PRACTICAL WIRELESS

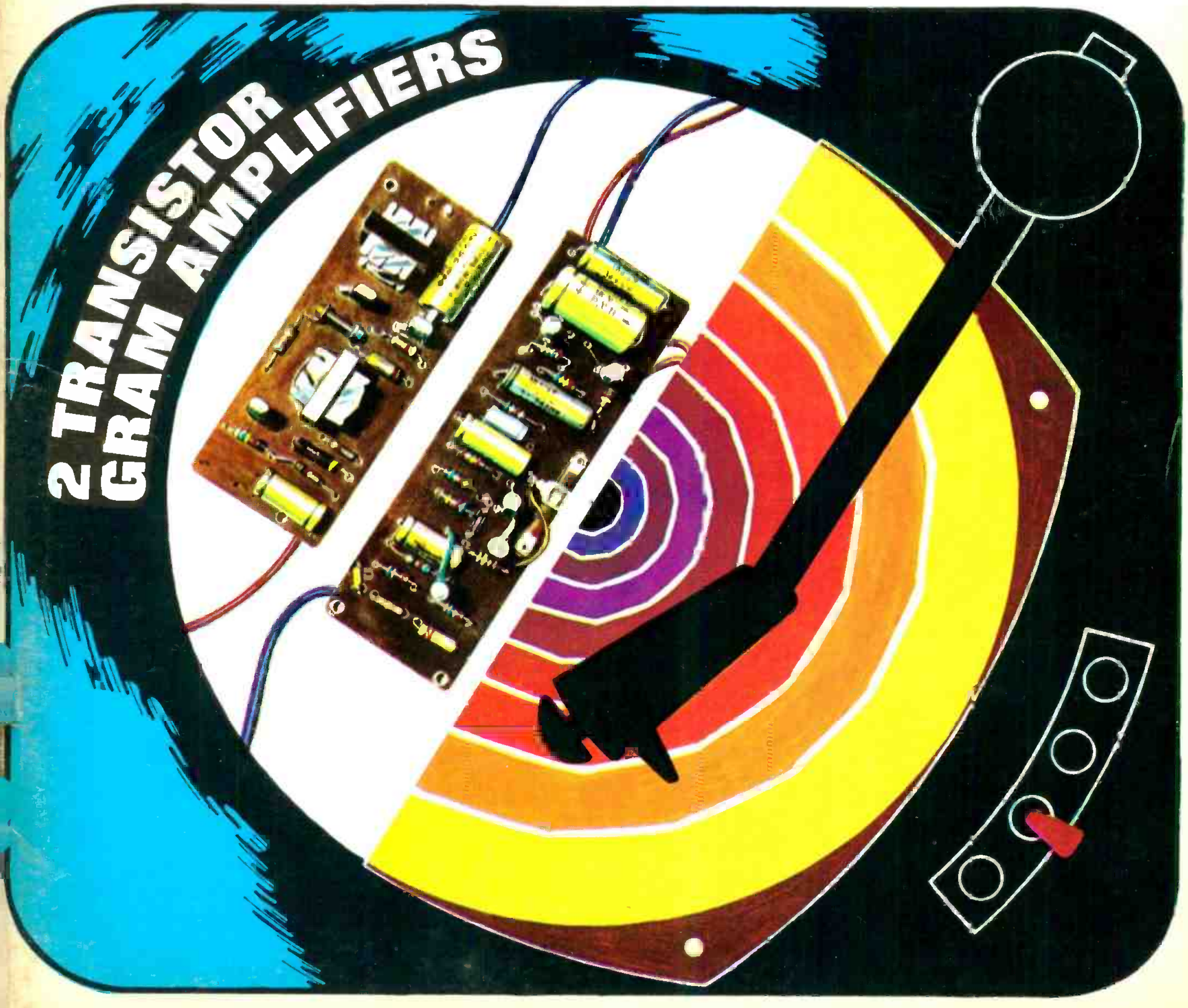
NOVEMBER
1968

3/0

FREE INSIDE
- AUDIO REFERENCE CHART
TABLES, DATA,
COLOUR CODES, ETC, ETC

PLUS

EXTRA
12 PAGE PULLOUT AUDIO SUPPLEMENT
- LOUDSPEAKERS
- PICKUPS
- PLAYING DECKS



AUDIO REFERENCE CHART

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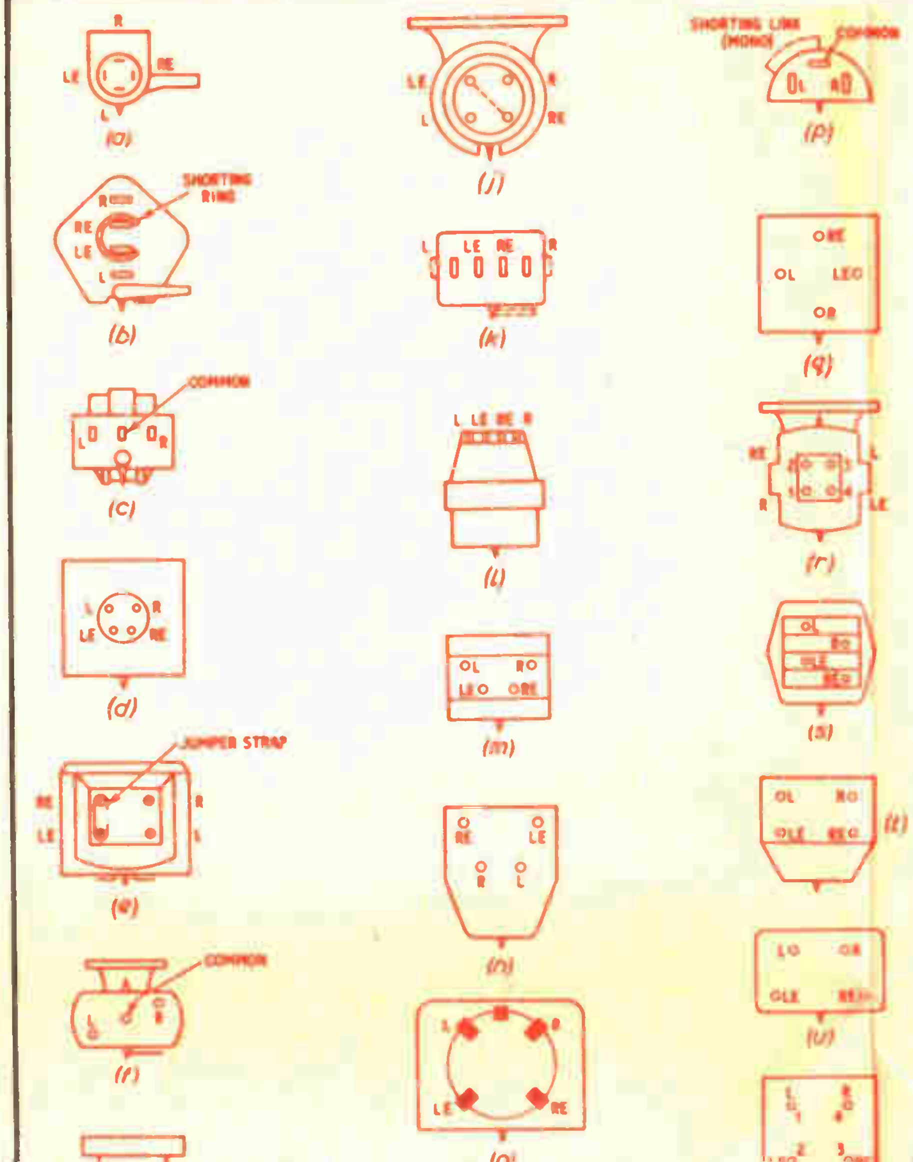
PRACTICAL WIRELESS
NOVEMBER 1968



Stereo cartridge connections

There are many different pin and tag formations on gramophone pickup cartridges. Fig. 1 brings together most of the popular configurations. These are stereo cartridges, with left channel live connection marked 'L', left earth, 'LE', right channel live, 'R', right channel earth 'RE', and common connection where this applies marked 'C'. For monaural connection, it is usual to parallel channels, connecting the live pins together and the earth pins together unless these are already commoned.

The diagrams show the rear view of cartridges, with stylus in the playing position. Dotted lines indicate fitted links. In most cases it is necessary to link at the amplifier, rather than the cartridge end.

Types of cartridges using the connections shown are principally as follows.

(a), (b), (c) and (d) Acos (Cosmocord).
(e) ADC (KEF Electronics)
(f) BSR, (also 4-pin type as in (k).)
(g) Connoisseur
(h) Decca Mark I and II
(j) Decca Deram
(k) Elac magnetic (crystal and ceramic types for universal application have turnover styli, shown dotted connections remain similar).
(l) Elac 'plug-in' types, crystal and ceramic
(m) Empire (De Villiers)
(n) Ortofon (Metro-Sound)
(o) and (p) Philips, with shorting link for mono shown dotted, (p)
(q) Pickering (Goldring).
(r) Ronette. (Some types are three-pin, with left pin for left channel, right pin for right channel and centre pin for common connection.)
(s) and (t) Shure. (Pin spacings may differ, but phasing is as shown.)
(u) Shure (see above)
(v) Tannoy.
(w) Garrard (five different plug-in head shells are employed and wiring to cartridges is colour-coded. Earlier versions used left grey, left-earth, blue, right, brown, right-earth or common, black. Later versions conform to international practice, left, white, left-earth, blue right, red, right-earth, green.
(x) Goldring.

