband, David reports signals from: EI9J, GM3YOR, GW3UCB, GW3UPK, GW4AHN/A, HB9CM, HB9NL, OL1AOH, OL5ANJ, PA0PN. These were all on c.w. but PA0PN is on most Sunday mornings on s.s.b.

Eighty-three W stations start off the eight metre log of **Richard Coyle** (Glasgow). Additional appearances from: VE1ANZ, VE2WA, VE3GCS, VE3VE, ZL3GS, 6W8DY.

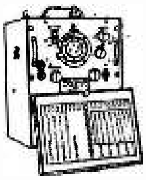
Fifty-nine W stations in the ten-metre log from an unknown listener at Henrietta Street, Girvan in Ayrshire. OK, don't sign your name, but I know you've got a CR70A and a ten-metre dipole. Incidentally, it is surprising how many logs don't get in because no receiver is mentioned, or the aerial hasn't been divulged or the whole list is not in alphabetical order. (Hint! hint!!)

John Guy (Wimborne), B40C, 70ft end-fed, 28MHz, mode unspecified: CR4BS, CR6I1, ET3USA, FL8MM, HC2GG/P, KP4DHD, VS6DO, YV1AMX, YV3SZ, 7Q7BC, 8R1G.

More news from **John Stevenson** (Woking) about his d.c. (direct conversion) receiver. A number of mods have given a large increase in sensitivity. Log for 14MHz s.s.b. reads: CT1BZ, HR1RS, HV3SI, KP4BSA, PY1CAD, PY2YRS, PY4AS, VK2NN, VK2RV, VQ9R, ZL1BE, 3A2CP, 4X4BL, 4X4NJ, 4Z4TV, 9H1CZ.

Happenings for the merry month of May include: 6-7, 432MHz contest; 21, 2 metres contest. June: 3-4, National Field Day; 10-11, 4 metre contest.

BETTER GET 'SET'



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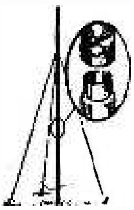

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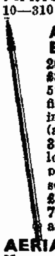

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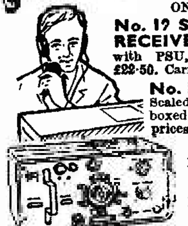

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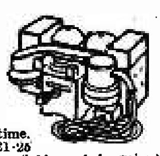

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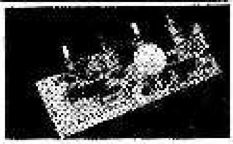

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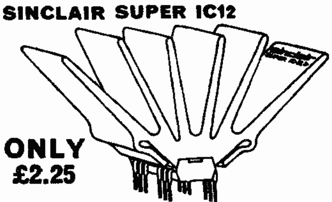

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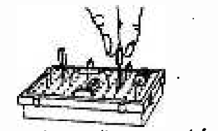

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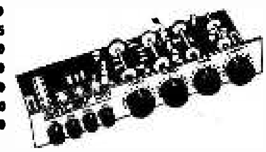

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I.C. OF THE MONTH

L.A.J. IRELAND

Number 30 | **RCA CA3090Q Stereo Decoder**

IN AUGUST 1970 this column reported on the introduction of a stereo decoder i.c., the Motorola type MC1303. In the interval this unit has proved very successful and certain commercial concerns are marketing decoder units based on this device. However, technology does not stand still; it was recognised that the elimination of the set of coils required in a standard stereo decoder would facilitate the assembly of units on a commercial basis.

Successful decoding demands the selection of the 19kHz pilot tone from the audio signal developed by the discriminator stage of the f.m. tuner, followed by the reconstruction of the 38kHz carrier by frequency doubling without degrading the phase relationship with the pilot tone. Replacement of the carrier into the 38kHz sideband permits demodulation of the "difference" signal; the audio components of the discriminator output provide the "sum" signal.

The final stage in decoding is the reconstruction of the separate right and left channels from the "sum" and "difference" signals supplied. To reduce noise in the subcarrier (38kHz) regeneration process, it is desirable that sharply tuned circuits be used to reduce the bandwidth about 19kHz when determining the pilot tone. This however, is in conflict with the requirement of phase coherence, since then slight detuning can introduce significant phase shift. Remembering that a channel separation of at least 20dB is the minimum acceptable in a stereo decoder and that less than 10° of phase shift in each of the three inductors alone can cause a reduction in channel separation approaching this figure, the care necessary in designing and aligning the coils can be estimated, even with a sound basic system such as the MC1303.

