

PRACTICAL WIRELESS

ISSUE
No. 800

OCTOBER
20p 1973

FREE
inside

DATA CARD
SYSTEM 1973

First 2 Cards
RESISTORS &
CAPACITORS

*Elect. switches - 525
2 meter trans - 546*

PW

Q4

PROJECT

*Constant current
source - 558.*

QUADRAPHONIC
SOUND
SYSTEM

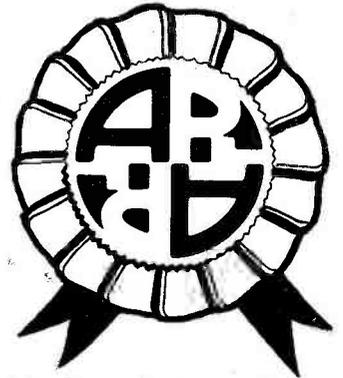


- QS Recordings
- SQ Recordings
- Discrete CD-4 Recordings
- SURROUND SOUND

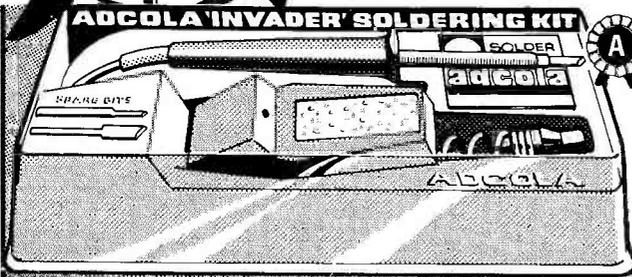


ADCOLA

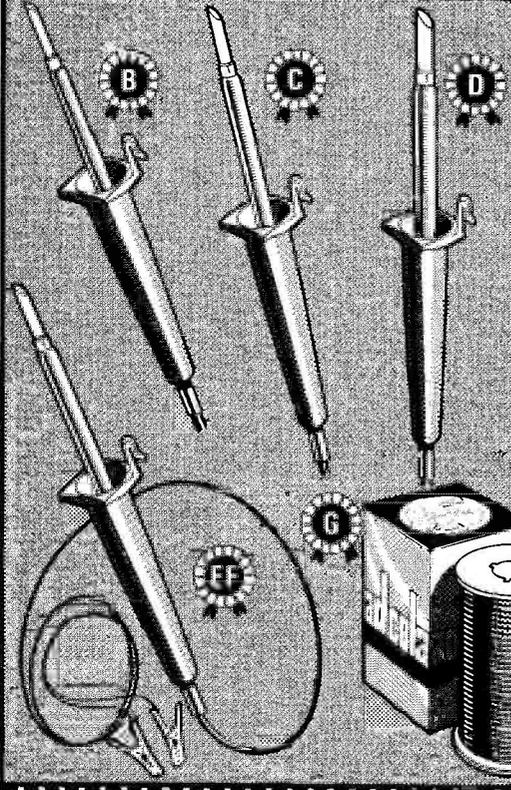
the champions of soldering equipment



ELECTRICAL SOLDERING EQUIPMENT
OF THE FINEST QUALITY AVAILABLE
FROM STOCK!

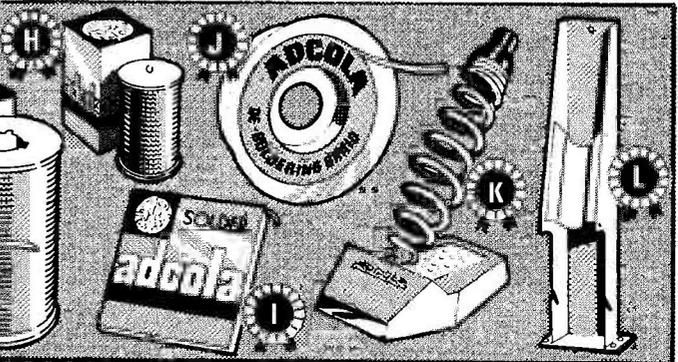


We don't expect to hear from you for some time once you have purchased our Invader Soldering Kit containing a 3/16" bit soldering instrument, two spare bits, a soldering station and a pack of solder—everything you need.



The versatile Invader Range with a large selection of interchangeable bits

- B L706 19 watt instrument 1/8" bit with cable
- C L646 23 watt instrument 3/16" bit with cable
- D L1076 27 watt instrument 1/4" bit with cable
- E.F. BL646 and BL1076 12 volt battery models 3/16" & 1/4" bit size come complete with crocodile clips and 12ft PVC cable. Just clip on to a car battery.
- G.H.I. 18 swg top quality cored solder in 1/2 kilo, 3 oz and handy pack sizes.
- J Non-corrosive de-soldering braid allows quick easy de-soldering (5 1/2 ft spool).
- K For extra safety use an L686 soldering station.
- L L68 protective shield for your Invader



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C L646 INVADER	£2-42	<input type="checkbox"/>
D L1076 INVADER	£2-48	<input type="checkbox"/>
E BL646 BATTERY MODEL	£3-05	<input type="checkbox"/>
F BL1076 BATTERY MODEL	£3-17	<input type="checkbox"/>
G SOLDER REEL 1/2 KILO	£1-40	<input type="checkbox"/>
H SOLDER REEL 3 OZ	£0-48	<input type="checkbox"/>
I SOLDER PACK	£0-07	<input type="checkbox"/>
J DE-SOLDERING BRAID	£0-75	<input type="checkbox"/>
K L686 SOLDERING STATION	£1-88	<input type="checkbox"/>
L L68 PROTECTIVE SHIELD	£1-08	<input type="checkbox"/>

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PRACTICAL WIRELESS

VOL. 49 NO. 6

ISSUE 800

OCTOBER 1973

BRITAIN'S PREMIER MAGAZINE FOR THE DO-IT-YOURSELF RADIO AND ELECTRONICS CONSTRUCTOR

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BACK NUMBERS

We regret that we are unable to supply back numbers of Practical Wireless. Readers are recommended to enquire at a public library to see copies. Requests for specific back numbers of Practical Wireless and Television only can be published in our CQ Column.

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RSC GROUP/DISCO UNITS

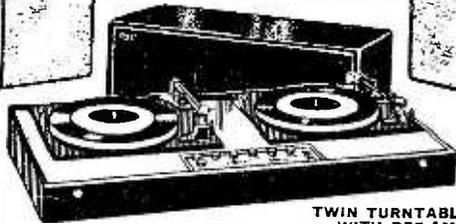
50 WATT SPEAKER

100 WATT AMPLIFIER

50 WATT SPEAKER



HEADPHONES MICROPHONE



TWIN TURNTABLE WITH PRE-AMP



RSC DISCO MASTER

DISCOTHEQUE CONSOLE with integrated power supply, 100W OUTPUT TWIN JACK OUTPUT SOCKETS Inc. twin Garrard SP25 Mk111 or BSR Macdonald MP60 type turntables, Pick-ups with high compliance cartridges and diamond styl. Separate volume controls for each turntable. Bass controls. Separate input for mic. with vol. control switch. **£99.75**

FULL MONITORING FACILITIES plus Treble and Bass control switch. Rexine covered cabinet size approx. 38 1/2" x 16 1/2" x 7 1/2" with lid. Terms: Deposit £20 and 12 monthly payments £7.90 (Total £111.20). Carr. £2.50

R.S.C. COLUMN SPEAKERS IDEAL FOR VOCALISTS AND PUBLIC ADDRESS

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

TYPE C132 30-40 WATTS Fitted two exceptionally efficient, low feedback howl characteristic high flux 1 1/2" x 8" 20 watt speakers. Terms: Dep. £2.95 and 9 mthly payments £2.43 (Total £24.83) Carr. 65p

TYPE C4100 100 WATTS Inc. four 12" 60 watt speakers for conservative rating. Extra heavy construction. Size approx. 68 x 16 x 10" Acoustically filled and pressurised. Terms: Dep. £15.50 & 12 mthly. pymts. £5.46 (Total £81.02). Carr. £1.40

TYPE C913 50 WATTS Low feedback characteristic. Fitted three 1 1/2" x 8" deep cone high flux speakers with high power voice coils. Size approx. 54" x 14" x 11". Dep. £4.72 & 9 mthly pymts £3.22 (Total £36.94) Carr. 85p

TYPE C132 30-40 WATTS Fitted two exceptionally efficient, low feedback howl characteristic high flux 1 1/2" x 8" 20 watt speakers. Terms: Dep. £2.95 and 9 mthly payments £2.43 (Total £24.83) Carr. 65p

F.A.L. DISCO PRE-AMPLIFIER

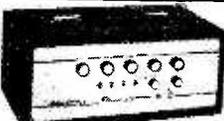
Designed for use with a pair of Player Units and Amplifier with Bass and Treble Controls. Incorporates MONITORING FACILITIES and Mic. input. The 4 inputs are ind. controlled. Detector switch Gram (1), (2), and Tape. 200-250v A.C. Mains 50Hz. Brush Silver finished fascia. Size approx 16 1/2" x 3" x 4" deep. Fully enclosed but can mounted in cabinet. **£18.97**

FANE "CRESCENDO" SPEAKERS

FULL RANGE AVAILABLE AT ALL BRANCHES

FAL PHASE 50 MK.III AMPLIFIER 50 WATT.

Solid state. 4 Separately controlled inputs Plus master vol. control. Ind. Bass and Treble Controls. Protective circuit to guard against damage from accidental shorts. Output for Speaker's 8 to 30 ohms. Size 17" x 7" x 7 1/2" 200-250v. A.C. mains. Output 50 watts music rating. Or deposit £8.95 & 9 monthly payments £3.98. Total £42.59. **£37.95** Carr. 82p.



RSC PHANTOM '50' Combined 50W Amplifier and 12in. Loudspeaker.

For Lead Guitar, Mic., Gram, Radio, Tape (Not for use with Bass instruments). Inc. 3 inputs and 2 vol. controls plus Treble, Bass and Presence. Output Jack for additional 15 ohm Speaker. Attractively finished in black with silver-finished fascia and trimmings. Compact size. Fitted carrying handle. Terms: Deposit £8.95 and 12 monthly payments £4.97 (Total £68.59). Carr. Free SAE for leaflet. **ONLY £59.95**

RSC BASS-REGENT 50 WATT AMPLIFIER

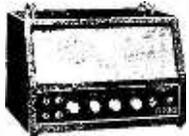
A powerful high quality all-purpose unit for lead, rhythm, bass guitar, vocalists, gram, radio, tape. Peak Output rating. Loudspeaker unit either horizontal or vertical mounting. ★ Two extra heavy duty 12in. 50w Loudspeakers. ★ Four Jack inputs and two Volume Controls for instant use of up to four pick-ups or 'mikes'. Bass and Treble controls. Send S.A.E. for leaflet. Credit Terms: Deposit £15.50 & 12 monthly payments of £5.46. (Total £81.02.) Carr. £2.20 **£71.50**



RSC GP30 HI-FI AMPLIFIER

For Guitar, Vocal or Instrumental Group

A 4 input, 2 vol. control Hi-Fi 30 watt unit with Separate Bass and Treble controls. Current Strong Rexine covered cabinet with handles. Attractive black/silver P.V.C. fascia. Neon indicator. For 200-250v. A.C. mains. For 3 or 15 ohm speakers. Send S.A.E. for leaflet. Terms: Deposit £4.40 and 9 monthly payments of £2.75 (Total £29.15). **£25.85** Carr. 72p



NOW SIX NEW BRANCHES

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TERMS C.W.O. or C.O.D. No C.O.D. under £1.
POSTAGE 25p EXTRA UNDER £2. 33p EXTRA OVER £2 OR AS QUOTED. TRADE SUPPLIED.
S.A.E. PLEASE WITH ENQUIRIES.
SUPPLIERS TO GOVT. DEPTS. H.M. FORCES. EDUCATION AUTHORITIES & HOSPITALS. Etc.
MAIL ORDERS MUST NOT BE SENT TO SHOPS

PACKAGE OFFER

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

(a) (b) (c) (d) & (e) **£149.50**
Carr. £2.50

Terms Deposit £30 and 18 monthly payments of £8.30 (Total £179.00).

RSC TDI DISCO CONSOLE

Incorporating twin Garrard SP25 or BSR MP60 type turntables and Sonotone or Acos Cartridges with diamond stylus. Separate Vol. controls for each turntable. Also MONITORING FACILITIES, plus Treble and Bass Controls. Separate input for 'mike' with vol. control switch. Black Vynide covered Cabinet with lid. see illustration on left. Or Dep. £9.55 and 12 mthly pymts £5.66 (Total £77.47) **£67.55**
Carr. £1.50

FANE ULTRA HIGH POWER LOUDSPEAKERS

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

'POP' 100	'POP' 60	'POP' 50
18" 100 Watt 14,000 gauss 8/15Ω	15" 60 Watt 14,000 gauss 8/15Ω	12" 50 Watt 13,000 gauss 15Ω
£25.95	£14.75	£11.99
Dep. £5.95 and 9 mthly payments £2.56 (Total £23.98)	Dep. £3.75 and 9 monthly payments. £1.50 (Total £17.25)	Dep. £2.99 and 9 monthly payments vol. control (Total £14.51)

FOR BASS GUITAR, ELECT. ORGAN, ETC. PAIR SUITABLE ALL PURPOSES

FANE SPEAKERS 'POP' 25/2 12 in. 25 WATT
Dual Cone 15 Ω (for uses other than Bass-Guitar or Electronic Organ). Carr. free **£7.95** or Dep. £1.25 and 9 mthly payments 89p (Total £9.20)

DISCO PACKAGE OFFER £45

Pair BSR MP60 T/tables GP91 PU Cartridges. FAL Disco Pre-amp. Total Rec. Ret. Price £50.11 Carr. £1

GROUP/DISCO EQUIPMENT PACKAGE OFFERS

F.A.L. PHASE 50 MK.III AMPLIFIER PR. FANE POP 25/2 25W L/SPEAKERS Terms: Deposit £7.50 and 12 monthly payments of £4.10 (Total £56.70)	£37.95 £15.90 £53.85	PACKAGE PRICE £49.50 Carr. £1.10
F.A.L. PHASE 50 MK.III AMPLIFIER PR. FANE POP 50 L/SPEAKERS Terms: Deposit £9.50 and 12 monthly payments of £4.88 (Total £65.66)	£37.95 £23.98 £61.93	PACKAGE PRICE £57.50 Carr. £1.10
F.A.L. PHASE 50 MK.III AMPLIFIER PAIR L12/20 25W L/S in cabinets Terms: Deposit £10 and 12 monthly payments of £4.97 (Total £69.64)	£37.95 £28.80 £66.75	PACKAGE PRICE £61 Carr. £1.35
F.A.L. PHASE 100/5 AMPLIFIER 4 FANE POP 50 L/SPEAKERS Terms: Deposit £20 and 18 monthly payments of £8.35 (Total £134.30)	£69.95 £47.98 £117.93	PACKAGE PRICE £110 Carr. £2

HIGH QUALITY LOUDSPEAKER UNITS

ALL TWO TONE REXINE AND VYNAIR FINISH L125 50 WATT Fitted pair of 12" 50 watt high flux speakers for conservative rating. Impedance 8-15 ohms. Carr. £1.50
Or deposit £8.95 and 9 monthly parts. of £4.34. Total £43.01
L12/20 12" 20-25 WATT 13,000 lines 15 ohms
Dep. £2.15 & 9 mthly pymts £1.50 (Total £15.65) Carr. 55p

L12/10 10-15 Watt venter finish cabinet 12" unit 8-15 ohm. Size approx. 14" x 14" x 9". Carr. 60p **£8.25**

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

FAL PHASE 100/2 AMPLIFIER

100 WATTS MUSIC RATING. Solid State. Sep. Bass and Treble Controls. 4 separate controlled inputs plus master control. Output for speakers 3-30 ohms. Includes protective circuit against damage from short circuits. Terms: Deposit £7.85 & 12 monthly payments £6.05 (Total £80.45). Carr. 75p **£69.85**



FAL TWIN CHANNEL AMPLIFIERS

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

FAL 'SUPER 50' 50 WATTS MUSIC RATING **£59.50** Carr. 80p
Terms: Dep. £9.50 & 9 mthly. pymts. £6.50 (Total £67)

FAL 'SUPER 100' 100 WATTS MUSIC RATING **£79.95** Carr. 90p
Terms: Dep. £12.50 & 12 mthly. pymts. £6.45 (Total £89.90)

HUGE DISCOUNTS ON LEADING BRAND TAPE AND TURNABLE UNITS

CREDIT TERMS AVAILABLE
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These are only a few of our many discount lines—visit your nearest RSC Hi Fi Centre

AKAI GXC 40D Tape Unit £62.95 (Rec. Price £89.74) Carr. £1
AKAI 4000DS Tape Unit £68.95 (Rec. Price £93.50) Carr. £1
AKAI 1721L Tape Unit £66.95 (Rec. Price £93.87) Carr. £1
AKAI CR81D Tape Unit £58.95 (Rec. Price £84.10) Carr. £1
GOLDRING GL72 T/Table & P.U. £29.95 (Rec. Price £37.29) Carr. 75p
 Also FREE with above GL72 Goldring G800 cartridge worth over £10
B.S.R. MACDONALD MP60 TYPE T/Table & P.U. £10.95
 Discount prices shown correct at time of going to press (Rec. Price £14.95) Carr. 40p

FANE 'MODE ONE' HIGH FIDELITY SPEAKER KIT

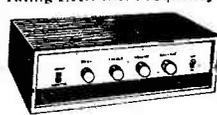


Incorporating a model 803 8" 13,000 Gauss Bass Speaker with ultra low resonance P.V.C. surround cone. Printed circuit cross-over assembly with ferrite cored coils. Model 303 Pressure Tweeter, Acoustic damping material, Screws, Panels etc., and instructive diagrams, Frequency Response 25 Hz-20 kHz. Impedance 8-15 ohms.

Or Dep. £2 & 9 mths. by instal. £1.60 (Total £11.93)

RSC G66 Mk II 6.6 WATT high quality STEREO AMPLIFIER

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



COMPLETE KIT OF PARTS INCLUDING FULLY WIRED PRINTED CIRCUIT and FACTORY BUILT IN TEAK VENEERED CABINET £12.65 40p
 as illustrated £16.60 or dep. £2.60 and 9 monthly payments £1.83 (Total £18.97)

AUDIOTRINE HIGH FIDELITY SPEAKERS

Heavy construction. Latest high efficiency ceramic magnets. Plasticated 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	£8.95	HF180D	12"	15W	£5.50
HF108D	10"	10W	£8.50	HF12D	12"	15W	£9.85
HF120	12"	15W	£4.95	HF18D	18"	15W	£9.85

FANE 807T HIGH FIDELITY SPEAKER

A full range 8in. 10 watt unit for excellent sound quality. In suitable enclosure. Cast chassis Roll P.V.C. cone surround and long throw voice coil to achieve very low fundamental resonance of 30 c.p.s. Tweeter cone is fitted to extend high note response. Frequency range 25 Hz to 15 KHz. Gauss 10,000. Impedance 3 or 8-15 Ω. PLEASE STATE IMPEDANCE WHEN ORDERING.
MODEL 808T 8" 15w. with parasitic Tweeter. £4.95
 Response 25 Hz to 15 KHz. Gauss 13,000 Imp 3 or 8-15Ω.



ALL R.S.G. PRICES INCLUDE VAT FULL LABOUR AND MATERIAL GUARANTEES FOR 12 MONTHS

HI-FI SPEAKER ENCLOSURES MODERN DESIGN

Teak veneer finish. Acoustically lined. Sizes approx. Carr. 35p. per enc.

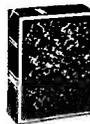
JE8 Size 16" x 11" x 9". Pressurised. Gives pleasing results with any 8in. Hi-Fi speaker. **£5.50**

SE8 For optimum performance with any 8in. Hi-Fi spkr. **£6.50**

SE10 For outstanding results with 10in. Hi-Fi spkr. Size 25½ x 16 x 9in. Ported **£6.75**

SE12 For excellent performance with 12in. Hi-Fi speaker and tweeter **£7.95**

Size 25½ x 16 x 9in. **£7.95**



AUDIOTRINE HI-FI SPEAKER SYSTEMS

Consisting of matched 12in. 11,000 line 15 Watt 15 ohm high quality speaker, cross-over unit and tweeter. Smooth response and extended frequency range ensure surprisingly realistic reproduction.
OR SENIOR 15 WATT INCLUDING HF126 15,000 LINE SPEAKER £7.65 Carr. 39p



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

200-250v. AC mains operated. Frequency Response 30-20,000 c.p.s. ±2db. Harmonic Distortion 0.8%, 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 3-16 ohm spkrs. Max. sensitivity 5mV. Output rating I.H.F.M. Fully enclosed enamelled case, 9½ x 2½ x 5½in. Attractive brushed silver finish fascia plate 10½ x 3½in. and matching knobs. Complete kit of parts with full wiring diagrams and instructions.
OR FACTORY BUILT WITH 12 MONTHS' GUARANTEE £12.05 Carr. 40p.



R.S.C. BATTERY/MAINS CONVERSION UNITS

TYPE BML An all-dry battery eliminator. Size 5½ x 4½ x 2½in. approx. Completely replaces batteries supplying 1.5v and 90v. to battery radio where A.C. mains 200/250v. Post 30p
 50c/s is available. **ASSEMBLED READY FOR USE £4.15**



R.S.C. TRANSFORMERS, L.F. CHOKES & RECTIFIERS FULLY GUARANTEED. Impregnated and Interleaved where necessary. Primaries 200-250v. 50c/s. Screened

MIDGET CLAMPED TYPE 2½ x 2½ x 2½in.
 250v., 60mA, 6.3v. 2a. £1.10
 200-0-250v., 60mA 6.3v. 2a. £1.16

FULLY SHROUDED UPRIGHT MOUNTING
 250-0-250v. 60mA, 6.3v. 2a., 0-6-6.3v. 2a. £1.55
 250-0-250v. 100mA, 6.3v. 4a., 0-6-6.3v. 2a. £2.45
 300-0-300v. 100mA, 6.3v. 4a., 0-6-6.3v. 2a. £2.45
 300-0-300v. 130mA, 6.3v. 4a. c.t., 6.3v. 1a. £2.95
 For Mullard 510 Amplifier. £2.95
 350-0-350v. 100mA, 6.3v. 4a., 0-6-6.3v. 2a. £2.45
 350-0-350v. 150mA, 6.3v. 4a., 0-6-6.3v. 2a. £2.95
 425-0-425v. 200mA, 6.3v. 4a., c.t., 6v. 2a. £4.45
 425-0-425v. 200mA, 6.3v. 4a., 6.3v. 3a., 6v. 2a. £4.45
 450-0-450v. 220mA, 6.3v. 4a., c.t., 6v. 2a. £5.00

TOP SHROUDED DROP-TYPE TYPE
 250-0-250v. 70mA, 6.3v. 2a., 0-6-6.3v. 2a. £1.49
 200-0-250v. 100mA, 6.3v. 3.5a. £1.71
 250-0-250v. 100mA, 6.3v. 2a., 6.3v. 1a. £1.76
 350-0-350v. 80mA, 6.3v. 2a., 0-6-6.3v. 2a. £1.81
 200-0-250v. 100mA, 6.3v. 4a., 0-6-6.3v. 2a. £2.45
 300-0-300v. 100mA, 6.3v. 4a., 0-6-6.3v. 2a. £2.45
 300-0-300v. 130mA, 6.3v. 4a., c.t., 6.3v. 1a. £2.95
 Suitable for Mullard 510 Amplifier. £2.95
 350-0-350v. 100mA, 6.3v. 4a., 0-6-6.3v. 2a. £2.45
 350-0-350v. 150mA, 6.3v. 4a., 0-6-6.3v. 2a. £2.95

FILAMENT OR TRANSFORMER POWER PACK
 Types 6.3v. 1.5a. 55p; 6.3v. 2a. 60p; 6.3v. 3a. 85p;
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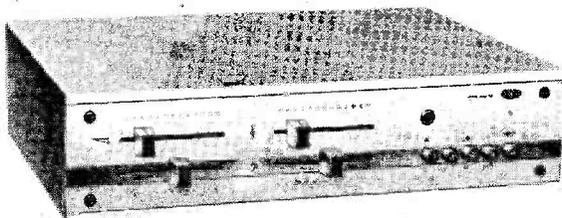
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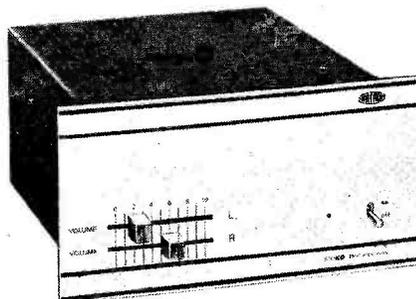
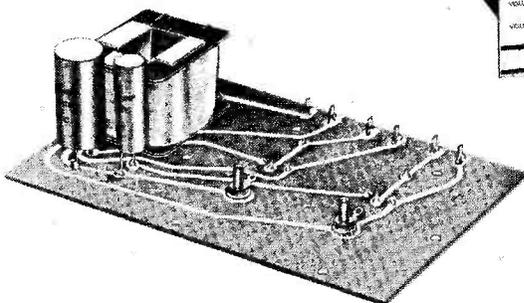


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The outstanding advantage of the UK185 is its compact size, which simplifies the assembly, thus comparing well with the best stereo amplifiers.

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SPECIFICATION OF UNITS

	Model 803	Model 303
Overall Diameter	8"	3"
Natural resonance	30Hz	—
Main resonance	*35Hz	1200Hz
Magnet Pole Diameter	1"	3/4"
Magnet Flux Density	13,000 gauss	10,000 gauss
Frequency response	30Hz-8kHz	2kHz-17kHz
Impedance	8-15 ohms	8-15 ohms
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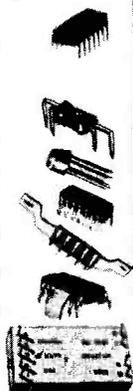
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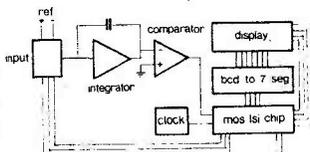
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BFS97	ZTX311	ZTX502	ZS144	ZS144	ZS144	ZS144	ZS144
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ZTX107	ZTX313	ZTX504	ZS146	ZS146	ZS146	ZS146	ZS146
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ZTX213	ZTX341	ZTX551	ZS176	ZS176	ZS176	ZS176	ZS176
ZTX214	ZTX382		ZS178	ZS178	ZS178	ZS178	ZS178
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1.5							61p	
2							61p	
2.2							61p	
3							61p	
3.3							61p	
4							61p	8p
4.7							61p	
5							61p	9p
5.6							61p	
6							61p	
6.8							61p	
10							61p	
15							61p	
22							61p	11p
33							61p	
47	61p		61p	61p	61p	61p	61p	
68	61p	61p	61p	61p	61p	61p	61p	10p
100	61p	61p	61p	61p	61p	61p	61p	23p
150	61p	61p	61p	61p	61p	61p	61p	13p
220	61p	61p	61p	61p	61p	61p	61p	31p
330	61p	61p	61p	61p	61p	61p	61p	39p
470	61p	61p	61p	61p	61p	61p	61p	26p
680	61p	61p	61p	61p	61p	61p	61p	48p
1000	10p	10p	11p	13p	20p	23p	25p	59p
1500	10p	12p	20p	23p	22p	25p	44p	79p
2200		18p	20p		36p	44p	79p	149p
3300		20p			44p	68p	79p	252p
4700					44p	68p	79p	252p
6800					75p	93p		299p
10000								333p

Potentiometers

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

Log or lin less switch (and 1kΩ lin)
Log or lin with switch
Dual less switch
Dual with switch 10kΩ, 100kΩ and
1MΩ, log only
10kΩ log + 10kΩ antilog less switch

10kΩ	Single
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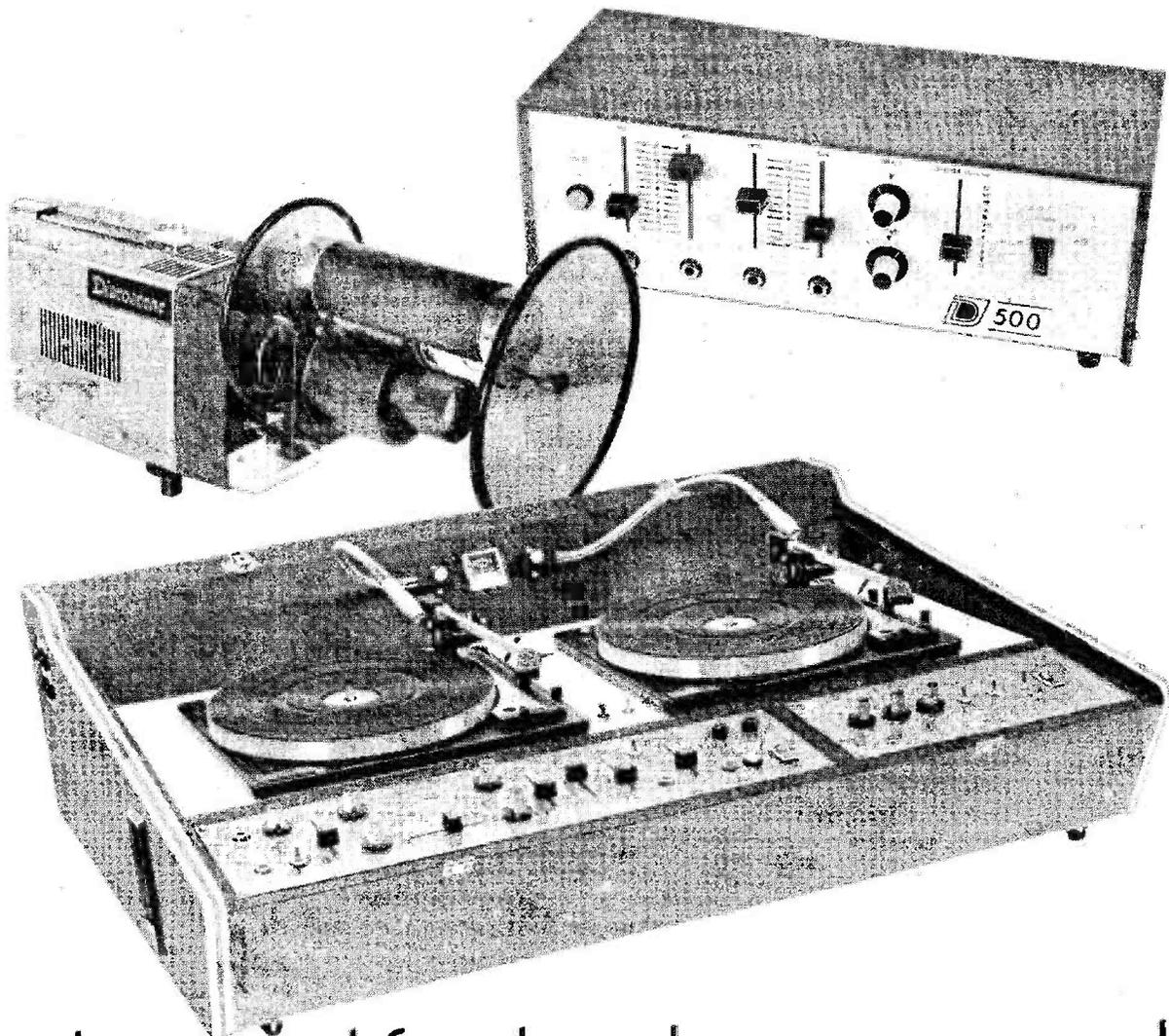
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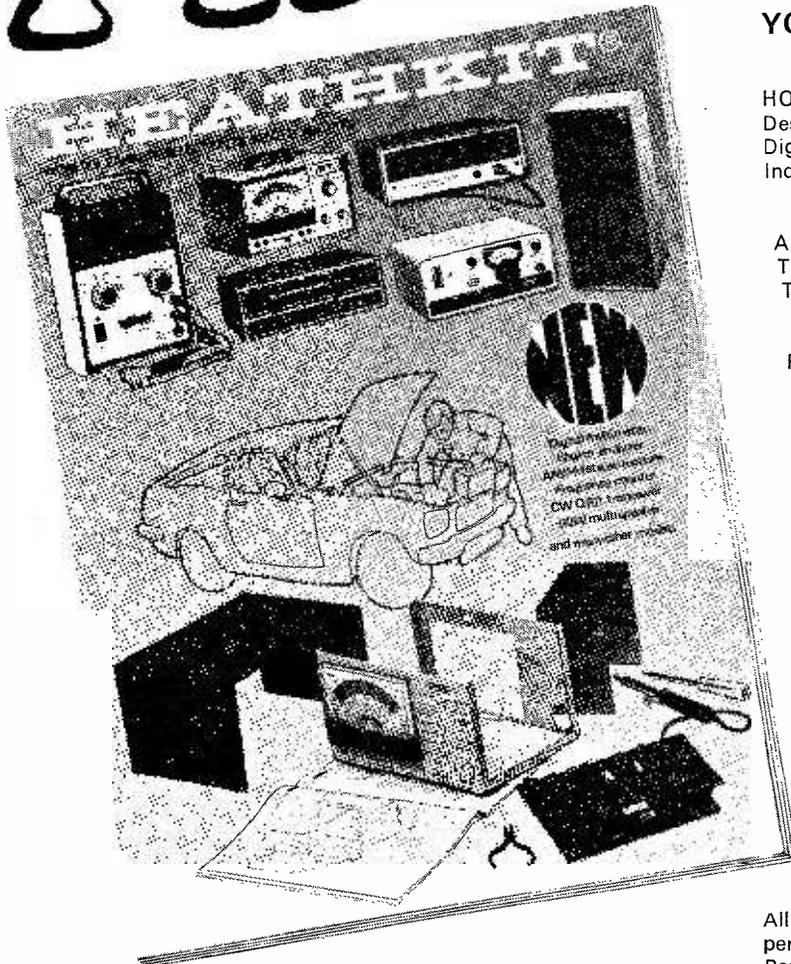


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Useful Response 35 to 18,000 cps
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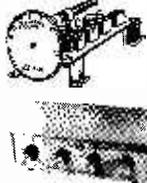
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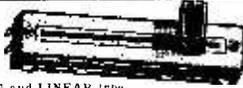
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Flux Density 12,000gauss
Useful response 45-13,000cps
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Flux Density 16,500gauss
Useful response 20-17,000cps
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Useful response 25-16,000cps
8 or 15 ohms models.

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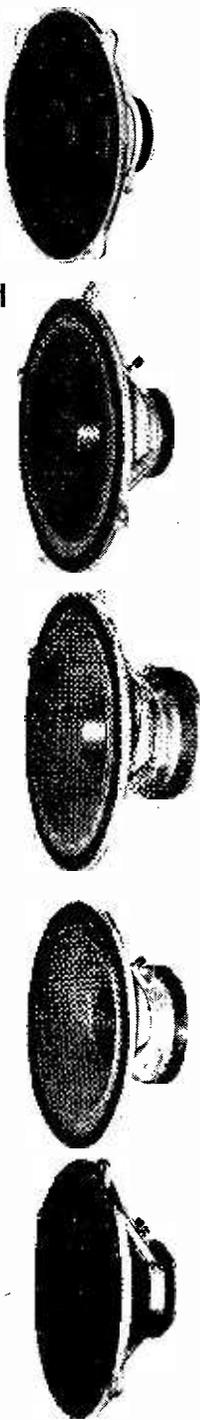
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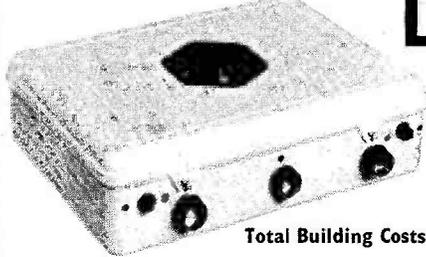
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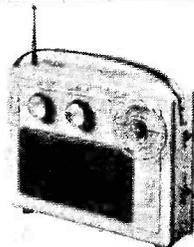
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NEW ROAMER NINE

WITH V.H.F. INCLUDING AIRCRAFT



Nine Transistors, 9 Tuneable wavebands as Roamer Ten Built in ferrite rod aerial for MW/LW. Retractable chrome-plated telescopic aerial for VHF and SW. Push Pull output using 600 mW transistors, 9 Transistors and 3 diodes, tuning condenser with V.H.F. section, separate coil for aircraft, moving coil loudspeaker, volume ON/OFF and wavechange. Attractive all white case with red grille and carrying strap. Size 9" x 7" x 2 1/2" approx. Parts Price List and Plans 30p (Free with parts).

Total Building Costs **£6-95**

P P & Ins. 44p
(Overseas P & P £1-05)

POCKET FIVE



3 Tuneable wavebands, M.W. L.W. and Trawler Band, 7 stages, 5 transistors and 2 diodes, supersensitive ferrite rod aerial, moving coil loudspeaker, attractive black and gold case. Size 5 1/2" x 1 1/2" x 3 1/4" approx. Plans and Parts Price List 15p (Free with parts).

Total Building Costs **£2-28**

P P & Ins. 24p
(Overseas P & P 65p)



TRANSONA FIVE

Wavebands, transistors and speaker as Pocket Five. Larger Case with Red Speaker Grille and Tuning Dial. Plans and Parts Price List 15p (Free with parts).

Total Building Costs **£2-50**

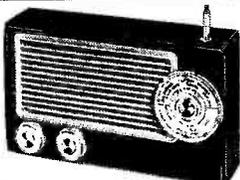
P P & Ins. 25p
(Overseas P & P 65p)

TRANS EIGHT 8 TRANSISTORS and 3 DIODES

6 Tuneable 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 x 5 1/2 x 2 1/2 in. approx. Push pull output. Battery commiserate switch for extended battery life. Ample power to drive a larger speaker. Parts price list and plans 25p (FREE with parts).

Total building costs **£4-48**

P P & Ins. 33p
(Overseas P & P £1-05)



ROAMER SIX

CASE AND LOOKS AS TRANS-EIGHT

6 Tuneable Wavebands: MW, LW, SW1, SW2, SW3, Trawler band plus an extra Medium waveband 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. Attractive black case with red grille, dial and black knobs with polished metal inserts. Size 9 x 5 1/2 x 2 1/2 in. approx. Plans and parts price list 25p (FREE with parts).

Total building costs **£3-98**

P P & Ins. 31p
(Overseas P & P £1-05)

NEW Everyday Series

Build this exciting New series of designs

E.V.5. 5 Transistors and 2 diodes, MW/LW. Powered by 4 1/2 volt Battery. Ferrite rod aerial, tuning condenser, volume control, and loudspeaker. Attractive case with red speaker grille. Size 9" x 5 1/2" x 2 1/2" approx. Parts Price List and Plans 10p. Free with parts.

Total Building Costs **£2-73**

P P & Ins. 30p
(Overseas P & P 70p)

E.V.6. Case and looks as above. 6 Transistors and 3 diodes. Powered by 9 volt battery. Ferrite rod aerial, loudspeaker, etc., MW/LW coverage. Push Pull output. Parts Price List and Plans 12p. Free with parts.

Total Building Costs **£3-60**

P P & Ins. 30p
(Overseas P & P 85p)

E.V.7. Case and looks as above. 7 Transistors and 3 diodes. Six wavebands, MW/LW, Trawler Band, SW1, SW2, SW3, powered by 9 volt battery. Push Pull output. Telescopic aerial for short waves. Parts Price List and Easy Build Plans 15p. Free with parts. Overseas P & P £1-05.

Total Building Costs **£4-08**

P P & Ins. 31p

ROAMER EIGHT Mk I

NOW WITH VARIABLE TONE CONTROL

7 Tuneable Wavebands: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built in Ferrite Rod Aerial for MW and LW. Retractable chrome plated Telescopic aerial for Short Waves. Push pull output using 600mW transistors. Car aerial and Tape record sockets. Selectivity switch. 8 transistors plus 3 diodes. Fine tone moving coil speaker. Air spaced ganged tuning condenser. Volume/on/off, tuning, wave change and tone controls. Attractive case in rich chestnut shade with gold blocking. Size 9 x 7 1/2 in. approx. Easy to follow instructions and diagrams. Parts price list and plans 25p (FREE with parts).

Total building costs **£6-98**

Overseas P & P £1-05 P P & Ins. 47p



ROAMER TEN

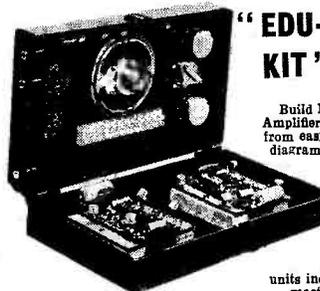
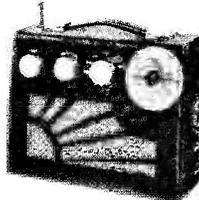
WITH VHF INCLUDING AIRCRAFT

10 Transistors, 9 Tuneable Wavebands, MW1, MW2, LW, SW1, SW2, SW3, Trawler Band, VHF and Local Station also Aircraft Band

Built in Ferrite Rod Aerial for MW/LW. Retractable, chrome plated 7 section Telescopic Aerial, can be angled and rotated for peak short wave and VHF listening. Push Pull output using 600mW Transistors. Car Aerial and Tape Record Sockets. 10 Transistors plus 3 Diodes. Fine tone moving coil speaker. Ganged Tuning Condenser with VHF section. Separate coil for Aircraft Band. Volume on/off, Wave Change and tone Control. Attractive Case in black with silver blocking. Size 9" x 7" x 4". Easy to follow instructions and diagrams. Parts price list and plans 30p (FREE with parts).

Total building costs **£8-50**

Overseas P & P £1-05 P P & Ins. 52p



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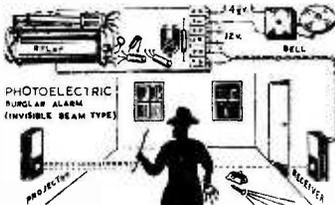
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SN7401AN	0-38	0-35	0-32	SN7451N	0-20	0-18	0-16
SN7402N	0-20	0-18	0-16	SN7453N	0-20	0-18	0-16
SN7403N	0-20	0-18	0-16	SN7454N	0-20	0-18	0-16
SN7403AN	0-38	0-35	0-32	SN7460N	0-20	0-18	0-16
SN7404N	0-24	0-21	0-18	SN7470N	0-33	0-30	0-27
SN7405N	0-20	0-18	0-16	SN7472N	0-35	0-32	0-29
SN7406AN	0-44	0-41	0-38	SN7473N	0-44	0-41	0-37
SN7406N	0-40	0-38	0-35	SN7474N	0-48	0-45	0-42
SN7407N	0-40	0-38	0-35	SN7475N	0-59	0-55	0-51
SN7408N	0-25	0-22	0-19	SN7476N	0-45	0-38	0-32
SN7409N	0-33	0-30	0-27	SN7480N	0-80	0-70	0-50
SN7409AN	0-44	0-41	0-38	SN7481N	1-25	1-10	0-95
SN7410N	0-20	0-18	0-16	SN7482N	0-87	0-80	0-72
SN7411AN	0-25	0-23	0-21	SN7483N	1-20	1-10	1-00
SN7412N	0-28	0-28	0-25	SN7485N	1-87	1-87	1-63
SN7412AN	0-38	0-35	0-32	SN7486N	0-50	0-50	0-44
SN7413N	0-30	0-27	0-25	SN7489N	4-32	4-32	3-78
SN7414N	0-72	0-72	0-63	SN7490N	0-75	0-70	0-63
SN7415N	0-30	0-27	0-25	SN7491AN	1-10	1-00	0-90
SN7417N	0-30	0-27	0-25	SN7492N	0-75	0-70	0-63
SN7420N	0-20	0-18	0-16	SN7493N	0-75	0-70	0-63
SN7422N	0-28	0-28	0-25	SN7494AN	0-85	0-80	0-75
SN7422AN	0-38	0-35	0-32	SN7495N	0-85	0-80	0-75
SN7423N	0-37	0-34	0-32	SN7496N	1-00	0-90	0-83
SN7425N	0-37	0-37	0-32	SN74100N	1-16	1-59	1-39
SN7427N	0-37	0-37	0-32	SN74102N	0-60	0-53	0-45
SN7428N	0-43	0-43	0-37	SN74105N	0-60	0-53	0-45
SN7429N	0-20	0-18	0-16	SN74107N	0-51	0-51	0-45
SN7432N	0-37	0-37	0-32	SN74110N	0-57	0-57	0-50
SN7433N	0-43	0-43	0-38	SN74111N	0-88	0-88	0-75
SN7433AN	0-57	0-57	0-50	SN74116N	2-18	2-18	1-89
SN7437N	0-43	0-43	0-37	SN74118N	1-00	0-90	0-83
SN7438N	0-43	0-43	0-37	SN74119N	1-92	1-92	1-88
SN7438AN	0-57	0-57	0-50	SN74120N	1-06	1-05	0-92
SN7440N	0-20	0-18	0-16	SN74121N	0-57	0-57	0-50
SN7441AN	0-85	0-79	0-73	SN74122N	0-80	0-80	0-70
SN7442N	0-85	0-79	0-73	SN74123N	1-44	1-44	1-26
SN7443N	1-50	1-27	1-13	SN74125N	0-60	0-59	0-50
SN7444N	1-50	1-27	1-13	SN74126N	0-89	0-89	0-80
SN7445N	2-16	2-16	1-89	SN74127N	0-72	0-72	0-63
SN7446N	2-16	2-16	1-89	SN74130N	0-63	0-63	0-55
SN7447AN	1-80	1-80	1-57	SN74141N	1-00	0-90	0-80

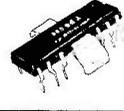
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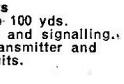
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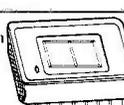
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500 9p	500 36p
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1-3 watts 5% Miniature Tubulars IN4700 series. From 3.3 volt - 33 volt 18p each. 10 watts. Stnd Mounting. ZS series 6-8 volts - 100 volts 5% 40p each.