Plugs and sockets

DIN standards resolve to 5 types of plug and soc
pin formation, as in Fig. 3

Standard connections to 5-pin DIN socket for au
purposes are as shown in Fig. 4. This is for ste
recording and replay. Variations permit parallel p
crossing of connections for dubbing and addition
alternative sources.

Phono plugs may have long or short pin leng
Cinch (Carr Fasteners Ltd) plugs may have shorter
length. Some Japanese types are also shorter than u
British version. Care must be taken to ensure connect
and to avoid short-circuits caused by using the wr
length plug.

Jack plugs are in 4 main varieties, classed accor
to diameter. 2.5 mm is miniature version, gene
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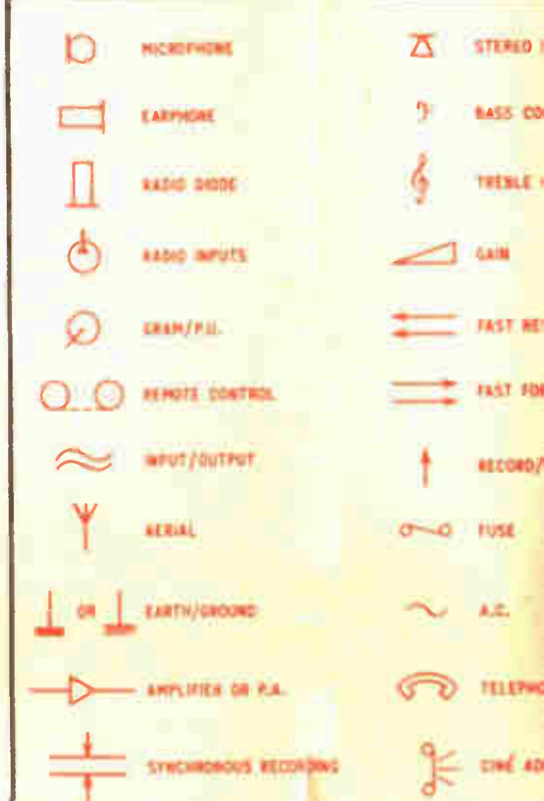
used input connection, especially on Japanese
recorders. Also employed for foot controls, head
etc.

5 mm is special diameter, limited in use to Fi
and Luxor.



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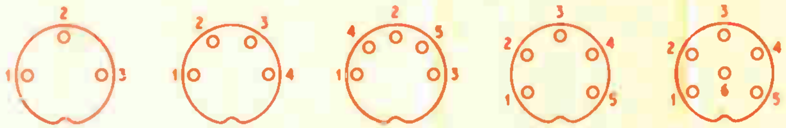

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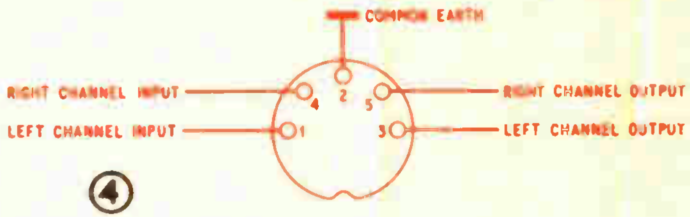
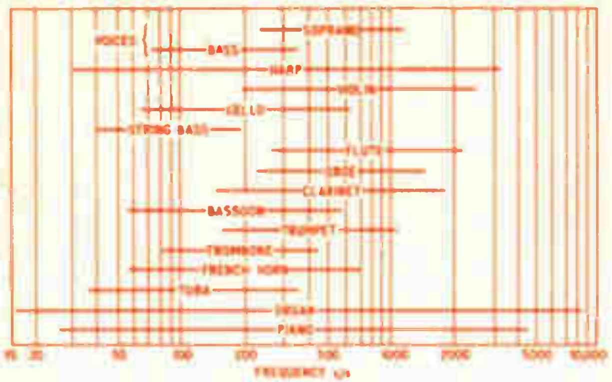


④

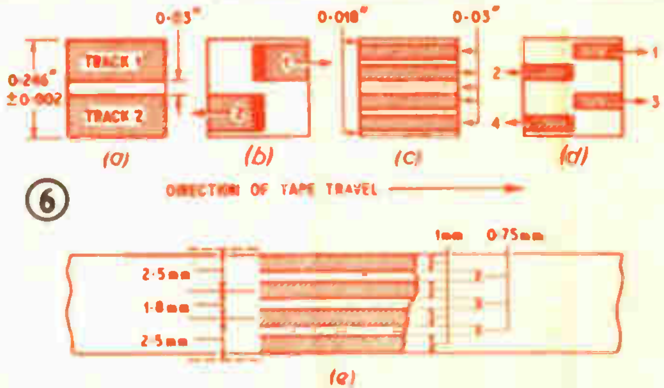
Standard ¼-in jack (G.P.O. type) has tip same diameter as barrel. Stereo jack is similar to standard, with additional ring. Tip may be of smaller diameter than sleeve. Tip is normally Channel 1, left-hand, and ring Channel 2, right-hand.



Audio spectrum

⑦

Frequency ranges of some commonly heard instruments and voices. Considerable overtone modification may be found, affecting the timbre, and giving instruments their characteristic sound.



⑥

Tape track and head dimensions

For compatibility between tape recorders and to enable interchange of tapes, exact dimensions of recorded tracks are needed. There are several standards the requirements of which overlap to some extent, with resultant changes in tolerance and in quality.

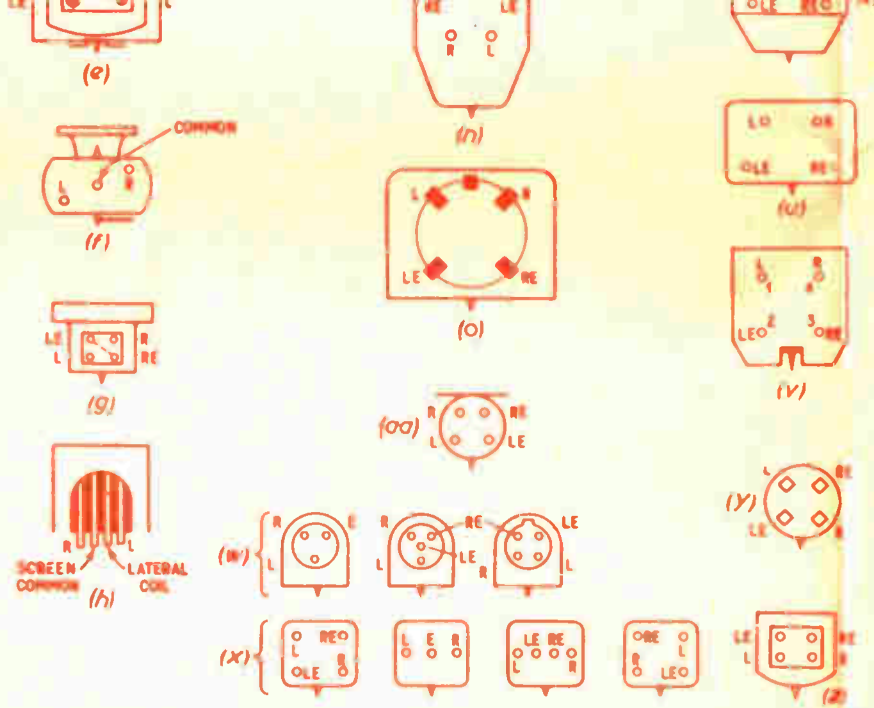
Tape width for domestic purposes is taken to be one-quarter-inch, but should actually be 0·246 in. with a maximum permissible tolerance of ± 2 thou (0·002 in.). Earlier standards specified ¼-inch ± 0·6 thou.

Fig. 6 shows some of the principal dimensions, with safety lanes between tracks and at edges of tape also given. Track width is determined by the gap dimensions: some two-track tape recorders use 0·118 in.

Metric equivalents

Gramophone disc sizes:	12 in. – 30 cm.
	10 in. – 25 cm.
	7 in. – 17·5 cm.
Gramophone stylus sizes:	1 mil. – 25μ
	0·7 mil. – 18μ
	0·5 mil. – 13μ
	0·2 mil. – 5μ
Tape speeds:	15 in/sec. – 38·1cm/s.
	7½in/sec. – 19·1cm/s.
	3¾in/sec. – 9·5cm/s.
	1⅞in/sec. – 4·8cm/s.
	15/16 in/sec. – 2·4cm/s.
Tape spool sizes:	7in. – 17.5cm.
	5¾in. – 14·6cm.
	5in. – 12·7cm.
	4in. – 10·2cm.
	3in. – 7·6cm.

Atmospheric pressure:
normal 14·7lbs/sq.in. – 1·034 Kgms/sq.cm.
Sound velocity at 20 deg. C.
1130 ft/sec. – 344 metres/sec.
Sound velocity at 0 deg. C.
1087 ft/sec. – 331 metres/sec.
(rising approximately 2 ft/sec. per deg. C.)