At this point it may be recalled that the introduc-

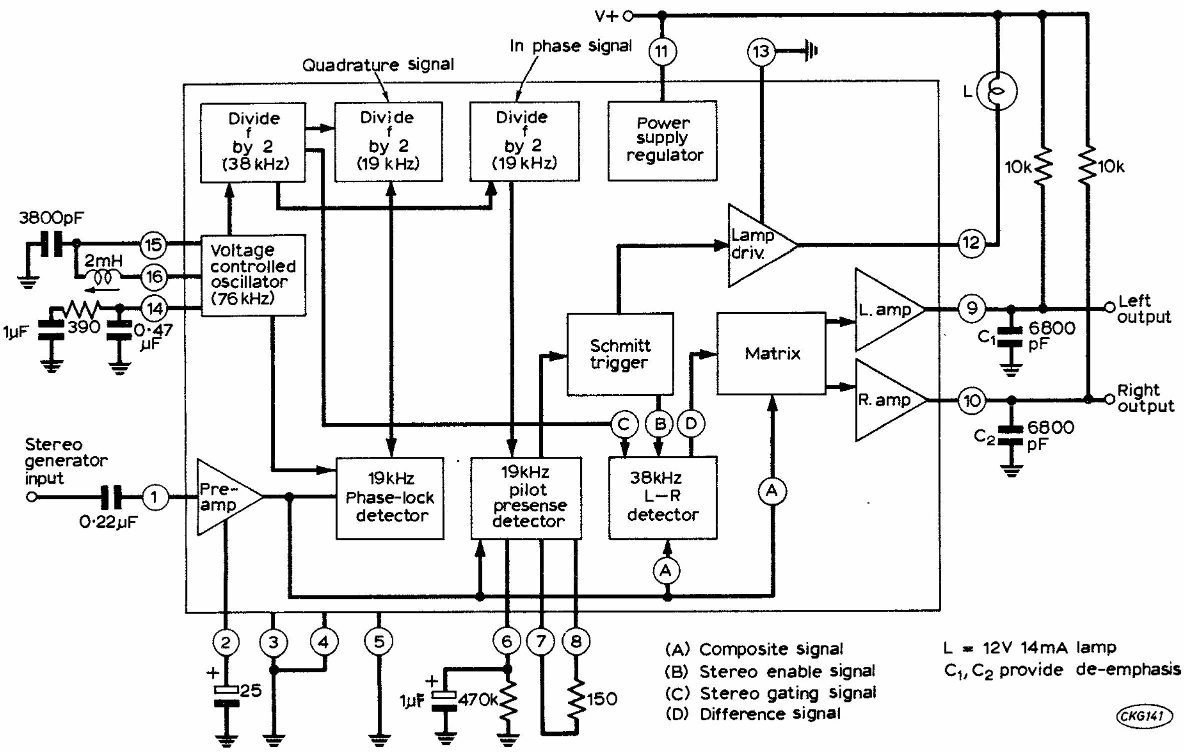


Fig. 1: The R.C.A. type CA3090Q phase-locked loop i.c. stereo decoder block diagram and applications circuit. In domestic tuner systems the f.m. discriminator is applied across the 0·22 µF capacitor.

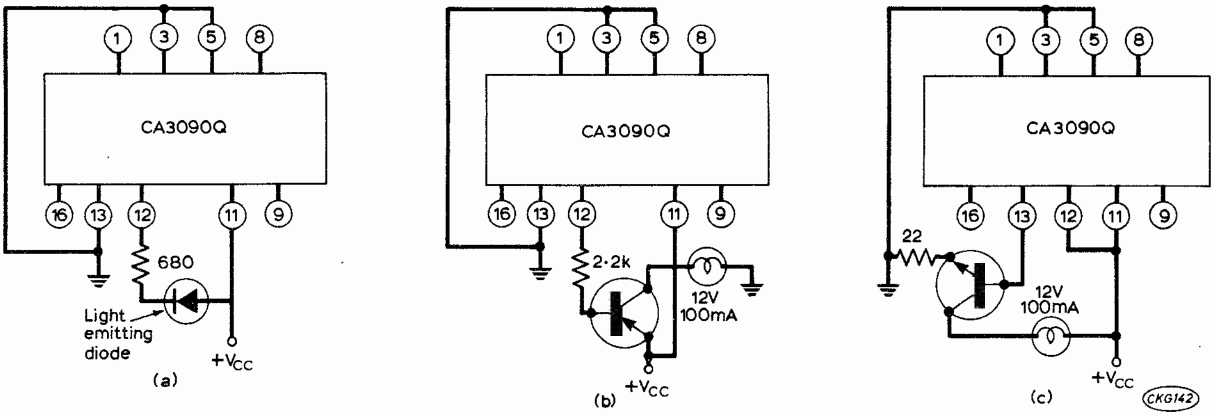


Fig. 2: Various methods of light indication (a) using a light emitting diode (b) PNP lamp driver (c) NPN lamp driver.

tion of monolithic silicon technology has opened an alternative route to the operation of tuned circuits, capable of eliminating to a great extent the requirements for precision LC circuits. It is, of course, the phase-locked loop circuit, first dealt with in "I.C. of the Month" in July 1971. Here, a local oscillator, whose operating frequency can be shifted by a limited amount by the application of an external voltage bias, drives a phase comparison circuit. The other input to the comparator is the external reference signal. The comparator output, a measure of frequency and phase separation of the local and the reference signal, feeds back to the local oscillator as an error voltage, correcting the local oscillator frequency.

The phase-locked loop i.c. considered last July was the Signetics NE561B system, suitable as an a.m./f.m. demodulator. This month exactly the same circuit concept is applied to the stereo decoder problem in the new R.C.A. Type CA3090Q. It is perhaps unnecessary to point out that by a phase-lock method, the problem of phase-shift degradation of channel separation is clearly avoided, and the need for design compromise between subcarrier circuit bandwidth and signal/noise ratio circumvented.

In the CA3090Q the loop local oscillator operates at a centre frequency of 76kHz and is followed by bistable frequency dividers, producing the 38kHz subcarrier at first division and 19kHz, the pilot tone frequency, at the second division. The frequency and phase comparison operation is carried out at 19kHz by reference to the received pilot tone, and the d.c. error voltage fed back to the local oscillator to maintain phase lock. Unlike the Signetics unit, the voltage controlled local oscillator of the CA3090Q is an LC oscillator, but the coil for this circuit is the only inductor required in the whole stereo decoder system, and even then alignment is non-critical. In point of fact, a 4kHz shift in local oscillator free-running frequency requires a correction voltage representing some 10° **total** subcarrier phase shift; the 40dB. channel separation figure then achieved is highly satisfactory, Fig. 1.

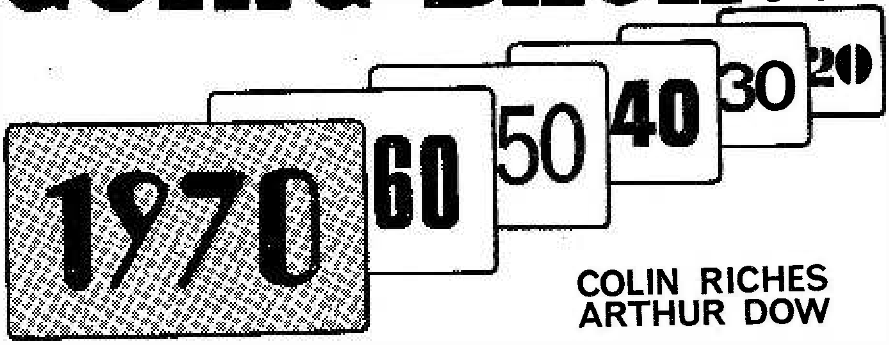
Signals at 19kHz are derived from the local oscillator by division independently for the phase comparator already mentioned and for a stereo signal presence detector circuit. When the pilot tone exceeds a preset value, corresponding to an f.m. detector output (i.e. the "composite" stereo signal comprising a.f. "sum" signal, 19kHz pilot tone and 38kHz suppressed carrier "difference" signal) of 40 mV, a Schmitt trigger operates, switching the i.c. into stereo mode, with demodulation of the 38kHz signal and matrixing for channel separation, together with a suitable stereo reception signal. External indication of stereo operation is therefore directly available in a dial light, with the attractive possibility that this may be an l.e.d. solid state indicator, rather than a mere bulb, Fig. 2. A manual override to the automatic mono/stereo switching operation may be incorporated; the control voltage to secure this function is applied at pin 4 (shown earthed in Fig. 1).