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1 amp series IN4001 to IN4007 From 6p ea 1-5 amp PL4001 to PL4007 From 8p ea 3 amp PL7001/IN5400 From 14p ea Send for full list 36

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3 AMP RANGE

Type	P.I.V.	Price ea.
SC35A	100v	80p
SC35B	200v	85p
SC35D	400v	90p
SC35E	500v	£1.20

6 AMP RANGE

SC40A	100v	90p
SC40B	200v	95p
SC40D	400v	£1.20
SC40E	500v	£1.50

10 AMP RANGE

SC45A	100v	£1.05
SC45B	200v	£1.15
SC45D	400v	£1.45
SC45E	500v	£1.85

15 AMP RANGE

SC50A	100v	£1.45
SC50B	200v	£1.65
SC50D	400v	£1.95
SC50E	500v	£2.25

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1/2 AMP 1-11 Pricing

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B1/10	100v	25p
B1/20	200v	25p
B05/40	400v	25p
B05/60	600v	27p

1 AMP P.I.V.

B1/05	50v	25p
B1/10	100v	25p
B1/20	200v	30p

1/2 x 1/2 x 1/2 dia.

1 AMP P.I.V.

W005	50v	29p
W01	100v	30p
W02	200v	32p
W08	600v	35p

1/2 x 1/2 x 1/2 dia.

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B2/05	50v	35p
B2/10	100v	40p
B2/20	200v	45p
B2/60	600v	55p

1/2 x 1/2 x 1/2 dia.

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B4/05	100v	55p
B4/20	200v	59p
B4/60	600v	65p
B4/800	800v	£1.00

1/2 x 1/2 x 1/2 dia.

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B6/05	50v	65p
B6/10	100v	70p
B6/20	200v	80p
B6/40	400v	90p
B6/60	600v	£1.00

1/2 x 1/2 x 1/2 dia.

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CRS 1/05AF

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B2004 2 ch. Stereo mixer	4-75 p & p 15p

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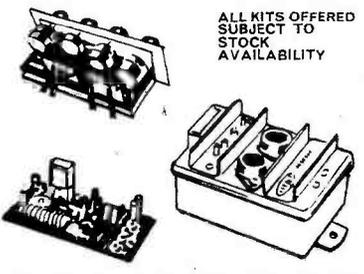
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115 8 watt Amplifier	2-87	
120 12 watt amplifier	3-88	
125 Stereo control unit	4-20	
130 Mono control unit	3-52	
605 Power supply for 115	3-88	
610 Power supply for 120	4-08	
615 Power supply for 2 x 120	4-85	
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275 Mic. preamplifier	5-83	
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575 Sq. wave generator 20Hz-20KHz	10-24	
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630 ST AB Power supply 6-12v 0-25-0-1A	2-63	
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760 Acoustic switch	7-27	
780 Metal Detector (electronics only)	6-16	
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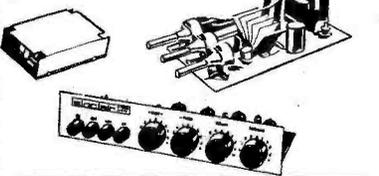
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 608, 10 watt 24 volt 4-10
 410, 10 watt 28 volt 4-95
 Z30, 15 watt 30 volt 3-57
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 Z50, 30 watt 50 volt 4-37
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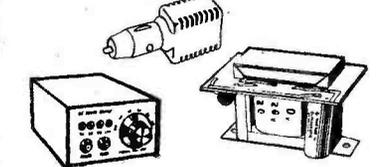
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Acousta	2500 20 watt	28-50 pr.	
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A25	20-60 watts	65-00 pr.	
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Linton 2	20 watt	31-00 pr.	
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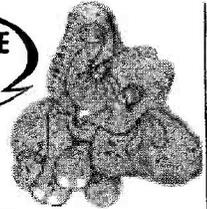
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AKAI	CR81	66-20
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8 TRACK PLAYER DECKS

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JB3DE Din Junction Box		1-60
JB11D De Luxe Junction Box		1-95
0250 Phone Switch		4-75
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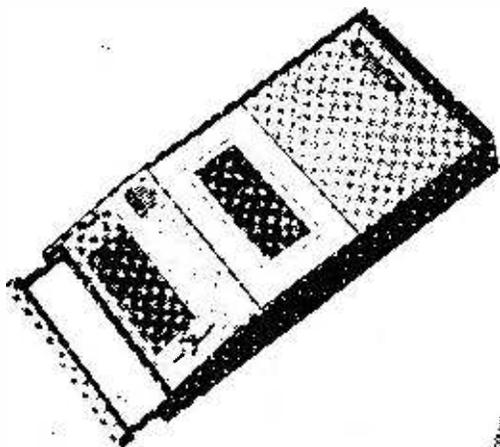
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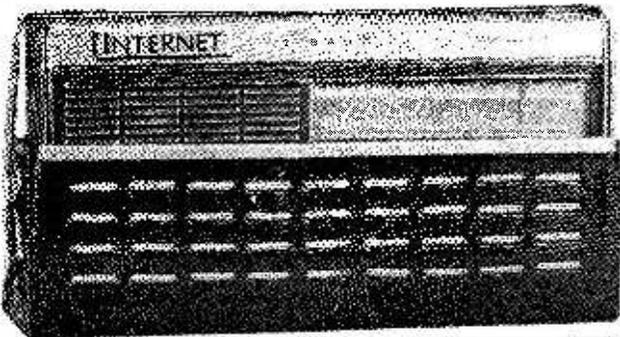
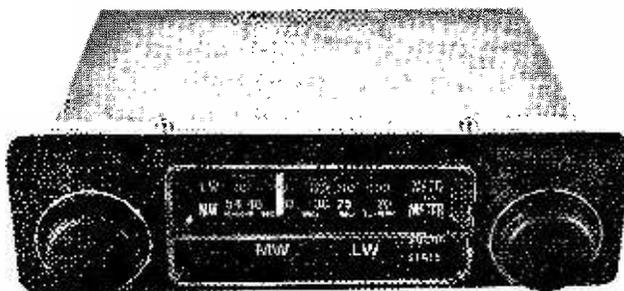
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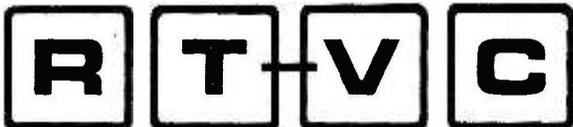


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Apart from the output stage, which is an integrated circuit, the only other electronic components that need soldering are some capacitors, resistors, etc. The kit includes a pre-built RF tuner unit, and fully modulated IF stages which are pre-aligned before despatch. As well as electronic components this kit also contains 2 diamond-spun aluminium knobs, elegant matching front panel, dial, washers, screws and wire.

The Tourist PB can be mounted in any standard size dash panel and it has an illuminated tuning scale. Chassis size is: 7in wide, 2in high and 4½in deep. Circuit diagram and comprehensive instructions 55p free with parts. Fully retractable and lockable car aerial £1.37 post paid.

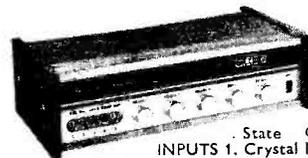
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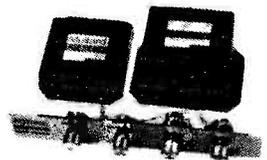
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SEE OPPOSITE PAGE FOR ADDRESS DETAILS

ISSUE No. 800

THIS issue of *Practical Wireless* is the 800th, in which we take off our hats to our predecessors going back to 1932. In those days *Practical Wireless* was a weekly and cost three old pence, and they certainly crammed in a great deal of material that was the slightest bit related to wireless in almost every sense. We recommend a look at our Going Back feature this month. What an eye-opener!

Today 41 years later things are very different, with changes in technology and a totally different attitude in the politics involved with entertainment electronics.

Readers will probably have noticed this from the international flavour of last month's issue, in which we showed that the whole of the entertainments electronics scene is not, of course, as parochial as it was in the 30's. Commercial competition rages furiously now in what we call the rat-race. To keep up with it, today's magazines have to employ human dynamos, always looking for new or different ways of encouraging readers to exploit new technology and ideas.



Here you are, chief! All 800 issues packed into one integrated circuit. Just arrived on the 8 o'clock carrier pigeon from "Ireland".

DO-IT-YOURSELF QUAD

In this issue we present a do-it-yourself "first". In quadrasonic sound there has been much argument which no doubt you will have heard about. We became fed up with waiting for someone to decide on a standard or universal system. So did the various manufacturers. We confidently predict that the Audio Fair in October will show a very wide variety of equipment that will attempt to satisfy the growing interest in quad.

But to the best of our knowledge this is the first time that a compatible four-system quad design with description and full constructional details has been published in a radio and electronics do-it-yourself magazine. A decoder for CD-4 can also be used with this unit.

In addition to enhancing ambience in reproducing recorded music, quad opens up a whole new form of aural effect that adds an indescribable sensation to recorded pop music of any kind. The listener can get a feeling of complete relaxation in the midst of his music, no matter how off-beat it might be.

There are several ways of getting quad sound and we have exploited all of them. So with Project Q4

you can choose to play stereo records or tapes through the different quad decoding processes; you can also play any currently available quad record through either the decoding process intended for it or through one of the other decoding channels for some different effects.

We have not used valuable magazine space on describing amplifiers and other equipment specially for this decoder, because we believe that most constructors will want to choose their own, whether they are commercial products or home-made. Most constructors will already have a stereo amplifier system of some kind so it is a simple matter to add to this our Q4 Decoder and another identical stereo amplifier and speakers. If you are starting with no equipment you still have the choice. It need not be expensive.

With this set-up, you can start quad straight away with stereo records or tapes, best played through the RM, SQ or QS channels. Even with this, the results will be quite staggering, and we hope you will then be encouraged to invest in quad records and tapes as and when available for the SQ, QS and discrete four-channel systems.

EXPERIMENTING

Also in this issue we start constructors on the trail of phase locked loop circuits. The ideas and theory behind phase locked loops are far from new; we think that many readers will have read enough theory about this subject already. We have therefore cut the theory down to manageable proportions so that constructors can get started on making up some interesting projects.

This month we start off with a.m. and f.m. demodulators and next month we exploit phase locked loop i.c.s for metal detection. Further articles showing their versatility will be published in future issues of *Practical Wireless*.

At a time when schools and colleges will be commencing new courses and sessions, we are providing a new series of self-contained articles describing how to learn while you build. "Experimental Workshop" explains the theory with working practical projects. You don't have to use soldering irons so you can re-use the components again.

We hope you will all find Issue No. 800 interesting to read and worthy to keep. As a bonus, we have included the first pair of PW Data-cards. Look out for more in this series in the next two issues.

M. A. COLWELL—Editor

The November issue, on sale 5th October, will include for all readers, and specially visitors to the London Audio Fair, an extra 8-page supplement "Dictionary of Audio Terms" to help you understand the language; the "P.W. Ferret" our new metal detector design using a phase locked loop i.c.; the second pair of P.W. Datacards dealing with DIN plugs and decibels. Further details on page 531.

Computerised security network

A minicomputer-controlled security network has been put into operation by a major bank in Pittsburgh, Pennsylvania, to watch windows, doors and bank vaults, and to call the police if the bank is robbed. One bandit was recently arrested less than two minutes after police headquarters received a teletype alert printed out on the command of a Computer Automation Alpha 16 minicomputer incorporated in the bank's new Diebold DGM-320 Security System.

This police alarm was an automatic function of the system, which continuously monitors security sensitive areas in the bank's headquarters and 22 area branch offices, through electronic sensors plugged into a private data communications network, as well as a CCTV system.

All conditions concerning security contact points are programmed into the minicomputer's 8K 16-bit core memory. The computer knows, for example, when a given area is secured or open for entry, and reacts instantaneously to every deviation from norm, implementing a series of prescribed activities designed to meet the potential 'emergency'. In routine operations, the minicomputer initiates a survey of all security points every 100 milliseconds, and instantly produces a legible teletype status report on every checkpoint.

The information-generating devices installed in security areas cover a broad spectrum of sensors and switches, noting such activities as the opening and closing of doors, windows and vaults. Also included are heat and smoke detectors, ultrasonic and infrared sensors. The system activates alarm devices to alert security personnel and/or the police when the vaults are entered illegally, when the bank or any of its branches are robbed, or when someone tampers with any of the multitude of security devices. The security system's minicomputer automatically determines whether a circuit has been cut, shorted or plugged into an external PSU.

When the DGM-320 system detects an emergency condition, it tells security personnel exactly what steps are to be taken to handle the situation by projecting a 35mm slide on a screen mounted in the system console; in addition, a teletype report is printed out and any required audio alarm is sounded.

Price slashed

GENERAL Instrument Microelectronics have slashed the small quantity prices of their single chip calculator series and are now offering their C500 microcircuit for £13.70.

This £18 reduction is such that an individual engineer can now build a complete calculator, using extensive application notes supplied with the microcircuit, for well under the market price. Equally the new pricing structure, resulting from the high volume of production now being achieved by the Glenrothes production unit, will make it extremely attractive for users such as instrument manufacturers to utilise the chip in instrument design, thereby economically deriving from one measurement a wide variety of parameters.

Radio in the N.E.

At the time of going to press it was expected that independent radio for the Tyne/Wear area would be run by Metropolitan Broadcasting. The IBA announced that they are having more detailed discussions with the company and would make a further announcement in September.

Meanwhile the starting date for broadcasting independent radio in London and the South-East was still not available.

Welsh radio

THE I.B.A., after full consideration of the two applications for the Swansea radio franchise, proposes to offer the contract, subject to certain conditions and further detailed discussion, to Swansea Sound Limited (Chairman — Mr. John Allison).

Storage tube

A NEW cathode ray tube from Mullard is designed for use with laboratory oscilloscopes which require a half-tone storage facility. Designated L14-110GH/55, it is a 14 cm. rectangular tube with a storage time of at least 1.5 minutes. The scan area is 90 x 72 mm. (10 x 8 divisions of 9 mm.). Correction coils supplied with the tube enable the raster to be aligned with the internal graticule.

P.C.M. in the North

THE BBC has now completed a further stage in its p.c.m. sound distribution system, which will make it possible to start a full stereophonic service from the stations at Holme Moss (near Huddersfield) and Belmont (near Louth, Lincs).

The use of the p.c.m. system means that the standard of technical quality will be appreciably higher than has been possible until now, and this improvement will apply to monophonic, as well as stereophonic reception.

Test transmissions in stereo started from both stations on August 4, and they will be maintained throughout programme hours as far as possible. But it may be necessary to revert to monophonic transmission on occasions, for essential engineering work. The date for the start of the full service will be announced later.

G3UDN

THE Mid-Warwickshire Amateur Radio & Electronics Society, G3UDN, inform us that they will resume full activities at their clubrooms on September 10th after their summer recess.

Meetings will be held each Monday evening at 8.00 p.m. at 28 Hamilton Terrace, Leamington Spa, and further information on club activities can be obtained from Alan Outhwaite, G8GDY, 7 St. Ann's Close, Leamington Spa.

Demodulating AM/FM the easy way or

PHASE LOCKED LOOP TECHNIQUES

W.S. POEL G8CYK

THE phase locked loop (PLL) technique is very little used by amateur radio and electronics enthusiasts. Perhaps too many people are daunted by the rather grandiose images conjured up by the title; which is a great pity, since the theory of operation is very straightforward. Thanks to the range of PLL integrated circuits, notably by Signetics and National, it is a very simple matter to put the theory into practice.

FIRST PRINCIPLES

As the name suggests, the basis of this system is a signal whose phase is the same as another signal, i.e. the reference source. At this point, a diagram will convey far more than a hundred words. There are two viewpoints when considering the reference signal:—

Fig. 1a. The reference may be derived from a crystal controlled oscillator, and may then be divided a number of times, say 'n'. The PLL will then be caused to operate at this frequency: the crystal frequency, divided by 'n'.

Fig. 1b. The reference may be the oscillator in the PLL itself, as in the case where the device is used as a demodulator.

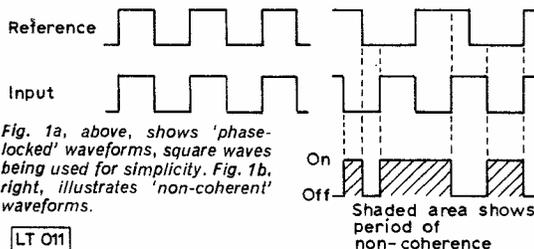


Fig. 1a, above, shows 'phase-locked' waveforms, square waves being used for simplicity. Fig. 1b, right, illustrates 'non-coherent' waveforms.

LT 011

ELEMENTS IN THE LOOP

The purpose of the **phase comparator** section, Fig. 2, is to compare the two signals at its inputs and produce a 'control' voltage at its output which is proportional to the frequency difference, or phase difference, between the input signals.

The low pass filter immediately after the phase detector control voltage output is to smooth out the high frequency components of the control voltage and so improve the stability of the voltage controlled oscillator.

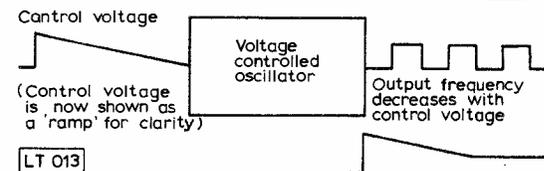
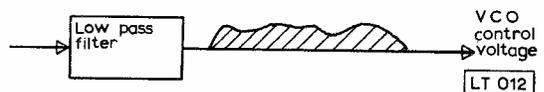
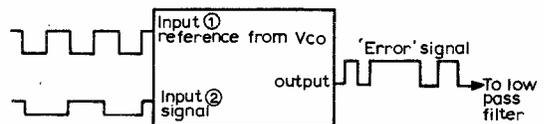
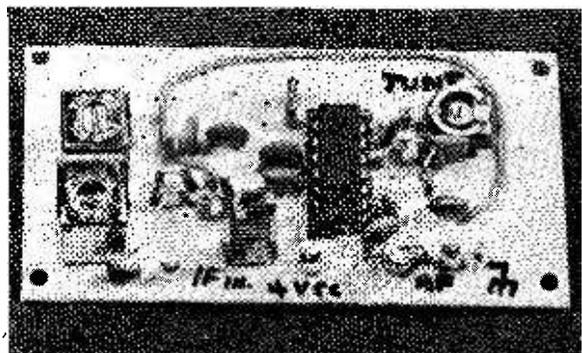


Fig. 2a, top and centre, production of 'error' signal from phase comparator.

Fig. 2b, bottom, change of output frequency by control voltage to VCO.

The **voltage controlled oscillator**, see Fig. 2, can be any form of variable frequency oscillator whose output frequency is a function of a controlling voltage. This can be a varicap tuned oscillator, but in the PLL IC described later, it is a voltage controlled multivibrator. The control voltage is derived from the error voltage from the phase detector. It should be noted that increasingly positive control will cause the VCO to go higher in frequency, and vice versa.

A practical loop system is shown in the block diagram of Fig. 3, using the Signetics NE561B IC.



Author's prototype decoder for NBFM at 455kHz. The board, shown full size in Fig. 9, includes a mechanical filter and matching transformer.

The classical loop is shown in double lines

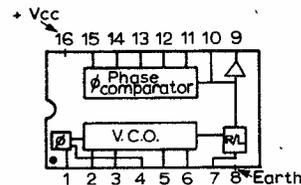
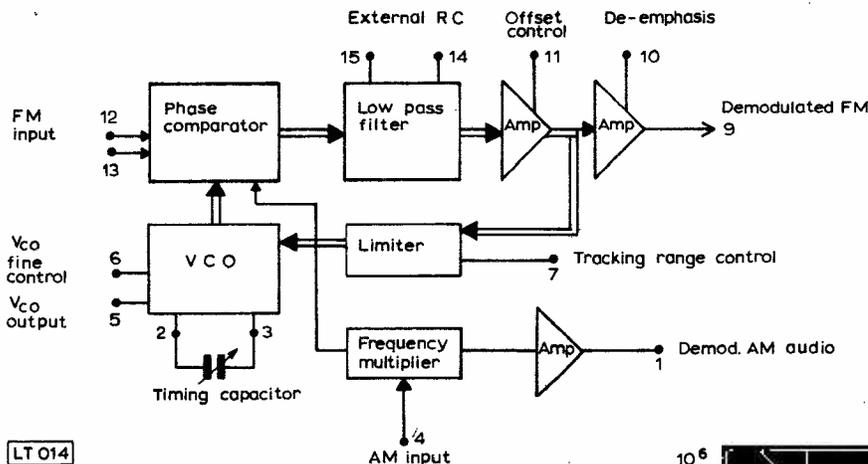


Fig. 3. A phase-locked system using the NE561B IC. Connections are given for the 16pin dual-in-line package, viewed from on top.

LT 014

APPLICATIONS OF NE561B

Apart from containing the essentials of the loop, the NE561B contains much more beside and can be used for tone decoders, telemetry decoding, signal reconstitution, tracking filters, FSK receivers, wide band detectors, AM and FM receivers.

Before running through the list it is as well to examine this excellent device in closer detail. As well as the classical loop components, there are a number of amplifiers, and a 'multiplier', which will be described when considering the action of the IC as an AM radio.

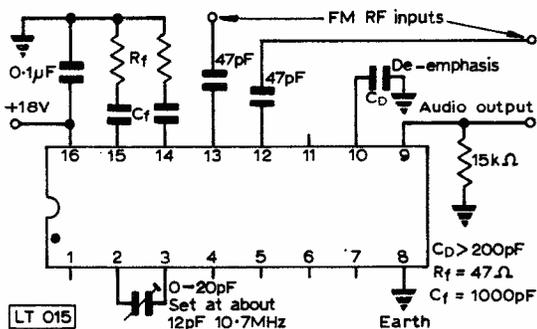
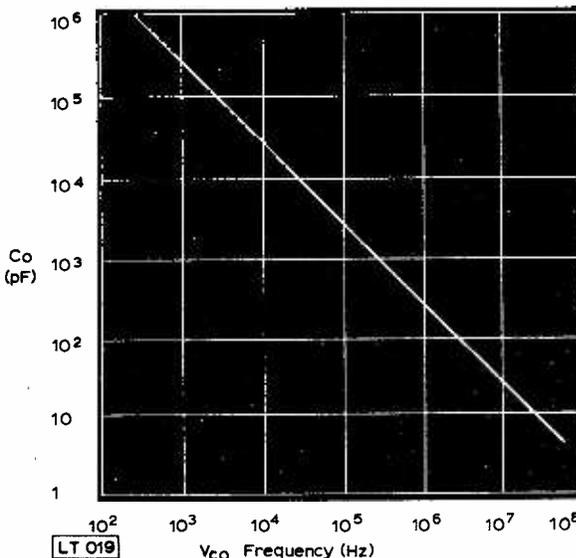


Fig. 4. Basic circuit using the NE561B as an FM demodulator at 10.7MHz.

TABLE 1

10-7MHz WBFM	Min.	Typ.	Max.	Conditions
Detection Threshold μ V		120	300	$V_{in} =$
Demod. Amplitude μ V	30	60		1mV RMS
Distortion % THD		0.5	1.5	70kHz Deviation
Signal + Noise Noise dB		35		$f = 10kHz$



Graph for determining the value of the timing capacitor connected between pins 2 and 3 on the IC.

FM demodulation (includes FSK, telemetry), Fig. 4. The NE561B will demodulate FM to a minimum of 15MHz, and typically up to 30MHz. To take, as an example, a wide band FM demodulator for 10.7MHz, the circuit is supplied with the correct timing capacitor for the VCO, as determined from the graph. For 10.7MHz a small trimmer of 0-20pF is recommended. Signetics specify the results as shown in Table 1.

One of the main advantages of the PLL FM demodulator is the automatic frequency control facility. The PLL itself will track the input signal by a minimum of $\pm 5\%$ of the input frequency, in this case $\pm 535kHz$. A typical range of $\pm 20\%$ is given, so be prepared for $\pm 2140kHz$!

One proviso though; if the wanted signal happens to drift through a stronger signal, or merely happens to be very close to a stronger signal, the loop will then lock on to this other signal. A ceramic FM filter is therefore a necessity to keep out unwanted signals. The tracking range of the device itself can be restricted by reducing the signal level, since the range is largely a function of the signal amplitude.

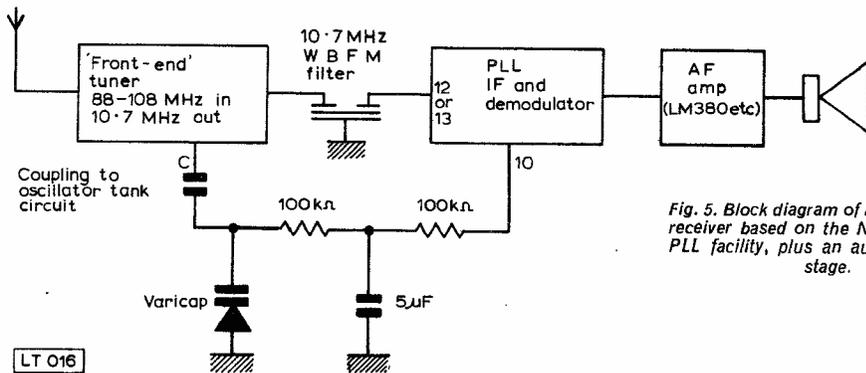


Fig. 5. Block diagram of a complete FM receiver based on the NE561B and its PLL facility, plus an audio IC output stage.

The figures given here are for a 5mV signal; the threshold voltage is the input signal where lock just occurs.

Since the VCO control voltage closely follows the deviation on the incoming signal, this can be used as the audio signal, Fig. 5.

With the popularity of NBFM ($\pm 2.5\text{kHz}$) on amateur bands, and not only on VHF, it is useful to realise that the NE561B will also work here. Considering the deviation as a percentage of the signal frequency, the following figures are obtained:—

$$\text{WBFM at } 10.7 \text{ MHz} = 75\text{kHz} \quad \% = \frac{75}{10\,700} \times 100 = 0.7\%$$

$$\text{NBFM at } 455 \text{ kHz} = 2.5\text{kHz} \quad \% = \frac{2.5}{455} \times 100 = 0.55\%$$

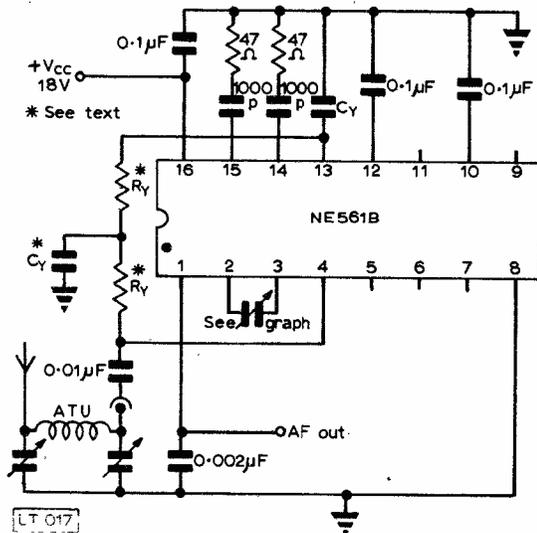


Fig. 6. The NE561B can also be used to demodulate AM signals, as shown in this simple complete receiver.

So, if the value of the timing capacitor is chosen for an IF around 455kHz, then NBFM can be very satisfactorily demodulated without the need for any coils whatever.

Figure 3 showed a fine tune control at pin 6 and by applying a small voltage via a preset the VCO can be tuned in this way. In order to determine the correct value, it is best to refer to the device data sheet before any experimental attempts are made. (Mistakes may be costly!) Similar comments apply when considering the tracking control range.

The AFC loop in the IC can also be tapped to provide AFC to the front-end oscillator. By taking the output from pin 10, feeding it via 100kΩ and a low pass filter to the AFC varicap, a vast tracking range can be attained, but it is subject to the limitations discussed earlier.

AM demodulation, Fig. 6, is the distinguishing feature of the NE561B. No other IC in the range is capable of AM demodulation. The PLL can only detect FM, so some modification is necessary. It turns out to be a kind of 'quadrature' detector in reverse! By means of the external phase shift network the AM signal is shifted through 90°.

Although the values should change when tuning over the MW band there is sufficient tolerance to allow the band to be tuned from end to end. The minimum (typical) signal to maintain lock is only 100µV so the device can be used straight away as a receiver, just attaching an aerial as shown. If strong signals predominate, then include a simple aerial tuning device to enhance selectivity. Of course, when used as an IF strip, i.e., after an RF stage, mixer and filter, the NE561B does away with the need for IF coils and all the encumbrances of standard techniques, Fig. 7.

Signal Reconstitution This is the last function of the NE561B that will be considered in detail although other members of the PLL family are more specifically applicable.

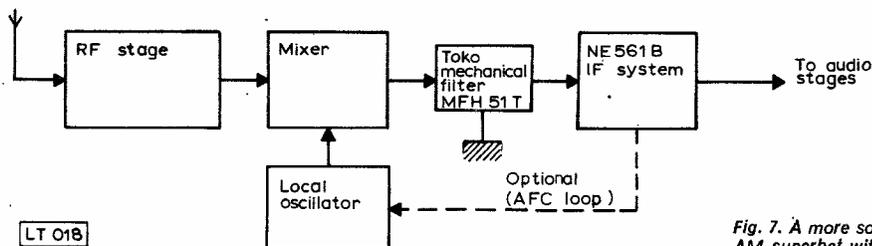


Fig. 7. A more sophisticated circuit, for an AM superhet with standard IF of 455kHz.

With reconstitution, the idea is to salvage a badly distorted, noisy or generally damaged pulse. Fig. 8 gives the idea in detail. The reconstituted pulses are taken from the VCO output and can be processed as required in standard digital circuitry. An interface to TTL is also shown which means that the loop can be locked to one of the standard frequency transmissions, notably Droitwich on 200kHz, and then divided down to provide very accurate frequency markers.

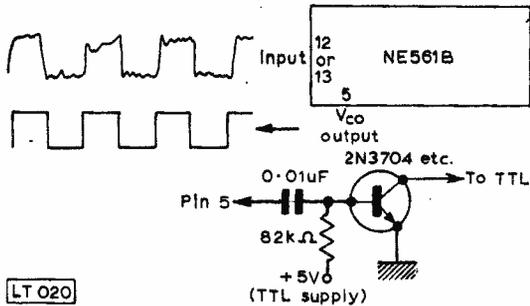


Fig. 8. NE561B used for the reconstitution of 'damaged' signals.

CONSTRUCTION

The author's layout of the pcb is shown in Fig. 9. The material used is fibre glass 1/16in. copper laminate since this does not suffer any of the problems experienced with paxolin based board such as the peeling of the strips and general brittleness. The board can be either etched at home or purchased ready made.

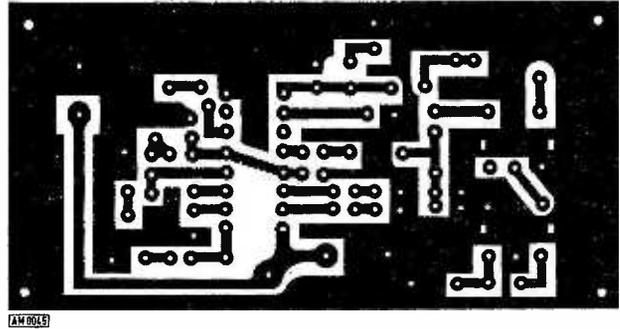
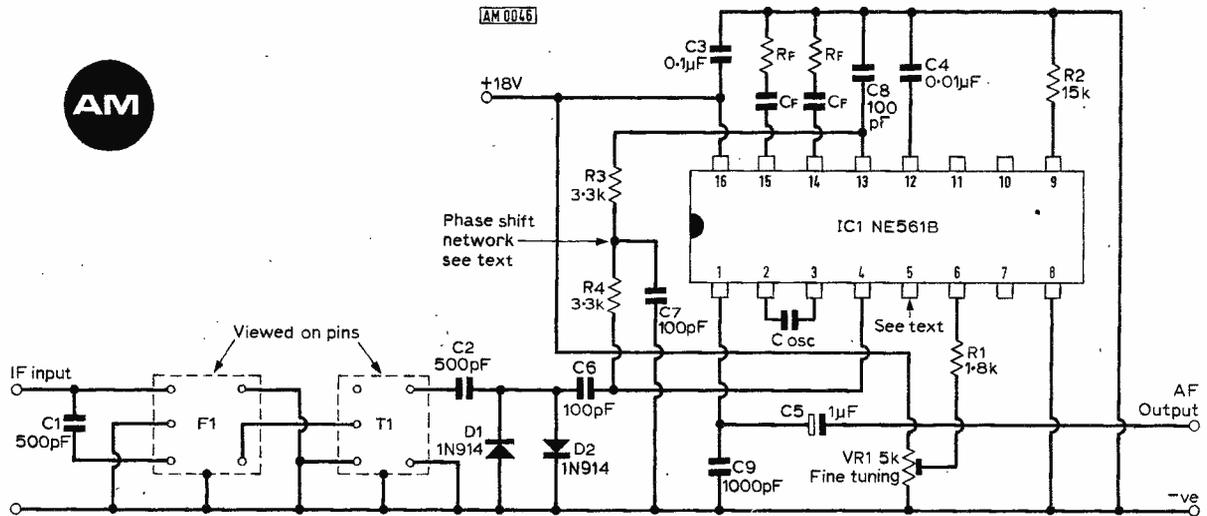
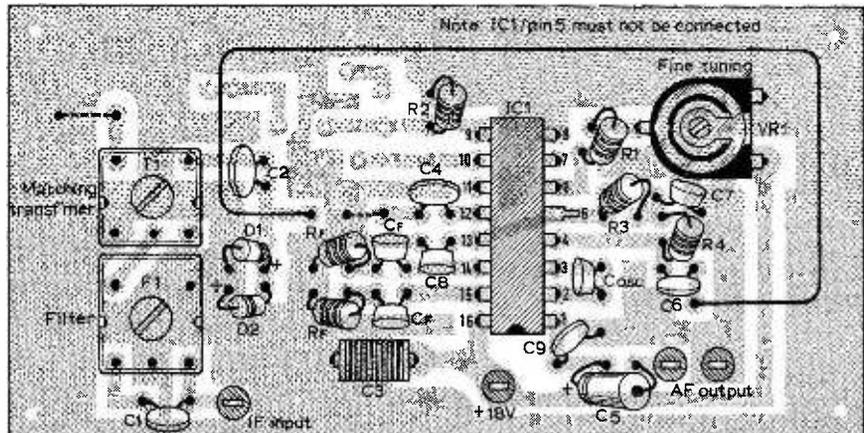


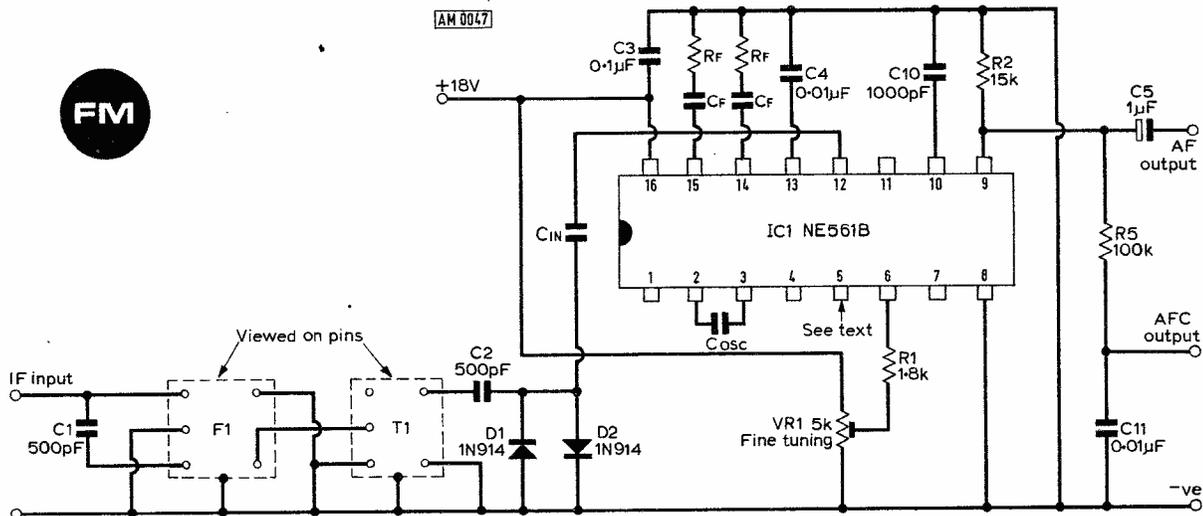
Fig. 9. Full size layout of pcb for those that wish to make their own board.



▲ Fig. 10. Complete circuit of the AM decoder board including the mechanical filter F1 and matching transformer T1.

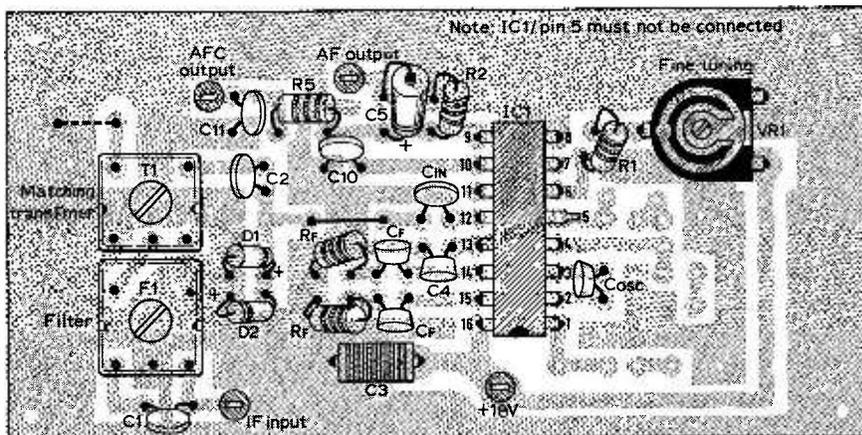
The layout of components on the plain side of the board for the AM circuit shown above. ▶





▲ Fig. 11. The FM decoder circuit using the same printed circuit board as for the AM circuit.

Components on top of the pcb for the FM circuit. ▶



Note that the track under pin 5 of the IC is not in any way connected with that pin. When mounting the IC remember to bend pin 5 inwards. If a socket is used, either bend or remove the pin 5 position.

When the board is prepared solder the components on as shown in Fig. 10 or 11. Two layouts and circuits are shown for the NE561B, one for AM detection, and the other for FM. It is possible therefore to change the operation quite simply, by switching the input and output. The phase shift components need not be removed for FM operation.

There is provision on the board layout for the incorporation of a mechanical filter from the MFH range by Toko. Bandwidths are available from 4 to 7kHz, depending on application. If a too narrow filter is used for NBFM, the signal will be reduced so greatly on deviation peaks that the loop will lose lock and a noise burst will result, making the modulation sound very choppy. Probably the lowest value to choose is 7kHz.

CHOOSING THE CONDITIONS

The filter shown is specifically for 455kHz, so if operation is desired at this frequency, it will be seen from the graph that the value of the VCO timing capacitor is approximately 1000pF. The fine

frequency adjustment can be made on the preset potentiometer.

For AM detection, the values of the phase shift network can be two 3.3kΩ resistors with 100pF capacitors, though the formula for computing this value allows for an almost infinite combination of values.

Operation at other frequencies can be calculated from the information given, the most probable use is perhaps the WBFM demodulator, at 10.7MHz. Followed by the coil-less PLL FM stereo demodulator, it is possible to produce a formidable array of technology just for 'consumer' use. In this case the 455kHz filter is obviously not required, a 10.7 MHz IF transformer being included instead.

TESTING AND ALIGNMENT

Once the assembly is completed, check that the IC is in the right way round. This is an all too easy mistake to make. Clear the swarf from the copper tracks and make certain that there are no stray blobs of solder.

Attach an audio amplifier stage and switch on, whilst monitoring the current. About 10mA is correct if all is well. There should be a quiet hiss from the speaker and if a finger is placed on the PLL input,

it is quite likely that you will pick up general SW/MW signals.

Now, find some source of IF at 455 kHz, which can be a signal from the IF of a communications receiver or pocket portable, and tune in a station. As the PLL acquires lock a rushing sound will be heard, followed by a click as lock is attained. The 'no lock' noise level will be quite high when operated in the NBFM mode and requires some form of interstation muting if the gain is increased.

★ components list

COMMON COMPONENTS	
C1	500pF disc ceramic
C2	100pF disc ceramic
C3	0.1µF mhp. foil
C4	0.01µF disc ceramic
C5	1µF 25VW electrolytic
C6	1000pF (2 off) disc cer.
C6A	100pF disc ceramic
D1/D2	1N914 JCI NIP41B diode holder
F1	Mechanical filter (Tape) (Ambit) T3, Matching transformer (Tape) (YK1000) (Ambit), Printed circuit board
	Terminal pins (6) * see text

ADDITIONAL COMPONENTS	
AM UNIT	
C6	100pF disc ceramic
C7	100pF disc ceramic
C8	100pF disc ceramic
C9	1000pF disc ceramic
R2	3.3kΩ
R3	3.3kΩ
FM UNIT	
C10	1000pF disc ceramic
C11	0.1µF disc ceramic
C12	50 to 200pF (not critical)
R4	10kΩ
All resistors 5%, 1/4 or 1/2W	

The pcb, ready drilled and punched and suitable for either unit, is available from Ambit International, 27 High Street, Brentwood, Essex, SA9 0AA. A basic kit comprising pcb, IC and holder, mechanical filter and matching transformer can be supplied for £5. Prices include V.A.T. and p/d.

There is very little to do in the way of alignment, since the PLL aligns itself. All that needs to be done is to bring the PLL VCO as close to the operating frequency as possible, by means of the preset on the board. To do this, tune to a weak station and lower the input level slowly until lock is just lost. Now turn the preset until a heterodyne whistle is heard as the VCO sweeps through the carrier. Adjust for zero beat, whereupon the VCO frequency and IF frequency are the same. This means that the PLL has less range to track to capture the desired IF signal and that lock will be maintained on weaker carriers.

It is very difficult to list all the possible applications of such a simple IF unit since if used in conjunction with the mechanical filter it forms a complete IF strip, requiring just the input from the mixer. The filter cores should be carefully adjusted for maximum output which will correspond to maximum noise when the loop is off lock.

TELEVISION

OCTOBER ISSUE

BASIC COLOUR FAULTS GUIDE... IN FULL COLOUR!

This issue of *Television* contains a special colour supplement, which you can pull out and keep for reference, showing by means of colour-coded colour photographs, the basic colour faults that can occur. The accompanying text explains the causes, and the cures, of the faults.

VARICAP TUNING SYSTEM

Television's correspondent on long distance TV reception has equipped his receiving installation with varicap tuners. These are equipped with the necessary power supplies and operating in compact diecast boxes, with varicaps for UHF and VHF. Full details and given of these units which have proved very successful in use.

110" COLOUR CHASSIS

This is an opportunity to get acquainted with the new techniques necessitated by the change to 110" colour tubes. *Television* has taken a detailed look at the first 110" colour chassis to come from a UK supplier. The Mullard Phase II geometry used is expected to be featured in other new-generation chassis now in the pipeline.