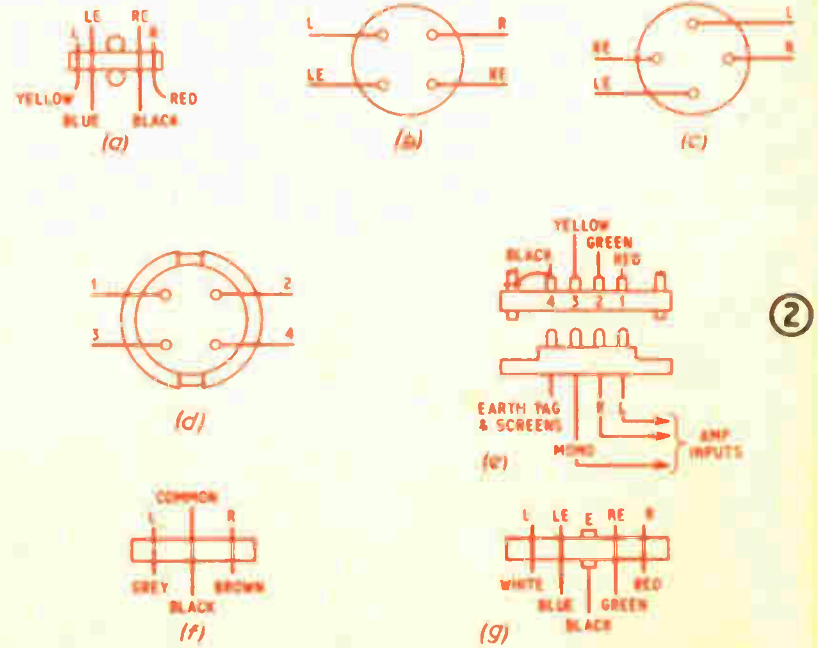
(r) Ronette. (Some types are three-pin, with left pin for left channel, right pin for right channel and centre pin for common connection.)
(s) and (t) Shure. (Pin spacings may differ, but phasing is as shown.)
(u) Shure (see above)
(v) Tannoy.
(w) Garrard (five different plug-in head shells are employed and wiring to cartridges is colour-coded. Earlier versions used left grey, left-earth, blue; right, brown, right-earth or common, black. Later versions conform to international practice, left, white, left-earth, blue, right, red, right-earth, green.
(x) Goldring
(y) Sonotone.
(z) Orbit (Neat).

Sony cartridges employ basic pin connections, in-line, left, left-earth, right-earth and right.

B & O cartridges are as in (aa)

Audio-Technica use two upper pins left and right with conforming lower pins linked, and commoned

1



2

Pick-up arm and shell connections and colour codes

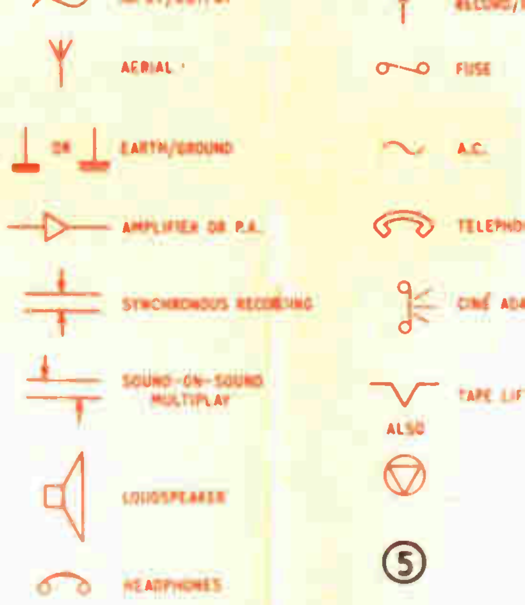
International agreement for pick-up cartridge and arm colour-coding is now as follows:

Left channel live – white
Left channel earth – blue
Right channel live – red
Right channel earth – green
Common or screen – black

There are numerous variations, and earlier models may have grey brown and black wirings for left right and common connections. See Fig. 2 (f) and (g).

Connections to shells and arms of some popular variations are as shown below:

(a) B.S.R. tag-board wiring. With three-pin systems, blue is not used.
(b) and (c) Ortofon pick-up arm connections. (Colour coding may be non-standard, with red left and white right channel, and blacks for both earths. A separate black may also be used for connection to the arm.)
(d) SME shell connections. Colour coding is 1, red; 2, green; 3, yellow and 4, black. Left channel connects to 1 and right channel to 2, with earth connection to 4.
(e) SME connections to tag strip.



5

Operational symbols

Despite many variations by different manufac some general agreement on international symb audio purposes has evolved. Fig. 5 lists those in p use. Note that the symbol for remote control ma denote 'Tape recorder socket' on some amplifie that for Input/Output may be a simple output soc some tape recorders and associated equipment

Gramophone record star

Disc Sizes:	$11\frac{7}{8} \pm \frac{1}{32}$ in. (12
	$9\frac{7}{8} \pm \frac{1}{32}$ in. (10
	$6\frac{7}{8} \pm \frac{1}{32}$ in. (7-i
Playing speeds:	77·92 ± 5% (78)
	45·11 ± 5% (45)
	33·33 ± 5% (33)
Grooves per inch:	(78 r.p.m.) coarse
	(33 and 45 r.p.m.)
Recorded diameters:	Outer–12-in. 11
	10-in. 9
	7-in. 6
	Inner–12-in. $4\frac{3}{4}$
	10-in. $4\frac{3}{4}$
	7-in. $3\frac{3}{4}$
Centre hole diameter:	0·285–0·2885 in.
	(for 45 r.p.m. disc
	1·502–1·506 in.)

Operational symbols

Despite many variations by different manufacturers, some general agreement on international symbols for audio purposes has evolved. Fig. 5 lists those in popular use. Note that the symbol for remote control may also denote 'Tape recorder socket' on some amplifiers, and that for Input/Output may be a simple output socket on some tape recorders and associated equipment.

For compatibility between tape recorders and to enable interchange of tapes, exact dimensions of recorded tracks are needed. There are several standards, the requirements of which overlap to some extent, with resultant changes in tolerance and in quality.

Tape width for domestic purposes is taken to be one-quarter-inch, but should actually be 0·246 in. with a maximum permissible tolerance of ± 2 thou (0·002 in.). Earlier standards specified ¼-inch ± 0·6 thou.

Fig. 6 shows some of the principal dimensions, with safety lanes between tracks and at edges of tape also given. Track width is determined by the gap dimensions: some two-track tape recorders use 0·118 in. track width and have their heads adjusted to scan the edge of the tape. Safety margins between tracks are reduced to as little as 0·01 in. Two-track stereo heads with track widths of 0·08 in. are used, giving a wide safety margin and less cross-track interference, but with reduced sensitivity and less protection against dropouts. Four-track recording is more general for pre-recorded stereo tapes.

(a) half-track recording
(b) half-track recording with reduced track width, showing direction of recorded information.
(c) quarter-track recording, showing safety lanes.
(d) quarter-track recording, showing direction of recorded information. For stereo recording, track 1 is left channel, track 3 right channel, in one direction, inversion of tape then makes track 4 left channel and track 2 right channel.
(e) metric dimensions, half-track to the left, showing method of overlap to procure full advantage of track and reduce variations due to tape and transport discrepancies. Quarter-track recording may also be carried to the edge of tape, as shown on the right of the diagram.

3¾in/sec. – 9·5cm/s.
1⅞in/sec. – 4·8cm/s.
$\frac{15}{16}$in/sec. – 2·4cm/s.

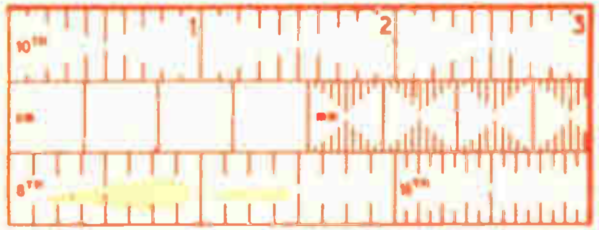
Tape spool sizes: 7in. – 17·5cm.
5¾in. – 14·6cm.
5in. – 12·7cm.
4in. – 10·2cm.
3in. – 7·6cm.

Atmospheric pressure:
normal 14·7lbs/sq.in. – 1·034 Kgms/sq.cm.

Sound velocity at 20 deg. C.
1130 ft/sec. – 344 metres/sec.

Sound velocity at 0 deg. C.
1087 ft/sec. – 331 metres/sec
(rising approximately 2 ft/sec. per deg. C.)

Acceleration: Standard g, 32 ft. per sec. per sec. – 980 cm/s/s



Gramophone record standards

Disc Sizes	11⅞ ± $\frac{1}{32}$ in. (12-in.)
	9⅞ ± $\frac{1}{32}$ in. (10-in.)
	6⅞ ± $\frac{1}{32}$ in. (7-in.)
Playing speeds	77·92 ± 5% (78) r.p.m.
	45·11 ± 5% (45) r.p.m.
	33·33 ± 5% (33) r.p.m.
Grooves per inch:	(78 r.p.m.) coarse, 90–120
	(33 and 45 r.p.m.) fine, 200–300
Recorded diameters:	Outer–12-in. 11½-in. ± $\frac{1}{64}$ in.
	10-in. 9½-in. ± $\frac{1}{64}$ in.
	7-in. 6$\frac{11}{16}$-in. ± $\frac{1}{64}$ in.
	Inner–12-in. 4¾
	10-in. 4¾
	7-in. 3¾
Centre-hole diameter:	0·285–0·2885 in. (for 45 r.p.m. discs, optionally 1·502–1·506 in.)

Eccentricity: centre of centre-hole not more than 0·005 in. from centre of groove spiral.
Stylus radius: Mono fine-groove 1 mil (25μ), stereo 0·5 mil (13μ).
Bi-radial (elliptical) styli: Major radius 0·7–0·8 mil, minor radius 0·2–0·3 mil.
Disc Replay Standards: for pickups having an electrical output proportional to stylus velocity (magnetic), mean slope of curve is 4dB per octave. (Response approximately 13½dB up and down at 100c/s and 10kc/s.) Crystal and ceramic pickups usually have response falling at 6dB per octave when fed into high resistive load.
Normal recorded velocity: 5 cm/sec.
Stereo colour-code: Left–white; left–earth–blue; Right–red; right–earth–green.
Vertical tracking angle: 15 degrees.