The circuit incorporates an internal voltage regulator, a feature widely accepted in complex function i.c.'s since it eliminates the need for external decoupling of power supply lines, a decoupling which could well be ineffective anyway due to internal "crosstalk" on the chip. Further, in a complex circuit, the availability of pins for external connections is often a limiting factor, and economically more significant in production than a few extra transistors on the chip, which require consideration once and for all only at the design stage. The effectiveness of the internal regulation is indicated by the capability of the unit to function over a power supply voltage range of 10 to 16 volts.

Design of the actual decoder can be based on Fig. 1, which shows the actual circuit for a phase locked loop automatic stereo decoder with function indicator lamp. The coil is a 2mH unit, and may be wound on an adjustable pot core. The complexity of the unit can be judged by the fact that it has 128 transistors! Clearly an itemised analysis of circuit function would not find a place in this note, so Fig. 1 also provides a block diagram to assist the constructor who wishes to study the system more fully. For the majority of readers, though, it will be sufficient that in this i.c. there is available a first-rate stereo decoder which is simple to apply even if highly sophisticated in design.

The unit is supplied in a 16-pin quad-in-line plastic package, i.e. differing from the d.i.p. package in that alternate pins are displaced to provide four lines each of four pins. This facilitates the design and construction of suitable p.c. boards; it is recommended that an earth strip be left down the centre of the i.c., screening contacts on one side of the i.c. from those on the other. However, no difficulty should be experienced, even by the relative newcomer to construction, in achieving success with this unit. ■

GOING BACK...

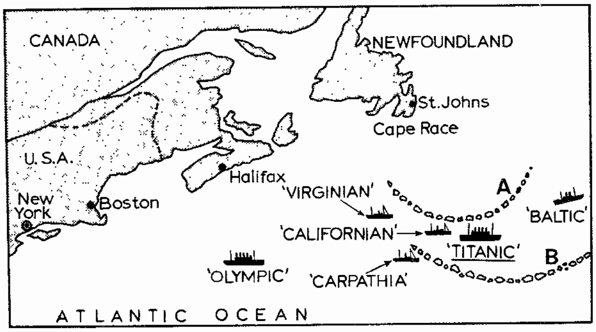


COLIN RICHES
ARTHUR DOW

TITANIC DISASTER - PART 2

Mr. Cyril Evans, examined by the Solicitor-General at the Court of Enquiry on the disaster, stated that he was the sole Marconi operator in the *Californian*. At 5.35 p.m. New York time, or 7.30 ship's time, he received a message from the steamship *Antillian* that an hour before she had seen three large icebergs to the southward. A little later he heard from the *Titanic* and offered her the report about the ice, and she replied, "All right, I heard the same thing from the *Antillian*". At 9.5 New York time, or 11 o'clock ship's time, the captain directed him to tell the *Titanic* that the *Californian* was stopped and surrounded by ice. He sent the message to the *Titanic* and got the reply, "Keep out." That was because the *Titanic* was at that moment in communication with Cape Race, and his message had caused an interruption. The *Titanic*, however, must have heard what he had said about the ice, because his signals were much stronger than the Cape Race signals. He next heard the *Titanic* say to Cape Race, "Sorry, please repeat". The messages from the *Titanic* to Cape Race were private messages from the passengers.

Mr. John Durrant, Marconi operator of the *Mount Temple*, was another witness. In reply to the Solicitor-General, he stated that the range of his wireless installation was 150 miles by day and 200 miles by night. On the evening of Saturday, April 13th—the day before the foundering of the *Titanic*—he got an official message from the captain of the *Mount Temple* that ice had been seen. This was the only message he received in regard to ice before the wreck.



Map showing the approximate positions of the Titanic and other ships.

H. T. Cottam, wireless operator on board the "Carpathia".

The witness then proceeded to give from his logbook the various calls he heard sent by the *Titanic* and the replies to them by ships which they reached.

The first thing he heard of the *Titanic* was at 11 minutes past 12 o'clock (ship's time) on Sunday night, when he got the message "C.Q.D." from the *Titanic*, giving her position, and adding, "Come at once. Struck berg. Advise captain." He told his captain at once. After the lapse of ten minutes he had the entry, "*Titanic* still calling C.Q.D.", that she was asked by the *Carpathia* what was wrong, and replied, "Struck iceberg. Come to our position," which was given. At 12.26 a.m. he made the entry—"*Titanic* still calling C.Q.D." At this time the *Mount Temple* had altered her course, and was speeding to the assistance of the *Titanic*. This had been done about 15 minutes after getting the first signal. At 12.34 he heard the *Frankfurt* answering the *Titanic* and the *Titanic* giving her position to the *Frankfurt*. The *Titanic* asked, "Are you coming to our assistance?" The *Frankfurt* said, "What is the matter with you?" and the *Titanic* answered, "Have struck an iceberg. Sinking. Come to our help. Tell captain." The *Frankfurt* then said, "O.K. Will tell bridge at once", and the *Titanic* replied, "O.K. Yes. Quick." At 12.42 he heard the *Titanic calling "S.O.S."*

At a quarter to 1 o'clock he heard the *Titanic* sending out both calls. She then got into touch with the *Caronia*, and next with the *Virginian*.

The Solicitor-General then asked if Mr. Durrant had broken in and talked to the *Titanic* would he have interrupted her messages to other ships? Yes, I never said a word after I got her position. The first rule in wireless telegraphy is "Never Interfere".

The witness, continuing the narrative from his log-book, said the *Titanic* called the *Olympic* at 12.43 a.m. The *Olympic* replied at 1.06 a.m. and got the message, "Get your boats ready. Going down fast by the head." At 1.11 the *Frankfurt* sent a message to the *Titanic*, "Our captain will go for you". At 1.13 he heard the *Titanic* working the *Baltic*.