SERVICING TV RECEIVERS

This feature details the common faults experienced with the ITT/KB VC200 single standard trichrome chassis. Among the interesting points of this chassis is the use of grid modulation of the CRT.

Also in this issue is a troubleshooting guide covering the timebase circuitry used in the Philips 11TCT10A series.

RECEIVER DE-BUGGING

Part 3 in this series describes the effects on the picture of deficiencies in the characteristics of the IF and video circuits and the methods to use to reduce these to a minimum.

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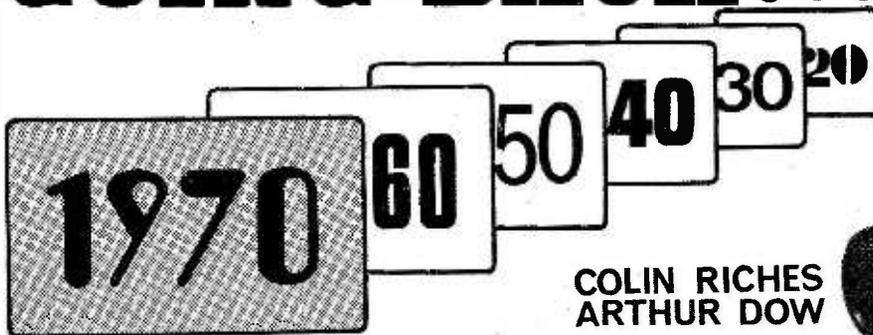
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SINCE the *Practical Wireless* century stepping stones take quite a while to come around perhaps we ought to take the opportunity in this issue No. 800 to look back at earlier marker points along the way. We might not be here for No. 900! In case any reader is doing a quick bit of mental arithmetic, it is of interest to make the point that in the early days of *PW* it was a weekly magazine, so the 100's rolled round that much faster!

Issue No. 1 Volume 1 of *Practical Wireless* was dated September 24th, 1932, and went to 68 pages in a 10³/₄ x 8in. format. Published weekly by George Newnes at a cover price of 3d it was edited by the redoubtable F. J. Camm assisted by H. J. Barton Chapple, Frank Preston, W. J. Delaney and W. B. Richardson on the Technical staff. Quoth the Editor "a well equipped laboratory staffed by enthusiastic experimenters closely associated with the home constructor movement will examine and test the latest components, the results of which will be reviewed in *Practical Wireless*."

The new 200kW Radio Luxembourg transmitter started up on the long wave band "despite international protests on the choice of 1275 metres." One writer affirmed "the variable-mu valve has come to stay and listeners who are troubled with swamping from a powerful local station should fit one if it is humanly possible." Anyone heard yet of a variable-mu transistor? Seems to be badly needed on many modern radios.

An "Experimenter's Baseboard" was fabricated from wood strips to provide slots in which movable bolts could be used for fixing down individual components when mocking up a circuit. Items published on the "Radio Wrinkles from Readers" page were rewarded with half a guinea, provided that the idea was original.

A review appeared of a kit of parts for making what was to become a very famous receiver, the Lissen Skyscraper. With the three valves, loud-speaker and walnut cabinet you would have been set back £5.5.0. in those days! For the constructor starting from scratch there was the Dolphin Straight Three design while W. B. Richardson exploded some commonly accepted notions about wireless on the "Radio Fads and Fallacies" page.

With this first issue of *PW* went a free blueprint for making the "Long Range Express Three" proudly described as "The Set of the Year". This blueprint

was the start of a very successful series of blueprints for various wireless sets and auxiliary equipment that went on into the 60's. Even today requests for back numbers of these blueprints are not infrequent. **No. 100** came up in Volume 4 and was for August 18th, 1934, and still priced at 3d. A great splash was made on the cover and inside of the National Radio Exhibition held at Olympia at which *PW* had Stand 8. "How to get there" and stand location information was given as well as a review of the exhibits themselves.

Prominence was given in the issue to the first number of *Practical Television*, "on sale now" price

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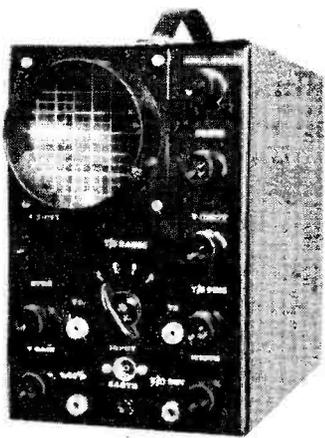
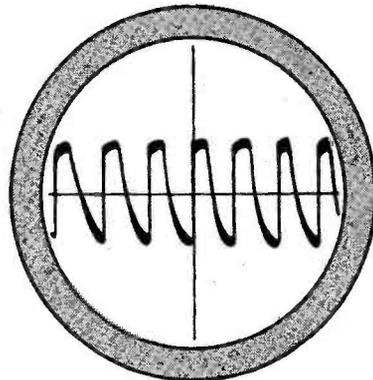
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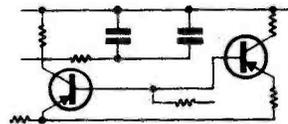
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H8/4	4.7µf	25v	4p	H7/7	100µf	25v	4p
H8/4A	5µf	64v	4p	H7/8	125µf	18v	5p
H8/5	5µf	10v	4p	H7/8A	100µf	35v	6p
H8/5A	5µf	150v	4p	H7/9	100µf	63v	6p
H8/6A	10µf	10v	4p	H7/9A	125µf	4v	4p
H8/7	10µf	70v	4p	H7/10	125µf	25v	6p
H8/8	16µf	35v	4p	H7/10A	160µf	2.5v	3p
H8/8A	16µf	16v	4p	H7/11	160µf	25v	6p
H8/9	20µf	6v	2p	H7/11A	150µf	18v	5p
H8/9A	20µf	70v	4p	H7/13A	200µf	25v	8p
H8/10	22µf	50v	4p	H7/14	220µf	4v	3p
H8/10A	22µf	100v	4p	H7/14A	220µf	16v	6p
H8/11	25µf	12v	4p	H7/15	220µf	25v	5p
H8/11A	24µf	275v	4p	H7/15A	220µf	35v	10p
H8/12	32µf	15v	4p	H8/1A	250µf	4v	3p
H8/12A	30µf	10v	4p	H8/2	320µf	10v	4p
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H8/15	47µf	50v	4p	H8/7	400µf	15v	5p
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H7/1	50µf	6v	3p	H8/8A	470µf	35v	20p
H7/1A	50µf	10v	4p	H8/9A	400µf	40v	20p
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071 16222	25	2200	2.2 amps	10z	15p	
072 16502	25	5000 + 5000	9.6 amps	31oz	37p	
072 18752	25	7500 + 7500	12.6 amps	41oz	49p	
072 17342	40	3400 + 3400	9.1 amps	31oz	37p	
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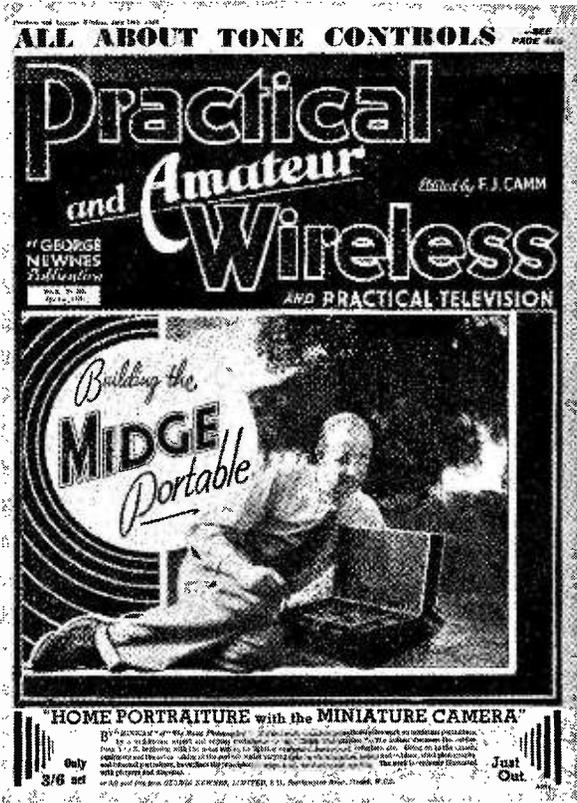
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6d, while in the parent paper W. J. Delaney suggested that the Friday morning experimental TV transmissions from the BBC on 261 metres (yes, on the medium waves!) could very well be viewed out in the country . . . "the equipment can easily be accommodated in a car, together with the batteries . . . the set can be one of the portable disc types! A wireless receiver was also carried to get the sound channel. A photograph showed two enthusiasts taking up the suggestion.

A survey of developments in valves noted the QPP (quiescent push-pull) double pentode battery valve having very low standing current, the production of much smaller valves without sacrificing reliability and changes to the shape of the valve envelope to enable it to more rigidly support the electrode assembly.

The constructors among the readership enjoyed themselves with the "Armada Mains Three", a low priced efficient radiogram design or the "Summit" three valve battery receiver which incorporated the WB "Stentorian" loudspeaker which was to become extremely popular probably because of the built-in tapping switch and transformer enabling the speaker to be very quickly matched to any output valve. In an accompanying competition the magazine offered fifty of the speakers to readers who could place a list of the speaker's virtues in the right order.

No. 200 for July 18th, 1936, now had gained a resplendent title! *Practical and Amateur Wireless and Practical Television*, no less. Obviously there had been some takeovers in the interim! but it was still a weekly and still 3d. Inflation, evidently, was not an "in" word at that time.



By 1936 No. 200 of PW had absorbed both *Amateur Wireless* and *Practical Television*.



After six years of publication PW still retained a cover price of 3d. as shown here with No. 300.

The cover and main article spread themselves on the subject of the "Midge" portable receiver with an internal frame aerial, the forerunner of the modern ferrite rod aerial. "Facts and Figures" dealt with components tested in the magazine's laboratory and reported on the Avo capacity meter and Collaro automatic record changer.

For listeners to the short wave bands Frank Preston described various desirable refinements that could be made to a short wave receiver with a view to obtaining smoother reaction, a highly prized objective. The repairman could glean a lot of useful tips from "Speedy Repairs" which showed how many receiver breakdowns could be diagnosed and fixed "in less than five minutes!" The modern dealer would give an awful lot to have that capability available today!

Practical Television was allowed a whole page to itself leading off with chat on television studio scenery followed by a report from the USA on a new invention that obviated the need for separate receivers for sound and vision frequencies. It was thought that two sets would still be needed for the BBC's TV service, yet to come, accommodating them in the same cabinet.

A Chicago receiver manufacturer managed to produce a set with forty valves. Wireless but not valveless . . . probably also had a valve factory just round the corner!

No. 300, still going strong on June 18th, 1938, at 3d a week featured a 2½-watt battery amplifier on the cover and centrespread. The Class B stage consumed little current without any signal but it must have been a fair load on peaks for the 135 volt high tension battery!

For the summer months the magazine recommended its experimental short wave receiver for the outdoor life. However, *Practical Television's* two pages reported high winds at Epsom racecourse which interfered with the BBC's efforts to televise the Derby although it all came right in the end. A London cinema fixed up an 8ft x 6ft 6in TV screen to enable viewers to see Bois Roussel romp home. The radio link between Epsom and Alexandra Palace was on 5 metres (60MHz).

WHY THE GRID LEAK? — See Page 190

A NEWNES PUBLICATION Edited by F.J. CAMM Vol. 18, No. 400

Practical Wireless 3d EVERY WEDNESDAY May 18th, 1940

*** PRACTICAL TELEVISION ***

Contents

- Getting the Best from the Pick-up
- British Long-distance Listeners' Club
- Thurley's Commentary
- Pull-in Tuning Circuits
- Practical Hints
- L.F. Amplifier Troubles
- Electronics
- Readers' Letters

BUILDING A DIVERSITY RECEIVER



THE PRACTICAL WIRELESS ENCYCLOPEDIA BY F. J. CAMM 7/6 NET

Warlike issue No. 400 of 1940 but PW was not to retain its price of 3d much longer. By September it had doubled to 6d.

A newspaper reader was reported to have complained about the frequent use of gramophone records by the BBC. He felt that he was "not getting his 10s. worth"! One reader's wrinkle was to add a lead balance weight to his pickup thus "reducing the weight on the record to about 1oz." Mind you, it was a 78! In a kind of "Going Back" atmosphere L. Ormond Sparks recalled how he had, in 1923, installed radio equipment in a motor coach for the first time. Being an open coach the aerial system had to be rigged in such a way that it did not interfere with the passengers. These good folk plugged their headphones into a socket located near each seat. The coach company organised strategically planned round trips enabling the passengers to listen to the station at Cardiff during the evening's run.

W. J. Delaney contributed a couple of ideas on improving the PW two valve deaf aid and "News from the Trade" looked at Tungstram valves, a new Hivac cathode ray tube akin to the VCR139, a Cosmocord playing deck and WB transformers for audio and mains use.

No. 400 issue of May 18th, 1940, continued the old price of 3d but by June had gone up to 4d and upward again to 6d by the issue for September, reflecting the new wartime conditions. A "Dig for Victory" photograph showed allotment enthusiasts digging furiously to music from an Ekco portable radio.

The equipment review covered the GEC portable set which used a single battery supplying the 1.5 volts for the filaments and 90 volts HT for the anodes of the valves. The price for the receiver was just £8.18.6.

A very interesting column which had, in fact, been going for some time was the "Replies in Brief" feature. In this a few lines only were devoted to replying to any reader whose query did not justify more detailed treatment or was not considered to be of general interest. Provided one was not in a great hurry for a reply, this system probably served its purpose.

The British Long Distance Listeners' Club had a page to itself for letters from its members describing their activities and experimental work. An interesting article described "pull-in" tuning circuits, or AFC as we would call it today, but these were for use on the medium wave band. W. A. Flint dealt with the construction of his Diversity Receiver. Being dissatisfied with the Home Service on both 391 and 449 metres and the "blasting and distortion" introduced by the AVC he had two separate straight receivers with the detectors feeding into a common audio stage.

No. 500 was in a smaller format, 8 $\frac{1}{2}$ x 6in., and dated March 1948 having become a monthly publication at a price of 9d. F. J. Camm was still in the chair and in his Editorial pointed out that while other commodities and services had increased in price by 100 per cent the licence fee was the last to be increased, from 10s to a £1 plus £1 for the TV licence. In view of rumours of further rises in the fee FJC wondered "if the time was ripe for the BBC to drop its outmoded belief that publicity is an unclean thing and to remove its ban on commercial broadcasting in this country". Readers will not be slow to note that the BBC policy remains the same in 1973 but commercials will take the air in the autumn on VHF and MW and so cream off the profits which could so well go towards reducing the already astronomical TV licence fee collected for the BBC.

C. L. Orsborne wrote on modifying the wartime Utility Receiver for reception of the Light programme on the long waves since some parts of the country experienced difficulty with the 261 metre signals after dark. Edwin N. Bradley described a test pattern generator for the TV service engineer. This produced a vertical bar pattern using a single valve, double triode 6SN7. Another article dealt with the design of test instruments with particular reference to multivibrators and sub-standard oscillators.

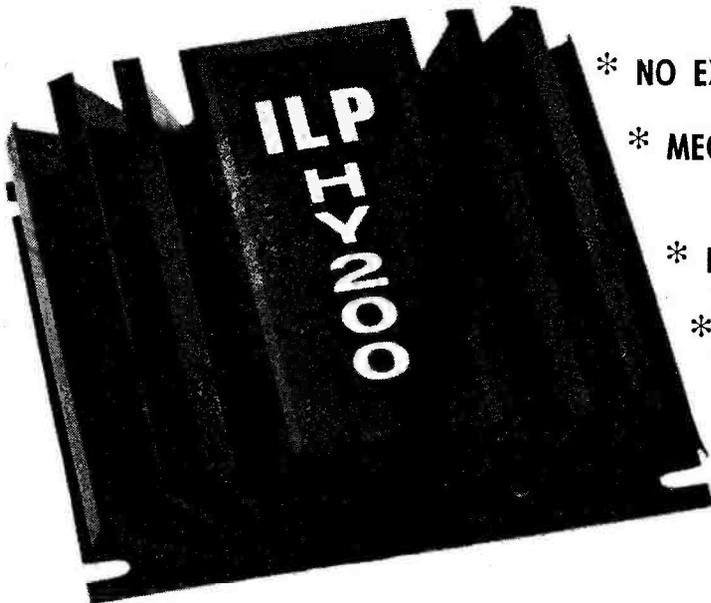
On special application to the GPO radio amateurs could obtain permission to use the six metre band for a limited period. The band was very active at the time but only certain countries, mainly in the Americas, included it in the standard amateur licence.

Readers were reminded that if a car had been laid up because of the petrol rationing they could



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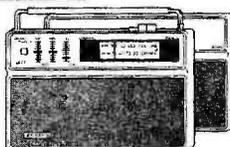


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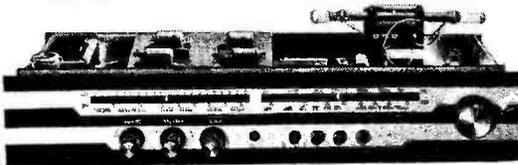
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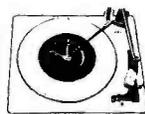


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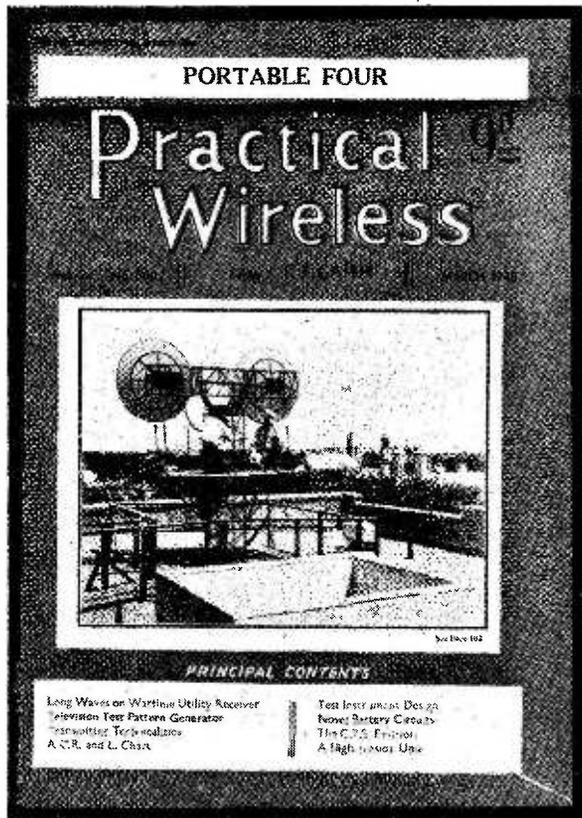
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EY86	22p	PL36	17p	20P1	12p
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		PY800	17p	30FL1	

ABOVE PRICES INCLUDE V.A.T.

obtain a refund of 1/8d. a month on the unexpired portion of a car radio licence. Full details were given of the construction of a four valve battery portable using a novel frame aerial which lay flat on the back of the cabinet.

No. 600 came at the festive season of December 1956 but the cover price had increased to 1/3d. The cover featured a front door intercomm system using relays for the switching circuits.



Smaller sized No. 500 in March 1948 had a very poor quality cover that even had a flagrant spelling error! Can you spot it?

Editor FJC wrote . . . "with nearly half a million VHF sets sold since the opening of Wrotham in May 1955 there is no doubt that this is the answer to interference-free reception of very high quality and in the course of a few years the system must inevitably oust the older one . . ." Seventeen years on and there is more MW broadcast activity in this country than possibly ever before!

The first of the Film Shows organised by PW was held at Caxton Hall in the following February and this issue gave full details of the films that were to be shown. These included methods of manufacturing CRT's, valves and transistors. These shows continued until quite recent times.

F. R. W. Strafford resigned from the position of Technical Manager of Belling and Lee Ltd. His claim to fame was as originator of G9AED the first UK Band III pilot television transmitter. Gordon King concluded his series on Servicing Radio Receivers but promised more including "AM/FM models and receivers using transistors".

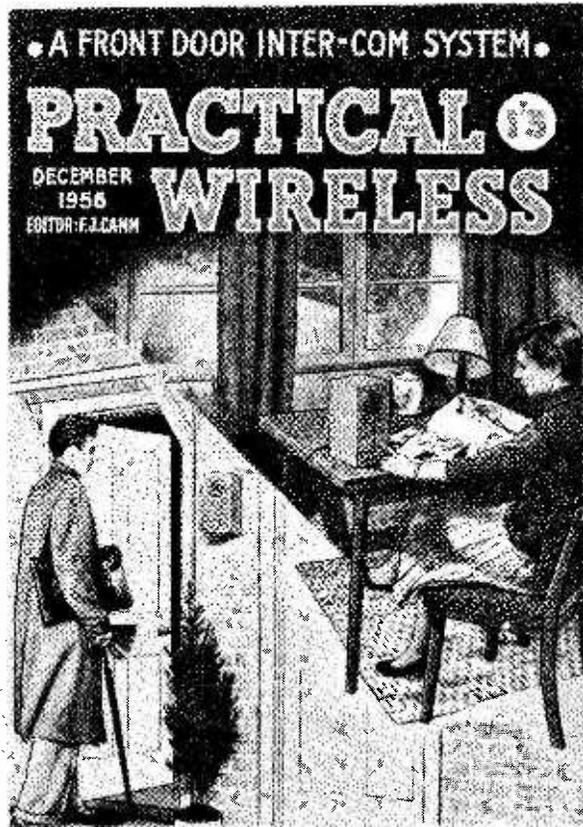
Practical projects included a Versatile Valve

Voltmeter, a Beginner's Shortwave Three for mains operation and an Electronic Metronome, using a transistor of all things! Incidentally an OC71 then cost 24/- compared to 2/6d today. "Matched Crystals" was very misleading since the reference was to germanium diodes as used in FM discriminator circuits.

No. 700 of June 1965 was still in the old, smaller format and "Free Inside" was a double-sided blueprint on how to build the electronic Hawaiian guitar featured on the cover. The blueprint service was still going strong costing from 1/6 to 8/- each including postage and whatever went for VAT in 1965. The service was always very popular and we often wonder if it could ever be resurrected, but like the Back Numbers department, we fear that it has gone forever!

Letters to the Editor numbered no less than nine in strong contrast to the meagre offerings of today. Personally, we'd like to see ninety-nine an issue!

The world's first commercial communications satellite was in stationary orbit and Goonhilly tracking station was busy modifying its equipment to handle the increased volume of traffic expected from "Early Bird". On a slightly smaller scale C. J. McClelland, G6AG, of Chalfont St. Peter in Bucks,



Looking at No. 600 with its colour printing, it would seem that the importance of bookstall appeal was beginning to be appreciated.

had reports from the USA on his 2 metre signals received there via amateur radio's very own satellite Oscar 3. He also made two way contact with amateurs in Germany, Switzerland and Sweden through the satellite.

—continued on page 530

practically wireless commentary by HENRY

No. 101
Doing
it
yourself

ANXIOUS to cure his noise without adding to—I quote —‘my heap of damaged output transistors’, a reader of a very popular audio magazine has written to the Editor, asking for advice. He read ‘with interest’ an article published a couple of months before, describing an editorial venture into d.i.y.

The relevant point for PW readers is that the kit he had blundered upon was first described in these pages, and has since earned worldwide acclaim as an inexpensive and honest attempt at quality without pretensions.

Henry wished that he had the ‘full might’ of his employer to enable him to indulge in some of the design problems that beset an ordinary workshop. Such as, making a new comparator, switch-boxes and pre-amplifiers that can couple anything to anything else, universal filters which enable specification tests to be made without recourse to the equipment supplier’s factory, an intermittent fault testing device that will ring a bell or activate a buzzer when the signal deviates from the normal . . . and so on. In our line of business, such service aids as one acquires are usually made up in the lonely winter evenings.



Intense antagonism between supporters.

Doing it yourself is great fun, especially when you have to surmount the initial difficulty of finding a suitable design. Better still, when you are capable of getting under the writer’s skin and determining whether a design is indeed suitable—let alone ‘good’—or will be followed in successive months by corrigenda.

Even the mighty lapse sometimes, and current argument in the audio glossies barely covers with politeness an intense antagonism between the supporters of shunt and series feedback.

Worse than this, far too many major makers of wireless and other electronic equipment bring out designs that are advertised as world-shaking, only to follow them, perhaps a year later, with carefully tabulated modifications. These are printed and listed, punched and perforated to be the more easily inserted into the original, elaborate service manual.

With hand on heart, the maker will state (through the mouth-piece of his Press Relations Officer), that he ‘reserves the right to make improvements to the original design.’ This simply means that he will take note of the feedback of complaints and questions from his dealers and rap his designer over the knuckles, producing one or two hasty amendments which will then be published with the usual hoo-ha of trumpets as ‘modifications’.

The trouble with modifications in do-it-yourselfery is that so many are made by the constructor, from expediency.

If only, in their avid desire to do it themselves, the electronic builders of this world would either take basic principles and evolve from there, or trust those whose experience and expertise has paved the way for them, the tangled travesties of published ideas would not land on the doorsteps of Henry and his ilk, to be, most uneconomically, unravelled.

In other words, brothers, if you must do it yourselves, please gen up on the underlying principles, or leave the job alone. If you simply want to build—and impress your more gullible neighbours, then buy some reputable kit, follow each instruction to the letter, and please do not try to circumvent the designers’ intentions. That way, you may save yourself, at least, a heap of damaged output transistors.

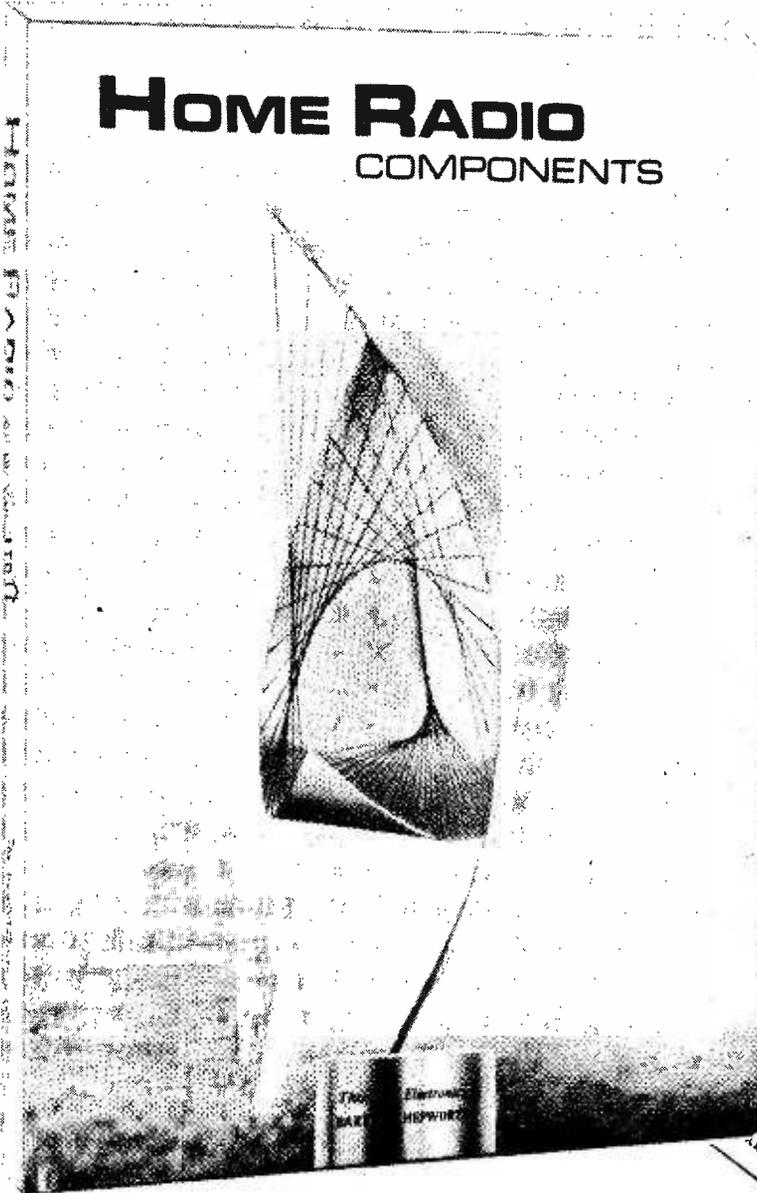
ALL ABOUT OUR CARTOONIST “PAX”

PAX—man of peace, or man of many pieces. Has survived the handling of editors for 55 years, and hopes to be around for at least another couple of weeks. Draws part-time, to earn enough to keep alive, though it looks doubtful if he has succeeded. Has illustrated a couple of books (editors do have incautious moments) and done many bits and pieces with pens and things. Born in Aberdeen, Scotland, probably the only town with no Jewish residents—they couldn’t hope to make a living up there. Unmarried, to the best of his knowledge. Has lived many long years in London, almost a Scotch Cockney by now. Likes drawing cars, animals and Pax characters. Gets mixed up with music when he isn’t drawing, with disturbing results.



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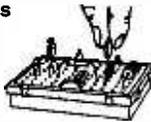
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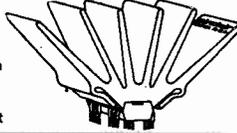
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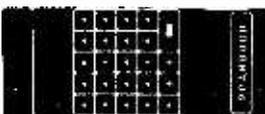
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LEARNING BY PRACTICAL PROJECT STEPS

THIS new series is designed to give the lesser experienced reader an interesting set of potential projects that can be taken along the lines of instructional articles but will be of a practical nature. Each month a series of experiments (which may be simple projects in themselves) will lead logically from one step to another and by combining the reading of the text and participating in the experiments the relative newcomer to electronics will not only get some very useful practical knowledge of various types of circuitry but could—if he wants to—make a number of useful novelties en route.

Economy will be very much in mind and we recommend that readers build the experimental circuits on T-Dec; as far as possible we shall

arrange the circuits to re-use components over and over again although there is no reason why any circuits that catch the eye should not be "permanised" on Veroboard or some other assembly.

To be involved in the experiments all you will need is T-Dec, a 9V battery (two 4.5V bell batteries in series are ideal) and an assortment of components that can be bought as you go along. A multi-range meter will be useful but separate voltmeters and milliammeters will do. Voltage measurements should only be made with 20,000 Ω /volt instruments or better. You should not cut the leads of the transistors if you want to re-use them; in fact it is advisable to lengthen the leads with about 1in. of 20 or 22 s.w.g. tinned copper wire to permit easy insertion in the T-Dec.

PART 1—ELECTRONIC SWITCH

THE heart of modern electronics is the transistor, so let us start with this and see what we can do with some surprisingly simple circuits. This month we shall look at the transistor as an electric switch.

A transistor is made to conduct between collector and emitter by passing a current into its base. To make base current flow you have to have a voltage at the base that is greater than the voltage at the emitter with respect to the common line or "earth". In the case of the more common npn silicon transistors, this voltage has to be at least 600mV more positive than the emitter. The amount of base current is controlled by a resistor in series between the base and the main voltage rail of the circuit in question. There are two factors which control the amount of current that flows between collector and emitter, these are (a) the value of resistor in the collector/emitter circuit and (b) the amount of base current that is permitted to flow. The maximum collector current one can control for a given base current can be calculated by multiplying the base current by h_{FE} or *beta* of the transistor in question. For a BC108 h_{FE} is between 100 and 250—depending on how lucky or unlucky you were in your purchase. You can see the effect of a transistor's current gain from the experimental circuit of Fig. 1. Measure the voltage between the collector and ground with

$R1=2.2k\Omega$ and $R2=220k\Omega$. Before point A is connected to the positive rail the potential at B should be virtually +9V. When 9V is applied to A we have arranged values so that sufficient base current flows to provide a collector current that will make the voltage at B fall to almost zero. We say that the transistor is in full conduction or in *saturation*. Change the value of $R2$ to 2.2M Ω and see what happens then. The base current is much less (down by a factor of ten) hence the maximum collector current will also come down by a factor of ten. This will be insufficient to give a 9V drop across $R1$ and the voltage you read will be by no means as low as zero. The actual value will be dependant on the h_{FE} of your transistor. If you now increase the value of $R1$ by a factor of ten to 22k Ω you will revert to a reading of zero because the smaller collector current is again able to give a 9V drop across the higher value resistor. Try reducing $R1$ to 220 Ω and see by trial what is the highest value of resistor you need for $R2$ to get back to the reading of zero at Tr1's collector.

The circuit that gives you a full 9V swing at the collector when 0V or 9V is applied at point A is sometimes called an inverter because when the voltage level is high at the input it is low on the collector output and vice versa. It is much used in logic systems. You can directly couple one inverter

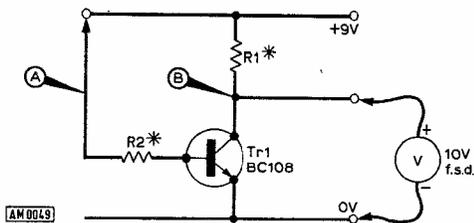


Fig. 1: *See text for experimental values. Experiment to show how collector current and voltage at B is controlled by the values R1 and R2 respectively.

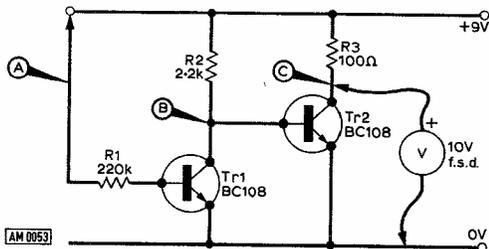


Fig. 1a: Double inversion. When point A is connected to +9V Tr1 goes into conduction and effectively shorts point B to ground so no base current flows into Tr2. Hence point C goes to +9V. Connect point A to ground (or leave it disconnected) and point C goes to 0V.

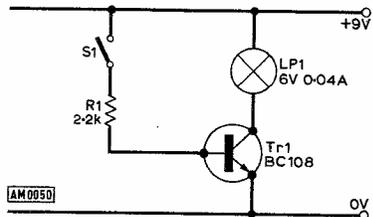


Fig. 2: Basic practical lamp driver circuit. Close the switch and the lamp lights

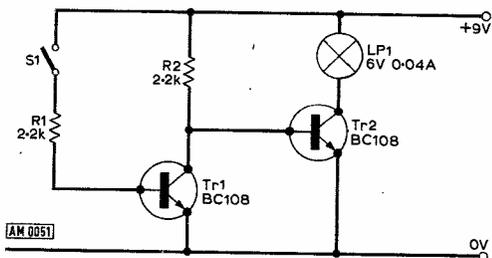


Fig. 3: Lamp driver preceded by an inverter. Close the switch and the lamp goes out

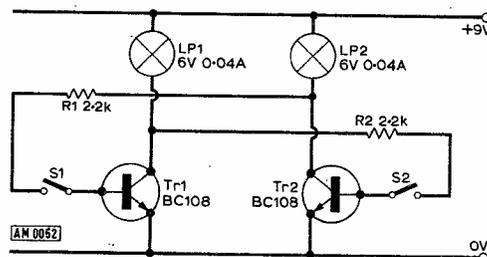


Fig. 4: Basic workable quiz "snap" detector.

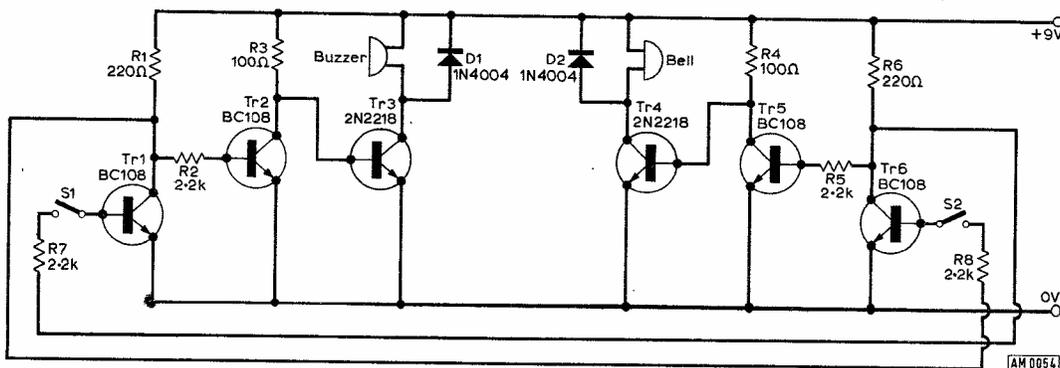


Fig. 5: Snap Indicator with direct drive to the bell and buzzer. Coil resistance of each should not be less than 12Ω. R2 and R5 are included so that the collector potentials of Tr1 and Tr6 are not held down by Tr2 and Tr5 drawing their respective base currents. For lower resistance coils use 2N3055's for Tr3 and Tr4.

to another—Fig. 1a—so that the sense (or level) of the output signal is the same as the input. Not at first a very likely thing to want to do but it does have a "not so obvious" application. The 9V of the first stage input is being fed through a 220kΩ source resistor (very small current is being drawn) whereas the output at the collector of Tr2 is coming through a collector load resistor of 100Ω. We have thus got the same voltage signal out as we put in but there is considerably more current being switched and this could be useful in itself or for driving other circuits.

The inverter is often used to drive low voltage lamps—which need a reasonable amount of current to make them glow. Because the maximum collector current rating for a BC108 is 100mA we can only control bulbs up to this capacity. For experimental purposes a 6V 0.04A bulb is ideal. You can liken this bulb to a 100Ω resistor for the purposes of calculating base current required to make it go on when it is in a collector circuit. Either by experimental methods or calculation you should find that 9V applied through a 2.2kΩ resistor as base current is ample to make LP1 (Fig. 2) turn on. If S1 was a push button, when you pressed it the lamp would go on. It might be you wanted the lamp to go off when you pressed the button. To do this it is only necessary to insert another inverter stage into the circuit—Fig. 3. Notice that the collector load of Tr1 has the same ohmic value that will supply the necessary base current for Tr2—when Tr1 is not conducting.

You can use two inverter circuits connected together to make a simple form of "snap" detector—these are frequently used in television quiz games to decide who was first to press their button. We have to modify the circuitry a bit so that when one button is pressed it makes it impossible for the opposition's light to go on when they press their

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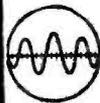
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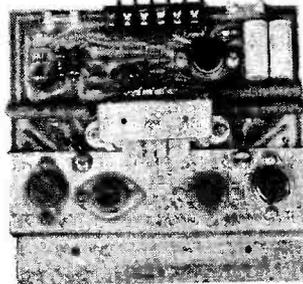
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button; of course the converse must hold true—depending on who presses first. See Fig. 4.

Tr1 draws its base current from the collector of Tr2 via the push switch. Initially neither transistor will be conducting therefore the collectors of both will be at +9V and the lamps will be off. Say that S1 is pressed first; base current can flow through LP2 via the switch and R1 into Tr1's base. LP1 will light up and the potential at Tr1's collector falls to nearly zero. If S2 is now pressed there is not sufficient potential at Tr1's collector to drive base current into Tr2 hence as long as S1 is pressed LP2 cannot be lit. As an indicator for a game you can make it more interesting if, say there are two teams competing, you have two—or more—switches in series on each side. Every member of the team must have their button pressed before their light goes on. Alternatively you could have several switches in parallel and then any one of the team can instigate the light going on. By introducing a relay instead of the respective lamps (6V coil with not less than 100Ω resistance) or an extra buffer stage and a power driving transistor (Fig. 5) you could dis-

pense with the lights and have a buzzer and bell (low voltage types with coil resistances of *more* than 12Ω) on opposing sides. It is necessary, in the latter case to include a diode across the buzzer bell to prevent any high voltages (caused by the sudden breaking of the inductive circuit) damaging the output transistor.

The snag with these circuits is that they lack *memory*. If the player was to take his finger off the button his light goes off and he leaves things open for the other side. If the judge was not quick enough there might be a few cries of "cheat". This can be overcome by building in a little more complexity—

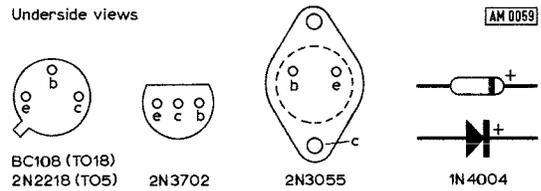
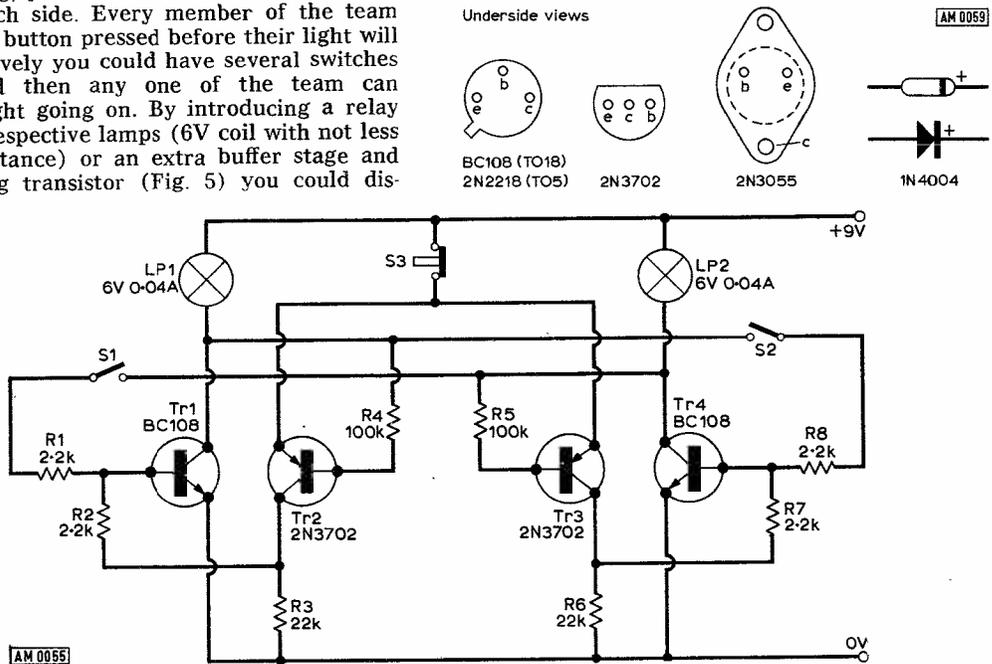
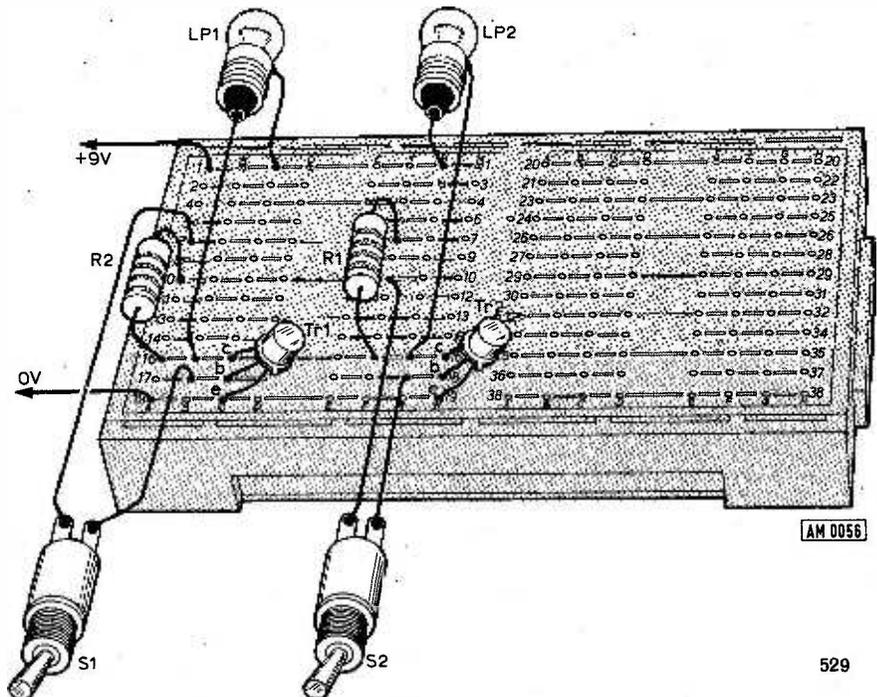


Fig. 6 (above): Snap indicator with memory on both sides. LP1 and LP2 can be replaced by 220Ω resistors and the bell/buzzer drive circuits of Fig. 5 substituted to give direct drive for an audible indicator.