Conversions

1 inch	– 2·54 cm.
1 thou	– 25·4 μ
1 foot	– 30·48 cm.
1 sq.in.	– 6·452 sq.cms.
1 cu.in.	– 16·39 cu.cms.
1 gram	– 980·62 dynes
1 oz.	– 28·35 gms.
1 lb.	– 0·4536 Kgms.
1 lb/sq.in.	– 70·307 gms/sq.cm.
1 micron (μ)	– 0·0394 thou (·00004 in.)
1 cm.	– 0·3937 in.
1 metre	– 39·3708 in.
1 sq.cm.	– 0·155 sq in
1 cu cm	– 0·061 cu in
1 dyne	– 0·00102 gramme weight.
1 watt	– 0·00134 horse power
	– 44 ft.lbs/min.
	– 0·1 Kgm/m/sec.

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5¾"	900ft.	**17/–**	1200ft.	**21/6**	1800ft.	**36/–**
7"	1200ft.	**21/6**	1800ft.	**33/–**	2400ft.	**52/6**

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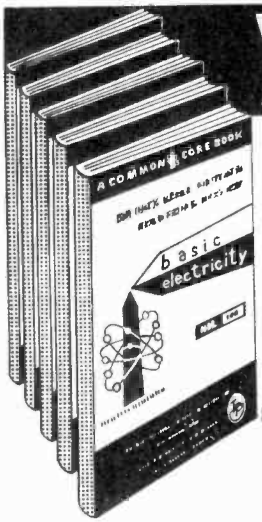

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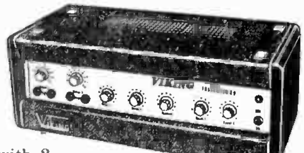

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Channel 2 4mV at 470K } microphone or guitars.
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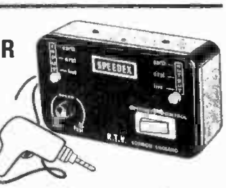
Gram sensitivity 40mV at 1 KHz. Aux sensitivity 50mV at 1 KHz. (Sensitivities are given for rated output). 4 watts r.m.s. (8 watts r.m.s. in monaural position). Output matches into standard 3 ohms speaker system. Suitable 10″ x 6″ speakers are available at 29/6 each, plus 5/- p. & p. Bass control at 100 Hz lift + 9dB cut − 10dB. Treble control at 10 KHz lift + 8dB cut − 13dB. Total harmonic distortion 0·35% at 3 watts and 2% for rated output at 1 KHz. Negative feedback 13dB at 1 KHz. Mains supply 220–250V A.C. 50–60 Hz.

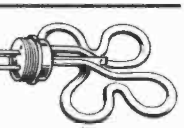
Price 13 gns P & P 15/-

SPEEDEX the SPEED CONTROLLER for ELECTRIC POWER DRILL



Infinitely variable electronic speed controller for your electric power drill. Varies the speed of all power tools (up to 600W) between 12 r.p.m. and maximum r.p.m.
Instantly adjustable with simple single control overriding switch for instant maximum speed. Simply connected into lead of power tool. Only **25**/- plus 3/6 P. & P.

GEC KETTLE ELEMENT



3,000W WITH AUTOMATIC EJECTION
200/240v. Size of hole required $1\frac{1}{16}$″
List Price **32**/-. Our PRICE **15**/-. P. & P. 1/6.

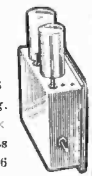
Goods not despatched outside U.K. Terms C.W.O.
All enquiries Stamped Addressed Envelope

RADIO & TV COMPONENTS (Acton) LTD
21c High Street, Acton, London, W.3.
323 Edgware Road, London, W.2.
All orders by post to our Acton address

POCKET MULTI-METER

Size $3\frac{7}{8}$ x $2\frac{1}{4}$ x $1\frac{3}{8}$in. Meter size $2\frac{1}{4}$ x $1\frac{7}{8}$in. Sensitivity 1000 O.P.V. on both A.C. and D.C. volts. 0–15, 0–150, 0–1000 D.C. current 0–150mA. Resistance 0–100k Ω. Complete with test prods, battery and full instructions, **42/6**. P. & P. 3/6. **FREE GIFT** for limited period only. 30 watt Electric Soldering Iron value 15/- to every purchaser of the Pocket Multi-Meter.

CYLDON U.H.F. TUNER



Complete with PC88 and PC86 Valves. Full variable tuning. New and unused. Size $4\frac{1}{4}$ x $5\frac{1}{2}$ x $1\frac{1}{2}$in. Complete with circuits diagram. **35/-** p. & p. 3/6

THREE-IN-ONE HI-FI 10 WATT SPEAKER

A complete Loud Speaker system on one frame, combining three matched ceramic magnet speakers with a low loss cross over network. Peak handling power 10 watts. Impedance 15 ohms. Flux density 11,000 gauss. Resonance 40–60 c/s. Frequency range 50c/s to 20kc/s. Size $13\frac{1}{2}$ x $8^1/_{16}$ x $4\frac{1}{2}$ inches. By famous manufacturer. List Price £7. Our price **69/6** plus 5/- P. & P.
Similar speaker to the above without tweeters in 3 and 15 ohm **39/9** plus 5/- P. & P.

600 mW FOUR TRANSISTOR AMPLIFIER

Features N.P.N. and P.N.P. complementary symmetrical output stage, $2\frac{1}{4}$″ x $\frac{7}{8}$″ x $\frac{7}{8}$″ Speaker. Output impedance 12 ohms frequency response 3dB points 90 c/s and 12 Kc/s. Price **19/6** plus 1/- P. & P. 7 x 4″ Speaker to suit, **13/6** plus 2/- P. & P.

$2\frac{1}{2}$ watt ALL TRANSISTOR AMPLIFIER

AC mains 240V. Size 7″ x $4\frac{1}{4}$″ x $1\frac{7}{8}$″. Frequency response 100 c/s—10 Kc/s Semi conductors, two OC 75's two AC 128's and two stabilizers AA129. Tone and volume controls on flying leads. **£2.10.0** plus P. & P. 3/6. Suitable 8″ x 5″ 10,000 line high flux speaker, **18/6** plus 2/- P. & P.

NEW TRANSISTORISED SIGNAL GENERATOR

Size $5\frac{1}{2}$ x $3\frac{1}{4}$ x $1\frac{1}{2}$in. For IF and RF alignment and AF output 700 c/s frequency coverage 460 kc/s to 2 mc/s in switched frequencies. Ideal for alignment to our Elegant Seven and Musette. Built and tested. **49/6** P. & P. 3/6.

FIRST QUALITY P.V.C. TAPE

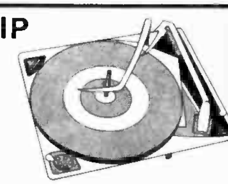
$5\frac{3}{4}$″	Std.	850ft.	9/–	5″	L.P.	850ft.	10/6
7″	Std.	1200ft.	11/6	3″	T.P.	600ft.	10/6
3″	L.P.	240ft.	4/–	5″	T.P.	1800ft.	25/6
$5\frac{3}{4}$″	L.P.	1200ft.	11/6	$5\frac{3}{4}$″	T.P.	2400ft.	32/6
7″	L.P.	1800ft.	18/6	7″	T.P.	3600ft.	42/6
$5\frac{3}{4}$″	D.P.	1800ft.	18/6	4″	T.P.	900ft.	15/–

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

THE RELIANT 10W SOLID-STATE HIGH QUALITY AMPLIFIER

SPECIFICATIONS
Output—10 watts RMS Sine-wave
13 watts RMS Music-power
Output Impedance—3 to 4 ohms
Inputs—1. -xtal mic 10mV
2. -gram/radio 250mV
Tone Controls—Treble control range ± 12dB at 10KH2
Bass control range ± 13dB at 100H2
Frequency Response—(with tone controls central) Minus 3dB points are 20H2 and 40KH2. Signal to Noise Ratio—better than −60dB. Transistors—4 silicon Planar type and 3 Germanium type. Mains input— −220 −250V. A.C. Size of chassis—10″ × $3\frac{3}{4}$″ × 2″. A.C. Mains, 200-250V. For use with Std. or L.P. records, musical instruments, all makes of pick-ups and mikes. Separate bass and treble lift control. Two inputs with control for gram. and mike. Built and tested. 8″ × 5″ speaker to suit price **14/6** plus 1/6 P. & P. Crystal mike to suit **12/6** plus 1/6 P. & P.
PRICE £5.5.0 plus 5/- P. & P.

RECORD PLAYER SNIP

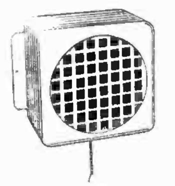


The "Princess" 4-speed automatic record changer and player engineered with the utmost precision for beauty, long life, and trouble free service. Will take up to ten records which may be mixed 7″ to 10″ or 12″. Patent stylus brush cleans stylus after each playing and at shut off, the pick-up locks itself into its recess, a most useful feature with portable equipment—other features include pick-up height adjustment and stylus pressure adjustment. This truly is a fine instrument which you can purchase this month at only **£5.19.6** complete with cartridge and ready to play. Post and insurance 7/6 extra.