The witness said the *Titanic* answered the *Olympic*, "We are putting the women off in the boats". At 1.29 the *Titanic* sent out a general call. "C.Q.D. Engine-room flooded". The *Titanic* also informed the *Olympic* that the sea was clear and calm. At 1.31 he heard the *Frankfurt* say to the *Titanic*, "Are there any boats round you already?" and to this the *Titanic* made no reply. At 1.33 he heard the *Olympic* send a message to the *Titanic* asking whether the *Titanic* was steering south to meet the *Olympic* and the reply of the *Titanic* was simply the code word for "Received". That was the last message that he heard from the *Titanic*. The messages from the *Titanic* did not get fainter towards the end. When the messages ceased, he thought the flooding of the engine-room had put the wireless out of condition. Most ships, including his own, carried storage batteries for use when power could not be obtained from the dynamos, and the wireless apparatus could be changed from the dynamos to the storage batteries in a minute: but the range of a wireless using storage batteries would be less than that of a wireless using dynamos.

At 1.41 a.m. he heard the *Frankfurt* and the Russian ship, the *Birma*, calling the *Titanic* and there was no reply. At 1.56 the *Olympic*, the *Frankfurt*, and the *Baltic* called, and again there was no answer from the *Titanic*. At 2.11 the *Birma* informed the *Frankfurt* that she was 70 miles from the *Titanic*. At 2.36 he made the entry, "All quiet now. The *Titanic* has not spoken since 1.33." At 3.11 he heard the *Carpathia* say, "If you are there, we are firing rockets." At 3.26 the *Carpathia* again called the *Titanic*. At 3.44 the *Birma* told the *Frankfurt* that he thought he heard the *Titanic* and calling her, said, "Steaming full speed to you. Shall arrive 6 in the morning. Hope you are safe. We are only 50 miles away." At 3.46 he heard the *Carpathia* calling again. At 4.40 he made the entry. "All quiet. We are stopped away. Pack ice." At 5.11 the *Californian* called "C.Q.", and he answered telling her that the *Titanic* had struck an iceberg and sunk, and he gave her the position. At 5.26 he heard the *Californian* speaking to the *Frankfurt*, and she replied to the same effect. His last entry was, "8 a.m. Heard from *Carpathia* that she had rescued 20 boatloads".

Mr. John Durrant, operator on the "Mount Temple".

P.M.G. Comments

The Right Honourable Herbert Samuel, M.P., Postmaster-General, referring to the disaster at the dinner of the London Chamber of Commerce on April 18th, 1912, said:

"Those who had been saved had been saved through one man, Mr. Marconi, whose wonderful invention was proving not only of infinite social and commercial value, but of the highest humanitarian values as well." He had seen it stated that in the United States of America the efficiency of the wireless telegraphy service had been impaired by lack of regulation. He did not know whether that was well founded or not, but as Postmaster-General he could assure them that such disturbance was impossible here. Parliament had given the Postmaster-General a complete control over the use of wireless telegraphy, and no one could operate or establish a station without the Postmaster-General's licence, which was only very sparingly given, and for purposes of experiment and research and under such conditions which precluded disturbance of commercial or humanitarian messages. Round the coast, in charge of his department, there was a girdle of wireless stations which were in constant communication with the telegraphic services of the country and with the life-saving stations. No fewer than 400 liners had been equipped with wireless apparatus, including a certain number of cargo vessels. All the operators on these ships were required to hold a Post Office Certificate of Efficiency, and to answer immediately any signals of distress, and under conditions which, as far as possible, precluded interference with one another.

David Sarnoff

David Sarnoff was on duty at the Marconi Wireless Telegraph Co. of America station at Saisconset on Nantucket Island. On the night of April 14, 1912, he picked up the messages that told of *Titanic's* distress signals and he stayed on duty continuously for 72 hours so that he could relay messages from the rescue ship to the rest of the world.

Brig. General David Sarnoff, born in a small village near Minsk in Russia, in 1891, and former Chairman of the Board of R.C.A. passed away on December 12th, 1971.

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SIEMENS MINIATURE RELAY. Double pole changeover dust cover/base 48v 2500 **50p** pp 5p new.

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		BD116	79p	MP8511	34p	OC35	28p	IN4003	5p
AL102	59p	BD121	50p	MP8513	45p	OC36	36p	IN4004	7p
AL103	49p	BD130	46p	OC41	13p	2N697	18p	OA90	6p
AU103	85p	BD131	59p	OC44	13p	2N1171	24p	OA91	6p
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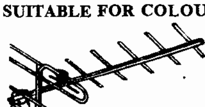

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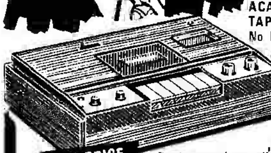


ACADEMY STEREO CASSETTE TAPE DECK. MODEL CS-2000D

No hi-fi system is complete without one – hook it up to any ROC or other good quality amplifier, and the results are fantastic! The CS-2000D records and plays back. A big feature is its easy-to-use piano-key controls. Easy-to-get-at mic inputs are on top; line inputs and outputs at the rear. Dual-channel recording level meter. Pop-up cassette ejection. Stereo/Mono button. Tape counter. Pause control. Tape speed 1⅞ ips (4·75 cms). Frequency response 100–10,000 Hz. Wow and flutter better than 0·3%. Rewind time better than 60 sec with C60 cassette. Engineered throughout to the highest electrical and mechanical standards. Size 16" wide, 4½" high and 8" deep. Walnut cabinet with satin aluminium trims.

ROC PRICE £42.00 Including two pencil microphones and all connecting leads. Normal Price £65·00

ROC PRICE £70.99 Including connecting leads. Normal Price £115·00

REALISTIC HI-FI 36-WATT STEREO CONCERTMASTER FM-AM RECEIVER SYSTEM. MODEL 12-694

Brilliantly designed tuner/amplifier with two matching speakers. All three units in beautifully finished walnut cabinets with smart aluminium vertical trims. The tuning dial is fronted by unique black glass. Figures light up behind it in green when the unit is on. Separate easy-to-operate Left and Right volume controls. Microswitch for on/off. Programme selector. Separate bass and treble controls. Headphone socket on front panel for easy access. Single tuning knob for FM and AM. Built-in aerials, facilities for external FM aerial. Illuminated dial. Stereo broadcast indicator light. Each speaker has 6½" bass and 3" treble units. Output: 9 watts r.m.s. per channel into 8 ohms. Frequency response: 30 to 20,000 Hz. FM: frequency range 80-108 MHz, sensitivity 2·5μV, stereo separation 30dB, image rejection 40db. AM: frequency range 530-1605 kHz, sensitivity 100μV. Sizes: speakers 8, wide, 12, high and 9¾, deep; receiver 6" wide, 12" high and 9¾" deep. And their sophisticated appearance matches the excellence of the specification.