Fig. 7 (right): Layout for Fig. 4.



without introducing any new major concepts. We need another transistor on each side of the basic indicator—as shown in Fig. 6. Note that these are pnp types. We have established that when S1 is pressed the potential at Tr1's collector falls to zero; this zero voltage is, in fact, a high base drive for the pnp transistor Tr2 so the latter switches on and its collector rises to about +9V. This level is applied back to the base of Tr1 through R2 so that when the finger is taken from the button, base current is maintained and LP1 stays on—inhibiting the other side. Exactly the same reasoning would apply to the other side of the circuit if S2 was operated first. To cancel the indication for the start of the next game the emitters of Tr2 and Tr3 have to be momentarily disconnected from the positive rail by depressing the normally closed switch S3—this would (presumably) be under the control of the judge.

All these circuits will work and you can build any of the versions—obviously some have more refinements than others and of course that will cost

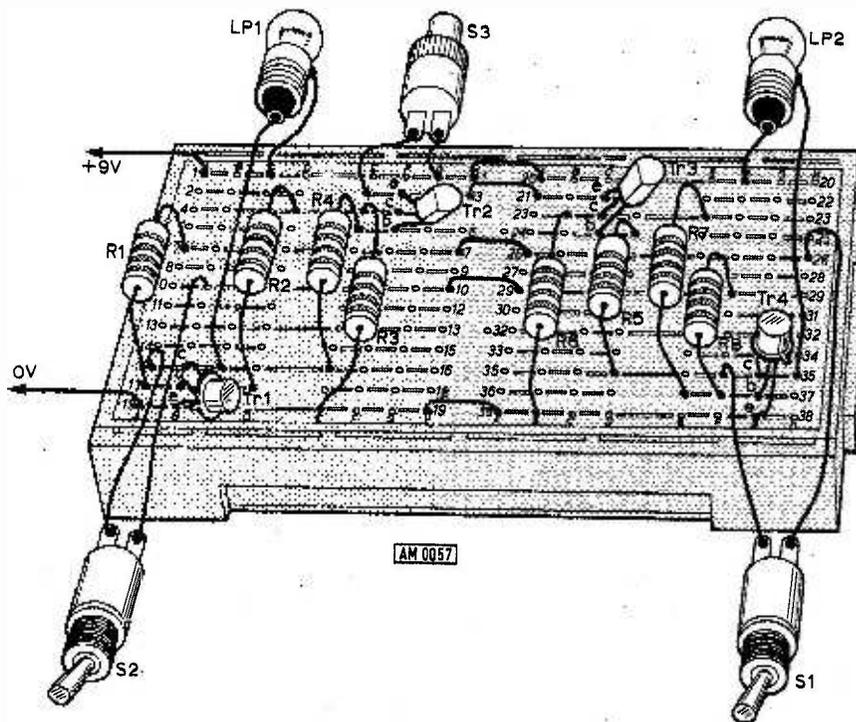


Fig. 8: Layout for Fig. 6.

a bit more. We leave it to you to go as far as you like!

Next month we shall look at more aspects of the transistor as a switch including the emitter follower (not a switch in itself) and some trigger circuits. ■

GOING BACK—continued from page 521

A two transistor radio, which today would be built on a small piece of veroboard, was assembled on a board 6×5×½in. so it seems that even transistors had to go through the breadboard stage! The PCR ex-government communications receiver was revamped by W. V. Woods by adding a mains operated power supply and rearranging the circuitry around more modern valves.

Increasing solar activity in 1965 led to information-packed reviews of the short wave broadcast bands by John Guttridge and of the amateur bands by "ol faithful" Dave Gibson, G3JDG. And, guess what? Here's Henry with his Practically Wireless No. 10 lashing out at the gimmicks at the International Audio Fair held at the Russell Hotel. He even mentions a Quad decoder! Did he mean quad or Quad??

Brian Robinson was churning out Part 8 of his series on preparing for the Radio Amateurs Examination. Since the exam is still going strong a repeat of the series or something like it might not come amiss. A whole page of Club News in 1965 has sadly dwindled out of existence although we are sure that the Clubs are just as numerous and active today as they were then.

Most of the magazine's advertisers in 1965 are still with us today. Indeed, without them there would not be a No. 800!

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JUNE 1965

2'

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'ferret'

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ALSO

- ★ VHF SUPER-REGEN RECEIVERS
 - ★ A SIMPLE WOBBULATOR FOR RECEIVER ALIGNMENT
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DON'T MISS ANY ISSUE OF PRACTICAL WIRELESS. NOVEMBER ISSUE ON SALE 5th OCTOBER

GOING QUAD

NOW that quadrphony is here to stay, many readers may be wondering what it sounds like in the home, how it functions, and what advantages it has to offer over stereo. This series of articles will set out to explain the basic principles, and give constructional information and tips to enable the amateur audio enthusiast to make a serious start on quad without too much expense.

With stereo, we were concerned with feeding two signals to a pair of speakers to achieve a distribution of individual sound-images in the gap or sound-stage between the speakers. The result is rather like listening to a musical performance through an open window. Sound-images are separate, with a real feeling of depth to them, but the listener is isolated from the performance and has no natural reverberation from the rear. Stereo headphones, on the other hand, actually place the sound-images inside the head, from ear to ear, and with no feeling of front to back depth at all.

It can be said, therefore, that the true aim of quadraphonic sound is to remove the inherent limitations of stereo and thus open up new possibilities of musical experience by placing the listener in a more intimate relationship with the sound.



PW

Q4P

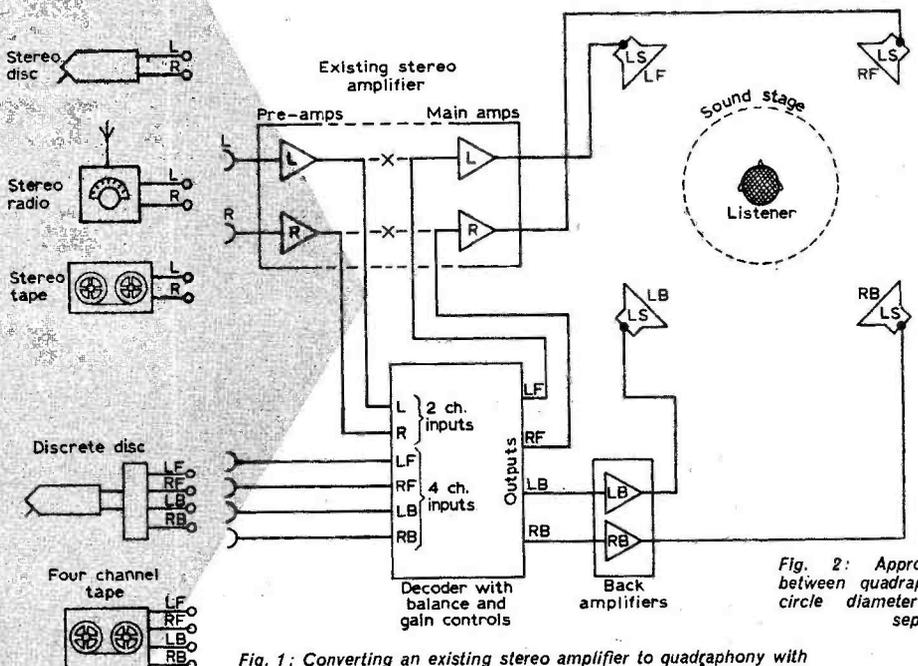


Fig. 1: Converting an existing stereo amplifier to quadrphony with a decoder and back amplifiers. The speaker arrangement for quadraphonic listening is also shown.

Fig. 2: Approximate relationship between quadraphonic sound stage, circle diameter and interchannel separation.

PART 1 C

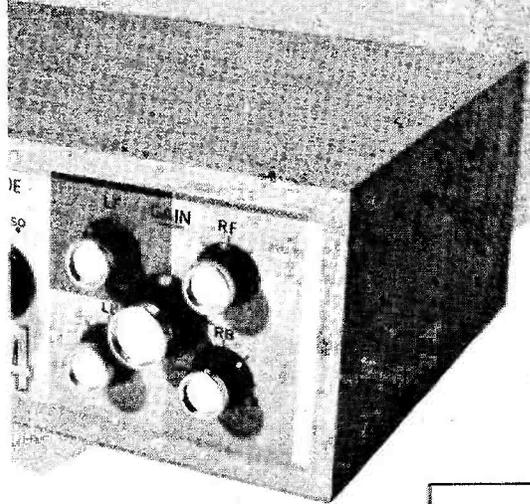
PERHAPS the most striking demonstration of the effectiveness of quadraphonic equipment in a home setting is when a familiar and well recorded stereo disc or tape is played through four speakers in the 'surround-sound' mode. The enhanced detail and realism is astonishing, to say the least. Actual quadraphonic recordings offer the promise of even better results, but with the limited amount of quadraphonic material to choose from at the moment, most of which is ineptly recorded 'muzak', it is difficult to arrive at a valid comparison.

It has been said that listeners prefer to hear their quadraphonic music at about half the normal stereo output level, but this could be attributed to a desire to remain apart from the performance, or to equipment defects. An experiment conducted by the

writer on a number of them slowly adjust to four tend to opt for higher a. The initial response is to as 'frightening' or 'uncanny' best describe quadraphonic. If you prefer music as an u conversation then you mig stereo.

One snag with quadrapl realism emphasises defect on the part of the musicians distortion, dust and scrat rumble, etc., but this is greater fidelity. With son systems it is difficult for

QUADRAPHONIC



- QS recordings
- SQ recordings
- Discrete CD-4 recordings
- SURROUND SOUND



PROJECT

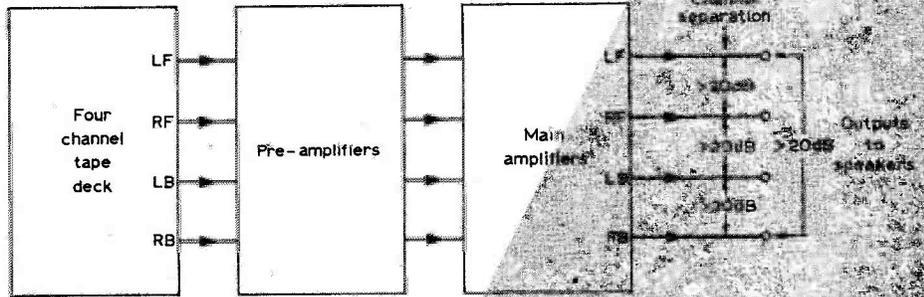


Fig. 3a: Discrete tape system.

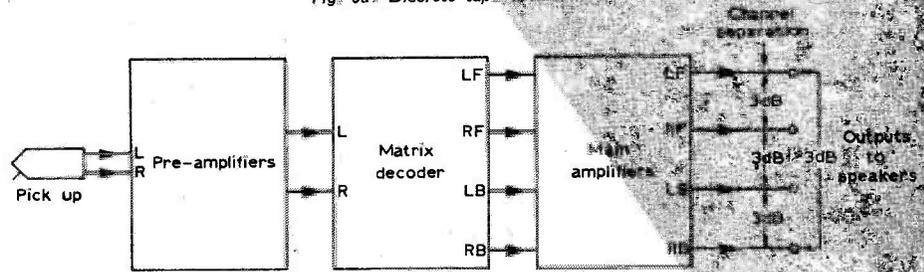
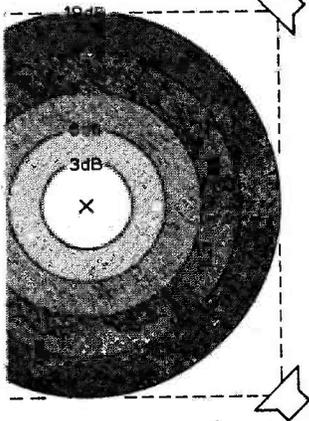


Fig. 3b: Matrix disc system.

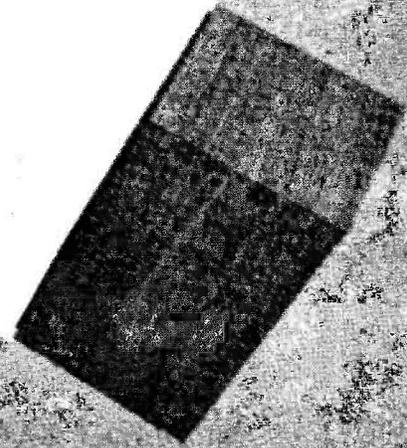
BOLLEN

Friends suggests that as speaker listening they had higher output levels describe the experience, but the word that may listening is 'involvement' nonobtrusive background to sit just as well stick to

in a small room to hear the performance in perfect balance.

How does it work?

The new standard arrangement for quadrasonic listening is to have four speakers placed in a square array—preferably in the corners of the room—and facing inwards along diagonals, with the listener seated at the centre of the square, see Fig. 1. Abbreviations LF, RF, LB and RB, denote left and right, front and back channels. The circular soundstage, shown dotted in Fig. 1, is a subjective



boundary which is felt as a 'hole' in the sound, or as a clear area of floorspace where few sound-images occur. There is, however, no limit to the apparent location of sound-images outside the circle. Many of them seem to be a long way off, beyond the walls of the listening room.

The old idea of coupling four speakers to a stereo amplifier is just not on these days. Each of the quadraphonic speakers needs to be fed with an adequate signal of low distortion. An economical and versatile way of going quadraphonic, with the least equipment redundancy, is to add a pair of back amplifiers and speakers, and a decoder, to an existing stereo set-up, as shown by the block diagram of Fig. 1 Stereo disc and tape decks, with their associated pre-amplifiers and tone controls, can then be employed for playing surround-sound stereo, and two-channel quadraphonic discs and tapes without modification, using the decoder circuit to split the two channels into four. Four-channel tape sources can also be played direct through the decoder gain and balance controls to the four main amplifiers, and it would be a simple matter to add on a CD4 disc demodulator and decoder in the same way. Thus, several quadraphonic systems can be catered for at the same time, with the vital controls centralised in the decoder unit.

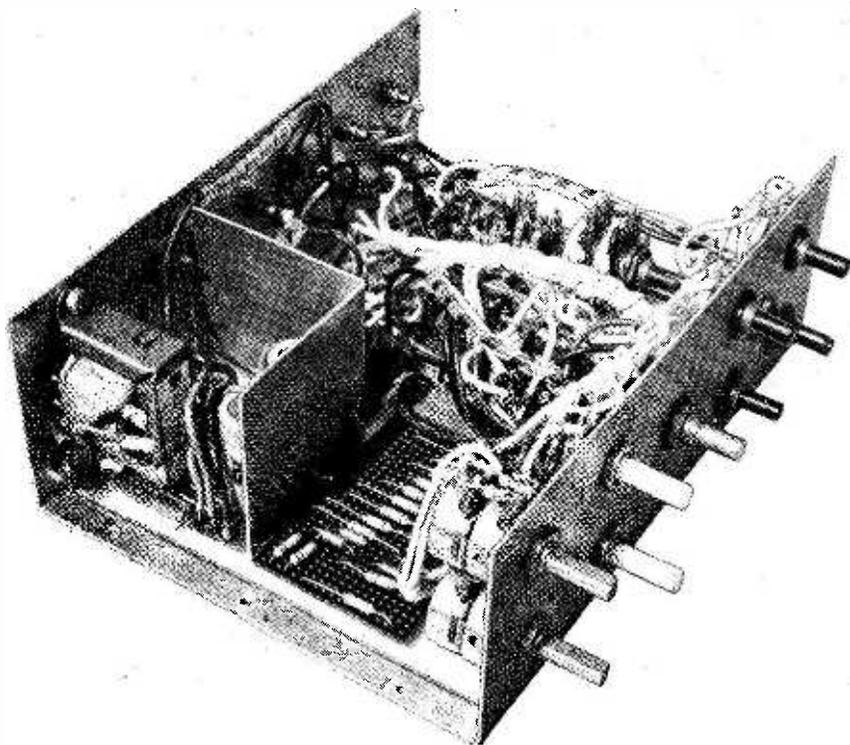
Discrete versus Matrix

A discrete four-channel recording medium, such as multi-track tape, offers the best in quadraphonic sound. Each channel is free from crosstalk with other channels and signals are relayed direct to the main amplifiers after suitable pre-amplification, see Fig. 3a. Another less satisfactory approach is to encode four signals on a two-channel disc or tape

Q4 MATRIX DECODER SPECIFICATION	
Two-channel input impedance	43-47k Ω
Four-channel input impedance	100k Ω
Output impedance	2-2k Ω
Maximum gain	2
Equivalent input noise	100 μ V
Maximum input signal	2V r.m.s.
Maximum output signal	2V r.m.s.
Distortion at 1kHz 500mV	0.1% or less
Phase shift error 90° 10%	100Hz-10kHz
Maximum channel separation	30Hz 60dB 1kHz 50dB 20kHz 25dB
Frequency response	30Hz-30kHz \pm 1dB

and then decode the resulting pair of signals with a mixing circuit or matrix to reconstruct the original four signals, Fig. 3b. Notice that separation between channels in the discrete case will be 20dB or more, while the matrix may offer as little as 3dB separation.

Poor separation with two-speaker stereo reduces the distance between sound images, and at zero separation the images would be piled on top of each other as a mono sound centrally placed between the speakers. The situation is slightly different with quadraphony because poor separation reduces the apparent size of the sound-stage circle without affecting the distribution of sound-images. All that happens is that balance adjustments become more critical and movement of the listener in relation to the speakers is more restricted.



Internal view of the P.W. Project Q4 matrix decoder.

Fig. 2 shows the approximate sound-stage diameter for several values of separation. Assuming the speakers are ten feet apart then a 3dB sound-stage will be 2ft. in diameter, and a 9dB stage 6ft. If a critical listener moves his head one quarter of the sound-stage diameter in any direction this will throw a musical performance out of balance, so in the above case the listener would be confined to an area 1ft. in diameter with 3dB matrix separation, and 5ft. in diameter when separation is virtually discrete and exceeds 19dB.

Matrix techniques also introduce undesirable phase shifts in the speakers, which will tend to *blur* and shift those sound images having a smooth, rounded tone. Images of sharp sounds are much less affected, due to the inability of the ear to detect phase shifting above about 8kHz, this is probably why matrixed quadrasonic recordings tend to favour the use of plenty of percussion instruments. When a matrixed recording is correctly decoded, image width and channel separation are optimised. Incorrect decoding not only alters the intended location of sound images and tonal balance, but it can also boost the sound level of some instruments and reduce others, with peculiar results in some instances.

To achieve widespread acceptance a quadrasonic system must be able to offer convenience of use, low cost per playing time, low noise, low distortion, a wide frequency response, and plenty of programme material, and these requirements are most easily met at the moment by vinyl discs. It is significant that the technically excellent, but inconvenient, four-channel open-reel tape recorder has been around for some time now and that little effort has been made to supply users of these machines with pre-recorded quadrasonic tapes. The quadrasonic snowball only started rolling when the matrix appeared, because this allowed highly developed stereo disc techniques to be readily adapted to quad.

The present position is, therefore, that matrix users can now quite literally surround themselves with surprisingly good sounds from disc, tape, and radio, and play those favourite old recordings to maximum advantage, despite the shortcomings of the system, while advocates of discrete systems must wait, and content themselves with a very limited range of good programme material.

Which system?

At the moment in the UK a serious choice exists between the following systems: discrete Q8 tape cartridge, discrete Victor-RCA CD4 disc, Sansui-Pye QS matrix disc, CBS-EMI SQ matrix disc, with RM or 'regular matrix' being employed as a 'back-up' system for stereo surround-sound playback. There are other systems in other countries, and new systems under development, but these are not likely to become established for some time. The Philips quadrasonic cassette is still under development, and may go discrete or matrix. A choice of system made by the BBC for FM radio will depend on the outcome of long-term listening tests, and many areas still await the coming of FM stereo.

The currently available quadrasonic systems will now be discussed in greater detail.

Q8 TAPE

Discrete four-channel Q8 tapes and playback equipment are at present marketed mainly for the motorist, and are not stereo compatible. The recorded tracks on quadrasonic Q8 do not match up with the tracks on a stereo Q8, but this problem can be solved by tape head switching. Provided that hiss and tape wear can be kept within reasonable bounds, and the manufacturers of pre-recorded tapes make some effort to extend frequency response, then this system could enjoy widespread popularity in the home as well as in the car. There is a rapidly increasing amount of quadrasonic programme material available for Q8.

VICTOR-RCA CD4

A conversion kit is available for this discrete disc system at a cost of around £90. The kit includes a special stylus and cartridge, low capacitance pick-up cables, and a pre-amplifier combined with decoder. CD4 is capable of providing a really good quadrasonic performance but uses complex circuitry which is prone to noise and distortion when incorrectly aligned. With less than fifteen discs available (at the time of writing), CD4 is still very expensive in terms of pleasure for money. Additional equipment would be needed to play surround-sound stereo or quadrasonic matrix discs.

RM (REGULAR MATRIX)

The main use for this system is to enhance ordinary stereo programme material with four speakers by 'bending' the stereo sound-stage around the listener giving the "surround-sound" effect. This is not true quadrasonic sound in its strictest sense, but a very acceptable compromise, giving subjectively better results than 'one-wall' stereo. The presence of 180° phase shifts in the speakers causes serious blurring of some sound images. With RM, the sound-stage can only occupy a 270° sector, leaving a 90° hole behind the listener. Basic channel separation is 3dB, but this can be modified by the use of a variable separation matrix. QS and SQ recordings played through RM will suffer slight to moderate image mislocation.

SANSUI-PYE QS

This Japanese system uses the same matrix values as RM but employs 90° phase shifts to give more distinct images and a 360° sound-stage. Results can be good, with an even distribution of images around the listener. Basic channel separation is 3dB, but this can be altered in the same way as RM and Sansui have now introduced an automatic separation enhancement circuit called Variomatrix. QS recordings are available under the Pye label and from import record stores. There is slight to moderate image mislocation from a stereo record played through QS, and serious image mislocation from an SQ record.

CBS-EMI SQ

90° phase shifts are also used in this American system, but matrix values are quite different to RM and QS. Excellent left to right separation is achieved at the expense of centre front to back separation, which means that a centre front or back sound-image will tend to be located close to the listener's head. A better image distribution can be achieved by deliberately introducing a measure of crosstalk between left and right channels, called blending, or

by the use of additional gain-riding 'logic' circuits. A stereo or QS record played through SQ will exhibit serious displacement of images, generally towards the back and to one side. The SQ system currently offers the largest number of quadraphonic recording in the UK, under CBS and EMI labels, and from import stores.

If the reader is wondering why an SQ record sounds reasonably good through an RM matrix, and a stereo record sounds bad through an SQ matrix, this seeming contradiction can be explained by so called 'psychoacoustic' factors. The ear does not behave in a predictable way when confronted by phase shifts and sounds issuing from point-source loudspeakers.

One must accept that SQ records played through an RM (or surround sound) system is only the poor man's substitute for real quadraphonic sound. It does not clearly define the position of the performers or the listener.

Back amplifiers and loudspeakers

All main amplifiers and the four speakers should be as closely matched as possible in terms of power output and frequency response. The task of installing a pair of back amplifiers is now made easy by readily available modules with matching power supplies. It is only necessary to house these modules in a suitable box and wire them up according to the manufacturer's instructions to achieve results not far removed from the best in hi-fi at power levels ranging from a few watts to more than a hundred watts r.m.s. per channel.

One very important point to check when setting up the back amplifiers and speakers is that these are in-phase with the front channels. This can be tested by feeding a low level signal of around 1kHz into a front and back amplifier via separate gain controls, see Fig. 4a, and adjusting those controls for identical output levels as measured with an a.c. voltmeter between amplifier outputs and earth. Do not use a high level test signal as this could damage the amplifiers or loudspeakers. If the voltmeter is now linked between the two amplifier outputs, Fig. 4b, a small or zero reading will indicate that phasing is correct, and a large reading that the amplifiers are incorrectly phased and that the polarity of the rear speakers should be reversed.

If speaker polarity is not indicated—usually by a red dot beside one speaker terminal—it can be found by applying a 1.5V battery to the terminals and noting the resulting cone movement. In most cases, when battery positive is applied to speaker positive there will be an outward movement of the cone, but check that this is so with the other speakers.

Room shape and furnishings may dictate a departure from the ideal square speaker array, in which case aim for a rectangular configuration with speakers equidistant from the listening position. The speakers should preferably radiate at head height.

Looking next at the stereo amplifier used for the front channels; if this is a modern unit it will almost certainly have pre-amplifier left and right outputs brought out to the rear panel, and bridged to the main amplifier inputs with a switch or plug. If not, then the unit will have to be modified to provide

this facility, and it would be a good idea to contact the manufacturers to see if they can supply a circuit diagram of the amplifier with suitable take-off points shown.

The *PW Project Q4* that follows examines matrix circuits more closely, and describes a decoder circuit which offers switch selection of RM and QS, both with variable separation and SQ with variable blend. There is also provision for inputs from discrete sources, such as a Q8 tape-deck or a CD4 decoder. Switched modules are used in the decoder to allow for individual modifications or the construction of a simplified version which caters for one system only.

The decoder design to be described in this series uses readily available components and will cater for several quadraphonic systems without adversely affecting the intended location of sound images or tonal balance. Correct decoding is achieved by switch selection of matrix parameters and infinitely variable adjustment of front and back crosstalk.

In addition to handling all available quad matrixed recordings, including Pye-Sansui QS and CBS-EMI SQ, the decoder will also operate in regular matrix (RM) surround-sound stereo with variable 'wrap-around' and ambience—conventional two speaker stereo, two or four speaker mono, and will serve as a common control centre for discrete signals from a tape player or CD-4 decoder. If desired, the decoder can be built in a simplified form to cater for one system only.

The matrix

A matrix circuit is a special kind of mixer with four outputs which responds to the amplitude and phase of a pair of input signals. When fed with appropriate left and right input signals, a symmetrical matrix circuit will phase cancel an output signal to one loudspeaker when the sound image associated with that signal is located diagonally opposite that speaker.

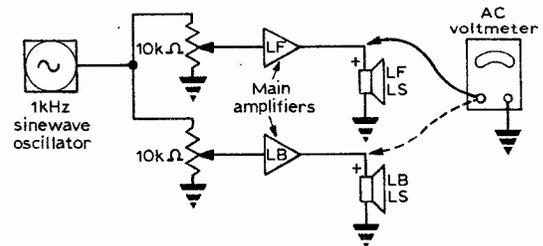
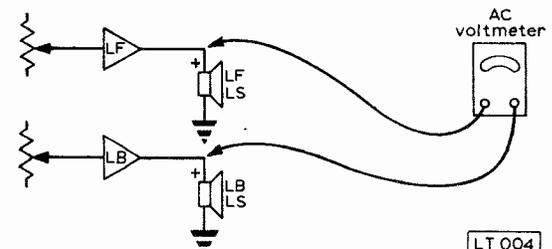


Fig. 4a: Checking amplifier phase, Step 1. Adjust input potentiometers for equal low-level outputs from LF and LB main amplifiers.

Fig. 4b: Checking amplifier phase, Step 2. If voltmeter reading is higher than Step 1, reverse connections to LB and RB speakers.

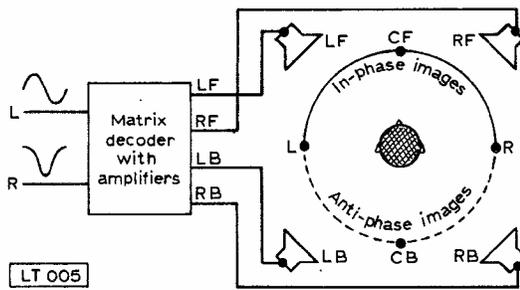


LT 004

The experienced stereo listener may have noticed that in-phase left and right signals create sound images in the gap between the two loudspeakers, while anti-phase signals cause sound images to extend outside the speakers. Anti-phase is sometimes used deliberately in stereo recordings to produce artificial effects, and it also occurs naturally in the form of ambience or reverberation, but in matrixed quadraphonic recordings phase should be carefully controlled.

When a two-channel recording is played through a matrix to four loudspeakers, the in-phase images will be distributed around a semi-circle to the front of the listener; this is equivalent to a 'wrap-around' stereo sound stage with a left only signal producing an image to the left of the listener and a right only signal to the right. Anti-phase images will then be located around a semi-circle to the rear of the listener. So, if there is any anti-phase content on a conventional stereo recording, this will be routed to the back speakers when played through a matrix.

Fig. 5 shows the circular quad sound stage made up of in-phase and anti-phase images, and also lists the properties of input signals for four selected image locations.



Input signals of the same amplitude and frequency	Sound-image location
L and R in-phase	CF
R only	R
L and R anti-phase	CB
L only	L

Fig. 5: How phase affects matrix image location.

The subject of separation between matrix channels is full of apparent contradictions. For example, a QS disc displays a separation of 7.7dB when played in two speaker stereo, and a simple QS decoder circuit also offers a left to right separation, of 7.7dB, but when the QS recording is played through the QS decoder the resulting separation is 3dB. Furthermore, although QS separation is 3dB between adjacent channels, it is not, as one might suppose, 6dB between alternate channels, that is, across the diagonals of the listening area. Instead, diagonal separation is infinite!

With the basic SQ matrix, on the other hand, left to right separation is infinite, but front to back and diagonal separation is only 3dB. All rather confusing, but explainable in terms of code and decode formulas.

Various tricks can be employed to increase separation with a matrix, such as the Sansui automatic matrix adjuster or 'Variomatrix' and the SQ gain-riding 'logic' circuit, but these will only operate effectively with simple sound sources and would be confounded by a full orchestra. Fortunately for the listener, the net effect of poor separation with a matrix is merely to make balance adjustments and the listening position more critical, without otherwise influencing the location of sound images and tonal balance, but if programme material coded for one matrix system is decoded by the equipment of another matrix system results will nearly always be disappointing.

Matrix decoders

If matrix decoders are compared, and are broken down into basic circuit elements, they can be seen to consist of similar phase splitters, phase shifters, and mixers. The phase splitting and shifting circuits take the left and right input signals and process them to give a group of phase related outputs which are then added and subtracted by the mixers in proportions depending on the system code being handled. It is possible to cater for all available

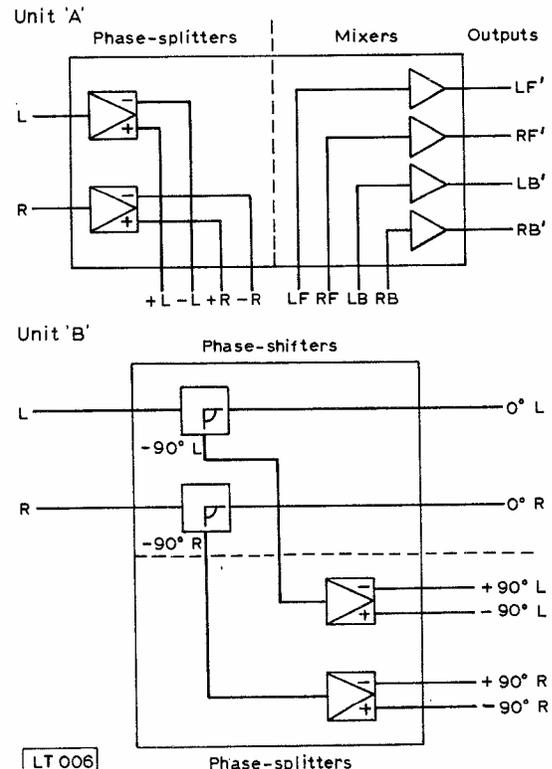


Fig. 6: The arrangement of units A and B.

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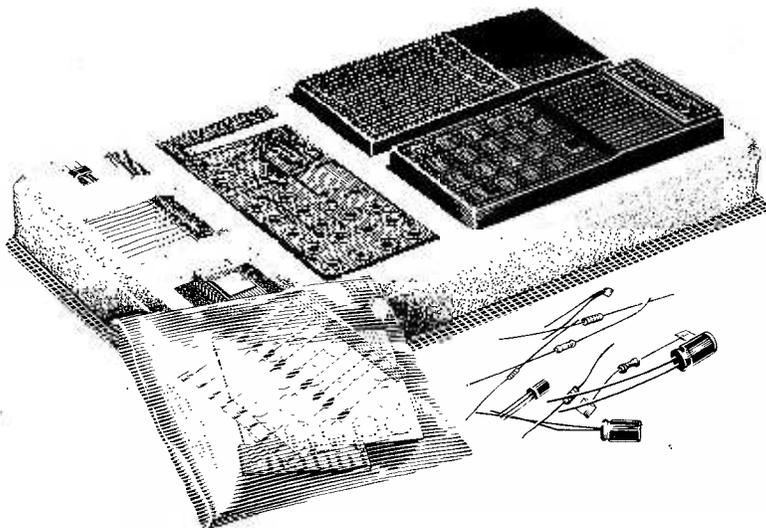
- * Uniquely handy package. $4\frac{1}{2}'' \times 2'' \times \frac{1}{16}''$, weight $3\frac{1}{2}$ oz.
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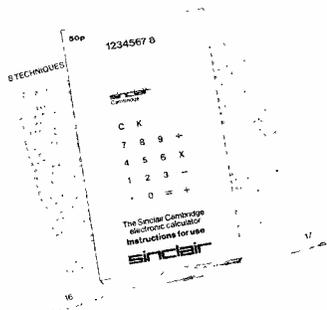
1. Coil.
2. Large-scale integrated circuit.
3. Interface chip.
4. Thick-film resistor pack.
5. Case mouldings, with buttons, window and light-up display in position.
6. Printed circuit board.
7. Keyboard panel.
8. Electronic components pack (diodes, resistors, capacitors, transistor).
9. Battery clips and on/off switch.
10. Soft wallet.



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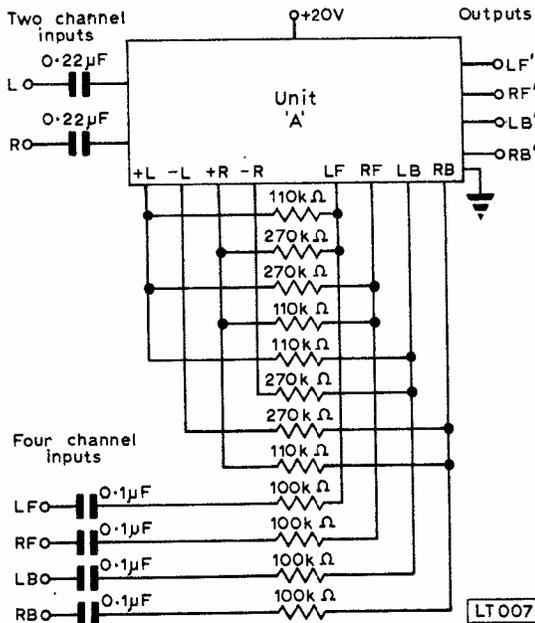


Fig. 7: Unit A as an RM surround-sound decoder with additional discrete inputs. LT 007

matrix systems with four phase splitters, two phase shifters, and four mixers.

In the PW Q4 decoder, these circuits are grouped into two units, see Fig. 6. Unit A contains a pair of phase splitters and the four mixers, with the splitters providing non-inverted and inverted (180° phase difference) outputs denoted by a plus and a minus sign respectively.

Unit A can be employed on its own for surround-sound stereo decode by connecting the splitter outputs via a suitable resistance network to the mixer inputs, and additional mixer input resistors would serve for discrete inputs also.

Unit B in Fig. 6 is designed to be coupled to unit A, and contains two phase shifters and two phase splitters. The shifters impart a lagging phase shift

of approximately 90° to the left and right input signals (leading is signified by a plus sign and lagging by a minus) which is then fed to the splitters to give leading and lagging outputs in relation to the 0° left and right outputs. For practical purposes the phase relationship between shifter and splitter outputs and the original left and right inputs may now be ignored as the 0° outputs serve as reference signals. Another way of looking at this is to assume that the 0° output has been shifted +45° in relation to the input signal and a -90° output has been shifted -45° in relation to the input.

When unit B is combined with unit A, and interconnected by a suitable resistance network, they will offer a basic QS or SQ decode.

With only two circuit modules, it is therefore possible to individually decode one of three systems

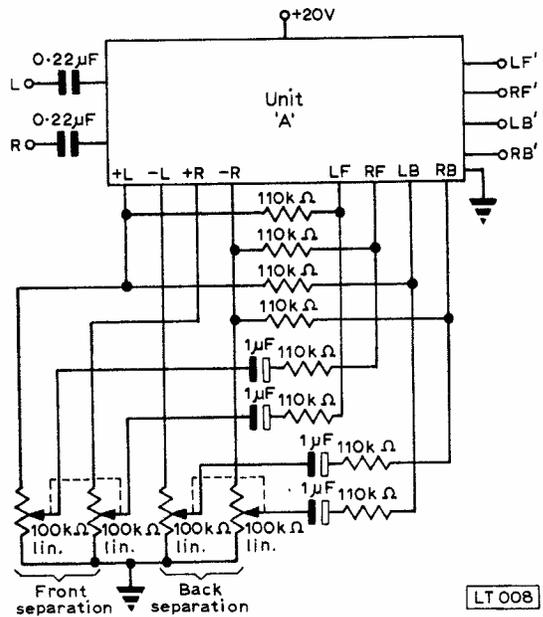
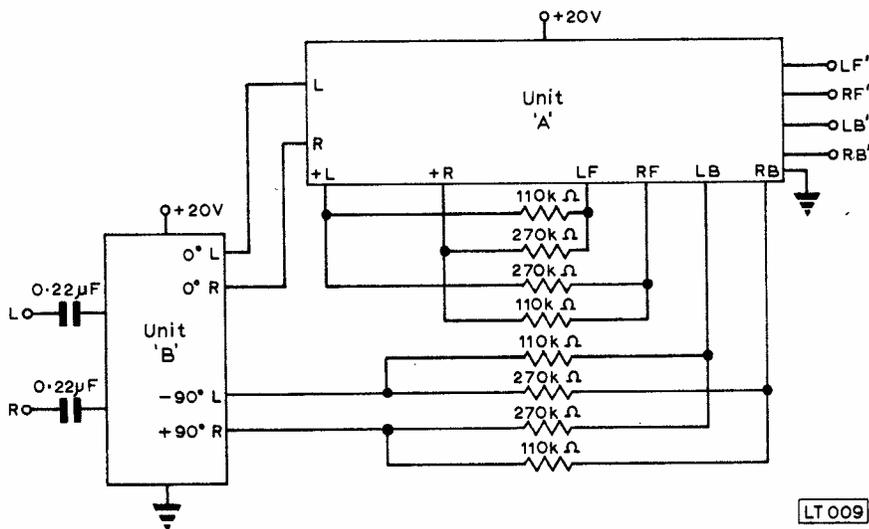


Fig. 8: Unit A as a surround-sound decoder with variable separation. LT 008

Fig. 9: Units A and B as a QS decoder with 3dB separation.



LT 009

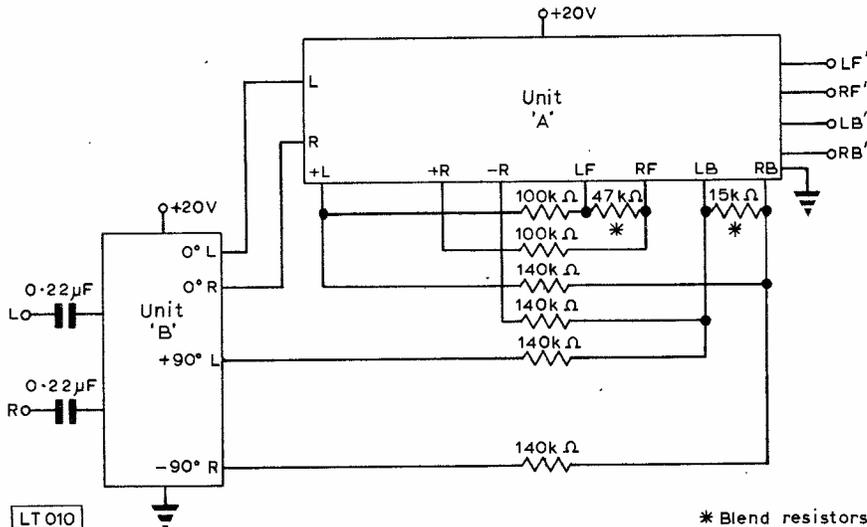


Fig. 10: Units A and B as an SQ decoder with 20dB front separation and 8dB back separation.

with a minimum of additional components, or to cover a wide range of codes and programme material by the use of a switched and variable resistance network. Suppose a user requires a surround-sound RM decode for his stereo tapes, plus discrete inputs for his four-channel tapes, he could employ the circuit of Fig. 7. An alternative RM decoder, which is suitable for surround-sound experimentation, with variable left to right separation set by dual-gang pots, is shown in Fig. 8. Yet another user might only be interested in a straightforward QS decoder, and he could combine units A and B with the resistance network values shown in Fig. 9. The circuit of Fig. 10 would give an SQ decode, with 10% (20db) front and 40% (8db) back blends to ensure a strong centre front image.

The circuits of Figs 7-10 all have a throughput gain of two and will function as shown, without additional components other than gain and balance controls and a power supply.

For those who wish to experiment with resistance

network values, they can be arrived at by dividing the code figure into 100kΩ. Thus, for the Scheiber code the values are $100k/0.92=108.7k\Omega$ rounded off to 110kΩ, and $100k/0.38=263.1$ rounded off to 270kΩ. In the circuit of Fig. 8 the potentiometers cover code values of 0.0-0.92, and are loaded by the 110kΩ resistors so that 0.38 occurs close to centre track.

The SQ decoder of Fig. 10 can also be modified for blend on the basis of blend resistor $R_b=480/\%$ blend, so if a blend value of 15% is required this will be $480/15=32k\Omega$ rounded off to 33kΩ. Since SQ blend resistors tend to reduce the outputs from a pair of blended channels the above formula become increasingly inaccurate above about 30% blend, hence the value of 15kΩ in Fig. 10.

The loudspeakers shown on this month's cover are the AUDIOTRONIC CRITERION.

Next month, full circuit details will be given.

RAE Courses

We give below some of the centres which are running courses for the Radio Amateurs Examination.

BATH City Technical College, Avon Street. The instructor is P. A. Bubb, G3UWJ.

BOSTON College of Further Education, Rowley Road. Lecturer is D. Byrne, G3KPO, Home House, Quadring Watergate, Spalding, Lincs.

BRIDGNORTH College of Further Education, Stourbridge Road. Starts September 17. Lecturer is P. Edwards, G3DKJ and M. Jones, G3JCX.

BRIGHTON Technical College, Faculty of Engineering, Richmond Terrace.

CANNOCK Technical College, Stafford Road. Further gen from Principal, Cannock 5811.

CANTERBURY College of Technology, New Dover Road. Lecturer: D. J. Bradford G3LCK.

FARNBOROUGH (North and West) Further Education Centre, St. John's Road, Cover, Farnborough. Lecturer is John Hardy, G3KND.

GOSFORTH The Grammar School, Gosforth, Northumberland. Tutor: D. R. Loveday, G3FPE.

LIVERPOOL College of Technology, Riverside Road. Details from the Head of Department of Electronics and Radio Engineering.

LONDON (Beckenham) Adult Education Centre, 28 Beckenham Road. Tutor is R. E. Piper, G3MEH.

LONDON (Chingford) Community Centre, Friday Hill House, Simmons Lane. Instructor is E. Johnson G2HR.

LONDON (Holloway) Shelburne Youth Centre, Hornsey Road, London N.7. Phone 01-607 8522.

LONDON (Wembley) Copland Evening Institute, Cecil Avenue, Wembley. Further gen from I. J. Bayliss, G8CZQ, 4 Aintree Close, Hillingdon, Middlesex. UB8 3HS.

MANCHESTER Adult Evening Centre, Moorside County High School. Swinton. Instructor is P. Whatmough, G8BFP, and further information may be obtained from: T. Honeyford, 2 Gorsefield Drive, Swinton, Manchester.

NEWPORT College of Further Education, Nach Road, Newport, Mon.

PETERBOROUGH Electronic and Engineering Dept., Peterborough Technical College, Enfield Road. Further details from D. Byrne G3KPO, Homa House, Quadring Watergate, Spalding, Lincolnshire.

HOTLINES

ON RECENT DEVELOPMENTS

TV MAGNIFIER

HAVE you ever wished you could take a closer look at some television programme? How about a television magnifier? One European research establishment has come up with a device which is based on closed circuit television (c.c.t.v.) principles. The unit can enlarge from 5× to 25× and could be used to help people with poor vision or, perhaps, for educational applications.

It must be confessed that the thought of having Raquel Welch on the television is exciting enough, but the prospect of having a gadget which could magnify her left toenail by 25× is positively unbearable, although it might put your scribes' viewing habits on a firm footing.