ANTI-THIEF CAR BURGLAR ALARM

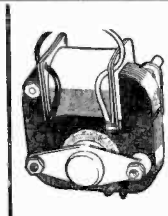
The Melguard Safermatic consists of an electrical device housed in small metal box 4″ × 2″ × $1\frac{1}{2}$″, which has been designed and developed to provide protection required by the average motorist at an economic cost. Using this system, an alarm and the immobilised condition is set automatically as soon as you park the car. Should you leave the key in the ignition, no one but you can drive the car away. Upon entering the vehicle the method of starting the car is by switching on the ignition, depressing two hidden switches, and simultaneously operating the starter. Location of the switches is known only to you. Should the alarm be set off it can be stopped by following the normal starting procedure. For 12V operation. List price **79/6**, our price **29/6** plus 2/6 P. & P. Full easy-to-follow instructions supplied.

EXTRACTOR FAN



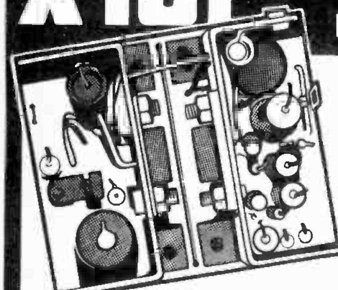
AC Mains 230/250 v. complete with pull switch. Size 6″ x 6″ x 4″. Price **27/6** plus 5/– P. & P.

AC MAINS MOTOR



1400 R.P.M. 230/250v
PRICE 9/6
P. & P. 3/-

X101 10 WATTS (RMS) SOLID-STATE HI-FI AMP WITH INTEGRAL PRE-AMP



Its great versatility ranges from: A simple intercom. to a modern HI-FI STEREO AMPLIFIER (2 are required for Stereo). The X101 is a brilliant new addition to our highly successful range of products. Its professional performance and advanced solid-state circuitry techniques ensures reliability, combined with high fidelity reproduction at AN UNBEATABLE PRICE

SPECIFICATIONS

R.M.S. Power Output: 13 W (music power), 10 W (Sine Wave).
Sensitivity: for rated output 1 mV into 3 K ohms load.
Frequency Response: minus 3dB points are 20 Hz and 40 KHz.
Total Distortion: at 1KHz for rated output 1·5%, for 5 W output 0·35%.
Output Impedance: 3 ohms (3-15 ohms may be used).
Supply Voltage: 24 V D.C. at 800 mA (6-24 V may be used) output at 14 V D.C. supply with 3 ohms speaker. 7 watts.
Size: $2\frac{1}{4}$" x 3" x $1\frac{9}{16}$".

The fully comprehensive instruction manual not only shows the basics, such as circuit diagram and connections, but also gives practical easy-to-understand detailed information about the X101. Standard equalisation networks are given for most types of conventional inputs. They include: Tape Head, Mag. P.U., Xtal P.U., Tuner, Mic. etc.

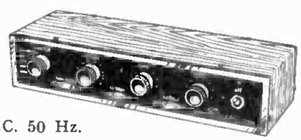
Built & Tested **49/6** + 2/6 p. & p.

Control assembly: (Including resistors and capacitors).
1. Volume: PRICE 5/-. 2. Treble: PRICE 5/-.
3. Comprehensive bass and treble: PRICE 10/-.
The above 3 items can be purchased for use with the X101.

POWER SUPPLIES FOR THE X101

P101 M (for mono) p. & p. 2/6 **35/-**
P101 S (for stereo) p. & p. 2/6 **42/6**

The CLASSIC HIGH QUALITY SOLID-STATE AMPLIFIER (MONO)



SPECIFICATION

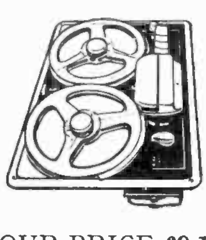
Switched inputs for: Tape Head, Mag. P.U., Cer. P.U., Radio and Aux.
Mains Input: 220–250V A.C. 50 Hz.

THE CLASSIC IS THE COMBINATION OF THE ABOVE DESCRIBED ITEM (X101, + P101/M AND PR101/M) ON ONE COMMON CHASSIS. ITS PERFORMANCE AND SPACE-AGE STYLING MAKE IT THE IDEAL CHOICE FOR THE VALUE-CONSCIOUS HI-FI ENTHUSIAST.

Size $12\frac{1}{2}$in. long, $4\frac{1}{2}$in. deep, $2\frac{3}{4}$in. high.
Teak finished case.

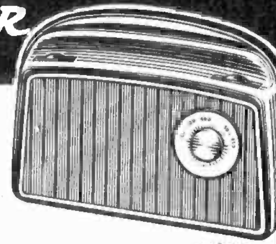
p. & p. free **8 gns**

The MOTEK 3 SPEED 2 TRACK TAPE DECK



3 Speed 2 Track
TAPE DECK
complete with heads
Takes 7 inch spools.
Incorporating 3 motors.
A.C. Mains 240 volts.
Listed at £21.
OUR PRICE **£9.19.6** plus 10/- post & pack.

NEW! THE Dorset TRANSISTOR PORTABLE RADIO



CAN BE USED AS BABY ALARM

600 milliwatt solid state 7 transistor plus diode and thermistor. Completely modulised high quality portable radio featuring complementary NPN and PNP output stage. The comprehensive easy-to-follow drawings supplied make this the easiest-ever transistor radio set of parts with the following features:

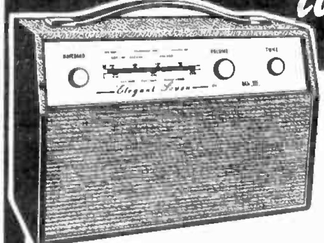
5gns

plus 7/6 postage and packing.
Circuit and parts list 2/6 free with parts.

- Simple connections to only 6 tags on the R.F./I.F. module, 3 I.F. stages, osc. coil and 3 transistors which with their associated components are completely wired.
- Only 4 connections on the A.F. module to complete the 4 transistor 600 milliwatt solid state amplifier.
- Pre-aligned R.F./I.F. module built and tested.
- A.F. module built and tested.
- Fully tunable over M.W. and L.W. bands. M.W. 540–1640 Kc/s (557–183 metres). L.W. 150–275 Kc/s (2000–1100 metres).
- Intermediate Frequency 470 Kc/s.
- Sensitivity: M.W. at 1 Mc/s 10 microvolts plus or minus 3dB. L.W. at 200 Kc/s 40 microvolt plus or minus 4dB.
- High Q internal ferrite rod aerial on both wavebands.
- Class 'B' modulised output stage with thermistor controlled heat stabilisation. Class 'B' output stage ensures long battery life. Current drain is proportional to the output level. Total current drain of the receiver under no signal conditions is 10–12 mA. At reasonable listening level 20–30 mA.
- Extension sockets for car aerial input, tape recorder output (independent of volume control) and External Speaker.
- All components (except speaker) mount on the printed circuit board. Easy-to-follow instructions. Size of cabinet 12in. long, 8in. high and 3in. deep.
- Finger-tip controls.

Special Offer—Power Supply Kit to purchasers of Dorset Portable Radio parts incorporating mains transformer, rectifier and smoothing condenser, AC mains 200/250V output 9V 100mA, 9/6 extra.

ELEGANT SEVEN Mk III COMBINED PORTABLE and CAR RADIO



Buy yourself an easy to build 7 transistor radio and save at least £10.0.0. Now you can build this superb transistor superhet radio for under £4.10.0. No one else can offer such a fantastic radio with so many de luxe star features.

SPECIAL OFFER

£4.9.6

POWER SUPPLY KIT
To purchasers of 'Elegant Seven' parts, incorporating mains transformer, rectifier and smoothing condenser. A.C. mains 200/250 volts. Output 9v 100mA. 9/6 extra.

Plus 7/6 P. & P. Parts List and circuit diagram 2/6 FREE with parts.

★ De luxe wooden cabinet size $12\frac{1}{4}$" x $8\frac{1}{2}$" x $3\frac{1}{2}$".
★ Horizontal easy to read tuning scale printed grey with black letters, size $11\frac{1}{2}$" x 2".
★ High 'Q' ferrite rod aerial.
★ I.F. neutralization on each separate stage.
★ D.C. coupled push pull output stage with separate A.C. negative feedback.
★ Room filling output 300mW.
★ Ready etched and drilled printed circuit board back printed for foolproof construction.
★ Fully comprehensive instructions and point-to-point wiring diagrams.
★ Car aerial socket.
★ Fully tunable over medium and long wave. 168–535 metres and 1250–2000 metres.
★ All components ferrite rod and tuning assembly mount on printed board.
★ 5" P.M. speaker.
★ Parts list and circuit diagram 2/6, free with parts.

RADIO & TV COMPONENTS (ACTON) LTD.

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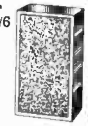
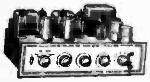
THE 'YORK' HIGH FIDELITY 3 SPEAKER SYSTEM

★ **Moderate size, only 25 x 14 x 10in. Complete Kit** **18 Gns.**
★ **Response 30-20,000 c.p.s. Impedance 15 ohms.**
★ **Performance comparable with units costing** Carr. 12/6 **over £40.** Consists of (1) 12 in. 20 watt Bass unit with cast chassis, Roll rubber surround for ultra low resonance, powerful 2in. diam. pole pieces and ceramic magnet. (2) 3-way quarter section series cross-over system. (3) 8 x 5in. high flux middle range 'speaker. (4) High efficiency tweeter. (5) Measured weight of woollen acoustic damping material. (6) Teak veneered cabinet. (7) Circuit and full instructions.



DEMONSTRATIONS AT ALL BRANCHES.