25-WATT 3-WAY CRYSLER 'LIVING AUDIO' SPEAKER CE-5b

This high quality speaker has its own built-in 3-way sound response switch, giving you the ideal frequency response for hi-fi, natural or mood music listening. Its beautiful, heavy, oiled walnut cabinet incorporates two separate speaker units an 8" woofer, and a 5" mid-range with 2" concentric tweeter. Power handling capacity: 25 watts r.m.s into 8 ohms. Overall frequency response: 35-20,000 Hz. Cabinet size: 10½" × 7½" × 8¾". Exactly right for matching the most modern decor.

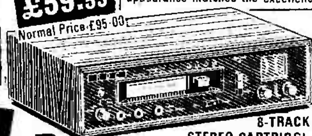
ROC PRICE £27.25 Normal Price £39·95 each.

As reviewed in "POPULAR HI-FI" February 1972

REALISTIC 30 WATT STEREO AMPLIFIER MODEL SA-500

A superb hi-fi amplifier with all the features you've ever wanted – for under £46·00. Saving over £10·00 on the normal retail price. Up-to-the-minute slider controls for bass and treble. Separate volume and balance controls. Headphone socket on front panel. Push-button input controls – magnetic phono (high/low) tuner, aux, mono, monitor. Loudness push-button control for perfect sound at low output levels. Left and right push-button on/off switches for speakers. Noise filtering and tape monitoring facilities. Two auxiliary AC outlets. Frequency response 20-20,000 Hz ± 1 db at full power. 15 watts rms per channel. Walnut cabinet with satin aluminium trims. Inputs: phono 2·5mV and 5mV RIAA; tuner/aux 250mV. Hum and noise: phono – 50db; tuner/aux – 65db. How's that for a specification! Size 14¼" wide, 3½" high, 10½" deep.

ROC PRICE £35.20 Normal Price £55·50



ROC PRICE £59.55 Normal Price £95·00

8-TRACK STEREO CARTRIDGE TAPE DECK MODEL RP-1000ST

The popular Lear-Jet type recording unit is the heart of the fantastic RP-1000ST, which has full record and playback facilities. Automatic track change with manual override. Press to start button. Stereo headphone and Left and Right Mic sockets on front panel. Dual recording level meter, and Left and Right volume controls. Built-in pre-amp. Tape speed 3¾ ips (9·5 cms). Frequency response: playback 30-10,000 Hz; recording/playback 30-8,000 Hz. Line output: fully variable 0-500mV. The RP-1000ST incorporates all the features you'd expect in a top quality Cartridge Tape Deck. Size 16" wide, 4" high, 9" deep. Cabinet in walnut. Including connecting leads

OLSON RA-310 AM/FM/MPX STEREO TUNER

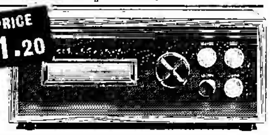
This ROC Tuner is especially designed to match the Olson AM-395 Stereo Amplifier. In price and value, as well as it's good looking design! But of course it's also ideal for use with any other amplifier. The RA-310 costs £10·00 less than the normal retail value, and yet it is a highly sophisticated unit, incorporating the latest solid state techniques. Operation is drift free for supreme station-holding capability. You can connect this Tuner to a stereo amplifier, to a tape deck or a tape recorder. And of course it covers all the stations in the AM and FM bands. FM: 87-108 MHz; AM: 525-1605 kHz. FM Sensitivities: FM, 3μV; AM, 250μV. Stereo separation 30dB at 1kHz, image rejection 60dB. Size: 11$\frac{1}{16}$" wide, 4" high, 7½" deep.

ROC PRICE £31.20 Normal Price £50·00

ROC PRICE £27.55 Normal Price £42·00

PALACE AM/FM/MPX STEREO TUNER AMPLIFIER SSA-16

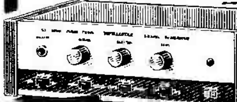
This is one of the lowest priced stereo tuner amplifiers on the market. It covers the full range of both AM and FM broadcast frequencies. And when you're switched to FM, an indicator lights up when a stereo signal is received – that's the time to switch to 'Stereo'! The SSA-16 has all the facilities you'd expect to find on tuners costing twice as much – separate volume, bass, treble, balance and tuning controls. Selector switch for tape, phono, AM, FM, stereo. Jack socket on front panel for stereo headphones. Frequency range: FM 88-108 MHz, AM 535-1605 kHz. Frequency response: 50-10,000 Hz ± 3dB. Power output: 4 watts total music power into two 8 ohm speakers. Size: 16" wide, 4¼" high, 8" deep.



ROC PRICE £31.20 Normal Price £49·00

8-TRACK HOME STEREO CARTRIDGE PLAYER MODEL E1

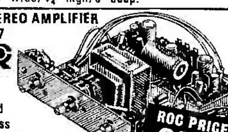
With this unit, you can play any standard 8-track cartridge on the market – at a fraction of the normal retail value! It gives you a total of 5 watts of power, to feed into two 8-ohm speakers. The frequency response is 50 to 10,000 Hz, giving you a fine tonal quality that can't be bettered at anything near this price. The E1 has separate tone, balance and volume controls, giving you complete freedom to select the sound you want to hear. Tape speed is 3¾ ips, and wow and flutter are both less than 0·3%. Size: 11½" wide, 5" high, 11" deep.



REALISTIC SA-100B 6-WATT STEREO AMPLIFIER

Here's fabulous, exciting value in miniature! This high quality stereo amplifier measures only 9" wide × 3" high × 5⅞" deep. And yet it has separate ganged volume, balance and tone controls. Plus speaker in/out, mono/stereo, phono/tuner and power on/off slide switches. The ends are oiled walnut, with matching enamelled metal top. The front panel is satin aluminium and walnut-brown enamel. Frequency response is 50 to 10,000 Hz ± 3dB. Output 3 watts r.m.s. per channel into 8 ohms. Inputs are 100mV for both phono and tuner.