ALPHA-NUMERICS

Alpha-numeric displays have been with us for quite some time. There are many types, i.e. l.e.d., hot wire, liquid crystal etc. Someone has just found another type and they are calling it "Electrochromic". The basis of operation is to take a colourless organic material and transfer electrons to it from an electrode.

A small, flat glass cell is filled using viologen bromide in aqueous solution. The display is formed by arranging a suitable pattern of working electrodes plus a common electrode inside the cell. The viologen ions receive electrons at the working electrodes by the application of only one volt between the common electrode and relevant working electrode. This causes the solution in the immediate vicinity of the working electrode to assume a blue/purple colour. Thus a shape (number, figure etc.) is shown coloured against a clear background.

By applying the voltage again, but in the reverse polarity, the viologen ions are forced to give up their captured electrons and thus the display is erased.

These displays can exhibit a memory effect and offer good contrast which is claimed to be independent of the direction of viewing.

AGAINST THE LAW!

Many people are becoming increasingly alarmed about the use of computers to store vast amounts of "personal" information. It is commonly felt that a great deal of private information about the individual can

be accessed by all and sundry. So, three rousing and sincere cheers for Sweden, the Swedish Government and for Prime Minister Olof Palme. A law has been passed which gives at least some protection to the man in the street. In Sweden, you are not allowed (now) to even compile a personal register of names etc. without the express permission of the newly appointed Data Inspection Board (D.I.B.). It is now against the law to keep "sensitive" information about people in computers, such as psychiatric notes, arrests, alcoholism etc. unless you have permission from the D.I.B. And you are not allowed to keep computer notes about an individual's political or religious views.

Two of the best items are a) An individual can sue a Data Bank which gives out wrong information about him or her and b) Every individual has the right to receive a free printout of all information which a Data Bank has on him—and that such a printout shall be in an understandable form. Government Departments can still keep Data information, but it is a very good start. At present, Sweden is the only country in the world to have such a system. Lets hope it's catching.

ENERGY CRISIS

The energy resources of the world are going fast, so we're told. Other methods of supplying power must be found. One possibility which has been with us for sometime is sunlight/daylight plus the photoelectric cell. I predict some really hot developments in this field, especially from the United States where people are becoming acutely aware of the energy crisis which is approaching.

One company over there currently markets a unit composed of five cells which has a 1.5 Watt capability and sells for around 30 dollars for quantities of 1,000 plus. Solar cells are already being employed in a variety of applications—to drive a small television receiver and to power a navigational beacon, the latter requiring 50 Watts.

A European company is manufacturing a unit which comprises 64 cells and measures just over 1.5 inches in diameter. It gives 8 Watts but before you get too excited the price in the States is around 310 dollars for 1,000 up

quantities. The U.S. is mentioned here because it uses such a colossal amount of energy. One official body in the U.S., the Solar Energy Panel, advises that 20% of the electrical energy required by the U.S. during the next three decades could be obtained from solar energy—but only if sufficient funds were made available for research.

THE T.S.D.

In London recently a company demonstrated what it called a Touch Sensitive Digitiser. This touching display involves a piece of glass. Two edges of the glass (at right angles to each other) have piezo-electric transducers bonded to them thus forming X-Y axes. The transducers are fed alternately with a signal which causes them to produce a pulse modulated surface wave. Frequencies involved are around 4,000kHz.

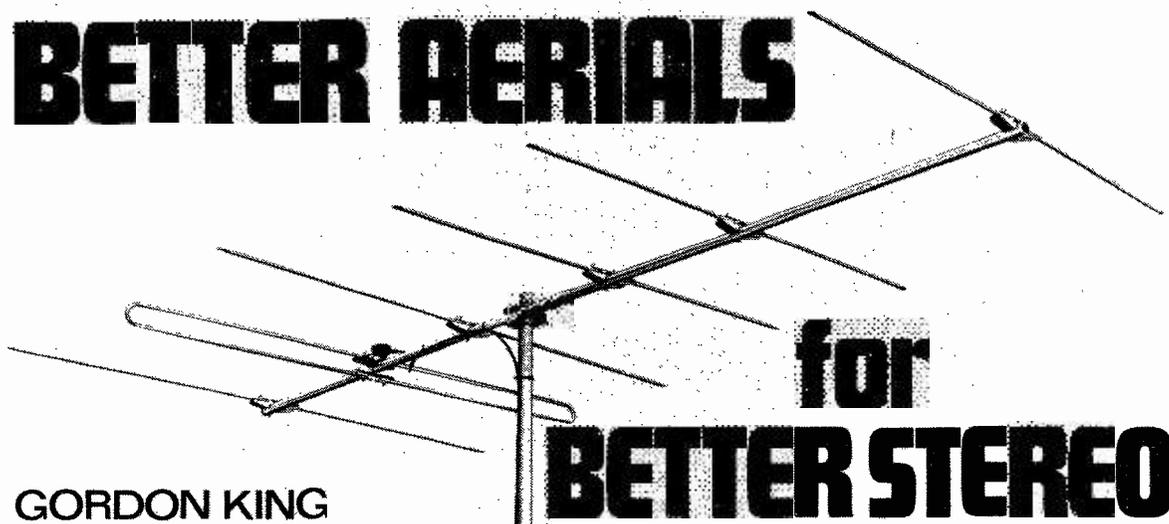
When not energised the relevant transducer is connected to a receiver circuit. Special counter circuitry carefully measures the intervals between transmission of the wave and the reflection from a finger in contact with the glass (or any other object in contact with the glass). Thus, by putting a finger on the surface, its position can be accurately determined.

Because the glass is clear and has nothing internal added (i.e. electrodes etc.) it can be simply laid over images such as photographs, maps or even have an image projected onto it. A finger may then be pointed to any part, and that portion of the image can be stored in a computer. Thus a complete image can be put into the computer memory just by using a finger.

Some of the applications are interesting and very practical. How about using the idea for an electronic keyboard for typewriters or even electronic organs—no contacts and no noise. Clearly the solution to many problems will soon be in everyone's hands.

Ginsberg

BETTER AERIALS



for BETTER STEREO

GORDON KING
PART 2

SIGNAL PROPAGATION

The FM programmes are carried on very high frequency (v.h.f.) channels in Band II which extends from approximately 88 to 108MHz. The signals thus have some similarity between those used for television in Bands I and III. They are propagated in a similar manner, and the service area of a transmitter spans a radius little more than 40 to 50 miles (sometimes more in one direction than others owing to deliberately engineered transmitting aerial directivity or due to topographic features).

Thus consistent reception, particularly of stereo, cannot be normally expected much beyond this maximum range. However, this is not to imply that FM reception over greater distances is impossible. Indeed, under favourable conditions reception is not unknown over hundreds of miles, but then the propagation is enhanced by signal refraction in the troposphere (upper atmosphere) and sometimes in the ionosphere (the electrical layers above the Earth's local atmosphere).

However, reception due to such propagation is singularly unreliable and occurs (tropospheric) during spells of fine weather (i.e., during an anti-cyclone when the pressure is high). Fading is experienced as the refractive index of the troposphere varies.

LONG-DISTANCE RECEPTION

Reasonably consistent reception can sometimes be achieved over a path up to about 100 miles or so at an elevated receiving site and with a very sensitive tuner (IHF usable sensitivity in the order of 1.5 μ V, p.d. 75 ohms) coupled to a high-gain multi-element aerial accurately orientated and connected to the tuner through low-loss feeder. The author is currently receiving stereo from his nearest stereo-encoded station over a distance of about 100 miles on the Goodmans Module 90 tuner-amplifier (receiver) in conjunction with a six-element Antiference aerial at a site with a good outlook towards the station at an elevation of about 200ft. Reception is not one hundred per cent reliable even then, but for most of the time 'entertainment quality' stereo reception is possible.

Readers who may be contemplating establishing a system to receive stereo at such extreme ranges must ensure that the tuner is of good quality and that it is endowed with good selectivity (IHF alternate channel selectivity not less than about 45dB) as well as high sensitivity, especially if the distant stereo station is close to the frequency of the much more powerful 'local' signal.

Moreover, if the 'local' signals are very strong the tuner or receiver must have a high immunity against input (or front-end) overload, this generally calling for two or more variable tuned circuits in front of the mixer and field-effect transistors for r.f. amplification, if not for mixing.

The aerial required for good stereo thus depends on the distance of the site from the transmitter, amongst the other factors already noted. In the inner service area, up to about 20 or so miles from a transmitter, a relatively simple aerial might extract sufficient signal strength from the passing radio signal, provided there is not a lot of local screening or electrical interference (e.g., car interference from a nearby main road!).

FM DIPOLE

The simplest FM aerial is the dipole. This is a length of wire or rod conductor of about 5ft. in overall length broken in the centre for feeder connection, as shown in Fig. 2. The actual length depends on conductor diameter and on the part of the FM band where it is desired to 'peak' the response. The length, in fact, tunes the aerial. The wavelength of an

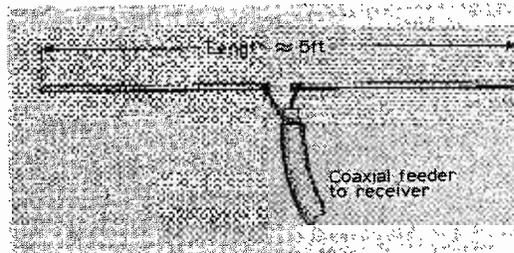
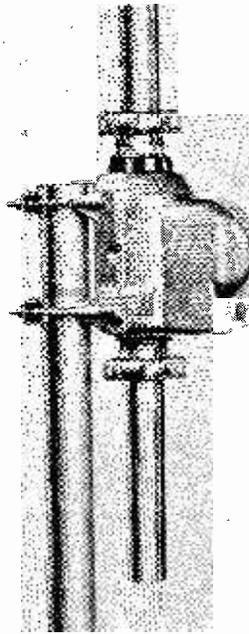


Fig. 2. The simple dipole aerial, useful in close proximity to the transmitter.

electromagnetic wave in metres is equal to the wave velocity divided by the signal frequency. The velocity is very close to 300×10^6 metres/sec., so the wavelength of a 100MHz signal is 3 metres.

The simple dipole is useful when its length corresponds to about half the wavelength, which in this case is 1.5 metres, which is close to 5ft. However, the velocity is reduced slightly as the wave is extracted by the aerial, depending on the velocity factor (a function of the length/diameter ratio), so a practical dipole is generally made a little shorter and tuned to a slightly lower frequency, such that it works out to approximately 5ft. again.

The FM signals are horizontally polarised (mostly, anyway, though 'slant' polarisation is used in some parts to facilitate response on FM car aerials which are vertically disposed). This means that the receiving aerial has to be disposed horizontally to secure maximum 'capture' of the signal. So arranged, the aerial has a so-called 'figure-of-eight' polar diagram, as shown in Fig.3, where there are two maxima and two minima response directions, the aerial picking up most signal when broadside on to the station and least when end on.



In some areas several FM programmes are receivable but usually only if it is arranged to rotate the aerial system. In the Stolle system the motor-driven rotator, left, is remotely controlled by the 'Memomatic' control box, below, thus showing the direction in which the aerial system is pointed. (J-Beam Ltd.)

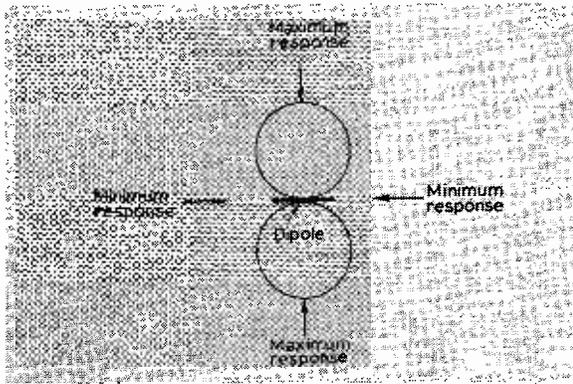


Fig. 3. Diagram showing the pickup characteristics of a dipole aerial.

This sort of aerial may be all right up to ten miles from a powerful station, even when placed indoors or in the roof space, though towards the edge of the inner service area it may have to be mounted outside

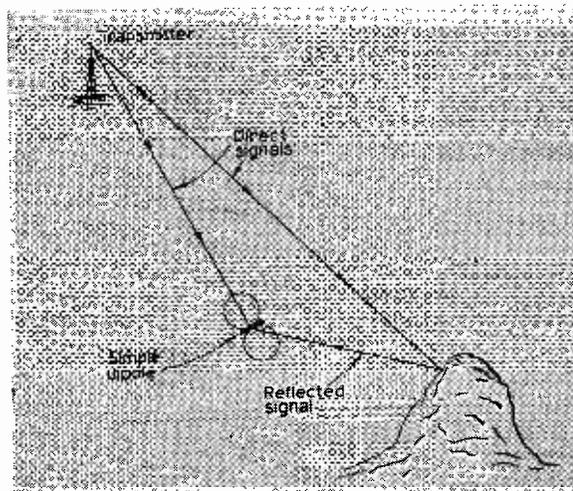
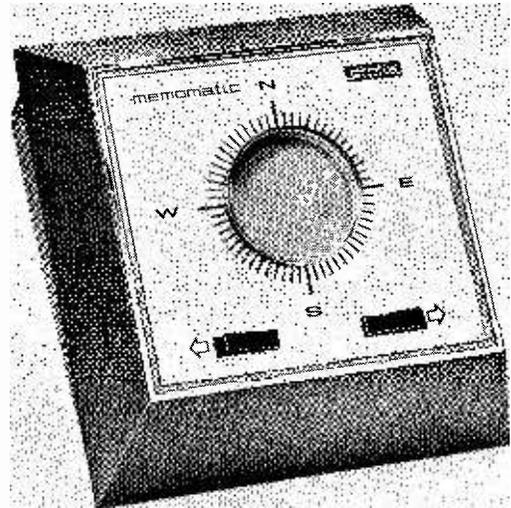


Fig. 4. Regardless of signal strength unwanted reflections of the signal can cause distortion on FM.

on a bracket, fixed to a wall for example. However, since it is wide-open to signals arriving from all directions it is of little use for discriminating against unwanted signals and interference.

REFLECTIONS

Like television signals, FM signals are vulnerable to reflection from hills and large structures. On television we get the well known ghost image or picture. On FM we get severe harmonic distortion, and, when the system is stereo, impairment of the stereo separation and consequent loss of stereo effect.

What happens is shown in Fig.4. The simple dipole receives the direct signal at one side and a reflected signal from a hill on the other side, where the response is still high. The reflected signal arrives a small fraction of a second after the direct signal owing to its longer route, and it is this which results in the distortion (and ghosting on television). An aerial of greater directivity is thus required to eliminate or reduce the response to the reflected signal or signals.

AERIAL DIRECTIVITY

A dipole is given directivity by the addition of so-called parasitic elements (meaning that they are not in actual effective electrical connection with the dipole). Such an element behind the dipole is called a reflector and elements in front are directors. There is usually one director (or director system, depending on aerial design) and one or more reflectors.

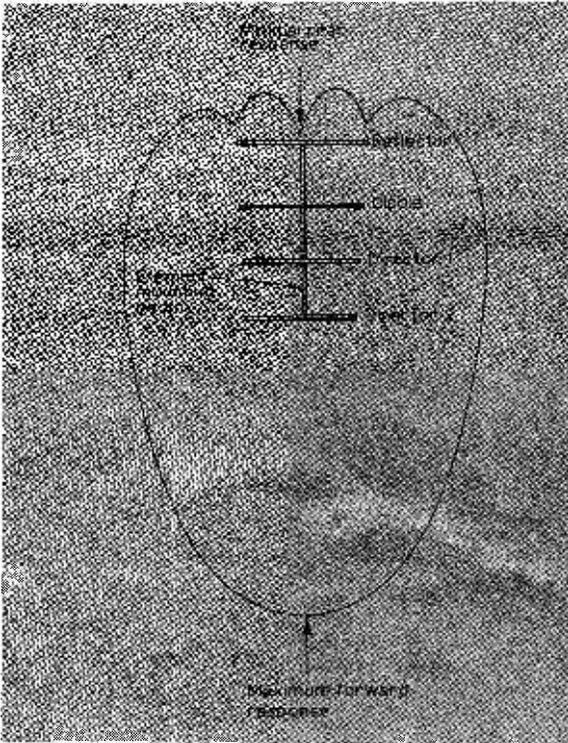


Fig. 5. Polar diagram of a typical four element FM beam aerial.

A simple horizontal 'H' type aerial could be composed of the dipole and one reflector or one director. With the former the dipole would face the station (reflector behind) and with the latter the director would face the station (dipole behind). Usually, however, the parasitic of an 'H' aerial is a reflector.

The greater the number of elements used in a design (up to a certain number governed by technical and practical factors), the greater the directivity, and with four elements (reflector, dipole and two directors) we might obtain a polar diagram as shown very approximately in Fig.5. Here is indicated that the

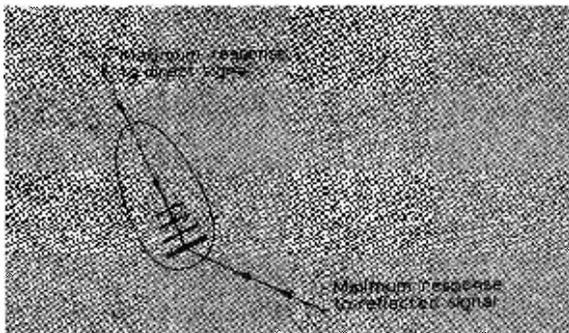
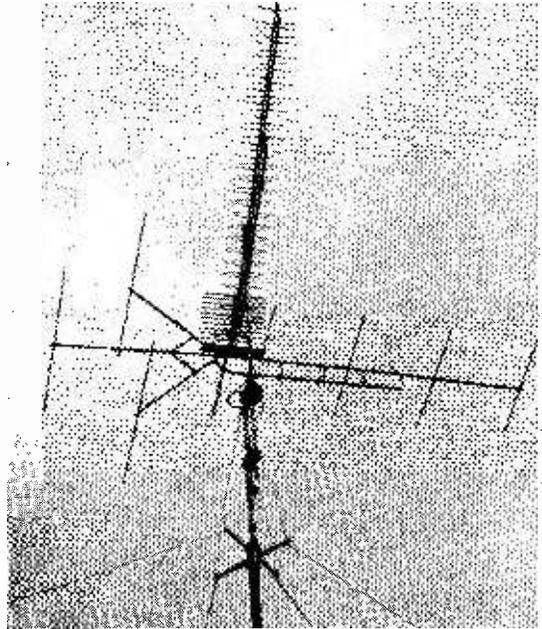


Fig. 6. Positioning of beam to avoid reflected signals can be quite critical.



The FM aerial here is an Arrow 'Eight' by R. Smith Aerials of Luton. The accompanying TV array is one of the Zodiac range by the same company.

response has been 'pushed' from the rear and sides towards the front (rather like a stressed balloon), and resulting from this the front of the aerial picks up more signal than a simple dipole.

The aerial is thus said to have 'gain'. Such an aerial, therefore, could be used to advantage in a situation as shown in Fig.4 to reduce the response to the reflected signal (Fig.6) and also in an area of weak signal field, where the intrinsic gain yields a greater signal than a simple dipole at the feeder.

Thus, even in areas relatively close to a transmitter a high-gain directional aerial may be required to discriminate against unwanted signals arriving at bearings off the main beam, while at locations towards the edge of the primary service area and into the outer service area a high gain array might be required to produce sufficient signal strength for noise-free stereo reception.

No hard and fast ruling can be given, but as a rough guide a simple dipole might prove adequate up to ten or so miles from a station, a two-element aerial from ten to twenty-five miles, a three-element aerial from twenty-five to about thirty-five miles and a four-element array at the extremes of the service area; but as already expounded, much will depend on the sensitivity of the tuner or receiver, on the site elevation and height of aerial above ground. For extreme fringe working an aerial of six elements could make all the difference between just about acceptable stereo reception and good, noise-free stereo reception.

PART 3, NEXT MONTH, WILL CONCLUDE THE SHORT SERIES BY SHOWING HOW TO CONSTRUCT A FOLDED DIPOLE AND A FOUR ELEMENT BEAM FOR FM. MATCHING DEVICES AND ATTENUATORS ARE ALSO DISCUSSED.

10 Watts For 2 Metres

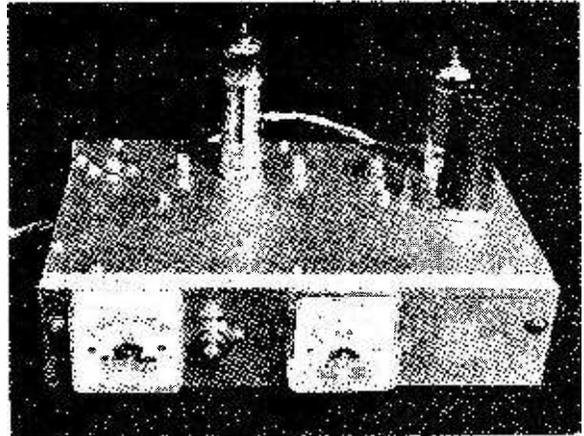
F.G. RAYER
G30GR

THE transmitter described here has only three stages, is crystal controlled, and gives a very useful RF output, running at about 10 watts. This, with a simple dipole aerial, will give solid contacts over a fair radius so for local working a rotary beam aerial is not necessary.

CIRCUIT

Fig. 1 is the circuit. The lowest frequency present is 72MHz, followed by a doubler to 144MHz. This results in an output free from unwanted frequencies. With a 144MHz transmitter it is quite usual to employ an 8MHz oscillator followed by multipliers (such as $3 \times 3 \times 2$) to obtain $18 \times$, or 144MHz. This can result in the presence of unwanted frequencies with the output. But with a 72MHz oscillator, followed by a doubler, incorrect adjustments, which will produce frequencies outside the band, are extremely unlikely.

A 72.2MHz crystal was fitted for output on 144.4MHz, but other frequencies can be used. V1, a 6C4, is employed with an overtone crystal with L1 tuned to about 72MHz. With this type of oscillator



the circuit does not oscillate at the crystal fundamental and so no lower frequency energy is present. Oscillation is directly at the overtone frequency for which the crystal is made.

Experiments with this kind of circuit show that it is almost useless trying to press old surplus

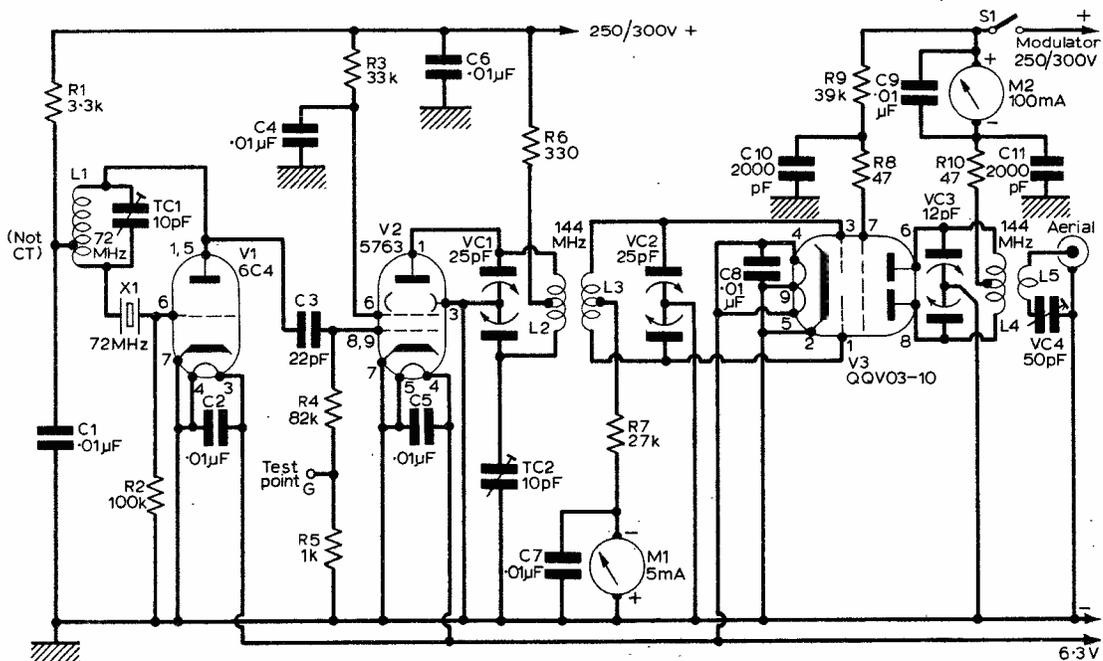


Fig. 1. Complete circuit of the 2m transmitter using spot frequency crystal control.

crystals into service even if a harmonic works out at the required frequency. These crystals may fail to oscillate or may give only a very small output or not provide the expected frequency when operating in an overtone mode. It is thus virtually useless to try the circuit with any crystal except the correct type.

Feedback depends on the position of the tapping on L1, and the small trimmer TC1 allows adjustments to tuning.

V2, a 5763, receives drive at 72MHz and doubles this to 144MHz so no problems of stability arise. It was not found necessary to operate this stage at maximum dissipation in order to get enough grid drive for the power amplifier. However, maximum ratings for the 5763 used may be noted, in case it is wished to raise the output. When operating as a doubler, 300V may be applied to the anode when R3 can be reduced to 12.5kΩ. Maximum anode current should then be 40mA resulting in a maximum anode dissipation of 12 watts.

L2 is tuned to 144MHz by VC1, and TC2 compensates for stray capacitance in V2. Tap G is a test point allowing grid current to be checked without having to disconnect R4.

The QV03-10 is an internally neutralised double beam tetrode, working as a straight through PA at 144MHz. L3, tuned by VC2, drives the grids in push-pull and, as bias is obtained by grid current through R7, a grid current meter M1 is permanently fitted. The actual maximum rating of this stage is 76mA anode current at 300V, or 23 watts input, with 3mA grid current. Normally, a somewhat lower input has been used, around 10 to 15 watts.

★ components list

Resistors	
R1 3.3kΩ 1W	R6 330Ω 1W
R2 100kΩ 1W	R7 27kΩ 1W
R3 50kΩ 2W	R8 47kΩ 1W
R4 82kΩ 1W	R9 39kΩ 1W
R5 15kΩ 1W	R10 47kΩ 1W

All 10%

Capacitors	
C1, C4, C6	0.01μF 350V disc ceramic
C2, C5, C7, C8, C9	0.01μF 150V disc ceramic
C3	22pF mica
C10, C11	2000pF 600V disc ceramic

Trimmers	
TC1	10pF trimmer (Jackson Tetter)
TC2	10pF tubular trimmer
VC1	25pF butterfly 0.015" spacing (Jackson C713)
VC2	25pF butterfly 0.015" spacing (Jackson C713)
VC3	12pF butterfly 0.045" spacing (Jackson C713)
VC4	50pF (Jackson C801)

Valves		
V1 6C4	V2 5763	V3 QV03-10

Miscellaneous	
M1	meter 5mA fsd, M2, meter 100mA fsd.
Chassis	8 x 5 x 2in. with 5 x 2in. screen.
Co-axial socket	On-off toggle switch.
Crystal	HC18U (or HC25U, see text) (Senator)
Crystals	36 Valleyfield Road, London, SW16).
Valveholders	B7A (1) ceramic with skirt and screen; B8A (2) ceramic.

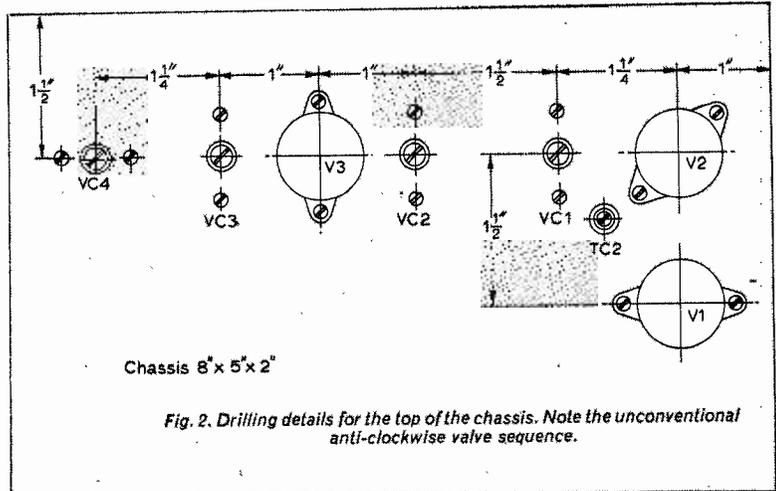


Fig. 2. Drilling details for the top of the chassis. Note the unconventional anti-clockwise valve sequence.

L4 is tuned by VC3, and M2 is permanently connected to show anode current. HT for this stage is drawn from the modulator so S1 can be opened during tune-up, so that HT is not applied to the PA.

TC3 adjusts PA loading and the output is fed into a co-axial cable which runs to the aerial. The original transmitter could be operated without the least disturbance to TV reception in the same house, but this depended on various factors and it is impossible to say that this happy state would remain so in all circumstances.

CHASSIS WORK

Drilling dimensions for the 8×5×2in. chassis are shown in Fig. 2, V1 requiring a skirted holder with screening can, but screens must not be used on V2 or V3. A screen is required across the holder of V3, below the chassis. If a "universal chassis" is used, an extra 5×2in. flanged side can be used for this purpose its flanges being cut to fit inside the front and back flanges.

Holes are cut or punched in the front runner to take the meters and switch, the back runner taking the co-axial aerial socket and a grommet for the power supply leads.

The capacitors VC1/4 are readily available each being mounted by two 6BA bolts. The exact values shown need not be used and some slightly smaller surplus capacitors of similar type have been cheaply available and are quite suitable.

WIRING

Fig. 3 shows all wiring and components and Fig 4 the construction of the coils. All by-pass capacitors (C1, C2, C4, etc.) should be connected with the shortest practical leads.

One end of L1 is soldered to the insulated tag of a small tag strip, which also supports TC1. A lead from the second tag of TC1 runs to pin 5 on V1 and this lead supports the other end of L1.

A wire-ended crystal was used its leads going to pin 6 on V1 and the junction of L1 and TC1 at the tag strip.

Keep heater and HT leads against the chassis, but RF leads, such as to C3, clear of the metal. TC2 is a tubular trimmer, mounted by a nut which forms the chassis return.

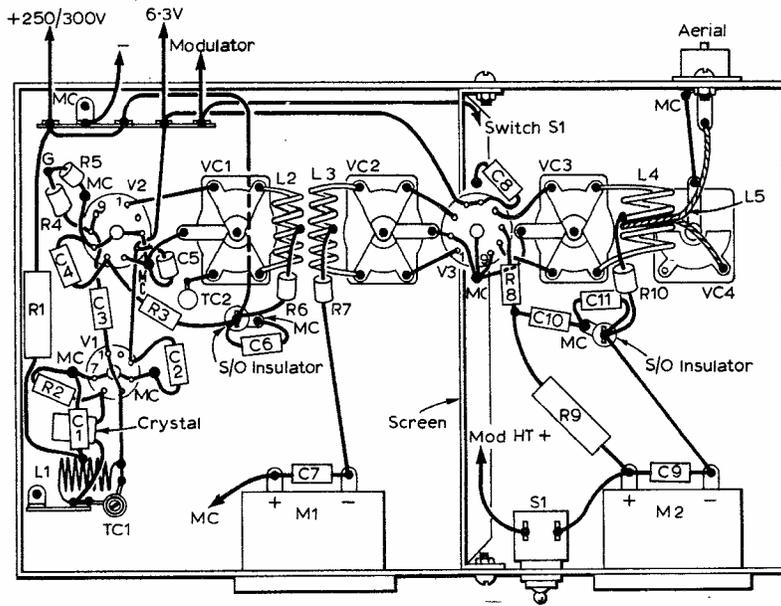


Fig. 3. Layout of components and wiring underneath the transmitter. See note at end of article with reference to crystal mounting.

R6, R7 and R10 have a very short lead to the centretap of the appropriate coil. Position L2 and L3 so that they are almost touching each other.

The junction of R3, C6 and R6 is supported by an insulated tag or pillar as is the junction of C10, C11 and R10.

Position the holder for V3 so that pins 1 and 3 come to the left of the screen, as in Fig. 3. Cut the screen to pass closely over the valveholder, while adequately clearing tags 1, 3 and 4. Note that the screen passes completely across the holder. It is secured by bolts fixing the valveholder and is also bolted to the front and rear of the chassis.

The ends of L5 are shaped so that they can be

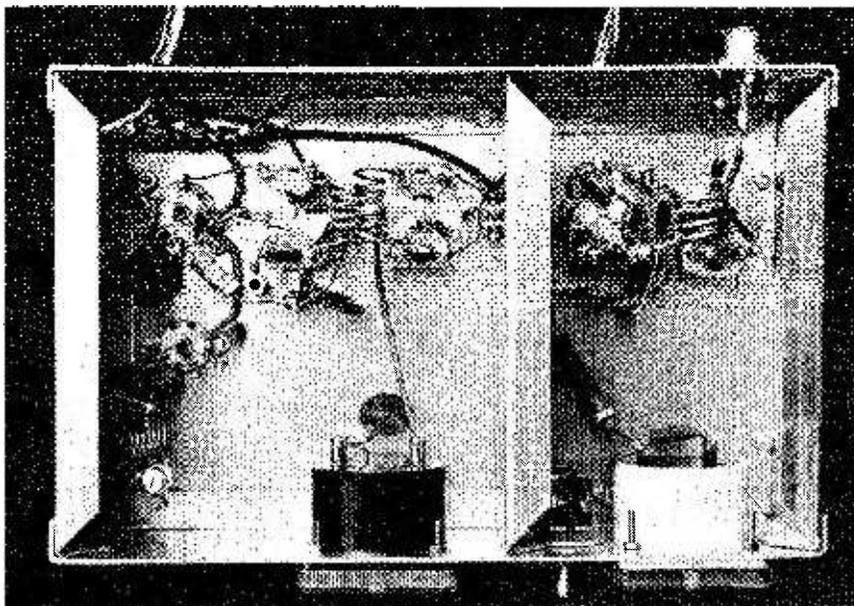
soldered to VC4 and the aerial socket, when L5 is pushed between the middle turns of L4.

Check that the capacitors can be adjusted without fouling leads or resistors. Chassis returns should be stout and as short as possible.

Fit flexible leads from the tag strip for power connections. The jumper between HT tags is to allow easy disconnection of V2.

The heaters require 1.73A at 6.3V. For HT purposes, a 300V 120mA or similar supply is most suitable, though the equipment will work satisfactorily at reduced input with a lower voltage.

If the HT voltage for V1 and V2 is too low, it may be difficult to obtain enough grid drive for V3.



Photograph of author's prototype transmitter which may be compared with Fig. 3, above.

A voltage of under 250V is not recommended for V3. With 250V it is better to keep to about 6W to 8W input, rather than trying to load V3 to a greater input, which may actually reduce RF output, when the HT voltage is low. Anode current is shown by M2.

A small push-pull modulator will do very well with the transmitter. Good results can also be secured with an economical modulator consisting of a twin triode such as a 12AX7, followed by a single 6BW6 or similar output stage, but the PA input should then be kept down to 8 or 9W.

ALIGNMENT

It is obviously necessary to adjust the circuits for proper working. However, wrong adjustment is more likely to result in no RF output, rather than an output which is outside the permitted band. The PA is not switched on by S1 until 1 to 2mA grid current has been obtained, as shown by M1. In any case correct operation of the crystal oscillator must first be checked.

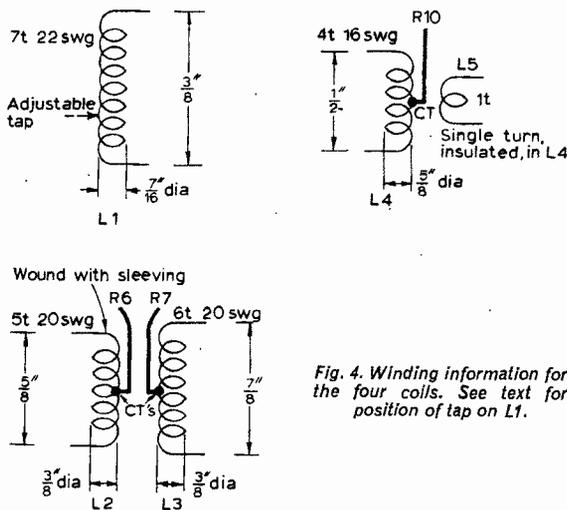


Fig. 4. Winding information for the four coils. See text for position of tap on L1.

Temporarily disconnect the HT jumper so that HT is on V1 only. V2 must however be in place. A meter should be included in the HT lead to V1. Ideally, rotation of TC1 should now show a point where the anode current of V1 falls, showing that oscillation has begun. Turning TC1 away from this position, either way, should result in anode current rising again, due to oscillation ceasing. In these circumstances, the frequency of oscillation is controlled by the crystal and all is well. In addition, checking with a receiver will show that the oscillator frequency does not change, no matter what setting is used for TC1. Wrong adjustment of TC1 merely causes oscillation to cease.

It may be found that current remains relatively low, say 7 to 8mA, for all settings of TC1 and that the oscillator frequency moves over the band as TC1 is adjusted. If so, the oscillator is not controlled by the crystal. This must be corrected by moving the tapping on L1 a little nearer the crystal end of the coil.

On the other hand, it may be found that no adjustment of TC1 produces oscillation and that current remains around 15mA or so. In this case, the tapping must be moved a little nearer the anode end of L1.

TC1 is purposely small, so that it is practically impossible to tune to wrong overtones of the crystal. It might thus be necessary to compress or stretch L1 a little to get the circuit on frequency. If a grid dip oscillator is available, adjust L1 so that this shows resonance at 72MHz with TC1 about half screwed down.

This type of oscillator is not particularly tricky, but may require a little care and patience. Once adjusted, it is reliable and will not need any more attention.

When oscillation is obtained, clipping a meter across R5 (meter negative to G) should show a little grid current in this stage, rather less than 1mA. HT can then be applied to V2.

Rotating the capacitors VC1 and VC2 should now show grid current on M1. If VC1 is fully closed without a peak being reached, compress L2 slightly, and vice versa. Coverage of these circuits is quite small, and it is impossible to tune them to wrong harmonics, if made as described. Coils L3 and L4 can also be adjusted in the same way, if necessary, so that each trimmer has a definite tuning point.

TC2 can be set about half open. Subsequently adjust it a little at a time, while correcting tuning with VC1, until the best grid current reading on M1 is obtained.

Should the best obtainable grid current be too small L2 may be moved nearer to L3. It may also be necessary to increase the HT voltage to V2 in particular, if this is rather low, or to reduce the value of R3, or to make a small adjustment to the tap on L1, to secure more drive. Final adjustments are made with all stages tuned up and working. Where grid current is more than adequate, L2 and L3 may be separated a little, or tuning slightly staggered.

PA ADJUSTMENT

As mentioned, HT must not be applied to V3 until at least 1mA is shown by M1. A load such as a 12V 6W lamp can then be plugged into the aerial socket, VC4 is opened and S1 is closed. Adjusting VC3 to resonance should light the lamp. If L4 needs adjustment, make this as described for L2 and L3.

Closing VC4 will increase loading. As is usually the case with VHF equipment of this type, an accurate indication of PA tuning cannot be obtained by observing the dip in anode current shown by M2. A slight re-adjustment of VC2 and VC1 may be required as the PA is loaded and tuned.

It should be found that the circuit works reliably when switched on. If the oscillator does not start, tune TC1 slightly off peak, until this is overcome.

For local working, a dipole is easily made which has the advantage of minimal directivity. It can be constructed from alloy tubing, flattened and drilled at the inner ends and secured here in an ordinary junction box. The overall total length should be about 38 1/2 in. A co-axial cable is attached to the inner ends of the elements, in the junction box. The aerial can be raised on a light post or pole, or can be fixed to a support arranged as convenient on the house. ■

As the use of a wired-in crystal severely restricts the versatility of the transmitter constructors may wish to use the similar plug-in crystals, type HC25U, with a suitable socket.—Tech. Ed.

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

A very simple project this month, based on our old friend the astable multivibrator. Although it uses only small-signal transistors it gives a surprisingly high output signal level into a 35 ohm loudspeaker.

Circuit

Transistors Tr1 and Tr2 are the active components of the multivibrator, the frequency of oscillation being set by C1 with R2 and C2 with VR1 and R3. The signal at the collector of Tr2 is directly coupled to Tr3 which works as an emitter follower to provide sufficient current drive for the loudspeaker.

Note that the circuit runs from a 4.5V battery. It would be very unwise to exceed this voltage because, as the circuit stands, Tr3 is working on the limit of its power dissipation; an increase in supply voltage could easily destroy this transistor. Because of the lower-than-usual supply voltage it is not necessary

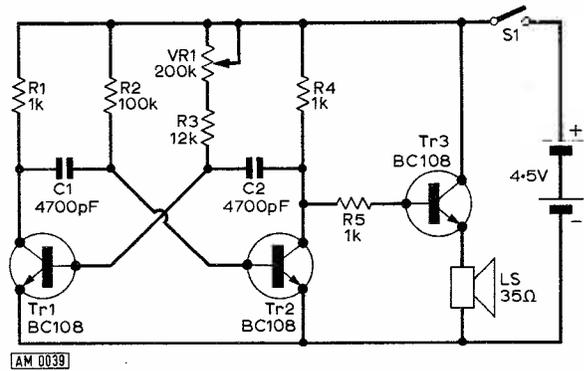
to protect the base/emitter junctions of Tr1 and Tr2 with diodes. Thus the circuit is probably as simple as it could possibly be.

Operation

Operation is effected by the push button in the supply line and provided this is of reasonable quality clicks should not be too troublesome. It would be possible to use a slider potentiometer for VR1 and make quite a smart looking instrument that would operate in much the same way as a real Swanee Whistle. If the frequency of operation is not in the

R1	1kΩ	1p
R2	100kΩ	1p
R3	12kΩ	1p
R4	1kΩ	1p
R5	1kΩ	1p
C1	4700pF	4p
C2	4700pF	4p
VR1	200kΩ (linear)	25p
Tr1	BC108	10p
Tr2	BC108	10p
Tr3	BC108	10p
SW1	Push switch	15p
		83p

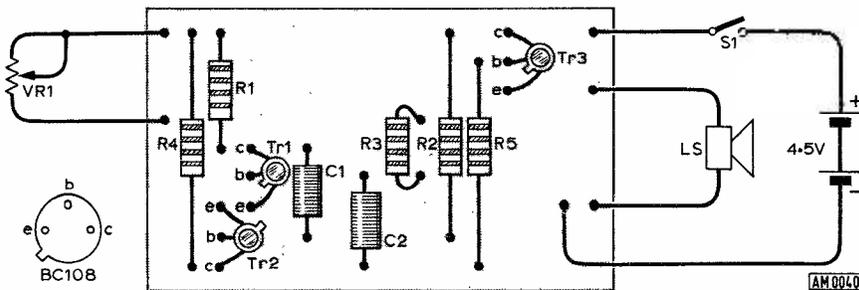
LS1 is a 35 ohm loudspeaker and is not allowed for in the above list.
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Circuit of the Swanee Whistle

range desired it can be dropped by about one octave by doubling the values of C1 and C2; conversely, halving the values of these two capacitors raises the frequency by about one octave.

A word of warning: it is not advisable to run the circuit with a loudspeaker having an impedance of less than 35 ohms but higher values may be used at the expense of power output.



Suggested layout of circuit on veroboard and connections to external components.