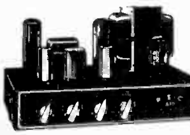
R.S.C. STEREO/20 HI-FI AMPLIFIER PROVIDING



10/14 WATT ULTRA LINEAR PUSH-PULL OUTPUT ON EACH CHANNEL. SUITABLE FOR "MIKE", GRAM, RADIO OR TAPE. (7) valves ECC83, (2) ECL86, (4) EZ81. **Frequency Response:** ±2dB 30-20,000 c.p.s. **Hum Level:** 65dB down. **Sensitivity:** 20 millivolts max. **Harmonic Distortion:** 0.2% ★**Four-position tone compensation and Input Selector Switch.** ★**Stereo/Mono switch.** ★**Neon panel indicator.** ★**Handsome Perspex Frontplate.** ★**Separate Bass and Treble controls.** Output transformers are high quality sectionally wound. Outputs for 3 and 15 ohms speakers. Complete set of parts, point-to-point wiring diagrams and instructions. Or factory assembled with our usual 12 mths' gntee 19gns. Or Dep. £4.10.0 and 9 monthly payments £2 (Total £22.10.0). *Send S.A.E. for leaflet.*

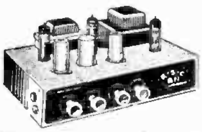
14 Gns. Carr. 12/6

R.S.C. A10 30 WATT ULTRA LINEAR HI-FI AMPLIFIER



Highly sensitive. Push-Pull high output, with Pre-amp./Tone Control Stages. Performance figures equal to most expensive amplifiers. Hum level —70dB. Frequency response ±3dB 30-20,000c/s. Sectionally wound output transformer. All first grade components. Valves EF86, EF86, ECC83, 807 807, GZ34. Separate Bass and Treble Controls. Sensitivity 12 millivolts so that **any kind of Microphone or Pick-up is suitable.** Designed for **Clubs, Schools, Theatres, Dance Halls** or **Outdoor Functions,** etc. For use with **Electronic Organ, Guitar, String Bass,** etc. Gram. Radio or Tape. Reserve L.T. and H.T. for **Radio Tuner.** Two inputs with associated volume controls so that two separate inputs such as Gram and "Mike" can be mixed. 200-250v. 50c/s A.C. mains. For 3 and 15 ohm speakers. Complete kit of parts with point-to-point wiring diagrams and instructions. Carr. 12/6 **13 Gns.** Twin-handled perforated cover **25/-**. Supplied factory built with EL34 output valves. 12 months' guarantee for **16 gns. TERMS: Deposit £5.14.0** and 9 monthly payments of **28/9** (Total **£18.12.9**). Send S.A.E. for leaflet.

R.S.C. A11 HIGH FIDELITY 12-14 WATT AMPLIFIER



PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP. Two input sockets with associated controls allowing mixing of "mike" and gram, etc. etc. High sensitivity. 5 valves—ECC83 (2), EL84 (2), EZ81. High quality sectionally wound output transformer. IND. BASS AND TREBLE CONTROLS. Frequency response ±3dB 30-20,000 c/s. Hum level —60dB. SENSITIVITY 23 millivolts. Suitable for Crystal or Ceramic PUs, all types "mikes". For Musical Instruments such as String Bass, Electronic Guitars etc. Size approx. 12 x 9 x 7in. For AC mains 200-250v. 50 cps Output for 3 and 15 ohm spkrs. SAE for leaflet. Complete kit. **9 Gns.** Full instructions and point-to-point wiring diagrams. Carr 11/6 (or factory built **12 Gns.**) Twin handled metal cover 25/-. TERMS ON ASSEMBLED UNITS. Deposit **87/6** and 9 monthly payments of **22/-**. (Total **£14.5.6**).

RSC A11T TRANSISTORISED VERSION of above complete kit **9 Gns** (Assembled **13 Gns**)

R.S.C. BASS-REGENT 50 WATT AMPLIFIER

An exceptionally powerful high quality all-purpose unit for lead, rhythm, bass guitar, vocalists, gram, radio, tape.

★ Two extra heavy duty 12in. Loudspeakers.
★ Four Jack inputs and two Volume Controls for simultaneous use of up to four pick-ups or "mikes". Bass and Treble controls.

49½ Gns. Carr. 30/- or dep. **£7.17.6** and 9 monthly payments of **£5.10.10.** (Total **55 gns.**). Send S.A.E. for leaflet.
Also B20 Bass inc. 15in. 25w Spkr. 29½ gns. G15 inc. 12in. 20w Spkr. 19½ gns.

R.S.C. BATTERY/MAINS CONVERSION UNITS

Type BM1 An all-dry battery eliminator. Size 5½x4¼x 2in. approx. Completely replaces batteries supplying 1.5v. and 90v. where A.C. mains 200/250v. 50c/s is available. Complete kit with diagram **47/9 or assembled 59/11.**

SELENIUM RECTIFIERS | F.W. (Bridged)

All 6/12v. D.C. output. Max. A.C. input 18v. 1a. **3/11.** 2a. **6/11.** 3a. **9/9.** 4a. **12/9.** 6a. **15/9.**

R.S.C. MAINS TRANSFORMERS

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

MIDGET CLAMPED TYPE 2½ × 2⅝ × 2¼in.	
250v., 60mA, 6·3v. 2a.	15/11
250-0-250v., 60mA 6·3v. 2a.	16/11
FULLY SHROUDED UPRIGHT MOUNTING	
250-0-250v. 60mA, 6·3v. 2a., 0-5-6·3v. 2a.	21/9
250-0-250v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	35/9
300-0-300v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	35/9
300-0-300v. 130mA, 6·3v. 4a., c.t., 6·3v. 1a. For Mullard 510 Amplifier	43/9
350-0-350v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	35/9
350-0-350v. 150mA, 6·3v. 4a., 0-5-6·3v. 3a.	45/9
425-0-425v. 200mA, 6·3v. 4a., c.t., 5v. 3a.	69/9
425-0-425v. 200mA, 6·3v. 4a., 6·3v. 4a., 5v. 3a.	75/-
450-0-450v. 250mA, 6·3v. 4a., c.t., 5v. 3a.	85/9
TOP SHROUDED DROP-THROUGH TYPE	
250-0-250v. 70mA, 6·3v. 2a., 0-5-6.3v. 2a.	21/9
250-0-250v. 100mA, 6·3v. 3·5a.	23/9
250-0-250v. 100mA, 6·3v. 2a, 6·3v. 1a.	24/9
350-0-350v. 80mA, 6·3v. 2a., 0-5-6·3v. 2a.	25/9
250-0-250v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	35/9
300-0-300v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	35/9
300-0-300v. 130mA, 6·3v. 4a., 0-5-6·3v. 1a. Suitable for Mullard 510 Amplifier	42/9
350-0-350v. 100mA, 6·3v. 4a., 0-5-6·3v. 3a.	35/9
350-0-350v. 150mA, 6·3v. 4a., 0-5-6·3v. 3a.	43/11

FILAMENT or TRANSISTOR POWER PACK Types 6·3v. 1·5a. 7/9; 6·3v. 2a. 8/9; 6·3v. 3a. 10/9; 6·3v. 6a. 21/9; 12v. 1a. 8/9; 12v. 3a. or 24v. 1·5a. 21/9; 0-9-18v. 1½a. 17/9; 0-12-25-42v. 2a. 29/9.

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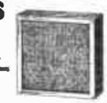

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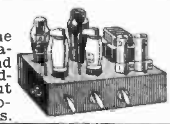

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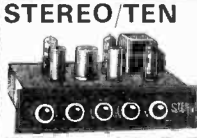

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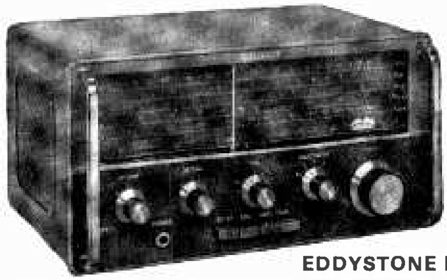

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OA95	2/6

SILICON POWER DIODES

60 P.I.V. 290 MA 2/-	6 AMP 5/6
70 P.I.V. 1 AMP 3/6	400 P.I.V. 8 AMP 7/6
140 P.I.V. 165MA 1/-	700 P.I.V. 100 AMP 35/-
150 P.I.V. 25 AMP 10/-	800 P.I.V. 500MA 5/6
200 P.I.V. 6 AMP 5/6	800 P.I.V. 5 AMP 7/6
400 P.I.V. 500MA 3/6	1000 P.I.V. 6 AMP 7/6
400 P.I.V.	1000 P.I.V. 650MA 6/6

THYRISTORS SILICON CONTROL RECTIFIERS

400 P.I.V. 3 AMP 7/6	200 P.I.V. 7 AMP 15/6
100 P.I.V. 7 AMP 13/6	400 P.I.V. 7 AMP 15/6

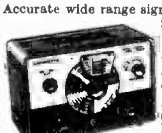
PLEASE ADD POSTAGE

ZENER DIODES

OAZ200	12/-	OAZ208	6/6
OAZ201	10/-	OAZ209	6/6
OAZ202	8/6	OAZ210	6/6
OAZ203	8/6	OAZ211	6/6
OAZ204	8/6	OAZ212	6/6
OAZ205	8/6	OAZ213	6/6
OAZ206	8/6	OAZ227	15/-
OAZ207	9/6		

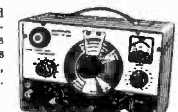
STC. 1 WATT SERIES 5% 2.4/2.7/3/3.9/4.3/13/16/18/20/30/33 volt, 5/- each.
Z series. All voltages from 3.9–50 volt. 250mW, 2/6 ea. 1.5w. 4/- ea. 7w. 5/- each.