ROC PRICE £12.45 Normal Price £21·00



ROC 7-WATT STEREO AMPLIFIER CHASSIS SK-317

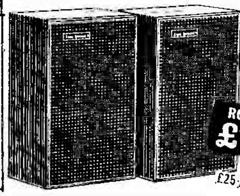
This exclusive ROC Stereo Chassis is completely self-contained, and it costs £2·25 less than the normal retail value! The SK-317 is a really compact unit measuring only 5½" wide, 1¾" high and 6⅞" deep. It contains its own mains power supply, and has a ganged tone control and separate volume controls for each channel. Specification: frequency response 40-17,000 Hz ± 3dB; output 3·5 watts music power per channel into 8 ohms; input, phono, 600mV; signal-to-noise ratio better than 45dB.

ROC PRICE £5.50 Normal Price £7·75

REALISTIC TM-100 AM/FM/MPX STEREO TUNER

Here's another unit that gives you fabulous value in miniature! Designed specifically to match the Realistic SA-100B in both appearance, size and performance, the TM-100 is superb value-for-money. It gives you the full FM and AM ranges – FM, 88-108 MHz; AM, 535-1605 kHz. Sensitivities FM 5μV; AM 250μV. Image rejection 50dB.

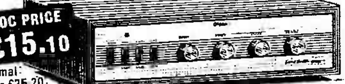
ROC PRICE £17.55 Normal Price £28·60



ROC PRICE £17.80 Normal Price £25·00 per pair.

R.446 3-WAY MATCHED SPEAKERS

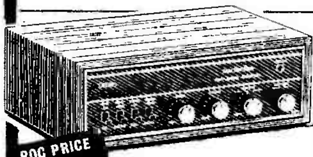
These will do justice to your amplifier – and to your pocket. At only £17·80 a pair, they are real value-for-money. Each cabinet is heavily legged and teak finished. They handle 16 watts rms (8 watts rms each). Each loudspeaker contains a large dual cone base unit, plus a separate tweeter. Frequency range: 40 to 19,000 Hz. Size 14" high, 9" wide, 6¼" deep.



ROC PRICE £15.10 Normal Price £25·20

OLSON AM-372 16-WATT, STEREO AMPLIFIER

Here's a really good amplifier at a really down-to-earth price – nearly £7 less than the normal retail value! Just look at what the AM-372 will do for you – reproduce signals from ceramic or crystal cartridges, AM and FM tuners, and tape recorders. And it gives you outputs for two sets of speakers, headphones and tape recorders. Frequency response is 30 to 20,000 Hz ± 3dB. Output 8 watts r.m.s. per channel music power into 8 ohm speakers. Phono input 200mV. Tuner input 200mV. Size: 12¼" wide, 3¼" high, 7½" deep.



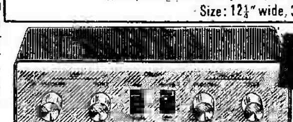
OLSON AM-395 40-WATT STEREO AMPLIFIER

An ideal unit for your new stereo separate system. It is more than £10·00 below the normal retail price! Making the AM-395 one of Britain's best hi-fi buys. It takes in signals from magnetic or ceramic pick-ups, tuners (see Olson RA-310) and tape decks. And it's got outputs for taping and for headphones. There are separate bass and treble controls, separate Left and Right channel volume controls. And a loudness switch for boosting the bass and treble notes when listening at low output levels. Frequency response: 20-20,000 Hz ± 3dB. Output: 20 watts r.m.s. per channel into 8 ohms. Inputs: magnetic phono 3·0mV RIAA, crystal phono 100mV; tape 160mV; tuner 160mV. Size 11$\frac{1}{16}$" wide, 4" high, 7½" deep. The specification reads well – sounds even better!

ROC PRICE £24.10 Normal Price £39·60

OLSON AM-357 4-WATT STEREO AMPLIFIER

Here's marvellous value for someone just starting to set themselves up in audio! At only £9·00 you get a fine amplifier in a scratch resistant metal cabinet, with a smart brushed aluminium front panel. It incorporates separate tone and volume controls for each channel. Inputs are provided for turntable (ceramic cartridge), tuner and tape deck or recorder. Frequency response: 70-20,000 Hz ± 3dB. Output: 2 watts r.m.s. per channel into 8 ohms. Inputs: phono 80mV; tuner/aux 80mV. Size 8" wide, 2⅞" high, 4½" wide.



ROC PRICE £9.00 Normal Price £14·70

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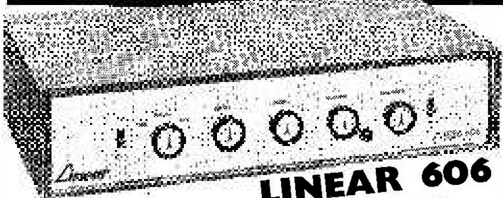

LINEAR 606

6+6 WATTS

Recommended Retail Price

£22·50

0-200-230-250v. 50 Hz A.C. mains operation. Inputs for magnetic or Ceramic Pickup, Tape or Radio Tuner.

TECHNICAL DETAILS

Bass Control ± 12 dB at 40 Hz.
Treble Control ± 12 dB at 14 KHz.
Sensitivities Mag. P.U. 3·5 m.v. into 47K ohm R.I.A.A. Ceramic P.U. 35 m.v. into 100K ohm. Tape Amp. 100 m.v. into 100K. Radio Tuner 400 m.v. into 400K ohm.
Crosstalk 53 dB.
Hum and Noise −75 dB min. vol. −65 dB max. vol.
Total Harmonic Distortion 0·1% at 1watt into 15 ohms.
Output (per channel) 6·5 watts I.H.F.M.

- ★ Individual Bass and Treble Controls.
- ★ Frequency Response ± 1½ dB 20 Hz to 65 KHz.
- ★ Outputs for Speaker impedances between 3 and 15 ohms.
- ★ Stereo/Mono Switch.
- ★ Input Selector Switch.
- ★ Solid State Circuitry.
- ★ Attractive silver finished metal facia and matching control knobs.

LINEAR 505

5+5 WATTS

Recommended Retail Price

£17·50

0-200-250v. 50 Hz A.C. mains operation

- ★ A modestly priced solid state unit.
- ★ The Silver Facia with black lettering enhanced by matching control knobs, provides a high standard of appearance.
- ★ Suitable for crystal or ceramic Gram. Pick-up cartridges, and Radio input.
- ★ A wide range of tone variation is provided by the separate Bass and Treble 'lift' and 'cut' controls.
- ★ A selector switch permits instantaneous selection of Gram. or Radio.
- ★ Speaker impedances between 3 and 15 ohms are suitable.