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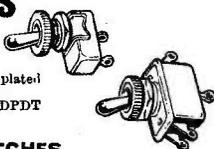
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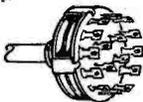


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47	7p		8p	7p	8p		12p
100	8p	7p	7p	7p	8p		11p
220	7p	8p	8p	8p	10p		17p
470	8p	8p	8p	10p	12p		24p
1000	10p	12p	12p	17p	20p		24p
2200	14p	17p	22p	28p	36p		40p
4700	25p	28p	37p	41p	54p		
10,000	40p	43p					

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C	1/4W	5%	4.7 Ω —10M Ω	E12	1	0-9	0-75 nett
C	1/2W	5%	4.7 Ω —10M Ω	E24	1-2	1	0-9 nett
C	1W	5%	4.7 Ω —10M Ω	E12	2-5	2	1-8 nett
MO	1/2W	2%	10 Ω —1M Ω	E24	4	3	2 nett
WW	1W	10% \pm 1/20 Ω	0.22 Ω —3-9 Ω	E12	7	7	6
WW	3W	5%	1 Ω —10K Ω	E12	7	7	6
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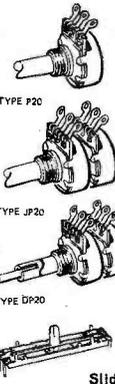
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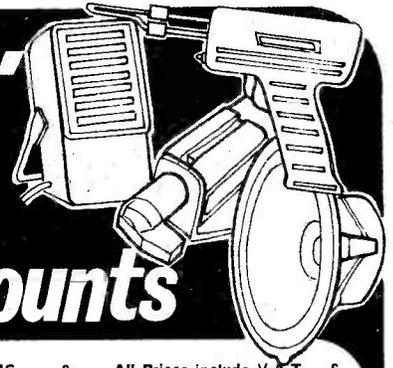
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Cone Tweeter 8 ohm, 3 watt		1.00	P. & P.		.10
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MICROPHONES		£	TW206		£
CM20 Crystal Hand		.50	CONDENSER MIKE 600 ohm,		7.90
CM70 Planet stick metal,	switch crystal	1.55	uni-dir		
DM160 Dynamic uni-dir, ball	metal	3.95	Cassette Stick Mike with R.		
UD130 50K/600 ohm, uni-dir	ball metal	4.50	Control on/off switch		
			(2.5 & 3.5mm J/Ply)		1.35
			Lapel type, crystal		.40
			P. & P.		.15

SOLDERING IRONS		£	X25 25 watt (low		£
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ACOS GP91/2SC or GP91/3SC	Stereo comp.	1.00	cer. diam.		1.80
GP831 Stereo crys.		1.35	19-TI Stereo crystal		.80
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GP95/1		1.35	SX5H Stereo crystal		1.60
GP96/1		1.75	SX5M Stereo crystal		1.60
GP104		.75	X5H Mono/stereo		1.25
SONOTONE			X5M Mono/stereo		1.25
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			P. & P.		.03

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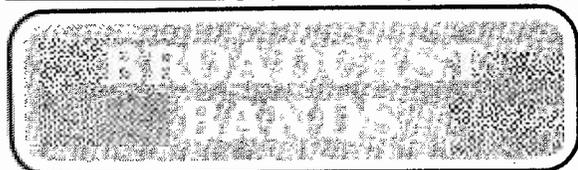
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MEDIUM WAVE BROADCASTS by CHARLES MOLLOY

BBC RADIO NOTTINGHAM is now broadcasting on 1520kHz (197m) from a temporary installation which is expected to provide satisfactory reception up to about 8 miles from the centre of the city. This brings the total number of BBC Local Radio Stations transmitting on the medium waves to eighteen, only Carlisle 755kHz (main) and 1457kHz (relay) and Derby 1115kHz have still to come on the air to complete the network of stations in England. The following are currently on the air:— Radio Blackburn 854kHz; Radio Solent (main) 998kHz; Radio Medway, Radio Sheffield 1034kHz; Radio Leeds 1106kHz; Radios Birmingham, London, Manchester, Newcastle on 1457kHz; Radios Brighton, Humberstone, Merseyside, Oxford on 1484kHz; Radio Stoke-on-Trent on 1502kHz; Nottingham 1520kHz; Bristol, Teeside 1546kHz; Leicester, Solent (relay) 1594kHz.

Ian Gordon (Birmingham) has tried the medium waves with his Codar CR70A receiver, aerial tuning unit and 80ft longwire aerial. He reports hearing Radio Nacional Espana, Madrid, on 584kHz; Radio Prague 1286kHz at 2200hrs; Radio Tirana, Albania 1394kHz in German at 2200hrs and Trans World Radio Montecarlo 1466kHz with sign-on at 2115hrs.

VHF/FM

by **SIMON DAVID**

I AM not quite sure how the editor would react to my mentioning Pirate Radio stations yet again especially after I mentioned that one of our readers had picked up Radio Classic recently. Another reader **Peter Welton** has sent information to me about some of these stations.

The reason I mention this is not so much to give these stations publicity but rather to highlight an increasing problem that could occur on the v.h.f. band which is already existing on the a.m. band. That is the increasing congestion of broadcasting stations coming in on particularly sensitive receivers especially around the 95MHz region.

Chris Webstor sends me an interesting letter in which he lists several stations which can be picked up from the continent. He says that he is in rather too steep a valley to enjoy tropospheric DX except from due north and south. He is at Ringwood, Hants.

His daytime loggings of BBC Local Radios are Nottingham 1520kHz at 1430hrs; Bristol 1546kHz at 1240hrs and Leicester 1594kHz at 1000hrs.

Richard Tubridy (Bickley, Kent) has been listening to North Africa on the medium waves and he reports hearing Algeria with its Arabic Service on 533kHz from Ain Beida and on 548kHz from Oran. The French Service was heard from Alger Chaine 3 on 890kHz and also during the daytime from Tipaza 251kHz on the long waves. Richard has been having difficulty with Radio London 1457kHz at night owing to interference from a station playing Chinese music and he asks if this could be coming from China itself. The 500kW transmitter at Durres in Albania operates on 1457kHz and as this station relays the External Service of Radio Peking every evening it is the most probable cause of the interference. A similar high power transmitter which operates on 1214kHz has caused trouble with reception of BBC Radio One in some parts of the U.K.

Radio 4 medium wave broadcasting is to be restored to the south-west of England. In a recent written parliamentary answer the Minister of Posts and Telecommunications stated that he has authorised the BBC to install low-power transmitters at Exeter, Barnstaple, Torbay, Plymouth and Redruth to broadcast on medium frequencies the programmes carried on the VHF transmissions of Radio 4, which include regional items. Redruth is now on 908kHz but so far there is no information as to the frequencies of the others. During 1973 it is likely that Radio 4 transmitters at Stagshaw and Scarborough will change from 1151kHz to 908kHz, according to the BBC.

On 16th June he says that several f.m. stations in France were completely swamped by Yugoslav signals and this report bears out what has been the experience of several readers of late. He uses an FM6S aerial a home made pre-amp and a Teleton tuner and lists several frequencies ranging from 87.7 up to 99.6MHz. These have all been the result of sporadic-E interference. Examples he mentions are Radio Beograd on 90 and 99.6MHz, the largest signal he claims comes from Celevac, Croatia, on 95.1MHz. This and Novi Sad, Serbia on 87.7MHz both transmit at 50kW. Most of the real DX, Chris says, comes from Russia around 70MHz but Russian television sound comes in on 91.75 and 99.75MHz.

Mr. G. M. Christie writes to me from Orkney, north Scotland. When there is a high pressure area situated to the East and South of his home he is able to receive clear and strong signals from the Norwegian f.m. stations, wiping out some BBC v.h.f. transmissions from local stations about 10 miles away.



He has received second channel images from Grampian television sound and the vision carriers from channel 9 Aberdeen and channel 8 Rumster.

Have you noticed the lack of v.h.f. frequency information—with the radio programmes in some newspapers? The wavelength on the medium or long wave is usually given but they seem to ignore the v.h.f. band. Perhaps the BBC could help to rectify the situation in the near future, or at least recommend through all newspaper editors that they include all broadcasting bands for their stations in the information provided opposite their programme material.

It is well worth recommending once again the use of good aerials, particularly near the edge of normal reception areas if you want to pick up a good stereo signal. Elsewhere in this issue you will find part two of an excellent article which Gordon King started last month on improved stereo reception which I would recommend to all enthusiasts of the v.h.f./f.m. band whether stereo biased or not.

Although modern receivers are extremely sensitive it is necessary to improve on background noise and to make sure that you lock on correctly to the stereo signal. This is not always possible if your aerial system is inefficient and in particular does not employ the correct matching cable between the aerial array and your receiver. Furthermore the interference from car ignition is a particular problem with f.m. so justifying the use of a highly directional aerial of high gain.

SHORT WAVE DX by MALCOLM CONNAH

A good receiver for the newcomer to the hobby is the ex-RAF R1155 which can be obtained in good working order for as little as £5. Other receivers which are commonly available include the early HRO and the AR88. The latter is probably the most well-known of these sets and can be obtained for about £25.

One receiver of particular interest is the CR100 which was made by Marconi for Services use during the last war. This set is ideal for both medium and short wave listening. The coverage is in six bands from 60kHz to 30MHz and the set has two r.f. and three i.f. stages, a crystal filter, a b.f.o. and an internal mains power supply.

The main shortcomings of the CR100 are its lack of sensitivity above 20MHz and the absence of an 'S'-meter. The high frequency performance can be improved by modifying the r.f. stages to use modern valves such as the 6BA6 and an 'S'-meter is a very simple addition. The CR100 can be obtained for about £5 to £15 depending on condition, and fully reconditioned sets have been seen for £20-£25.

Readers' Logs

The first log this month comes from **D. A. Lavender** of Gravesend in Kent who used his Teleton TF182 receiver and a 75 foot inverted 'L' aerial to hear the following:

3997 *SABC, South Africa* in English at 2330.

DX enthusiasts usually use a rotating aerial which is controlled from the receiver location but excellent results can be achieved by careful and strategic sighting of your aerial in the first place. If it is directed at a local high power British broadcasting station you are not likely to achieve very good results from long distance reception and you are also inclined to have difficulty in separating one station from an adjacent one.

The BBC issues local maps for v.h.f. radio services with average field strength contours of 60 and 48dB relative to $1\mu V/m$ for a receiving aerial height for 30ft above ground level. These are average figures and contours and do not take into account steep hills or any other such violent variations in the local topography. However very good and satisfactory results can be achieved in many places with sensitive receivers using telescopic aerials but one must not expect to get good stereo signals in this

"Birdies"

One of our frequent correspondents, **Hugh Cocks**, of Mayfield, Sussex, reports that on June 20th RNE Spain came in well on 87.75MHz. On July 13th, he reports, Spain and Yugoslavia was received and Genk—97.9MHz—from Belgium on August 2nd.

In certain parts of the country, reception is affected by transmitters operating on adjacent channels, i.e. on frequencies close to that of the wanted services. This interference can result in an audible effect known as "birdies"—a varying high-pitched background to the programme heard from the loudspeakers. A carefully positioned multi-rod aerial may help to eliminate the interference but it is also important that the receiver should incorporate a low-pass filter. All stereo receivers should have such filters.

- 4765 *C.R.E. Guayaquil, Ecuador* noted at 0435.
- 4820 *La Voz Evangelica, Honduras*, English at 0355.
- 4832 *R. Capital, Costa Rica* in Spanish at 0445.
- 4905 *R. Relogio, Brazil* in Portuguese at 2300.
- 4915 *Nairobi, Kenya* in Swahili at 2000.
- 4995 *R. Brazil Central* in Portuguese at 0035.
- 5047 *R. Lome, Togo* in French at 2130.
- 6020 *R. Nederland, Bonaire* relay at 0025.
- 11745 *HCJB, Quito, Ecuador* in English at 0158.
- 11810 *Beirut, Lebanon* in English at 0230.

Andrew Duffield of South Brent in Devon has a Trio 9R-59DS receiver and with this he connected to a 100 foot long-wire he was able to hear:

- 3335 *BCC, Taiwan* in Japanese at 2050.
- 3999 *Godthab, Greenland* in Danish at 2120.
- 4755 *RRI, Makassar, Indonesia* at 2105.
- 4865 *R. Ponta Delgada, Azores*, music at 2115.
- 5345 *Voice of Free Yemen* with music at 1840.
- 7690 *R. Espana Independiente*, music at 1910.
- 9870 *R. Bangladesh* in Bengali at 1935.
- 11415 *Peyk-e-Iran*, identification at 1945.

Harold Emblem of Mirfield in Yorkshire used his Lafayette HA-63 receiver and 18 metre long-wire aerial to hear the following interesting stations:

- 6020 *R. Nederland, Lopik* noted at 1515.
- 6065 *R. Sweden, Horby* noted at 2055.
- 9475 *R. Cairo, N. American Service* at 0300.
- 9515 *Voice of Turkey, Ankara* at 2210.
- 9625 *CBC, R. Canada* noted at 0230.
- 9745 *R. Baghdad, Iraq* noted at 1940.
- 11620 *All India Radio* from Delhi at 2120.
- 15205 *VOA, Tangier* noted at 2000.

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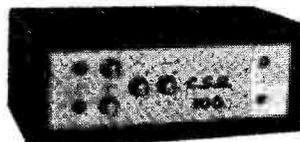
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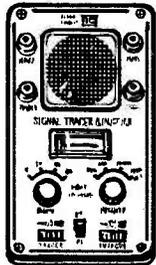
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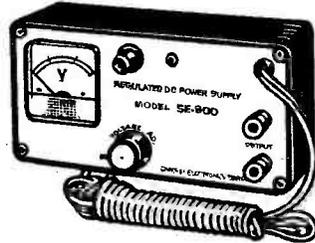


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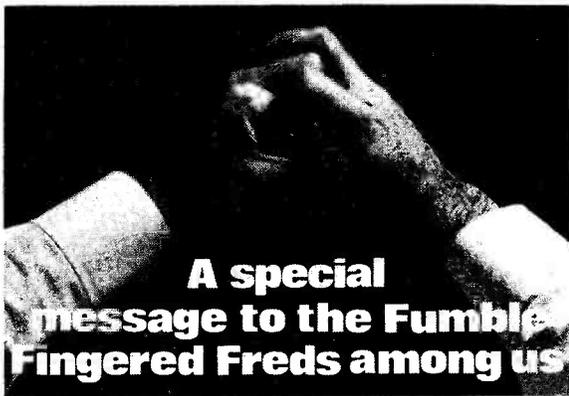
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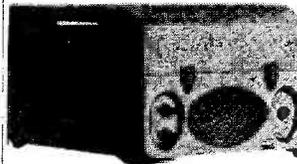
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SHORT WAVES

by DAVID GIBSON, G3JDG

IT has been another month where 28MHz has provided some surprises. Signals from ZP5, 5U7, CR6 and VU have been logged by more than one listener. Best periods to listen on ten metres appears to be late afternoons and early evenings but with this band one is never quite sure. The VU, for example, was heard around 1400 hours and quite a few African stations were logged around 1200 hrs.

Incidentally, on ten metres, there are a number of very useful beacon stations which operate and give an indication of what's happening on the band. On 28.180MHz is ZC4CY located in Cyprus, and on 28.190MHz there's 3B8MS on the island of Mauritius. Other beacon stations on ten metres are: VP9BA, 28.165MHz (Bermuda); VE3TEN, 28.175MHz (Ottawa, Canada); DL0IGI 28.195MHz and 28.200MHz—note this station is on 28.200MHz each hour between five minutes past the hour and 30 minutes past the hour (Salzburg, Germany); GB3SX, 28.185MHz (Crowborough, Sussex). Seems that you can log some quite good DX in beacon stations alone. Why not have a go this month and see just how many of these you can log—you might hear some other DX too.

Readers' Logs

Paul Newman (Thame), listens on 144MHz and 70cms. Best on 70cms; G2CXT, G3ISO/P, G3KEQ, G3WIR/P, G3YXZ/P. On 144MHz; PA0ZAZ/P, F0AKD, F6BHI/P, GC2FZC, GC8AWE. Paul uses an 8-element Yagi at 23ft on 144MHz and an 8-over-8 at 18ft. for 70cm. Gear consists of 'Sentinel' converters feeding an RA1 tuning 28—30MHz with an n.b.f.m. discriminator fitted. He also has an aerial in the loft called a turnstile—do you mean you actually charge the signals for admission?

Another 70cm enthusiast is **Nicholas Richardson** (Wendover, Bucks). The antenna is a 46-element Yagi at 37ft. Signals are down-converted to 144MHz and another converter is then used to feed an EC10 MkII receiver tuning 28—30MHz. Stations logged on 70cm include: G3s—BNL/P, EHM, LTF/A: RPE/P, THQ/A, TTV/P, VER/P, WDG/P, XJS, G4AJW,

G4ARD/P, G8s—ACE, ATD/P, ATP/P, AZU/P, FMK. Nicholas informs me that he is licensed to receive artificial Earth satellites and uses a MOSFET converter (136MHz-138MHz) feeding the EC10.

Michael Bolton (Banbury, Oxon) has been on ten metres for four weeks. The station consists of a homebrew MOSFET converter feeding a BC348RX tuning 4.6MHz. Antenna is a homebrew 6-element Yagi plus rotator at 30ft. Two-metre signals were heard from: F0AKD, FLAGV, F1CBH/A, F6BCK, F6BHI/P, G3IVE/M, G3TIR/P, G4AKA/P, GW3ONP/P, GW8PFU/M, PA0AKK, PA0VTR, PA0VV.

Stanley Sharred (South Yardley, Birmingham) sends in a super log for top band. His receiver is a CR150/2 and the antenna a horizontal Vee with 60ft. in each leg. "Ears" are Sharred Mk II's and the 160-metre stations heard: GM3TMK, GM3YOR, GW3VLX/P, GW3WSU/A, GW3ZQN, DL1FF, EP2BQ, HB9NL, K2ANR, LU5HFI, PY1DVG, 5Z4KL. A listen on 3.5MHz s.s.b. raised: GD6IA, C3IFO, CN8MN. KP4AN, LU2AFH, PY2CIQ, PY7BLV, VO1FG.

D. Dance (St. Boswell, Roxburghshire) claims to have logged the following stations using a CR70A, PR40 preselector, a.t.u. and a 264ft. end fed at 20ft. Topband c.w. signals from: DJ3CY, DL1FF, EI9J, GW3TLW, GW3UCB, OK1ATP, OK1MAC. On eighty c.w.; W4ZMQ, and W80N, while on eighty s.s.b.; CT1ADV, CN8MN, CT2BG, G3SKR/KP4, K2LWR, KP4AN, LU4CAM, OA4AKL, A OA4SS, VE1AHP, VE1ED, VO1BT, W3EGA, YV5AMW. Stanley even had a go on 7MHz and managed: LU5HFI, VK2BPN, ZL2BFU all on c.w., and VK3XI on s.s.b.

J. Eagland (Brighouse, Yorkshire) sends in a long, long log of G stations heard on 3.5MHz with the aid of his CR45 and 80ft. end-fed high up in the loft.

"I am a newcomer to Amateur Radio at the age of sixteen", says **John Hughes** (Gee—all those wasted years). John's equipment consists of an AR88LF, PR30 preselector "and a crude 60ft. of wire". The log for 14MHz reads: CT2BG, MP4BJR, OY3H, VK2MZ, VK3XI, VK5FM, VK6NM, VK8KK, ZE4NEB, ZD7SS, ZD7SD, ZK1PA, 5B4ES, 5X5FS, 6Y5ED, 7G1CD, 7Z3QR, 9F3USA, 9X5PK. John's best on eighty metres were: CX3BH, PJ2CW, PY2SUS, PY3GIQ, TF5TP, 3X2AX, 9G1DY, 9H1BX, 9J2WR. As a P.S. he asks where XK4 is hidden. Perhaps it's 20 miles each of XL4—anyone know for certain?

Stephen Fletcher (Bromsgrove, Worcester), has a 150ft. long wire in the loft and a homebrew, unaligned Heathkit SW717. Pick of Steve's best on eighty metres s.s.b.: CN8FL, VO1EL and 9H5D. Up on twenty metres Steve logged: CR4BS, CT1KA, EA2RAZ, EA3GN, HB9J, I0SNI, PJ2CW, PZ1DR, VE1HX, VE1WF, VK6JJ, VO1BT, VU2MX, YV3UN/P, YV5DER, 4X4UK, 7X2BK, 9H4E, 9Y4AVC, 9Y4VU, 9Y4VV, all on s.s.b. Ten metres produced: EA6BG and HB0AWQ, both on s.s.b.

BROADCAST BANDS

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

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

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

AMATEUR BANDS

Short Wave/VHF

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

The 'CONST-AMP'

a constant-current source

D. T. GOODWIN B. Sc.

ALTHOUGH a constant-current generator is not an essential piece of apparatus in the amateur's workshop, it is not without its uses. The "Const-Amp" is a simple yet effective constant current source which can be connected to almost any low voltage power supply. The circuit described has been designed to supply up to 100mA but with the data provided it is a simple matter to alter it to individual requirements.

CIRCUIT OPERATION

In the circuit of Fig. 1 it can be seen that the base voltage is accurately controlled by the zener voltage V_z . Thus, taking into account the base-emitter drop of the transistor V_{be} , the voltage across R_a is set and so its current is also set. This current $V_z - V_{be} / R_a$ can be assumed to flow completely into the collector circuit. By suitable choice of R_a the load current can be accurately set.

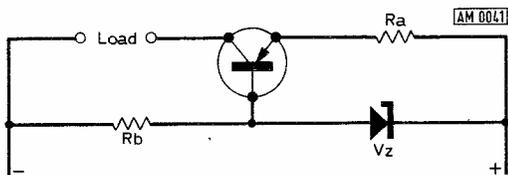
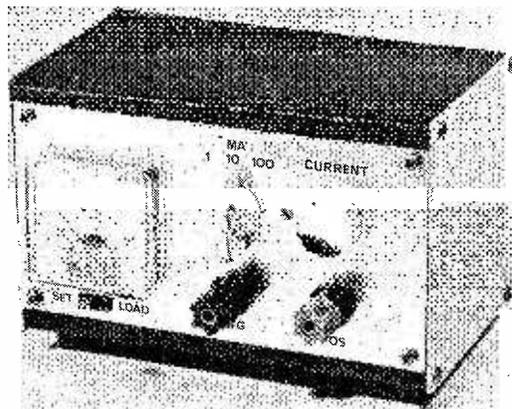


Fig. 1: A simple circuit for providing a constant current in a load.

The value of R_b must be chosen so that the current drawn through it, determined by the supply voltage minus the zener voltage, is greater than the zener operating current plus the transistor base

current. Assuming the transistor is of the OC28 family ($R_{fe} = 25$) then the base current is $I_c / 25$. Thus the current through R_b must be greater than I_z nominal + $I_c / 25$ but not so great that an excessive current is drawn through the zener. The only limit on R_a is that the maximum collector current of the transistor is not exceeded.



The 'Const-Amp' completed and ready for the workshop.

THEORY INTO PRACTICE

The completed circuit as shown in Fig. 2. The main control is $VR1/2$ which controls the amount of current flowing in the load, $R1$ being inserted so that the maximum collector current can be set. $R2$ has been calculated so that the zener is not overrun when $VR2$ is at minimum. $VR2$ ensures that when

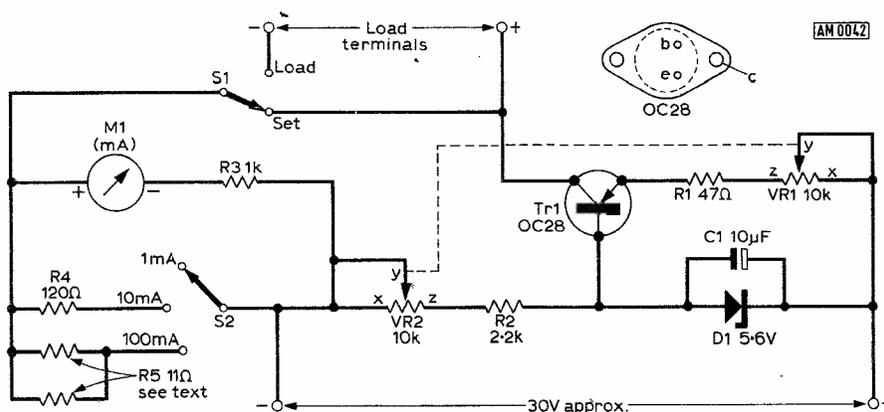


Fig. 2: Circuit of the 'Const-Amp'. $R1$ should be 1W, the remaining resistors $\frac{1}{2}W$ at 5% or better. The author used a 1mA meter of 75 Ω resistance but 100 Ω is suitable. The zener diode rating is 400mW (BZY88 series).

RECORD PLAYBACK HEADS (TRUVOX)

Individual prices of these are:
 2 track record playback heads 50p each
 4 track record playback heads 72p each
 Erase heads are also available separately—2 track 33p, 4 track 55p
 MC-metal mounting shields 89p each
 2 track-heads already fixed on heavy mounting plate with shield £1.22.

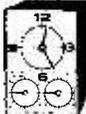


DRILL CONTROLLER NEW 1KW MODEL

Electrically changes speed from approximately 10 revs. to maximum. Pull power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. £1.95.
 Made up model also available. £2.95.

MIGHTY MIDGET

Probably the finest possible radio, as described in *Practical Wireless*, January '73. All electronic parts £2.20 post paid.



TIME SWITCH

Smith's mains driven clock with 15 amp switch, also notes showing how you can wake up with music playing, kettle boiling or come home to a warm house, warn off burglars, keep pets warm, halve your heating bill, etc. £1.95.

1 CHIP RADIO

Ferranti's latest device ZN414 gives results better than superhet. Supplied complete with technical notes and circuits. £1.38 each. 10 for £11.11.

HI-Q TUNER COMPONENTS

For experimenting with the ZN414.
 KIT NO. 1. Plessey Miniature Tuning Condenser with built-in LW switch and 3" Ferrite slab and litz wound MW coil, 72p.
 KIT NO. 2. Air spaced tuning condenser 6" ferrite rod litz wound MW and LW coils, 94p.
 KIT NO. 3. Air spaced TC with slow motion drive 8" ferrite rod, with litz wound LW and MW coils, £1.10.
 KIT NO. 4. Permeability tuner with fast and slow motion drive and LW loading coils, 50p.

ROCKER SWITCH

13 amp self-aligning into an oblong hole. Size approximately 1" x 1" 9p each. 10 for 82p.

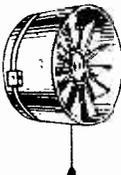


SLIDE SWITCHES

Slide Switch, 2-pole changeover panel mounting by two 6H.A. screws. Size approx. 1 1/2" x 3/4" rated 250V lamp. 8p each. 10 for 75p. Ditto as above but for printed circuit 6p each 10 for 65p.
 Sub Miniature Slide Switch. DPDT 19mm (1 1/2" approx.) between fixing centres. 20p each or 10 for £1.90. SP Change over spring return 250V, 1 amp. 11p.

MICRO SWITCH

5 amp changeover contacts. 11p each. 10 for 99p. 15 amp. on/off Model 15p Changeover 19p each.



EXTRACTOR FAN

Cleans the air at the rate of 10,000 cubic ft. per hour. Suitable for kitchens, bathrooms, factories, quieting rooms, etc. It's so quiet it can hardly be heard. Compact, 3 1/2" casing with 5 1/2" fan blades. Kit comprises motor, fan blades, sheet steel casing, pull switch, mains connector, and fixing brackets, £2.75 plus 20p post and ins.

MAINS OPERATED SOLENOIDS

Model 772—small but powerful lin. pull—approx size 1 1/2" x 1 1/2" x 1 1/2". 60p.
 Model 4001—1 1/2" lin. pull. Size 2 1/2" x 2 1/2" x 1 1/2". 85p.
 Model TTI—1 1/2" lin. pull. Size 3" x 2 1/2" x 2 1/2" lin. 95p plus 20p post and insurance.

MAINS TRANSISTOR POWER PACK

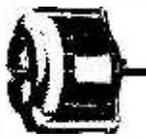
Designed to operate transistor sets and amplifiers. Adjustable output, 0v, 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP2, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor condensers and instructions. Real snip at only £1.10 plus 20p postage.

DESK TELEPHONES

Ex G.P.O. Black standard model with dialling dial but no internal bell. Supplied with connection diagram £1 each. Ditto with bell but without dialling dial £1.25 model as illustrated with bell and dial £1.50 each plus 50p post for single then 65p per pair.

PAPST MOTORS

Est. 1/40th h.p. Made for 110-120 volt working, but two of these work ideally together off our standard 240 volt mains. A really beautiful motor, extremely quiet running and reversibly. £1.65 each. Postage one-25p, two 33p, 230V model £3.30.



10 AMP DIMMER CONTROL

For the control of lighting on stage or in a studio or for control of portable equipment in workshops, etc. This has two 13 amp socket outlets each is controlled by a 5 amp solid state regulator. The overall length is 17in., width 3 1/2in. and depth 1 1/2in. In the end is fitted a master On/Off switch indicator, lamp and fuse. Price £8.25.

STANDARD WAFER SWITCHES

Standard size 1 1/2" wafer—silver-plated 5 amp contact, standard 1/4" spindle 2 1/2" long, with locking washer and nut.

No. of Poles	2Way 3 way	4Way 5Way	6Way 8Way	10Way 12Way
1 pole	44p	44p	44p	44p
2 poles	44p	44p	44p	44p
3 poles	44p	44p	44p	44p
4 poles	44p	44p	44p	44p
5 poles	44p	44p	44p	44p
6 poles	44p	44p	44p	44p
7 poles	77p	77p	77p	77p
8 poles	77p	77p	77p	77p
9 poles	77p	77p	77p	77p
10 poles	77p	77p	77p	77p
11 poles	77p	77p	77p	77p
12 poles	77p	77p	77p	77p

THE TWENTYLITE

Fluorescent lighting units with polyester choke and finished white enamel. 2ft. model. Ideal kitchen, bedroom, hallway, porch, lift, etc., with tube. Assembled ready to install. Price £2.50—25p p. & p.



MULLARD UNILEX

This D.I.Y. Stereo Amplifier is still available complete at £7.00 for the four Mullard Modules, or Modules can be bought separately as follows:—4 watt amplifier module (2 required) Mullard Ref. No. E.P.9000—£1.60. Pre amp module Mullard Ref. No. E.P.9001—£1.98 each. Power Module—Mullard Ref. No. E.P.9002—£2.58 each. In addition made to Mullard specification we offer—Standard Control Unit with escutcheon and knobs—£3.30. Knobs—Set of 4—50p. Special offer the complete Unilex with control panel at Pre VAT price £10.00 post paid.

TANGENTIAL HEATER UNIT

This heater unit is the very latest type, most efficient, and quiet running. Is as fitted in Hoover and blower heaters costing £15 and more. We have a few only. Comprises motor, impeller, 2kW, element and 1kW, element allowing switching 1, 2 and 3kW, and with thermal safety cut-out. Can be fitted into any metal line case or cabinet. Only needs control switch. £3.85, 2kW. Model as above except 2kW. £2.75. Don't miss this. Control Switch 39p, P. & P. 40p.



CENTRIFUGAL FAN

Mains operated, turbo blower type. Pressed steel housing contains motor and impeller. Motor is 1/10th h.p. giving considerable air flow but virtually no noise. Approx. dimensions 10 1/2 in. wide x 1 1/2 in. dia. outlet into trunking 10 x 4 1/2 in. £3.55 plus 21 post and insurance.



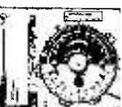
TAPE PLAYBACK UNITS

Mains operated. Made by Reditune the famous "music in background people". These are complete units ready to work and we understand that they are in good going order. We have not tested them but would exchange any that do not work properly. These have a superior motor driven fly wheel to control the tape through the capstan and also an even equally useful valve amplifier with EL84 output. In a steel case with carrying handle. Two models offered, good as new £8.50 and somewhat used at £3.50. 75p carriage up to 200 miles then 50p per 100 miles extra.



24-HOUR TIME SWITCH

Made by Smith's these are AC mains operated, NOT CLOCKWORK. Ideal for mounting on rack or shelf or can be built into box with superior motor driven fly wheel to control the tape through the capstan and also an even equally useful valve amplifier with EL84 output. In a steel case with carrying handle. Two models offered, good as new £8.50 and somewhat used at £3.50. 75p carriage up to 200 miles then 50p per 100 miles extra.



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All in module form, each ready built complete with heat sinks and connection tags, data supplied.
 Model 1153 600mW power output 72p.
 Model 1172 750mW power output 94p.
 Model EP9000 4 watt power output £1.60.
 EP9001 twin channel or stereo pre amp. £1.99 100% discount if 10 or more ordered.



THIS MONTH'S SNIP

ROOM THERMOSTAT. Made by the famous Smiths Company. 15 amp. at 250v. Elegant white and beige case, size 4 1/2 inches long by 1 1/2 square approx. Adjustment is by slider (lockable) adjusts through range 30°—90°F. Special Snip price £1.65

TERMS: 10% discount if ten of an item ordered, send postage where quoted—other items, post free if order for these items is £8.00 otherwise add 20p.

NEW ITEMS THIS MONTH

MINIATURE SEALED RELAY

American made. Our Ref.: REL AL. Measures only 1 1/2" wide x 1 1/2" thick and 2 1/2" high and it's a double change over, we don't know the contact rating but estimate this at 3/5 amps. The coil resistance is 600 ohms and 9-12 volt will close it. Ideal for models and miniaturised equipment. It's a plug in relay but we supply complete with base. Price 28p including base.

SUB-MINIATURE MICROSWITCH

Made by Burgess, their ref. V4T6—our ref. MS. A1. These measure only 1 1/2" x 1 1/2" x 1 1/2" thick—have change over contacts and tag connection. Price 16p each or 10 for £1.44.

3 CORE MAINS FLEX

Metric size 5mm which is approx. equivalent to the old 14/36 rating. Suitable therefore for mower or similar portable tools. Cores are colour coded to the new European standard. Brown—live; Blue—neutral; Yellow/Green—earth. Grey P.V.C. covered overall. 100m coils £5. 50m coils £3 and 25m coils £1.75. Post 40p on 100m. 25p for 50m coils and 20p for 25m coils.

PANIC SWITCHES

Tough enough to be foot switches and elegant enough to be panel switches. Bakelite construction with white push rod. Price 40p less quantity discounts. Switch is rated 250V—2 amp.

12 VOLT 1 1/2 AMP POWER PACK

This consists of double-wound 230/240V mains transformer with full wave rectifier and 2000 mF smoothing. Price £2.20 p. & p. 20p.

6 MAINS TRANSFORMERS

Our Ref.: MTM1 27 volt at 8 amp. Upright mounting fully shrouded—flying leads—fully tapped primary. Price £3.30.
 Our Ref.: MTM2 12v at 1 amp. Upright mounting with fixing lugs, tag connection. 240v primary—12v 1 amp secondary. Price 32p.
 Our Ref.: MTM3 6-3v 2 amp upright mounting with fixing lugs, tag connections. 240v primary 6-3v 2 amp secondary. Price 77p.
 Our Ref. MTM4 18v—1 amp with thermal cut-out. upright mounting with fixing lugs—tag connections. Primary 240v—secondary 18v at 1 amp. Price 89p.
 Mains Isolation MTM5 250 volts earth shielded flex leads—upright mounting lugs for fixing. Price £4.40 each.

6 VOLT RELAYS

Our ref.: REL M1. Removable clear plastic enclosed two screw fixing. Have a 6 volt D.C. operated coil but two change-over contacts, each rated to make and break 240v A.C. at 15 amps. Price 60p each.

P.O. TYPE 3000 RELAY

Our ref.: REL M2—100 ohm coil and 2 pair normally open heavy duty contacts. Price 75p each.

6 DIGIT COUNTER

Resettable. 400 ohm coil up to 25 impulses per second. Ex-equipment but guaranteed perfect. £2.20 each.



COMBINATION SWITCH

This comprises of 12 miniature change-over micro switches. Jointed in banks of 3 and mounted on frame with four digital numbered thumb wheels and a removable lever for locking the thumb wheel—the thumb wheel operates 3 banks. Over 4,000 combinations are possible but by re-wiring the switch connections underneath then thousands more variations are possible. If you are making equipment which you don't want switched on accidentally or without authority then this is a switch to consider—this can also be used as a coding switch for many other operations. Very neat and compact and measuring approx. 4" x 1 1/2" x 1 1/2" deep. Priced at £3.03.



PUSH BUTTON SWITCH

Type 14 D.M.G. A very fine switch made by Honeywell. The switch is intended for mounting on panel through oblong hole. No screws required for fixing its sprung clips secure it quite firmly. The operating button is approx. 1 1/2" dia. round and dished for ease of operation. Has 2 sets of 10 amp change-over contacts. Spring loaded, returns to normal when pressure is released. Ideal for instrument or quality gear. Price 60p each. 10 for £4.50, 100 for £40.

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We stock a large range of transistors and I.C.s, for details please see our catalogue. LOOK! These popular devices at amazingly low prices. BC107/8 9 1/2p each. BC169C 12p. BFY51 16p. TIS43 (SS43) 28p. 2N706 45p. 2N2646 45p. 2N3055 49p. 2N3819 24p.

DIN PLUGS. 3 pin, 9p. 5 pin A (180°), 5 pin B (240°), 10p each.
DIN SOCKETS. 3 pin, 5 pin A, 5 pin B, 7p each.
DIN LOUDSPEAKER. 2 pin plug, 8p. Socket 6p.
JACK PLUGS standard 1/4in plastic barrel, 13p, Stereo, 25p. Bright metal barrel, 17p. Stereo, 29p. Jack sockets standard 1/4in open type 10p, Moulded 2 break 13p, Moulded stereo 3 break 18p

ROTARY SWITCHES
Adjustable stop, 1 pole 2-12 way, 2 pole 2-6 way, 3 pole 2-4 way, 4 pole 2-3 way. Only 24p each.

SPECIAL IC, for organ builders, 7 stage frequency divider in one 14 pin DIL package, £2.63 or special price for pack of 12, £25.

Why not ask us to slip a data sheet in with your catalogue.

POTENTIOMETERS

Miniature carbon track with 1/4in spindles. 5kΩ, 10kΩ, 25kΩ, 50kΩ, 100kΩ, 250kΩ, 500kΩ, 1MΩ, 2MΩ. Log or lin (and 1kΩ lin), 12p. Log or lin with switch 23p. Dual gang less switch 38p.

HARDWARE
Wide range of nuts and bolts, plated brass and nylon types plus solder tags, shakeproof washers, etc.
SOLDER 10 metres of 22 gauge multi-core, 20p.
Insulating sleeving 3 sizes, 6 colours.

MISCELLANEOUS
LT700 Eagle sub-miniature O/P transformer 1200/50 200mW max., 35p. Slide switch DPDT, 12p. Miniature Push to make non-locking switch 12p. Silicon grease in special dispenser, 20ml, 38p.

SEE OUR CATALOGUE for details of how you can obtain £1 worth of components.

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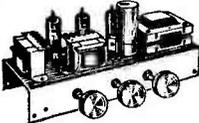
Postage and packing FREE in U.K. But we have to ask you to send a 10p handling charge with order under 50p.

SUPERSOUND 13 HI-FI MONO AMPLIFIER



A superb solid state audio amplifier. Brand new components throughout. 5 silicon transistors plus 2 power output transistors in push-pull. Full wave rectification. Output approx. 13 watts r.m.s. into 8 ohms. Frequency response 12Hz-30KHz ±3db. Fully integrated pre-amplifier stage with separate Volume, Bass boost and Treble cut controls. Suitable for 8-15 ohm speakers. Input for ceramic or crystal cartridge. Sensitivity approx. 40mV for full output. Supplied ready built and tested, with knobs, esatechone panel, input and output plugs. Overall size 3 1/2" high x 6 1/2" wide x 7 1/2" deep. AC 200/250V. **PRICE £11.60** P. & P. 25p.

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A.C. mains 200-240 v. Using heavy duty fully isolated mains transformer with full wave rectification giving adequate smoothing with negligible hum. Valve line up—2 x ECL86 Triode Pentodes, 1 x EZ30 as rectifier. Two EC20 as rectifier. Two dual potentiometers are provided for bass and treble control, giving bass and treble boost and cut. A dual volume control is used. Balance of the left and right hand channels can be adjusted by means of a separate 'Balance' control fitted at the rear of the chassis. Input sensitivity is approximately 300mV for full peak output of 4 watts per channel (8 watts mono) into 8 ohm speakers. Full negative feedback in a carefully calculated circuit, allows high volume levels to be used with negligible distortion. Supplied complete with knobs, chassis size 11 1/2" x 4 1/2". Overall height including valves 5 1/2". Ready built & tested to a high standard. **PRICE £29.90** P. & P. 45p.

PRECISION ENGINEERED PLINTHS
Beautifully constructed in heavy gauge "Colorcoat" plastic covered steel. Resonance free. Designed to take Garrard 1025, 2000, 2025TC, 2500, 3000, 3500, 5109, SP25 II and III, SL85B, AT80 etc. or B.S.R. C109, C129, A21 etc. Black leatherette finish. Size 12 1/2" x 14 1/2" x 3 1/2" high (approx. 7 1/2" high, including rigid smoked acrylic cover). **NOW £4.95** P. & P. 35p. **ONLY**

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the base current drops the current drawn through the zener does not increase to a dangerous amount. The zener diode that was used was a 400mW one and tests have shown that although the manufacturers recommended working current is 5mA the voltage remains steady with less than 1mA flowing.

The capacitor C1 has been added to ensure that rapid changes in supply voltage, such as from a poorly stabilised supply, do not adversely affect the zener voltage. In the meter circuit it was deemed necessary to add the switch S1 to the original design thus enabling the current to be set before it is allowed to flow through the load, thus eliminating costly mistakes. The power transistor is of the OC28 family, so the maximum collector current is of the order of 1A but if any significant current is likely to be drawn, say above 250mA, a heat-sink will be required.

CIRCUIT LIMITATIONS

The maximum load that can be supplied by this circuit will vary and is dependent on the current drawn and the supply potential. The prototype was designed for a 30 volt supply and thus the maximum load resistance (R) which can be supplied with a load current (I) is given by the following equation $R = V_s - V_z + V_{be} / I$. So for a load current of 100mA the maximum load for the prototype would be approximately 250Ω, for 10mA it would be 2.5kΩ and for 1mA it would be 25kΩ.

The circuit of Fig. 2 will supply up to 100mA with the minimum current being 0.5mA. If a higher supply voltage is used the designer must ensure that the zener is never overrun and if a higher current is desired the meter circuit and base current circuits must be altered.

The meter circuit needs little explanation. It has been designed to give an accuracy of about 5% and this should be an acceptable error for such a device and needs no alteration. If a meter of a greatly different resistance is used it may be necessary to alter some of the resistor values, but a meter of 100Ω should also give satisfactory results.

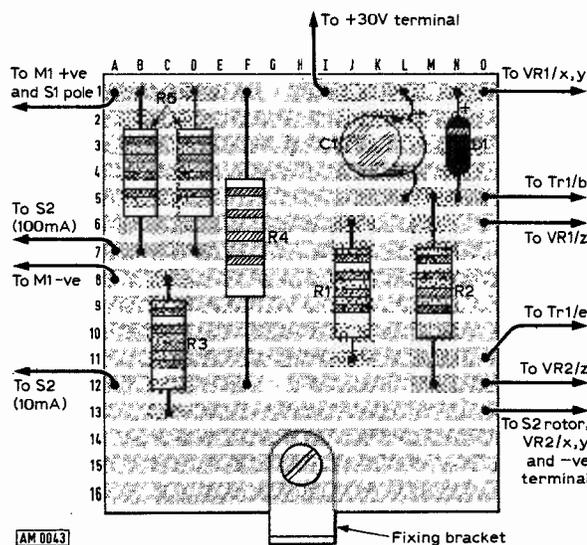
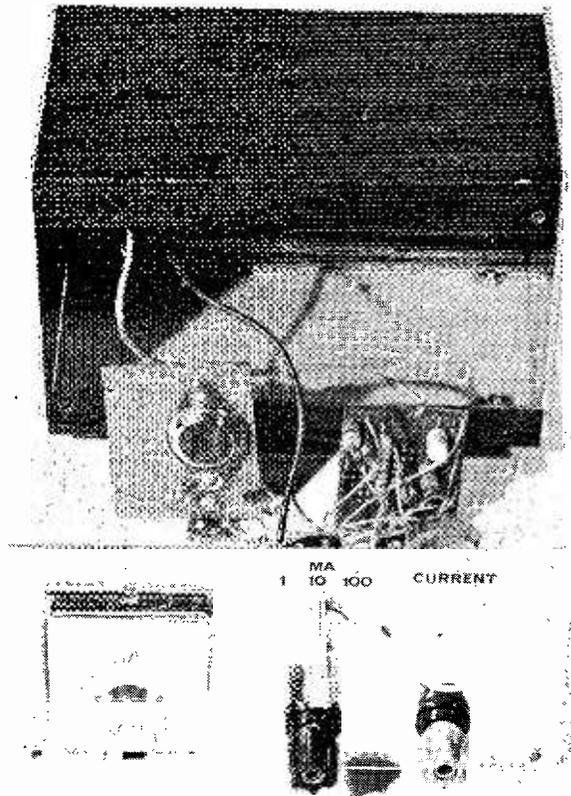


Fig. 3: A small piece of 0.1in. matrix veroboard will take the few components. The board could be omitted and the components wired directly between the panel components.



General construction of the 'Const-Amp' can be seen here.

CONSTRUCTION

The circuit, apart from the output transistor, was built on a small piece of veroboard, shown in Fig. 3, R5 consisting of 2 x 22Ω resistors in parallel to obtain the 11Ω required. The whole instrument was built into a case 6 x 4 x 3.1in. and was very light and sturdy.