TE-20RF SIGNAL GENERATOR



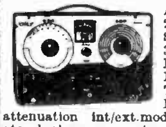
Accurate wide range signal generator covering 120 Kc/s–260 Mc/s on 6 bands. Directly calibrated Variable R.F. attenuator. Operation 200/240V. A.C. Brand new with instructions. £15.0.0. P. & P. 7/6, S.A.E. for details.

LAFAYETTE TE46 RESISTANCE CAPACITY ANALYSER



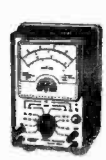
2 pF–2,000 mFd 2 ohms 200 megohms. Also checks impedance, turns ratio, insulation, 200/250V. A.C. Brand New £17.10.0. Carr. 7/6.

ARF-100 COMBINED AF-RF SIGNAL GENERATOR



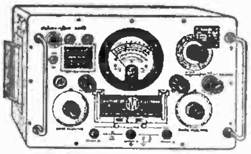
A.F. SINE WAVE 20–200,000 c/s. Square wave 20–30,000 c/s. O/P HIGH IMP. 21V. P/P600Ω 3·8V. P/P. TF 100 Kc/s–300 Mc/s. Variable R.F. attenuation int/ext.modulation. Incorporates dual purpose meter to monitor AF output and % mod. on R F. 220/240V. A.C. £30.0.0. Carr. 7/6.

T.E.40 HIGH SENSITIVITY A.C. VOLTMETER



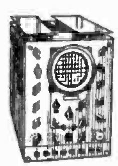
10 meg. input 10 ranges: ·01/·003/·1/·3/1/3/10/30/100/300V. R.M.S. 4cps.–1·2 Mc/s. Decibels —40 to +50dB. Supplied brand new complete with leads and instructions. Operation 230V. A.C. £17.10.0. Carr. 5/-.

AVO CT.38 ELECTRONIC MULTIMETERS



High quality 97 range instrument which measures A.C. and D.C. Voltage. Current, Resistance and Power Output. Ranges D.C. volts 250mV–10,000V. (10 megΩ–110 megΩ input). D.C. current 10μA–25 amps. Ohms:0–1,000 megΩ. A.C. volt 100mV–250V (with R.F. measuring head up to 250 Mc/s) A C. current 10μA–25 amps. Power output 50 micro-watts–5 watts. Operation 0/110/200/250V. A.C. Supplied in perfect condition complete with circuit lead and R.F. probe. £25. Carr. 15/-.

TYPE 13A DOUBLE BEAM OSCILLOSCOPES



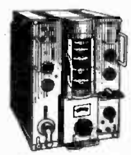
An excellent general purpose D/B oscilloscope. T.B. 2cps.–750 Kc/s. Bandwidth 5·5 Mc/s. Bandwidth 5·5 Mc/s Sensitivity 33mV/CM. Operating voltage 0/110/200/250V. A.C. Supplied in excellent working condition. £22.10.0. Or complete with all accessories, probe, leads, lid, etc. £25. Carriage 30/-.

AM/FM SIGNAL GENERATORS

Oscillator Test No. 2. A high quality precision instrument made for the ministry by Airmec. Frequency coverage 20–80 Mc/s. AM/CW/FM Incorporates precision dial, level meter, precision attenuator 1μV–100mV. Operation from 12 volt D.C. or 0/110/200/250 volt A.C. Size 12 x 8½ x 9in. Supplied in brand new condition complete with all connectors fully tested. £45. Carr. 20/-.

ADMIRALTY B.40 RECEIVERS

Just released by the Ministry. High quality 10 valve receiver manufactured by Murphy. Coverage in 5 bands 650 Kc/s–30 Mc/s. I.F. 500 Kc/s.



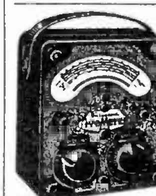
Incorporates 2 R.F. and 3 I.F. stages, band-pass filter, noise limiter, crystal controlled B.F.O., calibrator. O/F output, etc. Built-in speaker, output for phones. Operation 150/230 volt A.C. Size 19¼ x 13½ x 16in. Weight 114 lbs. Offered in good working condition. £22.10.0. Carr. 30/-. With circuit diagrams. Also available B.41 L.F. version of above. 15 Kc/s–700 Kc/s. £17.10.0. Carr. 30/-.

MARCONI CT44/TF956

AF Absorption Wattmeter

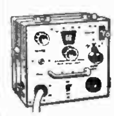
1 μ/watt to 6 watts. £20. Carr. 10/-.

AVOMETERS



Supplied in excellent condition, fully tested and checked. Complete with prods, leads and instructions. Model 47A £9.19.6. Model 8 £18. P. & P. 7/6 each.

CLASS D WAVEMETERS



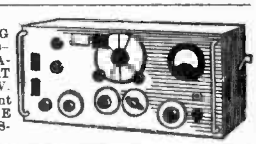
A crystal controlled heterodyne frequency meter covering 1·7–8 Mc/s. Operation on 6 volts D.C. Ideal for amateur use. Available in good used condition. £5.19.6. Carr. 7/6. Or brand new with accessories. £7.19.6. Carr. 7/6.

AUTO TRANSFORMER

0/115/230v. Step up or step down. Fully shrouded.

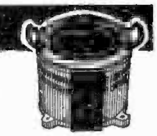
150 W.	£1.12.6.	P. & P. 3/-.
300 W.	£2. 7.6.	P. & P. 3/-.
500 W.	£3.10.0.	P. & P. 6/6.
1,000 W.	£5.10.0.	P. & P. 7/6.
1,500 W.	£6.10.0.	P. & P. 8/6.
3,000 W.	£7.10.0.	P. & P. 12/6.
7,500 W.	£15.10.0.	P. & P. 20/-.

MARCONI TEST EQUIPMENT



EX-MILITARY RECONDITIONED. TF.144G STANDARD SIGNAL GENERATORS, 85 Kc/s–25 Mc/s, £25. Carr. 30/-. T.F.885 VIDEO OSCILLATOR 0–5 Mc/s, £45. Carr. 30/-. T.F.195M BEAT FREQUENCY OSCILLATOR 0–40 Kc/s, 200/250V. A.C. £20. Carr. 30/-. All above offered in excellent condition, fully tested and checked. T.F.1100 VALVE VOLTMETER, Brand New, £50. T.F.1267 TRANSMISSION TEST SET, Brand New, £75.

Variable Voltage TRANSFORMERS

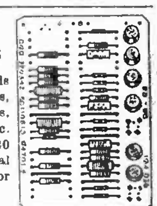


Brand new, guaranteed and carriage paid.
High quality construction. Input 230V. 50–60 cycles.
Output full variable from 0–260 volts. Bulk quantities available.
1 amp.—£5.10.0; 2·5 amp.—£6.15.0; 5 amp.—£9.15.0;
8 amp.—£14.10.0; 10 amp.—£18.10.0; 12 amp.—£21.0.0;
20 amp.—£37.0.0.

ADVANCE D.1 SIGNAL GENERATORS

A high quality U.H.F. signal generator covering 10–310 Mc/s. Operates on 200/250 volt A.C. Supplied in excellent condition complete with calibration charts. £15. Carr. 15/-.

PRINTED CIRCUITS

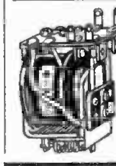


Five asstd. boards with transistors, diodes, resistors, condensers, etc. Guaranteed min. 20 transistors. Ideal experimenters. 5 for 10/-. P. & P. 2/-.

TE22 SINE SQUARE WAVE AUDIO GENERATORS

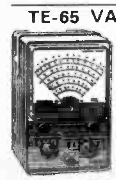
Sine: 20c/s to 200 Kc/s on 4 bands. Square: 20c/s to 30Kc/s. Output impedance 5,000 ohms, 200/250V A.C. Supplied brand new and guaranteed with instruction manual and leads, £16.10.0. Carr. 7/6.

OMRON MK2 RELAYS



Brand New and Boxed. 24V. D.C. coils. 2 Pole changeover. 5 amp. contacts. 7/6 each. P. & P. 1/6.

TE-65 VALVE VOLTMETER



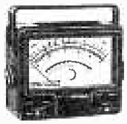
High quality instrument with 28 ranges. D.C. volts 1·5–1,500v. A.C. volts 1·5–1,500v. Resistance up to 1,000 megohms. 220/240v. A.C. operation. Complete with probe and instructions £17.10.0. P & P 6/-. Additional probes available: R.F. 35/-. H.V. 42/6.

G. W. SMITH & CO (RADIO) LTD.
3-34 Lisle St., W.C.2
Also see oppos. page

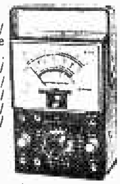
MULTIMETERS for EVERY purpose!

LAFAYETTE DE-LUXE 100KΩ/VOLT "LAB TESTER." Giant 6½in. scale. Built-in meter protection. 0/·5/2·5/10/50/250/500/1,000V D.C. 0/3/10/50/250/500/1,000V A.C. 0/10/100μA/10/100/500mA/2·5/10A, 0/1K/10K/100K/10M/10MΩ. −10 to 49·4dB. **£18.18.0.** P. & P. 5/-.

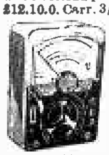
TE-900 20,000Ω/VOLT GIANT MULTIMETER mirror scale and overload protection. 6in. full view meter. 2 colour scale. 0/2·5/10/250/1,000/5,000v. A.C. 0/25/12·5/10/50/250/1,000/5,000v. D.C. 0/50μA/110/100/500 mA/10 amp. D.C. 02K/200K/20 MEG. OHM. **£15.** P. & P. 5/-.