TECHNICAL DETAILS

Frequency Range 20 Hz to 20 KHz
Output (per channel) 5 watts I.H.F.M.
Bass Control ± 12 dB at 60 Hz.
Treble Control ± 14 dB. at 14 KHz.

PRINTED CIRCUIT CONSTRUCTION EMPLOYING 10 TRANSISTORS

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TEL. HECKMONDWIKE 4285

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Amplifier Type A413. Complete with 5Z4 & 6V6gt Valves. 250/230 Volt Transformer. Clean Condition. Untested. **£1·25p.** Carriage 75p.

Latest Air Ministry Release Radio Receiver. Type R4187. 2·8 To 18 MHZ In Three Bands. Complete with 17 Miniature Valves. 26 Volt Motor. Power supply Motor and Manually Tuned. Very Clean, But not tested. **£5.** Carriage and Ins. 75p

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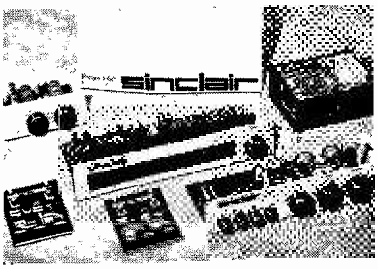
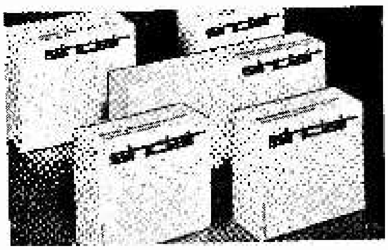
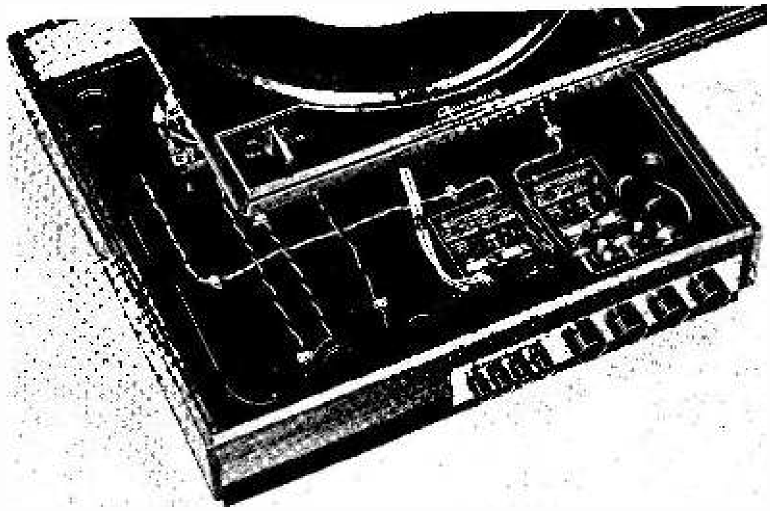
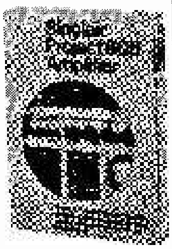






New!

Project 605



The easy way to buy and build Project 60

Project 605 is one pack containing: one PZ5, two Z30's, one Stereo 60 and one Masterlink. This new module contains all the input sockets and output components needed together with all necessary leads cut to length and fitted with neat little clips to plug straight on to the modules. Thus all soldering and hunting for the odd part is eliminated. You will be able to add further Project 60 modules as they become available adapted to the Project 605 method of connecting.

Complete Project 605 pack with comprehensive manual, post free **£29.95**

All you need for a superb 30 watt high fidelity stereo amplifier.

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Project 60 offers more advantage to the constructor and user of high fidelity equipment than any other system in the world.
Performance characteristics are so good they hold their own with any other available system irrespective of price or size.
Project 60 modules are more versatile – using them you can have anything from a simple record player or car radio amplifier to a sophisticated and powerful stereo tuner-amplifier. Either power amplifier can be used in a wide variety of applications as well as high fidelity. The Stereo 60 pre-amplifier control unit may also be used with any other power amplifier system, as can the AFU filter unit. The stereo FM tuner operates on the unique phase lock loop principle to provide the best ever standards of sensitivity and audio quality. Project 60 modules are very easily connected together by following the 48 page manual supplied free with all Project 60 equipment. The modules are great space savers too and are sold individually boxed in distinctive white and black cartons. With all these wonderful advantages, there remains the most attractive of all – price. When you choose Project 60 you know you are going to get the best high fidelity in the world, yet thanks to Sinclair's vast manufacturing resources (the largest in Europe) prices are fantastically low and everything you buy is covered by the famous Sinclair guarantee of reliability and satisfaction.

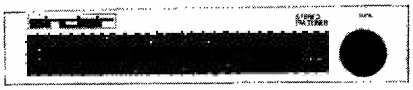
Typical Project 60 applications

System	The Units to use	together with	Cost of Units
Simple battery record player	**Z.30**	Crystal P.U., 12V battery volume control	**£4.48**
Mains powered record player	**Z.30, PZ.5**	Crystal or ceramic P.U. volume control etc.	**£9.45**
20+20 W. stereo amplifier for most needs	**2 x Z.30s, Stereo 60, PZ.5**	Crystal, ceramic or mag. P.U., F.M. Tuner, etc.	**£23.90**
20+20 W. stereo amplifier with high performance spkrs.	**2 x Z.30s, Stereo 60, PZ.6**	High quality ceramic or magnetic P.U., F.M. Tuner, Tape Deck, etc.	**£26.90**
40+40 W. R.M.S. de-luxe stereo amplifier	**2 x Z.50s, Stereo 60 PZ.8, mains trsfrmr**	As above	**£34.88**
Indoor P.A.	**Z.50, PZ.8, mains transformer**	Mic., guitar, speakers, etc., controls	**£19.43**

F.M. Stereo Tuner **(£25)** & A.F.U. Filter Unit **(£5.98)** may be added as required.