The OC28 transistor was mounted on a piece of s.r.b.p. board. If a heat-sink is fitted ensure that it is electrically isolated from the rest of the circuit.

OPERATIONAL NOTES

Before switching on the device the meter selector switch should be switched to its maximum value of 100mA. Linear potentiometers for VR1 and VR2 give a rapid rise in current towards the end of their travel so log potentiometers may be preferred. R1 may need to be reduced in value because the potentiometers minimum resistance may reduce the maximum obtainable current.

If possible a well regulated DC supply would be preferred but a simple supply as shown in Fig. 4 should suffice and give little ripple on the output current.

APPLICATIONS

Many types of equipment require a constant current supply. One application is the testing of semiconductor devices and the measurement of



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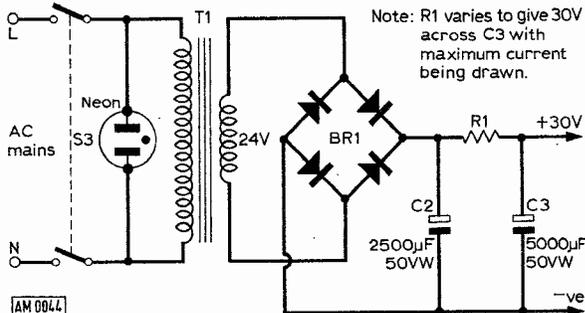


Fig. 4: Suggested circuit for power supply for use with the 'Const-Amp'.

transistor parameters. For example, in the evaluation of zener diodes it is important to use a constant current source. Also, most tunnel diode circuits perform at their best when operated from a source possessing constant current characteristics.

Ordinary diodes can be tested simply by placing them across the output terminals and watching the meter. In one direction the current should flow and in the other there should be very little or no current flow. It can also be used in conjunction with a voltmeter, to measure low values of resistance. A suitable current is chosen and applied to the resistor and the voltage across it is measured. Ohm's Law then provides the resistance value. Finally, it can also be used as a constant current battery charger, within the current limitations, with the advantage that the terminals may be shorted together without damaging the charger circuit.

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PW for November will contain Datacards Nos. 3 and 4 having a special appeal to those who need to inter connect audio equipment but can never find the DIN plug and socket information when they want it! Decibels come into the limelight with a simple explanation and a chart that will enable readers to decipher some of the weird terms used in some audio equipment brochures.

Datacards Nos. 5 and 6 will appear in the December issue of P.W. providing one chart for the rapid determination of current, voltage, power and resistance in DC circuits and another chart to assist in obtaining that odd value of resistance that is sometimes required, by connecting two or more resistors in parallel. The same chart can also be used for capacitors in series.

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EAB0C80	1-00	EF89	0-81	PC94	0-62	PL802	0-96	PCF805	0-90
EB01	0-38	EF91	1-80	PC98	0-65	PY33	0-66	30F6/PS818	
EB01	0-38	EF91	1-80	PC98	0-65	PY81/800	0-50	1-10	
EB01	0-38	EF91	1-80	PC98	0-65	PY82	0-55	30FL1/	0-75
EB01	0-38	EF91	1-80	PC98	0-65	PY83	0-50	PCF800	0-75
EB01	0-38	EF91	1-80	PC98	0-65	PY84	0-50	30FL2	0-75
EB01	0-38	EF91	1-80	PC98	0-65	PY85	0-50	30FL12	1-05
EB01	0-38	EF91	1-80	PC98	0-65	PY86	0-50	30FL14	0-85
EB01	0-38	EF91	1-80	PC98	0-65	PY87	0-50	30FL1/PC884	
EB01	0-38	EF91	1-80	PC98	0-65	PY88	0-50	1-10	0-52
EB01	0-38	EF91	1-80	PC98	0-65	PY89	0-50	30L15/PC805	
EB01	0-38	EF91	1-80	PC98	0-65	PY90	0-50	1-10	1-05
EB01	0-38	EF91	1-80	PC98	0-65	PY91	0-50	1-10	0-90
EB01	0-38	EF91	1-80	PC98	0-65	PY92	0-50	1-10	0-90
EB01	0-38	EF91	1-80	PC98	0-65	PY93	0-50	1-10	0-90
EB01	0-38	EF91	1-80	PC98	0-65	PY94	0-50	1-10	0-90
EB01	0-38	EF91	1-80	PC98	0-65	PY95	0-50	1-10	0-90
EB01	0-38	EF91	1-80	PC98	0-65	PY96	0-50	1-10	0-90
EB01	0-38	EF91	1-80	PC98	0-65	PY97	0-50	1-10	0-90
EB01	0-38	EF91	1-80	PC98	0-65	PY98	0-50	1-10	0-90
EB01	0-38	EF91	1-80	PC98	0-65	PY99	0-50	1-10	0-90
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CL33	1-50	EF89	0-28	PC90	0-48	U14	1-00	678GT	0-75
CY31	0-50	EF91	0-37	PC94	0-40	U25	0-85	678M	0-43
DAF91	0-30	EF92	0-35	PC88	0-55	U26	0-85	678GT	0-40
DAF96	0-50	EF95	0-40	PC99	0-50	U26	0-85	678GT	0-40
DC90	1-35	EF92	0-75	PC189	0-80	U26	0-85	678GT	0-40
DF91	0-30	EF183	0-30	PCF80	0-30	U26	0-85	678GT	0-40
DF96	0-50	EF184	0-35	PCF82	0-35	U26	0-85	678GT	0-40
DK91	0-45	EL32	0-60	PCF86	0-60	U26	0-85	678GT	0-40
DK92	0-70	EL33	1-75	PCF801	0-50	U26	0-85	678GT	0-40
DK96	0-60	EL34	0-50	PCF802	0-50	U26	0-85	678GT	0-40
DL92	0-40	EL36	0-50	PCF805	0-80	U26	0-85	678GT	0-40
DL94	0-48	EL37	2-35	PCF806	0-75	U26	0-85	678GT	0-40
DL96	0-55	EL41	0-90	PCF808	0-85	U26	0-85	678GT	0-40
DY86/87	0-37	EL42	0-80	PCL82	0-35	U26	0-85	678GT	0-40
DY802	0-37	EL84	0-25	PCL83	0-66	U26	0-85	678GT	0-40
EAB0C80	0-38	EL95	0-35	PCL84	0-45	U26	0-85	678GT	0-40
EAF42	0-75	ELL80	1-00	PCL85	0-50	U26	0-85	678GT	0-40
EB01	0-22	EM80	0-45	PCL86	0-45	U26	0-85	678GT	0-40
EBC83	1-00	EM81	0-60	PCL806/85		U26	0-85	678GT	0-40
EB01	0-75	EM84	0-35			U26	0-85	678GT	0-40
EB01	0-38	EM85	1-00	PD500	1-30	U26	0-85	678GT	0-40
EB01	0-40	EV71	0-40	PEK45	0-75	U26	0-85	678GT	0-40
EB01	0-40	EV86	0-40	PL30	0-55	U26	0-85	678GT	0-40
EB01	0-32	EZ40	0-75	PL81	0-60	U26	0-85	678GT	0-40
EBL31	1-50	EZ41	0-75	PL82	0-45	U26	0-85	678GT	0-40
ECC81	0-40	EZ80	0-25	PL83	0-45	U26	0-85	678GT	0-40
ECC82	0-38	EZ81	0-28	PL84	0-40	U26	0-85	678GT	0-40
ECC83	0-33	G7501	0-80	PL800	0-75	U26	0-85	678GT	0-40
ECC84	0-30	GZ20	0-45	PL504	0-75	U26	0-85	678GT	0-40
ECC85	0-40	GZ32	0-50	PL508	0-90	U26	0-85	678GT	0-40
ECC86	0-40	GZ34	0-60	PL509	1-55	U26	0-85	678GT	0-40
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ECH83	0-45	KT66	2-35	PK33	0-65	U26	0-85	678GT	0-40
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ECL82	0-35			PK82	0-35	U26	0-85	678GT	0-40
ECL83	0-68	KT81	1-75	PK83	0-38	U26	0-85	678GT	0-40
ECL86	0-40	KT88	2-25	PK88	0-40	U26	0-85	678GT	0-40
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AA215	0-10	BF167	0-25	OC25	0-40	ZTX503	0-17	2N2904A	0-25
AC107	0-35	BF173	0-25	OC25	0-40	ZTX551	0-20	2N2905	0-28
AC126	0-25	BF179	0-35	OC28	0-65	ZTX550	0-20	2N2905A	0-28
AC127	0-25	BF180	0-30	OC35	0-50	IN914	0-7	2N2926	0-20
AC128	0-25	BF181	0-32	OC36	0-65	IN4001	0-7	2N2926	0-10
AC176	0-25	BF194	0-15	OC42	0-40	IN4002	0-7	2N3053	0-20
AC187	0-25	BF195	0-15	OC44	0-15	IN4003	0-8	2N3055	0-55
AC188	0-25	BF197	0-15	OC45	0-15	IN4004	0-8	2N3252	0-75
ACY21	0-20	BF200	0-35	OC45	0-15	IN4004	0-8	2N3252	0-75
ACY39	0-55	BFS61	0-25	OC71	0-15	IN4005	0-10	2N3614	0-50
AD140	0-50	BFS98	0-25	OC72	0-25	IN4006	0-12	2N3615	0-75
AD149	0-50	BFX29	0-25	OC76	0-40	IN4007	0-15	2N3702	0-10
AD161	0-35	BFX88	0-20	OC77	0-45	IN4009	0-5	2N3703	0-10
AD162	0-35	BFY50	0-20	OC81	0-25	IN4148	0-15	2N3704	0-10
AF116	0-25	BFY51	0-20	OC81	0-25	IN4148	0-15	2N3704	0-10
AF116	0-25	BFY52	0-20	OC81	0-25	IN4148	0-15	2N3704	0-10
AF117	0-20	BFW10	0-61	OC81	0-25	IN4148	0-15	2N3704	0-10
AF186	0-40	BY100	0-15	OC81	0-25	IN4148	0-15	2N3704	0-10
AF239	0-40	BY128	0-15	OC81	0-25	IN4148	0-15	2N3704	0-10
AFY27	0-80	BY127	0-15	OC81	0-25	IN4148	0-15	2N3704	0-10
AFY28	0-80	BZX61 series		OC81	0-25	IN4148	0-15	2N3704	0-10
BA102	0-30	BZX61 series		OC81	0-25	IN4148	0-15	2N3704	0-10
BA115	0-7	BZY88 series		OC81	0-25	IN4148	0-15	2N3704	0-10
BC107	0-10			OC81	0-25	IN4148	0-15	2N3704	0-10
BC108	0-10	CRS1-05	0-25	OC81	0-25	IN4148	0-15	2N3704	0-10
BC109	0-10	CRS1-40	0-35	OC81	0-25	IN4148	0-15	2N3704	0-10
BC113	0-15	CRS3-05	0-30	OC81	0-25	IN4148	0-15	2N3704	0-10
BC117	0-15	CRS3-40	0-45	OC81	0-25	IN4148	0-15	2N3704	0-10
BC143	0-35	MJE340	0-50	OC81	0-25	IN4148	0-15	2N3704	0-10
BC147	0-12	MJE370	0-70	OC81	0-25	IN4148	0-15	2N3704	0-10
BC148	0-10	MJE520	0-75	OC81	0-25	IN4148	0-15	2N3704	0-10
BC169C	0-12	MJE2955	1-10	OC81	0-25	IN4148	0-15	2N3704	0-10
BC182	0-10	MJE3055	0-75	OC81	0-25	IN4148	0-15	2N3704	0-10
BC182L	0-12	MPP102	0-42	OC81	0-25	IN4148	0-15	2N3704	0-10
BCY32	0-60	MPP103	0-85	OC81	0-25	IN4148	0-15	2N3704	0-10
BCY33	0-60	MPP104	0-37	OC81	0-25	IN4148	0-15	2N3704	0-10
BCY33	0-34	MPP105	0-40	OC81	0-25	IN4148	0-15	2N3704	0-10
BCY34	0-35	NKT404	0-50	OC81	0-25	IN4148	0-15	2N3704	0-10
BOY70	0-15	0A5	0-50	OC81	0-25	IN4148	0-15	2N3704	0-10
BOY71	0-20	0A10	0-35	OC81	0-25	IN4148	0-15	2N3704	0-10
BOY72	0-15	0A79	0-7	OC81	0-25	IN4148	0-15	2N3704	0-10
BCZ11	0-50	0A81	0-10	OC81	0-25	IN4148	0-15	2N3704	0-10
BD121	0-75	0A91	0-7	OC81	0-25	IN4148	0-15	2N3704	0-10
BD124	0-80	0A200	0-7	OC81	0-25	IN4148	0-15	2N3704	0-10
BD131	0-75	0A202	0-10	OC81	0-25	IN4148	0-15	2N3704	0-10

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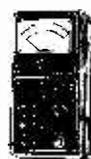
MODEL TH-12

20,000 o.p.v. overload protection. Slide switch selector 0/25/2.5/10/50/250/1000V. D.C. 0/10/50/250/1000V. A.C. 0/50µA/250/250mA. D.C. 0/3K/30K/800K/3 meg ohm -20 to +50dB. £4.97. Post 15p.



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High sensitivity tester. 200,000 o.p.v. Overload protection. Mirror scale. Ranges: 0/-06/3/3/30/120/600/1200V. D.C. 0/2/12/60/300/11,200V. A.C. 0/2µA/1.2mA/120mA/600mA/12A. D.C. 0/12A. A.C. -20 to +63dB. 0/2K/200K/2 meg/200 meg ohms. £16.95. Post 30p.



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10 meg. input 10 ranges: 01/003/1/3/1/3/10/30/100/300V. R.M.S. depts. -1.2 Mc/s. Decibels -40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V. A.C. £17.50. Carr. 25p.



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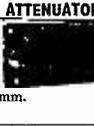
RUSSIAN CI-16 DOUBLE BEAM OSCILLOSCOPE

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All transistorised, compact, fully portable. AF sine wave 18 Hz to 220 KHz. AF square wave 18 Hz to 100 KHz. Output sine / square 10v. P-P. RF 100 KHz to 220MHz. Output I.v. maximum. Operation 220/240V. AC. Complete with instructions and leads. £29.95. Post 60p.



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Transistorised. Operates as Grid Dip, Oscillator, Absorption Wave Meter and Oscillating Detector. Frequency range 440Kc/s-250Mc/s in 6 coils. 500µA Meter. 9V battery operation. Size 180 x 80 x 40mm. £15.00. Post 20p.



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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 £17.50. Carr. 37p. Size 140 x 215 x 170 mm.



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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. 37p.



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1500 W	£11.25	P. & P. 43p
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RP214 REGULATED POWER SUPPLY

Solid state. Variable output 0-24V DC up to 1 amp. Dual scale meter to monitor voltage and current. Input 220/240V AC. Size 185 x 85 x 105mm. £8.97 P. & P. 25p.



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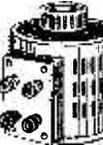
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Excellent quality at low cost. All models—Output 230V, 50/60 c/s. Variable output 0-250V.



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5 Amp ..	£11.75
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12 Amp ..	£23.60
20 Amp ..	£40.00
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POWER RHEOSTATS

High quality ceramic construction. Windings embedded in vitreous enamel. Heavy duty brush wiper. Continuous rating. Wide range available ex-stock. Single hole fitting. 1/4 in. dia. shafts. Bulk quantities available.

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Over 200 ranges in stock—other ranges to order. Quantity discounts available. Send for fully illustrated brochure.

Type SW.100 100 x 80 mm.

50-0-50µA	£4.15
50-0-50µA	£3.95
100µA	£3.95
100-0-100µA	£3.90
500µA	£3.70
1mA	£3.60
10 amp.	£3.10
50V. D.C.	£3.60
50V. D.C.	£3.60
300V. A.C.	£3.70
1 amp. D.C.	£3.60



5 amp. D.C. £3.60
300V. A.C. £3.70
VU Meter £4.30

Type SD.830 82.5mm x 110mm Fronts

10mA	£3.10
50mA	£3.10
100mA	£3.10
500µA	£3.10
500-0-500µA	£3.10
1mA	£3.90
1-0-1mA	£3.90
5 amp.	£3.10
10 amp.	£3.10
6V. D.C.	£3.10
10V. D.C.	£3.10
20V. D.C.	£3.10
50V. D.C.	£3.10
300V. D.C.	£3.10
15V. A.C.	£3.90
300V. A.C.	£3.90
5mA	£3.10



Type SD.640 63.5mm x 85mm Fronts

50µA	£3.05
50-0-50µA	£3.05
100µA	£3.00
100-0-100µA	£3.00
200µA	£3.00
500µA	£2.95
1mA	£2.90
5mA	£2.90
10mA	£2.90
50mA	£2.90
100mA	£2.90
500µA	£2.90
500-0-500µA	£2.90
1mA	£2.90
1-0-1mA	£2.90
5 amp.	£2.90
10 amp.	£2.90
5V. D.C.	£2.90
20V. D.C.	£2.90
50V. D.C.	£2.90
300V. D.C.	£2.90
15V. A.C.	£2.90
300V. A.C.	£2.90
100mA	£2.90
VU Meter	£3.15

Type SD.460 46mm x 59.5mm Fronts

50µA	£2.60
50-0-50µA	£2.60
100µA	£2.75
100-0-100µA	£2.75
200µA	£2.70
500µA	£2.65
1mA	£2.60
5mA	£2.60
10mA	£2.60
50mA	£2.60
100mA	£2.60
500µA	£2.60
500-0-500µA	£2.60
1mA	£2.60
1-0-1mA	£2.60
5 amp.	£2.60
10 amp.	£2.60
5V. D.C.	£2.60
20V. D.C.	£2.60
50V. D.C.	£2.60
300V. D.C.	£2.60
15V. A.C.	£2.70
300V. A.C.	£2.70
100mA	£2.60
VU Meter	£2.90



"SEW" EDGWISE METERS

Type PE.70. 3 1/2 1/32in. x 1 1/2 1/32in. x 2 1/2in. deep

50µA	£3.75
50-0-50µA	£3.60
100µA	£3.60
100-0-100µA	£3.50
200µA	£3.40
500µA	£3.40
1mA	£3.40
500µA	£3.90
1mA	£3.90
300V. A.C.	£3.25
VU Meter	£3.95

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Type MR.85P. 4 1/4in. x 4 1/2in. fronts

50µA	£3.90
100mA	£3.90
500µA	£3.90
1 amp.	£3.90
5 amp.	£3.90
15 amp.	£3.90
30 amp.	£3.95
20V. D.C.	£3.90
50V. D.C.	£3.90
150V. D.C.	£3.90
300V. D.C.	£3.90
15V. A.C.	£3.95
300V. A.C.	£3.95
8 Meter 1mA	£3.90
VU Meter	£4.55
1 amp. A.C.*	£3.90
5 amp. A.C.*	£3.90
10 amp. A.C.*	£3.90
20 amp. A.C.*	£3.90
30 amp. A.C.*	£3.90



Type MR.52P. 2 1/2in. square fronts

50µA	£2.60
50-0-50µA	£2.60
100µA	£2.60
100-0-100µA	£2.60
500µA	£2.60
1mA	£2.60
5mA	£2.60
10mA	£2.60
50µA	£2.60
50-0-50µA	£2.60
100µA	£2.60
100-0-100µA	£2.60
500µA	£2.60
1mA	£2.60
5 amp.	£2.60
10V. D.C.	£2.60
20V. D.C.	£2.60
50V. D.C.	£2.60
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15V. A.C.	£2.60
300V. A.C.	£2.60
8 Meter 1mA	£2.60
VU Meter	£2.60
1 amp. A.C.*	£2.60
5 amp. A.C.*	£2.60
10 amp. A.C.*	£2.60
20 amp. A.C.*	£2.60
30 amp. A.C.*	£2.60

Type MR.65P. 3 1/2in. x 3 1/2in. fronts

50µA	£3.70
50-0-50µA	£3.70
100µA	£3.70
100-0-100µA	£3.70
200µA	£3.70
500µA	£3.70
1mA	£3.70
500-0-500µA	£3.70
1mA	£3.70
1-0-1mA	£3.70
5 amp.	£3.70
10V. D.C.	£3.70
20V. D.C.	£3.70
50V. D.C.	£3.70
160V. D.C.	£3.70
300V. D.C.	£3.70
15V. A.C.	£3.70
300V. A.C.	£3.70
8 Meter 1mA	£3.70
VU Meter	£3.70
1 amp. A.C.*	£3.70
5 amp. A.C.*	£3.70
10 amp. A.C.*	£3.70
20 amp. A.C.*	£3.70
30 amp. A.C.*	£3.70

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Type ED.107. Size overall 100mm x 90mm x 108mm

A new range of high quality moving coil instruments ideal for school experiments and other bench applications. 3" mirror scale. The meter movement is easily accessible to demonstrate internal working. Available in the following ranges:

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100µA	£6.40
500-0-500µA	£6.40
1mA	£5.95
1-0-1mA	£5.95
1A d.c.	£5.95
5A d.c.	£5.95
10V d.c.	£5.95
20V. d.c.	£5.95
50V. d.c.	£5.95
300V. d.c.	£5.95
Dual range	
500mA/5A d.c.	£7.00
5V/50V d.c.	£7.00



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

200mA	£2.25
300mA	£2.25
500mA	£2.25
750mA	£2.25
1 amp.	£2.25
2 amp.	£2.25
5 amp.	£2.25
10 amp.	£2.25
3V. D.C.	£2.25
15V. D.C.	£2.25
20V. D.C.	£2.25
50V. D.C.	£2.25
100V. D.C.	£2.25
150V. D.C.	£2.25
300V. D.C.	£2.25
500V. D.C.	£2.25
8 Meter 1mA	£2.25
VU Meter	£2.25
1 amp.	£2.25
5 amp.	£2.25
10 amp.	£2.25
3V. D.C.	£2.25
15V. D.C.	£2.25
20V. D.C.	£2.25
50V. D.C.	£2.25
100V. D.C.	£2.25
150V. D.C.	£2.25
300V. D.C.	£2.25
500V. D.C.	£2.25
8 Meter 1mA	£2.25
VU Meter	£2.25



Type MR.45P. 2in. square fronts

50µA	£2.70
50-0-50µA	£2.65
100µA	£2.60
100-0-100µA	£2.60
200µA	£2.60
500µA	£2.60
1mA	£2.60
500-0-500µA	£2.60
1mA	£2.60
5mA	£2.60
10mA	£2.60
50µA	£2.60
50-0-50µA	£2.60
100µA	£2.60
100-0-100µA	£2.60
500µA	£2.60
1mA	£2.60
5 amp.	£2.60
10V. D.C.	£2.60
20V. D.C.	£2.60
50V. D.C.	£2.60
160V. D.C.	£2.60
300V. A.C.	£2.60
500V. A.C.	£2.60
8 Meter 1mA	£2.60
VU Meter	£2.60
1 amp. A.C.*	£2.60
5 amp. A.C.*	£2.60
10 amp. A.C.*	£2.60
20 amp. A.C.*	£2.60
30 amp. A.C.*	£2.60

"SEW" BAKELITE PANEL METERS

Type MR.65. 3 1/2in. square fronts

1 amp.	£2.60
5 amp.	£2.60
15 amp.	£2.60
30 amp.	£2.60
50 amp.	£2.60
5V. D.C.	£2.60
10V. D.C.	£2.60
20V. D.C.	£2.60
50V. D.C.	£2.60
160V. D.C.	£2.60
300V. D.C.	£2.60
50µA	£4.60
50-0-50µA	£3.55
100µA	£3.50
100-0-100µA	£3.50
500µA	£3.50
1mA	£3.50
500-0-500µA	£3.50
1mA	£3.50
1-0-1mA	£3.50
5mA	£3.50
10mA	£3.50
50mA	£3.50
100mA	£3.50
500µA	£3.50
500-0-500µA	£3.50
1mA	£3.50
1-0-1mA	£3.50
5 amp.	£3.50
10V. D.C.	£3.50
20V. D.C.	£3.50
50V. A.C.*	£3.50
100V. A.C.*	£3.50
150V. A.C.*	£3.50
300V. A.C.*	£3.50
8 Meter 1mA	£3.50
VU Meter	£3.50

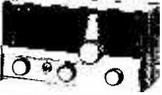


Type S-80 80 mm. square fronts

50µA	£2.50
50-0-50µA	£2.40
100µA	£2.40

DWS C.W. SMITH & CO (RADIO) LTD

UNR 30 RECEIVER



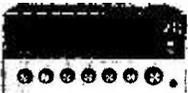
4 Bands covering 550 kc/s-30 mc/s B.F.O. Built-in Speaker 220/240 v. A.C. Brand new with instructions.
Our Price £15-75 Carr. 37p

UR-1A RECEIVER



4 Bands covering 550 kc/s-30 mc/s. FET, 8 Meter. Variable BFO for SSB. Built-in Speaker, Bandspread, Sensitivity Control, 220/240 v. A.C. or 12 v. D.C. 1 1/2 in. x 4 1/2 in. x 7 in. Brand new with instructions.
Our Price £25-00 Carr. 37p

SKYWOOD CX203 RECEIVER



Solid state, 5 bands covering 200-420 KHz and 55 to 30 MHz. Illuminated slide rule dial. Bandspread, Aerial tuning, BFO, AVC, ANL, "8" meter, AM/CW/SSB. Integrated speaker and phone socket. 220/240 v. A.C. or 12 v. D.C. Size 3 1/2 x 2 1/2 x 1 1/2 in. Complete with instructions and circuit.
Our Price £32-50 Carr. 50p

LAFAYETTE HA-600 RECEIVER



General coverage 150-400 kc/s, 550 kc/s-30 mc/s, FET front end, 2 mech. filters, product detector, variable B.F.O., noise limiter, 8 Meter Bandspread, RF Gain, 15in. x 9 1/2in. x 9 1/2in. 13 B. 220/240 v. A.C. or 12 v. D.C. Brand new with instructions.
Our Price £50-00 Carr. 50p

TRIO 9R59DS RECEIVER



4 bands covering 550 kc/s to 30 mc/s continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4 1/2 ohm output and phone jack. SSB-CW, ANL, Variable BFO. 8 Meter. Sep. bandspread dial. IF frequency 445 kc/s, audio output 1.5w. Variable RF and AF gain controls 115/250 v. A.C. Size: 7in. x 13in. x 10in. with instruction manual.
Our Price £49-50 Carr. Paid. FULL RANGE OF TRIO STOCKED



EMI LOUDSPEAKERS



Model 350. 13" x 8" with single tweeter/crossover. 20-20,000 Hz. 15 watt RMS. Available 8 or 15 ohms. £7-25 each. P. & P. 37p.
 Model 450. 13" x 8" with twin tweeter/crossover. 55-13,000 Hz. 8 watt RMS. Available 8 or 15 ohms. £3-82 each. P. & P. 25p.

SPECIAL OFFER! STEREO SPEAKERS



Matched pair of stereo bookshelf speakers. Deluxe teak veneered finish. Size 14 1/2" x 9" x 7 1/2". 8 ohms. 8 watt RMS.

16 watt peak. Complete with DIN lead.

Our Price £12-95 Carr. 50p

HA-10 STEREO HEADPHONE AMPLIFIER



All silicon transistor amplifier operates from magnetic, ceramic or twin stereo tuner inputs with twin stereo headphone outputs and separate volume controls for each channel. Operates from 9v battery. Inputs 5MV/100MU. Output 50MW.

Our Price £6-97 P. & P. 15p

1021 STEREO LISTENING STATION



For balancing and gain selection of loudspeakers with additional facility for stereo headphone switching. 2 gain controls, speaker on-off slide switch, stereo headphone sockets. 6" x 4" x 2 1/2".

Our Price £2-25 P. & P. 15p

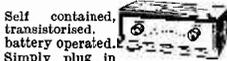
MP7 MIXER PREAMPLIFIER



5 microphone inputs each with individual gain controls enabling complete mixing facilities. Battery operated. 9 1/2" x 5" x 3". Inputs Mics: 3 x 3mV 50K; 2 x 3mV 600 ohm. Phono meg. 4mV 50K. Phono ceramic 100mV 1 meg. Output 250mV 100K.

Our Price £8-97 P. & P. 20p

EA.41 REVERBERATION AMPLIFIER



Self contained, transistorised, battery operated. Simply plug in microphone, guitar, etc., and output into your amplifier. Volume control, depth of reverberation control. Beautiful walnut cabinet. 7 1/2" x 3" x 4 1/2 in.

Our Price £7-50 P. & P. 15p

AUDIOTRONIC

RANGE OF HIGH QUALITY EQUIPMENT

Audiotronic Products are manufactured exclusively for the Audiotronic Group of Companies and as a member of the group we are pleased to offer you this fabulous range of high quality equipment. Made to our own specifications each item provides outstanding performance and reliability at a value for money price!

ACD.660 Stereo Cassette Deck



A beautifully styled 4 track stereo deck with an outstanding specification offered at a remarkably low price. Incorporates a host of features including switchable noise filter normal/chrome tape selector, twin VU meter, slider record/playback level controls, front panel headphone socket, recording indicator lamp, phono/DIN line input sockets, 8 ohm mike input sockets etc. etc. Frequency response 100-8KHz (100-12KHz Cr02) S/N-45dB. Crosstalk 45dB. Separation-35dB. Noise limiter-6dB at 10KHz. Complete with phono connecting leads.
Our Price £39-50 Carr. & Ins. 60p

AHP-8D 8 Track Stereo Tape Deck



Can be used with most hi fi amplifiers. Push button track selector and illuminated track indicators. Attractive cabinet with black and silver trim. Output level 250mV AC 220/240v.
Our Price £11-95 P. & P. 50p.

AHP-8A 8 Track Stereo Tape Player



Incorporates built in amplifiers giving 2 1/2 + 2 1/2 watts rms output. Push button track selector, illuminated track indicators, slider controls for volume, balance and tone. Attractive cabinet with black and silver trim. Output impedance 8 ohms. AC 220/240v.
Our Price £17-25 P. & P. 50p.

Stereo Headphones

LSH.20 Individual volume controls Stereo mono switch. 8 ohms. 40-13,000 Hz. £3-50 P & P 30p
 LSH.30 Open back type. Individual tone and volume controls. 8 ohms. 30-20,000 Hz. £5-50 P & P 30p
 LSH.40 Two way speaker system. Individual volume controls. 8 ohms. 20-20,000 Hz. £2-95 P & P 30p
 LSH.60 3" speaker units. 8 ohms. 20-20,000 Hz. Complete with zipped carrying case. £3-50 P & P 30p
 LQH.400 4-channel dynamic headphones. Each earpiece has 4 drive units. 4-32 ohms. 20-20,000 Hz. £9-95 P. & P. 30p
 LSH.50 Electrostatic with self powered energiser and control unit with headphone/speaker selector. 4-32 ohms. 20,000 Hz. £15-95 P. & P. 30p

AUDIOTRONIC DOLBY 'B' NOISE REDUCTION UNITS

Reduce tape hiss by 3dB at 600Hz, 6dB at 1200Hz and 10dB for all frequencies above 3000Hz. Size 16 1/2" x 8" x 3 1/2". AC 200/250v



PROCESS FOUR

For use with semi-professional tape recorders. Freq. res. 30Hz-20KHz ± 2dB. S/N better than 70dB. Full source tape monitoring. Record/Replay metering. Switchable multiplex filter. Supplied with test tape.
Our Price £50-00 P & P 50p

PROCESS TWO

For use with cassette and tape recorders. Freq. res. 30Hz-20KHz ± 2dB. Off tape monitoring. Switchable multiplex filter. Twin Dolby calibration meters. S/N better than 70dB. Supplied with test cassette or tape as required.
Our Price £34-50 P & P 50p

ACR.14 Battery Mains Cassette Recorder

Portable twin track mono recorder with automatic recording level control. Built in speaker. Earpiece socket. Input for radio or record player. Fast forward and rewind. Output 500mW. AC 220/240v or 6v DC operation. Complete with remote control microphone, mains lead, earpiece and batteries.
Our Price £10-50 P. & P. 50p.



LOW NOISE TAPE CASSETTES

TYPE	5	10	25	Cassette
C60	£1-29	£2-53	£5-99	Tape Head
C90	£1-85	£3-62	£3-59	Cleaner 30p
O120	£2-29	£4-43	£10-63	

P. & P. 16p. post free

ACR 3500 CAR RADIO



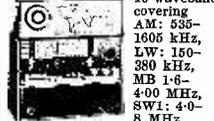
Manual tuning of Medium and Long waves. 12v pos. or neg. earth. Complete with speaker, mounting brackets and instructions.
Our Price £6-50 P & P 50p

ACP.8 8 TRACK CAR PLAYER



12v neg. earth. Slider controls for Volume, Tone and Balance. Channel selector button with red pilot lamp, with speakers, mounting brackets and instructions.
Our Price £12-50 P & P 40p

AMR-900 GLOBAL AM/FM PORTABLE RADIO



10 wavebands covering AM: 535-1605 KHz, LW: 150-380 KHz, MB 1-6, 4-00 MHz, SW1: 4-0-8 MHz, SW2: 8-0-1-6 MHz, SW3: 16-24 MHz, PSB1: 30-50 MHz, PSB2: 148-174 MHz, FM 88-108 MHz, AIR: 108-135 MHz. Features time zone map and timing dial. Large clear scale. Telescopic aerial and built in aerial. AFC or FM. 6" x 4" speaker and personal earpiece. Battery/mains operation. Size: 3 1/2 x 1 3/4 x 3 1/2 in.
Our Price £36-00 P & P. 50p.

AR.1000 SPORTSMAN AM/FM PORTABLE RADIO



5 wavebands covering AM 535-1605KHz. FM 88-108MHz. AIR 108-135MHz. PSB 147-174MHz. WB 162-5MHz. Large horizontal slide dial with logging scale. Slider volume and squelch controls. 7 section telescopic aerial for FM and built in ferrite bar for AM. AFC. 3in. speaker. Earpiece socket. Green leatherette covered cabinet with metal side panels. Size 152 x 79 x 219mm. Battery/mains operation.
Our Price £11-50 P. & P. 35p.

AUDIOTRONIC AMB.500 MULTIBAND RADIO



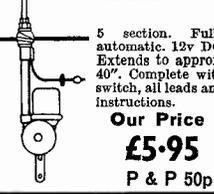
5 wavebands covering MW 535-1605KHz and FM 88-175MHz. 4 transistor. Battery or mains operation. Built in aerial and 8 section telescopic aerial. Complete with batteries, shoulder strap and earpiece.
Our Price £6-95 P & P 35p

ACRI PUSHBUTTON CAR RADIO



Push button tuning of one LW and five MW stations of your choice. 12v pos. or neg. earth. Complete with speaker, mounting brackets and instructions.
Our Price £8-95 P & P 50p

ACASSE ELECTRIC CAR AERIAL

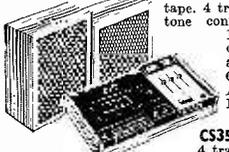


5 section. Fully automatic. 12v DC. Extends to approx. 40". Complete with switch, all leads and instructions.
Our Price £5-95 P & P 50p

SAVE UP TO 33 1/3% OR MORE! GWS

SUPER AKAI HIFI BARGAINS

CS35 STEREO CASSETTE RECORDER



For conventional or Chromium Dioxide tape. 4 track record/playback. Volume and tone controls. Frequency response 40-16kHz (using CrO2 tape), distortion better than 2%, wow and flutter better than 0.2% R.M.S. Complete with pair of matching Akai CS85 speakers.
 Rec. Price £96.10 P.&P. 50p
OUR PRICE £56.50

CS35D STEREO DECK

4 track record/playback deck. Accepts chrome/regular tape cassettes.
 Rec. Price £68.30 P. & P. 50p
GWS PRICE £44.45

CASSETTE (P. & P. 50p)
 GXC40D Deck ... £57.20
 GXC40 Recorder ... £27.90
 GXC40T Deck/Receiver ... £99.05
 GXC45 Deck ... £78.25
 GXC46D Dolby Deck ... £88.55
 GXC46 Recorder ... £89.95
 GXC60D Deck ... £87.65
 GXC63D Dolby Deck ... £92.65

MICROPHONES (P. & P. 50p)
 ADM Dynamic (pair) ... £7.50
STEREO RECEIVERS (P. & P. 75p)
 AA6300 20+20 watt ... £74.30
 AA8030 25+25 watt ... £92.50
 AA8090 40+40 watt ... £117.50
 AA8100S 2x36 or 4x18 w. ... £175.00
 AA8500 65+65 watt ... £150.50

CARTRIDGE (P. & P. 50p)
 CR81D Deck with amps. ... £65.40
 CR81D Deck ... £53.60
 CR81T Recorder/Receiver ... £92.75
 CR80SS 4 channel Rechr. ... £114.25
 CR80SSD 4 channel Rechr. ... £93.65

STEREO AMPLIFIERS (P. & P. 60p)
 AA5200 20+20 watt ... £61.75
 AA5500 30+30 watt ... £78.50
 AA5800 45+45 watt ... £117.50

TAPE (P. & P. 75p)
 4000DS Deck ... £59.95
 4000DS Dust Cover ... £3.95
 1721L Recorder ... £60.85
 X5000 Recorder ... £92.50
 X201D Deck ... £108.20
 GX220D Deck ... £129.85
 GX221D ... £138.40
 GX280D Deck ... £196.50
 GX370 Deck ... £211.50

STEREO TUNERS (P. & P. 50p)
 AT650 AM/FM ... £60.50
 AT680 AM/FM ... £94.50

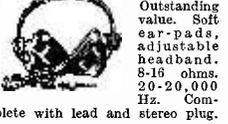
4-CHANNEL UNIT (P. & P. 50p)
 S51 Synthesiser ... £89.95

SPEAKERS
 SW155 (each) ... £51.00

STEREO HEADPHONES
 ASE11 ... £4.75
 ASE20 ... £7.30
 ASE22 ... £8.25

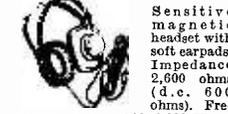
SUPER HEADPHONE BARGAINS!

SH628 STEREO HEADPHONES



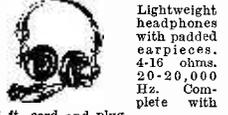
Our Price **£1-87** P. & P. 30p

TE1018 DE-LUXE MONO HIGH IMPEDANCE HEADSET



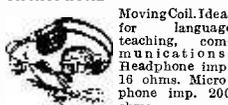
Our Price **£2-25** P. & P. 30p

LH025 STEREO HEADPHONES



Our Price **£1-95** P. & P. 30p

BH.001 HEAD SET AND BOOM MICROPHONE



Our Price **£4-95** P. & P. 30p

SPECIAL PURCHASE! BSR 8 TRACK PLAYER CHASSIS

Famous BSR 8 track chassis as used in Model TD88 complete with silver and black excutechone ready to fit into cabinet. Output 125mV. AC 240v. Overall size approx. 185 x 215 x 50mm.
OUR PRICE £8.95 P. & P. 50p.



RECORD DECK PACKAGES



Carriage and Packing 75p.

Complete units with Stereo cartridge ready wired in plinth cover.

GARRARD
 2025 T/C/STANCD ... £10.85
 SP25 111/G800 ... £11.90
 SP25 111/M44E ... £17.40
 SP25 111/M44 ... £16.95
 SP25 111/M55E ... £17.95
 SP25 111 Module/M75-6 ... £19.45
 AP76/G800 ... £25.55
 AP76/G800E ... £28.10
 AP76/M44E ... £27.05
 AP76/M44-7 ... £16.95
 AP76/M55E ... £27.50
 AP76/M75EJ ... £21.70
 AP76/M75EJ ... £28.30
 AP76 Module M75-6 ... £30.10
 AP96 Module M75-6 ... £33.20
 ZERO 1008 Module/M98E ... £44.15

B.S.R. McDONALD
 TD100/SC7M ... £7.40
 MP60/G800 ... £15.00
 MP60/TPD1/G800 ... £15.80
 MP90/M44-7 ... £18.60
 HT70/TPD1/G800 ... £19.20

GOLDRING
 GL72/G800 ... £31.50
 GL75/G800 ... £28.65
 GL75/G800E ... £39.15

GOODMANS
 TD100/G800 Teak ... £46.85
 TD100/G800 White ... £48.00

LEAK
 Delta/M75-6 ... £47.90
 Truspeed ... £35.95

PHILIPS
 GA105/GP200 ... £18.80
 GA160/GP200 Teak ... £19.50
 GA210/GP400 ... £45.25
 GA308 (Less cartridge) ... £29.95
 GA308 P.U. ... £28.75

PIONEER
 PL12D (Less cartridge) ... £31.75
 PL15C (Less cartridge) ... £24.05
 PL14D (Less cartridge) ... £104.75
 PL50 (Less cartridge) ... £98.90
 PL61 (Less cartridge) ... £110.30
 FLA35 (Less cartridge) ... £81.55

THORENS
 TD160C/Ortofon M15E5 ... £70.95
 TD125 AB/11/Ortofon M15E Super ... £92.05
 TD165/Ortofon M15E Super ... £62.55

WHARFEDALE
 Linton/M44-7 Teak ... £28.55
 Linton/M44-7 White ... £24.70

HOMER INTERCOMS



Ideal for home, office, stores, factories, etc. complete with batteries, cable and instructions.
 2 Station £2-97, P. & P. 15p.
 3 Station £5-25, P. & P. 15p.
 4 Station £6-62, P. & P. 17p.

RECORD DECKS



Carriage and Packing 50p B.S.R. McDONALD

C114 Mini ... £3-95
 C129 Mono ... £5.50
 C137 ... £7.00
 S10/TPD1 ... £13.95
 S10 ... £10.55
 710 ... £21.15
 810 ... £26.30
 MP60 ... £28.25
 MP60/G800 ... £10.90
 MP60/TPD1 ... £13.20
 MP60/TPD2 ... £11.25
 HT70 ... £11.60
 HT70/G800 ... £14.25
 HT70/TPD1 ... £16.55

CONNOISSEUR
 BD1 Kit ... £9.10
 BD1 Chassis ... £11.95
 BD2/SAU2/Chassis ... £22.70
 BD2/SAU2/Plinth/Cover ... £28.20

GARRARD
 2025 T/C Stereo ... £6.35
 SP25 III ... £9.25
 SP25 III Acos GP104C ... £8.50
 SP25 III/G800 ... £10.20
 SP25/M75-6 ... £13.90
 AP76 ... £19.00
 SL65B ... £11.15
 SL72B ... £17.75
 SL95B ... £31.15
 ZERO 100A ... £24.95
 ZERO 100S ... £31.40

GOLDRING
 G99 ... £29.50
 G101P/C ... £32.50
 GL69/2 ... £15.75
 GL72 ... £25.45
 GL72/P ... £38.75
 GL75 ... £32.20
 GL75P ... £41.95
 GL78P/C ... £58.25
 GL85P/C ... £72.00

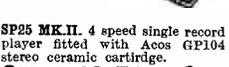
SPECIAL GARRARD OFFERS!



STEREO 1025T

4 speed autochanger unit fitted with stereo ceramic cartridge.
 Our Price **£4-95** Carr. 50p

SP25 III WITH ACOS GP 104



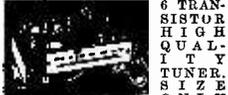
SP25 MK.II 4 speed single record player fitted with Acos GP104 stereo ceramic cartridge.
 Our Price **£8-50** Carr. 50p

SINCLAIR PROJECT 60 PACKAGE DEALS



2 x Z30 Stereo 60/PZ5 £15-95 P. & P. 37p.
 2 x Z30/Stereo 60/PZ6 £18-00 P. & P. 37p.
 2 x Z50/Stereo 60/PZ8 £20-25 P. & P. 37p.
 Transformer for PZ8 £9-85.
 Active Filter Unit £4-45.
 Pair of Q16 Speakers £10-70
 Sinclair Project 60S £20-97.
 P. & P. 37p.
 All other Sinclair Products in stock
 2000 Amplifier £22-95
 3000 Amplifier £28-95
 2000/3000 Tuner £28-30
 Q830 Speakers £29-98 pair
 P. & P. 50p each of above items

FM TUNER CHASSIS



6 TRAN-SISTOR HI G H QU A L I T Y TUNER S I Z E O N L Y
 6 x 4 x 2 1/2in. 9 L stages.
 Double tuned discriminator. Ample output to feed most amplifiers.
 Operates on 9V battery. Coverage 88-108Mc/s. Ready built ready for use. Fantastic value for money.