Project 60 Stereo F.M. Tuner

Built and tested. Post free. **£25**



The phase lock loop principle was used for receiving signals from space craft because of its vastly improved signal to noise ratio. Now, Sinclair have applied the principle to an F.M. tuner with fantastically good results. Other original features include varicap diode tuning, printed circuit coils, an I.C. in the specially designed stereo decoder and squelch circuit for silent tuning between stations. In terms of a high fidelity this tuner has a lower level of distortion than any other tuner we know. Stereo broadcasts are received automatically as the tuning control is rotated, a panel indicator lighting up as the stereo signal is tuned in. This tuner can also be used to advantage with most other high fidelity systems.

SPECIFICATIONS—Number of transistors: 16 plus 20 in I.C. **Tuning range:** 87.5 to 108 MHz. **Capture ratio:** 1.5dB. **Sensitivity:** 7μV for lock-in over full deviation. **Squelch level:** 20μV. **Signal to noise ratio:** >65dB. **Audio frequency response:** 10 Hz – 15 KHz ($\pm$1dB). **Total harmonic distortion:** 0.15% for 30% modulation. **Stereo decoder operating level:** 2μV. **Cross talk:** 40dB. **Output voltage:** 2 x 150mV R.M.S. **Operating voltage:** 25-30 VDC.
Indicators: Stereo on; tuning. **Size:** 93 x 40 x 207mm.

Stereo 60 Pre-amp/control unit

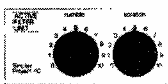
Built, tested and guaranteed. **£9.98**

Designed for Project 60 range but suitable for use with any high quality power amplifier. Again silicon epitaxial planar transistors are used throughout, achieving a really high signal-to-noise ratio and excellent tracking between channels. Input selection is by means of push buttons and accurate equalisation is provided for all the usual inputs.

SPECIFICATIONS—Input sensitivities: Radio – up to 3mV. Mag. p.u. 3mV: correct to R.I.A.A curve $\pm$1dB :20 to 25,000 Hz. Ceramic p.u. – up to 3mV: Aux – up to 3mV. **Output:** 250mV. **Signal to noise ratio:** better than 70dB. **Channel matching:** within 1dB. **Tone controls:** TREBLE + 12 to —12dB at 10 KHz: BASS + 12 to —12dB at 100Hz. **Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm.

A.F.U. High & Low Pass Filter Unit

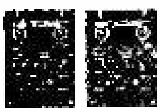
Built tested and guaranteed. **£5.98**



For use between Stereo 60 unit and two Z.30s or Z.50s, and is easily mounted. It is unique in that the cut-off frequencies are continuously variable, and as attenuation in the rejected band is rapid (12dB/octave), there is less loss of the wanted signal than has previously been possible. Amplitude and phase distortion are negligible. The A.F.U. is suitable for use with any other amplifier system. Two filter stages – rumble (high pass) and scratch (low pass). Supply voltage – 15 to 35V. Current – 3mA. H.F. cut-off (—3dB) variable from 28KHz to 5KHz. L.F. cut-off (—3dB) variable from 25Hz to 100Hz. Distortion at 1KHz (35V. supply) 0.02% at rated output. **Size:** 66 x 40 x 90 mm.

Z.30 & Z.50 power amplifiers

Built, tested and guaranteed with circuits and instructions manual. **Z.30 £4.48** **Z.50 £5.48**

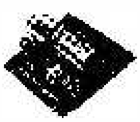


The Z.30 and Z.50 are of advanced design using silicon epitaxial planar transistors to achieve unsurpassed standards of performance. Total harmonic distortion is an incredibly low 0.02% at 15w (8Ω) and all lower outputs. Whether you use Z.30 or Z.50 amplifiers in your Project 60 system will depend on personal preference, but they are the same size and may be used with other units in the Project 60 range equally well.

SPECIFICATIONS ***(Z.50 units are interchangeable with Z.30s in all applications).***

Power Outputs
Z.30 15 watts R.M.S. into 8 ohms using 35 volts: 20 watts R.M.S. into 3 ohms using 30 volts.
Z.50 40 watts R.M.S. into 3 ohms using 40 volts: 30 watts R.M.S. into 8 ohms using 50 volts.
Frequency response: 30 to 300,000Hz $\pm$1dB.
Distortion: 0.02% into 8 ohms.
Signal to noise ratio: better than 70dB unweighted.
Input sensitivity: 250mV into 100 Kohms (for 15w into 8Ω)
For speakers from 3 to 15 ohms impedance.
Size: 14 x 80 x 57 mm.

Power Supply Units



Designed special for use with the Project 60 system of your choice. Use PZ.5 for normal Z.30 assemblies and PZ.6 where a stabilised supply is essential.

PZ.5 *30 volts unstabilised* **£4.98**
PZ.6 *35 volts stabilised* **£7.98**
PZ.8 *45 volts stabilised (less mains transformer)* **£7.98**
PZ.8 *mains transformer* **£5.98**

Guarantee

If within 3 months of purchasing Project 60 modules directly from us, you are dissatisfied with them, we will refund your money at once. Each module is guaranteed to work perfectly and should any defect arise in normal use we will service it at once and without any cost to you whatsoever provided that it is returned to us within 2 years of the purchase date. There will be a small charge for service thereafter. No charge for postage by surface mail. Air-mail charged at cost.

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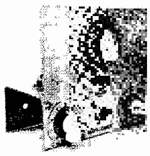

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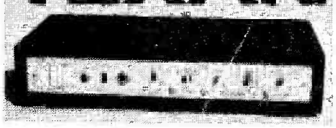

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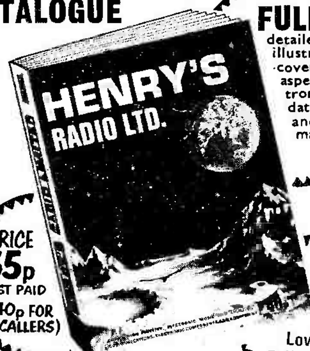

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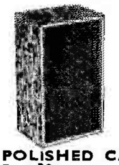

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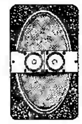

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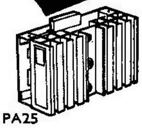

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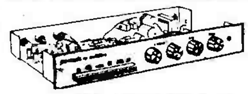

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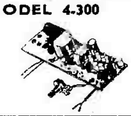

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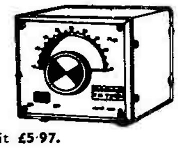

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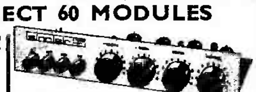

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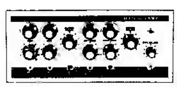

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