Our Price **£5-95** P. & P. 20p
 Stereo multiplex adaptors £4-97.

SPECIAL PURCHASE!

FERGUSON EXPORT MODELS



FERGUSON 3408 STEREO TUNER AMPLIFIER

Covers FM 88-108 MHz. Five push button tuning scales. 8+8 watts rms. Inputs for stereo ceramic cartridge and tape etc. Separate bass treble, balance and volume controls.
 Our Price **£31-50** P. & P. 50p



3418 STEREO TAPE DECK

4 track. 7 1/2, 3 1/2, 1 1/2 i.p.s. Stereo/mono record/play. 7" reels. Inputs for dynamic mikes, radio, gram. Complete with cover.
 Our Price **£41-95** P. & P. 75p

LONDON'S LARGEST STOCKS INCLUDING PRODUCTS BY-

GWS

ARMSTRONG
 CAMBRIDGE
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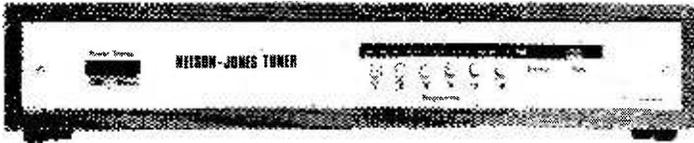
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NELSON-JONES FM TUNER KIT



as in 'W.W.' June '73

Now available to readers of 'Practical Wireless'. The Nelson-Jones tuner was originally made available by this company in May 1971, and consequently all 'bugs' have been 'ironed out' of this highly successful kit.

A recent design addition has used variable capacitance diodes and a Push Button Unit with 6 positions. AFC disable is incorporated as well as a pointer for each button showing tuning position in the range 87.5-108MHz.

Our complete metalwork system is supplied with nuts, bolts, board standoffs, push button mains on/off and stereo mute assembly, sockets, fuse and holder. Printed and Anodised Front Panel and Veneered Teak case. Power supply kits are supplied with complete kits of parts, or separately.

Prices for complete kits start at £23.75 + 45p pp. + VAT for mono tuners, (phase locked decoders are also available to fit in the cabinet). Please send large SAE for complete details of special offers and our complete lists.

TEXAN AMPLIFIER

The Cabinet of the Nelson-Jones Tuner is specially designed to match the Texan amplifier cabinet, see photographs, so that owners of Texan's are assured of compatibility, both in superb performance and appearance.

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TRANSISTORISED F.M. tuner head with A.M. gang, slow motion drive. 88-108Mcs, with circuit diagram. £2.30p.

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X806.. 14 off BC148. 2 RCA ca 8054(No). 1 crystal 4-433618MHz. Z607.. 12 off BC148. 1 BC158. 1 BC108. 1 RCA ca8046. 1 RCA ca8045 (No).

Z608.. 23 off BC148. 2 BC158.
Z612.. 12 off ME4102. 2 BC251B. 1 BFY50.

CRYSTAL CALIBRATOR (Second Hand) No. 10 crystal controlled heterodyne wave-meter covering 500KHz-10MHz (harmonics up to 30MHz) power required 300V DC 15mA. 12V 0-3A DC. Test equipment for 82T M/R.C. £2 50 each.

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1/2W Mullard CR25 carbon film—very small body size 7.5 x 2.5 mm.
1/2W 2% ELECTROSIL TRS.

Power watts	Tolerance	Range	Values available	Price
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Carbon track 5kΩ to 2MΩ, log or linear (log 1/2W, lin 1/2W).
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Linear: 100, 250, 500Ω and decades to 5MΩ. Horizontal or vertical P.C. mounting (0.1 matrix).
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AC128	12p	AF139	32p	BF173	20p	OC44	12p	2N3705	12p
AC131	12p	AF178	32p	BF177	28p	OC45	12p	2N3706	11p
AC132	12p	AF180	40p	BF178	32p	OC70	12p	2N3707	12p
AC176	12p	AF181	40p	BF179	32p	OC71	12p	2N3708	11p
AC187	22p	BC107	9p	BF180	32p	OC72	12p	2N3709	11p
AC188	22p	BC108	9p	BF181	32p	OC81	12p	2N3710	11p
AD140	50p	BC109	9p	BF194	15p	OC82D	12p	2N3711	11p
AD149	45p	BC147	13p	BF195	15p	2N2904	20p	2N4062	12p
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AF114	20p	BC157	14p	BFY50	20p	2N2926Y	9p	40362	40p
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BZY10	800V	6A	25p
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IN4002	400V	1A	8p
IN4007	1000V	1A	10p

SIGNAL

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OA9	5p
OA202	5p
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12in x 6in, 25p; 12in x 2 1/2in, 10p; 9in x 2in, 7p

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86mm x 9mm x 16mm length of track 59mm.
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3 1/2 x 5	24p	24p
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7403	18	16	14	13	7454	18	16	14	13	74150	330	280	250	220
7404	20	18	16	14	7460	18	16	14	13	74151	110	100	95	89
7405	20	18	16	14	7470	30	28	25	24	74153	120	110	105	95
7406	50	45	40	35	7472	30	28	25	23	74154	200	180	170	160
7407	56	50	44	38	7473	40	36	32	30	74155	150	120	100	86
7408	36	30	27	23	7474	40	36	32	28	74156	30	20	100	66
7409	36	30	27	23	7475	55	52	50	49	74180	155	136	112	105
7410	18	16	14	13	7476	40	36	32	30	74190	195	190	185	180
7411	23	21	20	18	7480	100	95	90	85	74191	195	190	185	180
7412	36	30	27	23	7481	125	115	110	105	74192	200	190	180	164
7413	34	28	26	22	7482	100	96	90	85	74193	200	180	170	150
7416	45	43	39	34	7483	100	97	95	92	74196	200	190	180	170
7420	18	16	14	13	7484	100	115	110	105	74197	200	195	180	170
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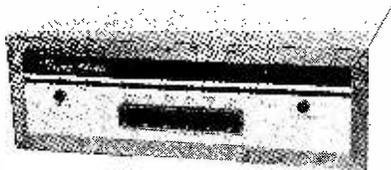
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We regret we cannot supply lists for projects published before July 1973 issue.

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

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RF Chokes

CH1. 2.5mH 25p CH2. 5.0mH 25p

CH3. 7.5mH 25p CH4. 10mH 25p

CH5. 1.5mH 25p

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DRX1 Crystal set 56p DRR2 Dual range 45p

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SWITCHES

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1 1/2" and 20mm. 100mA. 200mA, 250mA, 500mA, 1A, 1.5A, 2A

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Crystal 3.5mm plug 33p

8 ohms 2.5mm plug 22p

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H1012 £1.87

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Send S.A.E. and 10p.

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(Black Vinyl covered)

No. Length Width Height Price

BV1 8" x 5 1/2" x 2" 90p

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ALUMINIUM BOXES

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BA2 4" x 4" x 1 1/2" 41p

BA3 4" x 2 3/4" x 1 1/2" 41p

BA4 5 1/2" x 4" x 1 1/2" 47p

BA5 4" x 4" x 2" 41p

BA6 3" x 2" x 1" 34p

BA7 7" x 5" x 2 1/2" 86p

BA8 8" x 6" x 3" 84p

BA9 6" x 4" x 2" 54p

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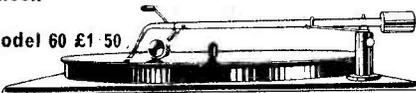
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Ref. 32. Tape editing Kit £1.54

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X25. 25 watt £1.03

CCN 240. 15 watt £2.15

Model G. 18 watt £2.15

SK2. Soldering Kit £2.86

STANDS: ST1 £1.21. ST2 77p

SOLDER: 18SWG Multicores 7oz 82p

22SWG 7oz 82p. 18SWG 22ft 28p

22SWG Tube 22p

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Bits No.

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1100 For model CCN240 3/32" 28p

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1021 For model G240 1/8" 28p

1022 For model G240 3/16" 28p

50 For model X25 3/32" 37p

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52 For model X25 3/16" 37p

ELEMENTS

ECN 240 £1.16 ECN 240 £1.16

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C7 1 Pack Wire 50 metres assorted colours 0.55

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C11 5 Jack Sockets 2 x 3.5m 2 x Standard Switch Type 0.55

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C16 20 Assorted Tag strips & Panels 0.55

C17 10 Assorted Control Knobs 0.55

C18 4 Rotary Wave Change Switches 0.55

C19 3 Relays 6—24V Operating 0.55

C20 4 Sheets Copper Laminate approx. 10" x 7" 0.55

PLUGS AND SOCKETS

SOCKETS

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PS 36 DIN 3 Pin 0.10

PS 37 DIN 5 Pin 180° 0.10

PS 38 DIN 5 Pin 240° 0.10

PS 39 Jack 2.5mm Switched 0.09

PS 40 Jack 3.5mm Switched 0.10

PS 41 Jack 1" Switched 0.17

PS 42 Jack Stereo Switched 0.28

PS 43 Phono Single 0.06

PS 44 Phono Double 0.10

PS 45 Car Aerial 0.09

PS 46 Co-Axial Surface 0.09

PS 47 Co-Axial Flush 0.14

INLINE SOCKETS

PS 21 D.I.N. 2 Pin (Speaker) 0.13

PS 22 D.I.N. 3 Pin 0.17

PS 23 D.I.N. 5 Pin 180° 0.17

PS 24 D.I.N. 5 Pin 240° 0.17

PS 25 Jack 2.5mm Plastic 0.10

PS 26 Jack 3.5mm Plastic 0.12

PS 27 Jack 1" Plastic 0.24

PS 28 Jack 1" Screened 0.28

PS 29 Jack Stereo Plastic 0.28

PS 30 Jack Stereo Screened 0.32

PS 31 Phono Screened 0.14

PS 32 Car Aerial 0.15

PS 33 Co-Axial 0.17

PLUGS

PS 1 D.I.N. 2 Pin (Speaker) 0.11

PS 2 D.I.N. 3 Pin 0.12

PS 3 D.I.N. 4 Pin 0.15

PS 4 D.I.N. 5 Pin 180° 0.14

PS 5 D.I.N. 5 Pin 240° 0.15

PS 6 D.I.N. 6 Pin 0.15

PS 7 S.I.N. 7 Pin 0.15

PS 8 Jack 2.5mm Screened 0.10

PS 9 Jack 3.5mm Plastic 0.09

PS 10 Jack 3.5mm Screened 0.12

PS 11 Jack 1" Plastic 0.13

PS 12 Jack 1" Screened 0.18

PS 13 Jack Stereo Screened 0.29

PS 14 Phono 0.06

PS 15 Car Aerial 0.15

PS 16 Co-Axial 0.10

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CP 2 Twin Common Screen 0.08

CP 3 Stereo Screened 0.08

CP 4 Four Core Common Screen 0.23

CP 5 Four Core Individually Screened 0.30

CP 6 Microphone Fully Braided Cable 0.10

CP 7 Three Core Mains Cable 0.07

CP 8 Twin Oval Mains Cable 0.06

CP 9 Speaker Cable 0.04

CP 10 Low Loss Co-Axial 0.10

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Log and Lin

4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M

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VC 2 Single D.P. Switch 0.28

VC 3 Tandem Less Switch 0.44

VC 4 1K Lin Less Switch 0.14

VC 5 100K Log anti-Log 0.44

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0.1 watt. 0.08 each

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47K, 100K, 220K, 470K, 1M, 2M, 4.7M

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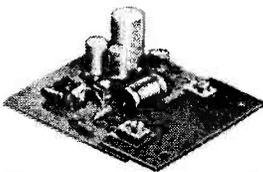
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AL10/AL20/AL30 AUDIO AMPLIFIER MODULES



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

Parameter	Conditions	Performance
HARMONIC DISTORTION	Po = 3 WATTS f=1KHz	0.25%
LOAD IMPEDANCE	—	8 - 16 Ω
INPUT IMPEDANCE	f=1KHz	100 k Ω
FREQUENCY RESPONSE @ 3dB	Po=2 WATTS	50 Hz - 26KHz
SENSITIVITY for RATED O/P	Vs=25V, Ri=8 Ω f=1KHz	75mV. RMS
DIMENSIONS	—	3" x 2 1/2" x 1"

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

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

AUDIO AMPLIFIER MODULES

AL 10. 3 watts RMS	£2.19
AL 20. 5 watts RMS	£2.59
AL 30. 10 watts RMS	£3.01

POWER SUPPLIES

PS 12. (Use with AL10 & AL20)	88p
SPM 80. (Use with also AL30 & AL50)	£3.25
FRONT PANELS PA 12 with Knobs	£1.00

PRE-AMPLIFIERS

PA 12. (Use with AL10 & AL20)	£4.35
PA 100. (Use with AL30 & AL50)	£13.15

TRANSFORMERS

T481 (Use with AL10)	£1.38 P & P 15p
T538 (Use with AL20)	£1.93 P & P 15p
BMT80 (Use with AL30 & AL50)	£2.15 P & P 25p

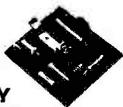
PA 12. PRE-AMPLIFIER SPECIFICATION

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

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

EA1000 AUDIO AMP MODULE 3 WATTS R.M.S.

Module Tested and Guaranteed. Full hook-up diagrams and complete technical data supplied free with each module or available separately at 10p each.



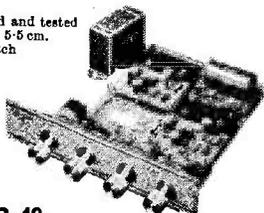
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The STEREO 20

The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 5.6 cm. This compact unit comes complete with on/off switch volume control, balance, bass and treble controls, Transformer, Power supply and Power amps. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or alternatively, into a separate cabinet. Output power 20w peak. Input 1 (Cer.) 300mV into 1M. Freq. res. 25Hz-25kHz. Input 2 (Aux.) 4mV into 30K. Harmonic distortion. Bass control ±12dB at 80Hz typically 0.25% at 1 watt. Treble con. ±14dB at 14kHz.



£13.48

50W pk-25w (RMS)

0.1% DISTORTION!
HI-FI AUDIO AMPLIFIER

THE AL50

★ Frequency Response 15Hz to 100,000-1dB.

★ Load—3, 4, 8 or 16 ohms.

★ Distortion—better than .1% at 1 KHz.

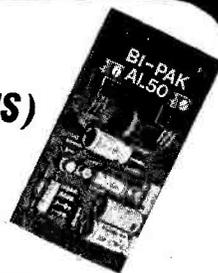
★ Signal to noise ratio 80dB.

ONLY
£3.58 each

★ Supply voltage 10-35 Volts.

★ Overall size 63mm 105mm x 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.
FULLY BUILT—TESTED—GUARANTEED.



STABILISED POWER MODULE SPM80

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (r.m.s.) per channel simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1.5 amps at 35 volts. Size: 63mm x 105mm x 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:—Disc Systems, Public Address, Intercom Units, etc. Handbook available 10p **PRICE £3.25**



TRANSFORMER BMT80 £2.15 p. & p. 28p

STEREO PRE-AMPLIFIER TYPE PA100

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

SPECIFICATION

Frequency Response	20Hz - 20KHz ± 1dB
Harmonic Distortion	better than 0.1%
Inputs: 1. Tape Head	1.25 mV into 50K Ω
2. Radio, Tuner	35 mV into 50K Ω
3. Magnetic P.U.	1.5 mV into 50K Ω
All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIA curve within ± 1dB from 20Hz to 20KHz.	
Bass Control	± 15dB at 20Hz
Treble Control	± 15dB at 20 KHz
Filters: Rumble (High Pass)	100Hz
Scratch (Low Pass)	8K Hz
Signal/Noise Ratio	better than -65dB
Input overload	+ 25dB
Supply	+ 35 volts at 20mA
Dimensions	292mm x 82mm x 35mm

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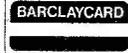
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10 watt	2.70

FANE 7" x 4" 3 or 8 ohm	1.15
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10 watt	2.95
BAKERS GROUP 25	
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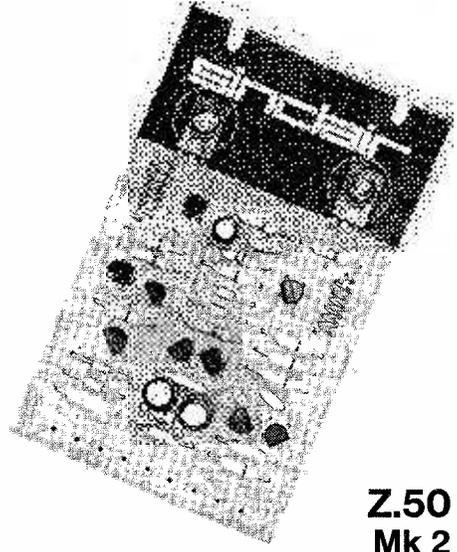
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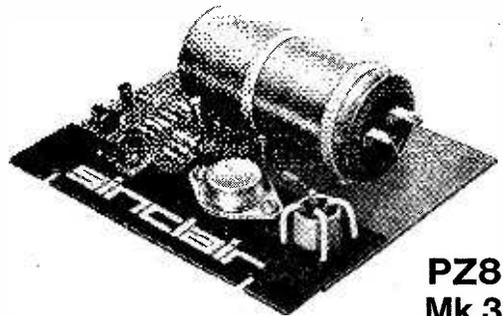
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Sinclair Project 60

New performance standards ... new safety margins



**Z.50
Mk 2**



**PZ.8
Mk 3**

Such are the results of using a PZ.8 Mk.3 to drive two Z.50 Mk.2 power amplifiers. Developed from the original Z.50, the Mk.2 has improved thermal stability, better regulated D.C. limiting to ensure more symmetrical output voltage swing with still less distortion at lower outputs and automatic transient overload protection. The PZ.8 Mk.3 is the most advanced power supply unit ever to be made at a reasonable price. It cannot be damaged by direct shorting, nor will it fail through overloading, because of an ingenious re-entrant current limiting principle used usually only in expensive laboratory equipment. Because output voltage is variable, the PZ.8 Mk.3 makes a worthwhile alternative where PZ.5 and PZ.6 are recommended for Project 60 applications, particularly since this most powerful of all Sinclair supply units can be operated from a smaller mains transformer. Together, the Z.50 Mk.2 and PZ.8 Mk.3 provide new standards of performance and reliability and these modules are compatible with earlier types in the Project 60 range.

Z.50 Mk.2 SPECIFICATIONS

Input impedance 100 K Ω
 Input (for 30w into 8 Ω) 400mV
 Signal to noise ratio, referred to full o/p at 30v HT 80dB or better
 Distortion 0.02% up to 20W at 8 Ω .
 See published curve
 Frequency response 10Hz to more than 200 KHz \pm 1dB
 Max. supply voltage 45v (4 Ω to 8 Ω speakers) (50v 15 Ω speakers only)

Min. supply voltage 9v
 Load impedance – minimum: 4 Ω at 45v HT
 Load impedance – maximum: safe on open circuit

£5.48 + V.A.T.
 54p

PZ.8 Mk.3 SPECIFICATIONS

Nominal working output 45V.
 Adjustable between 20 & 50V

£7.98 + V.A.T.
 79p

Mains Transformer £5.98 – V.A.T. 59p

Other power supplies

In addition to the remarkable Sinclair PZ.8 Mk.III as described, there are two other power units available, which should be chosen according to their types in order to buy to best advantage. All are for operation from A.C. mains 240V.

PZ.5 30 volt, un stabilised

£4.98
 + V.A.T. 49p

PZ.6 35 volt, stabilised (Not suitable for Super IC.12).

£7.98
 + V.A.T. 79p

Guarantee

If, within 3 months of purchasing any product direct from Sinclair Radionics Ltd, you are dissatisfied with it, your money will be refunded at once. Many Sinclair appointed Stockists also offer this same guarantee in co-operation with Sinclair Radionics Ltd.

Each Project 60 module is tested before leaving our factory and guaranteed to work perfectly. Should any defect arise in normal use, we will service it at once and without any charge to you. A small charge may be made in those cases where damage arises through miss-use. No charge is made for postage by surface mail. Air Mail charged at cost.

Typical Project 60 applications

System	The Units to use	together with	Units cost
Simple battery record player	Z.50	Crystal P.U., 12V battery volume control, etc.	£5.48 + V.A.T. 54p
Mains powered record player	Z.50, PZ.5	Crystal or ceramic P.U., volume control, etc.	£10.46 + V.A.T. £1.04
12W. RMS continuous sine wave stereo amp. for average needs	2 x Z.50, Stereo 60; PZ.5	Crystal, ceramic or mag. P.U., F.M.; Tuner, etc.	£25.92 + V.A.T. £2.59
25W. RMS continuous sine wave stereo amp using low efficiency (high performance) speakers	2 x Z.50, Stereo 60; PZ.6	High quality ceramic or magnetic P.U., F.M Tuner, Tape Deck, etc.	£28.92 + V.A.T. £2.89
80W. (3 ohms) RMS continuous sine wave de luxe stereo amplifier. (60W. RMS into 8 ohms)	2 x Z.50 Mk.2, Stereo 60; PZ.8 Mk.3 transformer	As above	£34.90 + V.A.T. £3.49
Indoor P.A.	Z.50 Mk.2, PZ.8 Mk.3 transformer	Mic., guitar, speakers, etc., controls	£19.44 + V.A.T. £1.94

A.F.U. (£5.98 + V.A.T. 59p) may be added as required.

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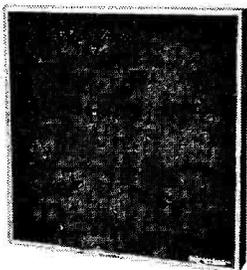
Specifications

Construction: A sealed seamless sound or pressure chamber is used with internal baffle, and special high flux driver

Loading: Up to 14 watts RMS, into 8 ohms

Frequency response: From 60 to 16,000 Hz

Size and styling: 248 mm square x 120 mm deep (9 3/4" x 4 1/2") with neat pedestal base.



£7.70 + V.A.T.
77p



Stereo 60 pre-amp/control unit

Designed specifically for Project 60 systems, the Stereo 60 is equally suitable with any high quality power amplifier. Silicon epitaxial planar transistors used throughout ensure high signal-to-noise ratio and excellent tracking between channels. Input selection is by press buttons, with accurate equalisation on all input channels. The unit is easy to mount.

SPECIFICATIONS—Input sensitivities: Radio—up to 3mV. Mag. p.u. 3mV; correct to R.I.A.A. curve ± 1 dB; 20 to 25,000Hz. 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 10KHz; BASS+12 to -12dB at 100Hz. **Front panel:** brushed aluminium with black knobs and controls. **Size:** 66 x 40 x 207mm.

Built, tested and guaranteed.

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99p

AFU filter unit

For use between Stereo 60 and two Z.30's or Z.50's in stereo formation. Cut off frequencies are continuously variable, with 12dB/octave cut in the rejection band. Two stages of filtering—rumble (high pass) and scratch (low pass). Amplitude and phase distortion are negligible. Supply voltage needed—15–35V. H.F. cut-off (-3dB) 28KHz to 5KHz; L.F. (-3dB) 25Hz to 100Hz. For Project 60 or any hood stereo system.

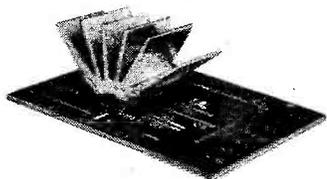
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Super IC.12 Integrated circuit high fidelity amplifier



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contained within a 16 lead DIL package, and the finned heat sink is sufficient for all likely requirements. The Super IC.12 is also compatible with those Project 60 modules which would be used with the Z.50 and Z.30 amplifiers. Complete with free manual and printed circuit board.

SPECIFICATIONS

Output power: 6 watts RMS continuous (12 watts peak) into 6–8 Ω . **Frequency Response:** 5Hz to 100KHz ± 1 dB. **Total Harmonic Distortion:** Less than 1%. (Typical 0.1%) at all output powers and frequencies in the audio band (28V). **Load Impedance:** 3 to 15 ohms. **Input Impedance:** 250 Kohms nominal. **Power Gain:** 90dB (1,000,000,000 times) after feedback. **Supply Voltage:** 6 to 28V. **Quiescent current:** 8mA at 28V. **Size:** 22 x 45 x 28mm including pins and heatsink.

Manual available separately 15p post free

With FREE printed circuit board and 40 page manual.

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the simple way to build a Project 60 system without soldering

For the many audio enthusiasts anxious to build to high standards without too many involvements, there could be nothing better or simpler than Project 605. It offers the advantages of Project 60 and is absolutely complete down to the last piece of wire cut to length. Whilst not as powerful as assemblies using Z.50 power amplifiers, we know from experience that there are many for whom the specifications of Project 605 are ideal, particularly in relation to the environment in which it is required to be used. In Project 605 you have everything necessary to build a versatile Project 60 thirty watt high fidelity amplifier system suitable for all domestic requirements. The convenient pack includes two Z.30 power amplifiers, a Stereo 60 pre-amp control unit and the special Masterlink unit to and from which all input and output connections are made. For power a PZ.5 is provided. Building is particularly easy since all necessary leads are supplied colour coded, cut to length and terminated by contact clips which connect firmly to the modules. There is absolutely no soldering to be done. Complete with comprehensive, easy to follow instructions manual.

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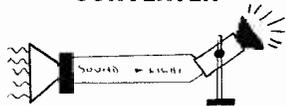
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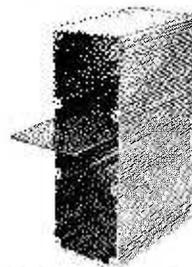
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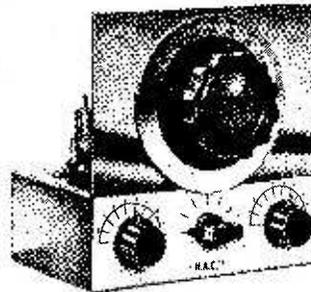


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DY87	25p	EF83	60p	PCF82	27p
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OC83DM	15p	2N1307	25p	AC128	25p	AC128	25p	8K7	17p	30CL5	70p
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OC139	25p	2N2904A	25p	ADY28	17p	CR81/10	25p	ZR11	33p	30FL1	70p
OC140	40p	2N2989	24.00	AD149	50p	CR81/20	35p	ZR21	46p	30FL12	85p
OC170	25p	2N3053	20p	AD161	35p	CR81/30	40p	ZR22	42p	30FL14	80p
OC171	30p	2N3054	20p	AD162	35p	CR81/35	45p			30L15	80p
OC172	37p	2N3065	64p	AF113	50p	CR82/05	30p			30L17	75p
OC200	60p	2N3730	50p	AF127	20p	CR82/20	35p			30P12	70p
OC201	75p	2N3731	22.75	AF139	30p	CR82/30	40p			30P19	70p
OC206	85p	2N4172	50p	AF173	40p	CR82/35	45p			30P21	70p
IN25	60p	3F100	62p	ABY26	25p	CR82/02S	25p			30P22	70p
IN43	10p	3FR5	32p	ABY28	25p					30P23	70p
IN70	7p	3N128	87p	ABY67	45p	CR83/40	48p			30P24	70p
IN77	12p	3N139	1-75	BAW19	25p	CR83/05	30p			30P27	70p
IN702-72888p	18p	3N140	97p	BC107	10p	CR83/20	35p			30P28	70p
UY42	50p	UY85	35p	3Q4	85p	6AH6	50p			30P29	70p
UY85/30	35p	384	28p	6AK5	35p	6BE25	25p			30P30	70p
VR150/30	35p	3V4	48p	6AK8	30p	6BG6G	47p			30P31	70p
Z800U	1-40	5B/255M	2-75	6AL5	18p	6B36	45p			30P32	70p
Z801U	1-40	5B/255M	2-75	6AL5W	35p	6BQ7A	48p			30P33	70p
Z803U	1-10	6M6	35p	6BR7	21.00p	6B7	50p			30P34	70p
Z807U	30p	5R4GY	65p	6A78	60p	6B78	30p			30P35	70p
IL4	13p	5V4G	30p	6A95	30p	6B7W	30p			30P36	70p
IR5	35p	5V4G	45p	6AQ5W	45p	6C4	25p			30P37	70p
IR8	30p	5Y3GT	35p	6A86	30p	6C6	20p			30P38	70p
IR15	30p	5Y4G	35p	6A76	30p	6CH6	55p			30P39	70p
IT4	30p	5Z3	70p	6A76	30p	6C6	20p			30P40	70p
IX2A	30p	5Z4	70p	6AX4GT	50p	6D6	15p			30P41	70p
IX2B	30p	5Z4	70p	6AX4GT	50p	6E4	60p			30P42	70p
IX2C	30p	5Z4GT	32p	6AX5GT	60p	6F23	80p			30P43	70p
IX2D	30p	6A7	25p	6B7	35p	6F33	1-36			30P44	70p
IX2E	30p	6A7	25p	6B7	35p	6F33	1-36			30P45	70p
IX2F	30p	6A7	25p	6B7	35p	6F33	1-36			30P46	70p
IX2G	30p	6A7	25p	6B7	35p	6F33	1-36			30P47	70p
IX2H	30p	6A7	25p	6B7	35p	6F33	1-36			30P48	70p
IX2I	30p	6A7	25p	6B7	35p	6F33	1-36			30P49	70p
IX2J	30p	6A7	25p	6B7	35p	6F33	1-36			30P50	70p
IX2K	30p	6A7	25p	6B7	35p	6F33	1-36			30P51	70p
IX2L	30p	6A7	25p	6B7	35p	6F33	1-36			30P52	70p
IX2M	30p	6A7	25p	6B7	35p	6F33	1-36			30P53	70p
IX2N	30p	6A7	25p	6B7	35p	6F33	1-36			30P54	70p
IX2O	30p	6A7	25p	6B7	35p	6F33	1-36			30P55	70p
IX2P	30p	6A7	25p	6B7	35p	6F33	1-36			30P56	70p
IX2Q	30p	6A7	25p	6B7	35p	6F33	1-36			30P57	70p
IX2R	30p	6A7	25p	6B7	35p	6F33	1-36			30P58	70p
IX2S	30p	6A7	25p	6B7	35p	6F33	1-36			30P59	70p
IX2T	30p	6A7	25p	6B7	35p	6F33	1-36			30P60	70p
IX2U	30p	6A7	25p	6B7	35p	6F33	1-36			30P61	70p
IX2V	30p	6A7	25p	6B7	35p	6F33	1-36			30P62	70p
IX2W	30p	6A7	25p	6B7	35p	6F33	1-36			30P63	70p
IX2X	30p	6A7	25p	6B7	35p	6F33	1-36			30P64	70p
IX2Y	30p	6A7	25p	6B7	35p	6F33	1-36			30P65	70p
IX2Z	30p	6A7	25p	6B7	35p	6F33	1-36			30P66	70p



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6J6GT	30p	19AQ5	40p	6085	65p
6J7	25p	19G3	25.75	6086	1-55
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6K6GT	55p	20P4	1-00	9001	40p
6K7	40p	2SL6GT	50p	9002	40p
6K8	40p	30CL5	70p	9003	45p
6K9GT	40p	30C17	85p	9004	12p
6K25	70p	30C18	75p	9006	12p
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6N3	30p	30P23	70p		28.10
6N4	30p	30P24	70p		28.10
6N5	30p	30P25	70p		28.10
6N6	30p	30P26	70p		28.10
6N7	30p	30P27	70p		28.10
6N8	30p	30P28	70p		28.10
6N9	30p	30P29	70p		28.10
6N10	30p	30P30	70p		28.10
6N11	30p	30P31	70p		28.10
6N12	30p	30P32	70p		28.10
6N13	30p	30P33	70p		28.10
6N14	30p	30P34	70p		28.10
6N15	30p	30P35	70p		28.10
6N16	30p	30P36	70p		28.10
6N17	30p	30P37	70p		28.10
6N18	30p	30P38	70p		28.10
6N19	30p	30P39	70p		28.10
6N20	30p	30P40	70p		28.10
6N21	30p	30P41	70p		28.10
6N22	30p	30P42	70p		28.10
6N23	30p	30P43	70p		28.10
6N24	30p	30P44	70p		28.10
6N25	30p	30P45	70p		28.10
6N26	30p	30P46	70p		28.10
6N27	30p	30P47	70p		28.10
6N28	30p	30P48	70p		28.10
6N29	30p	30P49	70p		28.10
6N30	30p	30P50	70p		28.10
6N31	30p	30P51	70p		28.10
6N32	30p	30P52	70p		28.10
6N33	30p	30P53	70p		28.10
6N34	30p	30P54	70p		28.10
6N35	30p	30P55	70p		28.10
6N36	30p	30P56	70p		28.10
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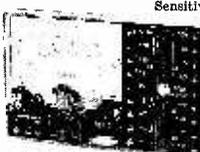
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0A3 0.48	6AT6 0.45	6F13 0.50	10D2 0.55	90A1 2.00	DY51 0.55	ECC89 0.50	EF95 0.40	KT66 2.50	PL36 0.55	U801 0.80
0B2 0.40	6AU6 0.30	6F14 0.70	10F1 0.75	90C1 0.75	DY86 0.35	ECC91 0.30	EF97 0.65	KT77 1.00	PL81 0.50	UABC80 0.40
0B3 0.70	6AV6 0.45	6F16 0.85	10F9 0.65	90CV 2.40	DY87 0.38	ECC189 0.65	EF98 0.75	KT88 2.90	PL82 0.45	UAF41 0.70
0B3G 0.48	6AW8A 0.55	6F18 0.50	10F13 0.80	90F1 0.50	DY89 0.37	ECC807 1.00	EF184 0.35	PABC800.40	PL84 0.40	UAF42 0.60
0D3 0.40	6BA6 0.35	6F20 0.90	10L1 0.90	90L1 1.50	DY90 0.35	ECC808 0.35	EL33 0.50	PC86 0.60	PL302 0.95	UB41 0.75
0D3GT 0.48	6BB6 0.35	6F24 0.80	10LD11 0.70	90L1A 1.50	ES0F 1.40	ECC82 0.55	EK90 0.35	PC88 0.60	PL504 0.75	UBC41 0.55
1L4 0.28	6BF6 0.65	6F25 1.00	10P13 0.75	90L1B 0.45	ES10F 2.00	ECH49 0.75	EL34 0.50	PC89 0.60	PL508 0.90	UBC81 0.45
1R4 0.50	6BH6 0.75	6F26 0.35	12AB5 0.70	90L1C 0.95	EA800.38	ECH81 0.30	EL36 0.50	PC97 0.50	PL509 1.10	UBF80 0.40
1R5 0.45	6BJ6 0.55	6F28 0.70	12AC5 0.70	90L1D 0.95	EAF42 0.60	ECH83 0.45	EL41 0.75	PC90 0.48	PL801 1.00	UBF89 0.40
1R6 0.30	6BK7A 0.75	6GK6 0.60	12AE6 0.65	90L1E 0.95	EAP42 0.60	ECH84 0.45	EL81 0.55	PC88 0.40	PL802 0.95	UBL1 0.70
1R5 0.50	6BN6 0.45	6J4 0.50	12AL5 0.55	90L1F 0.95	EBC33 0.60	ECH85 0.55	EL84 0.58	PC85 0.40	PL302 0.95	UBL21 0.70
1T4 0.80	6BN6 0.60	6J5GT 0.45	12AQ5 0.50	90L1G 0.95	EBC41 0.65	ECL80 0.55	EL85 0.43	PC89 0.50	PL303 0.95	UC92 0.45
1U4 0.60	6BQ5 0.28	6J6 0.30	12AT6 0.40	90L1H 0.95	EBC81 0.33	ECL81 0.55	EL86 0.40	PC89 0.50	PL304 0.95	UC98 0.45
1U5 0.75	6BR7 1.00	6J7 0.45	12AT7 0.45	90L1I 0.95	EBC81 0.33	ECL82 0.35	EL90 0.45	PC89 0.50	PL305 0.95	UC98 0.45
1V2 0.60	6BR8 0.80	6KAJT 0.70	12AU6 0.40	90L1J 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL306 0.95	UC98 0.45
1X2B 0.60	6BS7 1.35	6KGGT 0.75	12AU7 0.33	90L1K 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL307 0.95	UC98 0.45
2D21 0.45	6BW6 0.80	6K7 0.45	12AV6 0.50	90L1L 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL308 0.95	UC98 0.45
3A4 0.50	6BW7 0.90	6K9G 0.45	12AV7 0.70	90L1M 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL309 0.95	UC98 0.45
3B4 0.40	6BX6 0.25	6K25 0.75	12AX7 0.33	90L1N 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL310 0.95	UC98 0.45
3V4 0.70	6BZ6 0.45	6LGGT 0.55	12AY7 0.75	90L1O 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL311 0.95	UC98 0.45
5BR4GY 0.80	6BZ7 0.70	6L7 0.45	12BA4 0.70	90L1P 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL312 0.95	UC98 0.45
6V4G 0.50	6C4 0.35	6L18 0.50	12BA6 0.45	90L1Q 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL313 0.95	UC98 0.45
5V4G 0.50	6C5GT 0.55	6LD20 0.50	12BE6 0.50	90L1R 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL314 0.95	UC98 0.45
5Y30T 0.45	6CB6 0.40	6NTGT 0.55	12BF7 0.50	90L1S 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL315 0.95	UC98 0.45
3Z2 0.75	6CD6GA 0.45	6G4 0.50	12AV7 0.70	90L1T 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL316 0.95	UC98 0.45
2Z4G 0.45		6SA7 0.45	12B1 3.00	90L1U 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL317 0.95	UC98 0.45
6/30L2 0.90	6CG7 1.65	6SG7 0.45	12C1 3.00	90L1V 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL318 0.95	UC98 0.45
6AB4 0.45	6CL6 0.65	6SK7 0.45	12K7G70.50	90L1W 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL319 0.95	UC98 0.45
6AB5 1.00	6C6 0.80	6SL7GT0.48	12Q7G70.45	90L1X 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL320 0.95	UC98 0.45
6AF4A 0.65	6CW4 1.00	6SN7GT0.48	12R7 0.50	90L1Y 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL321 0.95	UC98 0.45
6AG5 0.35	6CY5 0.50	6S07 0.50	12S7 0.50	90L1Z 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL322 0.95	UC98 0.45
6AG7 0.65	6CY7 0.75	6S17 0.50	20L1 1.10	90L1A 1.50	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL323 0.95	UC98 0.45
6AH6 0.60	6D3 0.55	6T8 0.38	20P1 1.50	90L1B 0.45	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL324 0.95	UC98 0.45
6AJ8 0.30	6DC6 0.85	6U4GT 0.75	20P4 1.10	90L1C 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL325 0.95	UC98 0.45
6AK5 0.40	6DK6 0.60	6V8A 0.45	20P5 1.20	90L1D 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL326 0.95	UC98 0.45
6AK6 0.60	6DQ6B 0.80	6VGT 0.50	20S7 0.70	90L1E 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL327 0.95	UC98 0.45
6AL3 0.43	6DS4 1.35	6W4 0.45	25C5 0.60	90L1F 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL328 0.95	UC98 0.45
6AL5 0.25	6EY5 0.50	6X4 0.45	35Z4G 0.40	90L1G 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL329 0.95	UC98 0.45
6AM6 0.37	6EH7 0.30	6X8 0.70	35Z4G 0.40	90L1H 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL330 0.95	UC98 0.45
6AQ5 0.45	6EJ7 0.35	6Y6G 0.60	35Z4G 0.40	90L1I 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL331 0.95	UC98 0.45
6AQ6 0.70	6EW6 0.70	7Y4 0.75	30A3 0.40	90L1J 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL332 0.95	UC98 0.45
6AR5 0.60	6F1 0.75	9BW6 0.75	30C1 0.30	90L1K 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL333 0.95	UC98 0.45
6AR6 0.68	6F5 0.75	10C2 0.60	30C15 1.00	90L1L 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL334 0.95	UC98 0.45
6AS6 0.55	6F6G 0.50			90L1M 0.95	EBC81 0.33	ECL83 0.70	EL90 0.45	PC89 0.50	PL335 0.95	UC98 0.45

TRANSISTORS

2N696 0.15	29746 0.25
2N697 0.15	AC113 0.15
2N698 0.80	AC125 0.30
2N705 0.70	AC126 0.20
2N706 0.10	AC127 0.17
2N708 0.15	AC128 0.25
2N725 0.20	AC129 0.25
2N929 0.20	AC153 0.30
2N930 0.20	AC154 0.15
2N997 0.45	AC167 0.17
2N1181 0.25	AC176 0.25
2N1182 0.25	AC187 0.25
2N1184 0.25	AC188 0.20
2N1802 0.17	AC177 0.35
2N1803 0.15	AC178 0.20
2N1804 0.20	AC179 0.25
2N1805 0.20	AC180 0.20
2N1806 0.25	AC181 0.20
2N1807 0.25	AC182 0.10
2N1808 0.25	AD139 0.40
2N1809 0.30	AD149 0.40
2N1613 0.17	AD161 0.35
2N1711 0.20	AD162 0.35
2N1756 0.15	AD211 1.25
2N2147 0.75	AD212 1.25
2N2160 0.10	AF114 0.17
2N2217 0.25	AF115 0.17
2N2218 0.20	AF116 0.17
2N2369A 0.15	AF117 0.17
2N2477 0.65	AF118 0.25
2N2646 0.40	AF180 0.50
2N2905 0.32	AF181 0.50
2N2923 0.18	AF186 0.40
2N2924 0.18	AF212 1.00
2N2926 0.10	AS126 0.25
2N2933 0.20	AS127 0.30
2N3054 0.20	AS128 0.25
2N3065 0.60	AS129 0.30
2N3133 0.25	AS154 0.25
2N3134 0.25	AS215 0.80
2N3391 0.17	AS216 0.80
2N3392 0.17	AS217 0.80
2N3393 0.15	AS218 0.80
2N3394 0.15	BC107 0.10
2N3395 0.20	BC108 0.10
2N3402 0.15	BC109 0.10
2N3403 0.15	BC113 0.15
2N3404 0.32	BC114 0.20
2N3414 0.20	BC118 0.20
2N3415 0.15	BC134 0.20
2N3417 0.25	BC147 0.10
2N3646 0.30	BC149 0.11
2N3702 0.10	BC152 0.19
2N3703 0.10	BC158 0.11
2N3704 0.12	BC159 0.11
2N3705 0.10	BC175 0.20
2N3706 0.10	BC186 0.25
2N3707 0.12	BC190 0.35
2N3709 0.10	BCY31 0.45
2N3710 0.10	BCY33 0.35
2N3711 0.20	BCY34 0.35
2N3819 0.25	BCY38 0.35
2N3906 0.25	BCY72 0.15

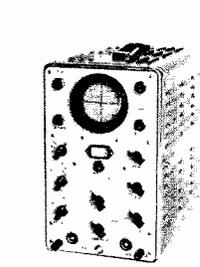
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0A7 0.15	0A86 0.07
0A10 0.20	0A90 0.15
0A47 0.08	0A91 0.07
0A70 0.07	0A95 0.07
0A79 0.07	0A200 0.07

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IAS029 (Avalanche) 1000 P.I.V.	1-5A	0-30	
IN640	400 P.I.V.	750mA	0-30
IN645	225 P.I.V.	400mA	0-16
IN649	600 P.I.V.	400mA	0-35
IN8193	200 P.I.V.	750mA	0-15
IN8194	400 P.I.V.	750mA	0-17
IN4002	100 P.I.V.	1A	0-07
IN4004	400 P.I.V.	1A	0-08
IN4006	800 P.I.V.	1A	0-12
IN6399	1000 P.I.V.	1-5A	0-25
IN6408	1000 P.I.V.	3A	0-50
BY100	700 P.I.V.	450mA	0-15
BY101	450 P.I.V.	1-1A	0-15
BY105	800 P.I.V.	1-1A	0-15
BY125	200 P.I.V.	425mA	0-10
BY126	650 P.I.V.	1A	0-10
BY127	1250 P.I.V.	1A	0-10
DD006	50 P.I.V.	500mA	0-15
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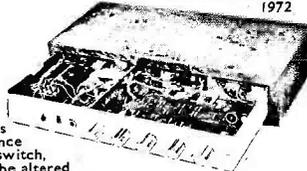
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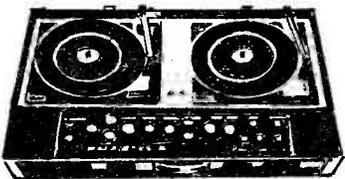
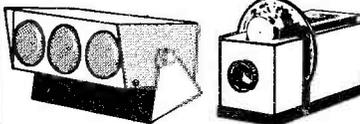
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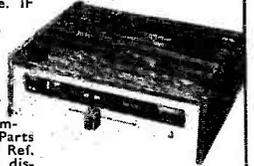
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