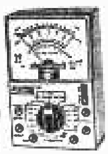
LAFAYETTE 57 Range Super 50kΩ/volt Multimeter. D.C. volts 125mV–1000V. A.C. volts 1·5V–1000V. D.C. current 25μA–10 amp. Ohms 0–10megΩ. dB −20 to +81 dB. Overload protection. **£12.10.0.** Carr. 3/6.



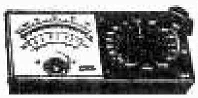
MODEL AS-100D. 100KΩ/VOLT. 5in. mirror scale Built-in meter protection. 0/3/12/60/120/300/600/1,200v. D.C. 0/6/30/120/300/600v. A.C. 0/10μA/6/60/300mA/12 amp. 0/2K/200K/2M/200MΩ. −20 to +17dB. **£12.10.0.** P. & P. 3/6.



NEW MODEL 500 30,000 O.P.V. with overload protection, mirror scale 0/·5/2·5/10/25/100/250/500/1,000v. D.C. 0/2·5/10/25/100/250/500/1,000v. A.C. 0/50μA/5/50/500mA. 12 amp. D.C. 0/60K/6 Meg./60 Meg..Ω **£8.17.6.** Post paid.



MODEL AF-105. 50kΩ/Volt. Mirror scale, built-in meter protection. 0/·3/3/12/60/120/300/600/1,200v. D.C. 0/6/30/120/300/600/1,200v. A.C. 0/30μA/6/60/300mA/12 Amp. 0/10K/1M/10M/100 MΩ. −20 to +17dB **£8.10.0.** P. & P. 3/6.

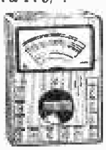


PROFESSIONAL 20,000 opv LAB. TYPE Multitester. Automatic overload protection, mirror scale. Ranges: 1/10/50/250/500/1,000 volts. D.C. and A.C. 0–500μA, 10mA, 250mA. Current: 0/20K, 200K, 2 megohm. Decibels: −20 to +22dB. **£5.19.6.** P. & P. 2/6.

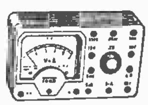
MODEL TE-12 20,000 O.P.V. 0/0·6/6/30/120/600/1,200/3,000/6,000v. D.C. 0/6/30/120/600/1,200v. A.C. 0/60μA/6/60/600mA. 0/6K/600K/6 Meg./60 Meg.Ω 50pF. 0·2 mFd. **£5.19.6.** P. & P. 3/6.

MODEL TE-70. 30,000 O.P.V. 0/3/15/60/300/600/1,200v. D.C. 0/6/30/120/600/1,200v. A.C. 0/30μA/3/30/300mA. 0/16K/160 K/1·6M/16 Meg. μ. **£5.10.0.** P. & P. 3/-.

MODEL TE-80. 20,000 O.P.V. 0/10/50/100/500/1,000v. A.C. 0/5/25/50/250/500/1,000v. D.C. 0–50μA, 5/50/500mA. 0/6K/60K/600 K/6 meg. **£4.17.6.** P. & P. 3/-.

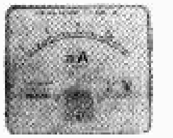


MODEL 250J. 20,00 O.P.V. 0/10/50/500/2,500v. D.C. 0/10/50/500/2,500v. A.C. 0/2 Meg. Ω. 0/250 mA. −20 to +36dB **49/6.** P. & P. 2/6.



MODEL PT-34. 1,000 O.P.V. 0/10/50/250/500/1,000v .A.C. and D.C. 0/1/100/500mA D.C. 0/100KΩ. **39/6.** P. & P. 1/6.

CLEAR PLASTIC PANEL METERS

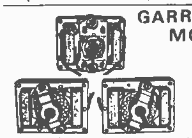


First grade quality Moving Coil panel meters available ex-stock S.A.E. for illustrated leaflet. Discounts for quantity. Type MR 38P, 1 21/32in. square fronts.

50μA	37/6	500-0-500μ	25/-	50mA	25/-	150V D.C.	25/-
50-0-50μA	35/-	1mA	25/-	100mA	25/-	300V. D.C.	25/-
100μA	35/-	1-0-1mA	25/-	150mA	25/-	500V. D.C.	25/-
100-0-100μA	32/6	2mA	25/-	200mA	25/-	750V. D.C.	25/-
200μA	31/6	5mA	25/-	300mA	25/-	15V. A.C.	25/-
500μA	37/6	10mA	25/-	500mA	25/-	50V. A.C.	25/-
		750mA	25/-	3V. D.C.	25/-	150V. A.C.	25/-
		1 amp	25/-	10V. D.C.	25/-	300V. A.C.	25/-
		2 amp	25/-	20V. D.C.	25/-	500V. A.C.	25/-
		5 amp	25/-	50V. D.C.	25/-	S meter 1mA	29/6
		20mA	25/-	100V. D.C.	25/-	VU meter	38/6

Postage Extra. Larger sizes available—send for lists.

GARRARD TAPE MOTORS



Brand new stock as used by famous manufacturer. 200/250V. A.C. Capstan motor **15/-**. Fast Forward 10/6. Fast Rewind **10/6**. P. & P. 3/-. Set of three motors **32/6**. P. & P. 5/-.

SINCLAIR EQUIPMENT

Z12 12 watt amplifier, **89/6**
PZ4 Power Supply Unit **89/6**
Stereo 25 Preamp., **£9.19.6**
Q14 Speakers, **£7.19.6**
Micromatic Radio Kit, **49/6**. Built **59/6**
Micro FM Radio Kit **£5.19.6**
ALL POST PAID

SPECIAL OFFER
Two **Z12** Amps., **PZ4** Power Supply, **Stereo 25** Preamplifier, **£22**, or with two **Q14** speakers **£37.**

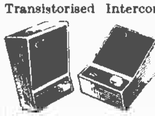
NEW SINCLAIR 2000 SYSTEM

35 watt Integrated Amplifier. **£29.** Carr. 5/-. Self-powered FM Tuner, **£25.** Carr. 5/-.

TRANSISTORISED TWO-WAY TELEPHONE INTERCOM

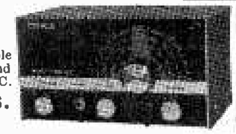
Operative over amazingly long distances. Separate call and press to talk buttons, 2-wire connection. 1000's of applications. Beautifully finished in ebony. Supplied complete with batteries and wall brackets. **£6.19.6.** P. & P. 3/6.

INTERCOM/BABY SITTER



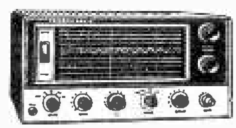
Transistorised Intercoms, ideal for home/office/workshop etc. 2-way buzzer call system. For desk or wall mounting. Supplied complete with connecting wire, batteries, instructions, 2 station **59/6.** P. & P. 2/6. 4 station **£6.12.6.** P. & P. 5/-

UNR-30 4-BAND COMMUNICATION RECEIVER



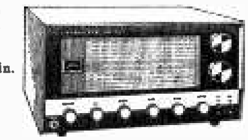
Covering 550 Kc/s–30 Mc/s. Incorporates variable BFO for CW/SS/B reception. Built in speaker and phone jack. Metal cabinet. Operation 220/240V. A.C. Supplied brand new, guaranteed with instructions. Carr. 7/6 **13 gns.**

LAFAYETTE HA-700 AM/CW/SSB AMATEUR COMMUNICATION RECEIVER



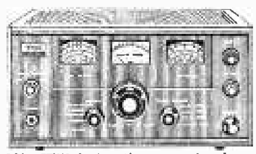
8 Valves, 5 bands incorporating 2 MECHANICAL FILTERS for exceptional selectivity and sensitivity. Frequency coverage on 5 bands 150–400 Kc/s, 550/1,600 Kc/s, 1·6–4·0 Mc/s, 4·8–14·5 Mc/s, 10·5–30 Mc/s. Circuit incorporates R.F. stage, aerial trimmer, noise limiter, B.F.O. product detector, electrical bandspread, S meter, slide rule dial. Output for phones, low to 2kΩ or speaker 4 or 8Ω. Operation 220/240V A.C Size 7¾×15×10in. Supplied brand new and guaranteed with handbook. **36 gns.** Carr. 10/-. S.A.E. for leaflet.

NEW LAFAYETTE SOLID STATE HA600 RECEIVER



5 BAND AM/CW/SSB AMATEUR AND SHORT WAVE. 150 Kc/s—400 Kc/s and 550 Kc/s—30 Mc/s. F.E.T. front end ● 2 mechanical filters ● Huge dial ● Product detector ● Crystal calibrator ● Variable BFO ● Noise limiter ● S Meter ● 24 in. Bandspread ● 230V A.C./12V. D.C. neg. earth operation ● RF gain control. Size 15in.×9½in.×8½in. Wt. 18 lbs. EXCEPTIONAL VALUE £45. Carr. 10/-. S.A.E. for full details.

TRIO COMMUNICATION RECEIVER MODEL 9R-59DE



4 band receiver 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. 4/8 ohm output and phone jack. SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. bandspread dial ● IF 455 Kc/s ● Audio output 1·5 W. ● Variable RF and AF gain controls. 115/250 V. A.C. Mains. Beautifully designed. Size: 7×15×10in. With instruction manual and service data. **£37.10.0.** Carriage 12/6.

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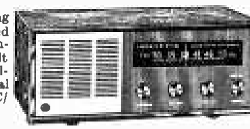
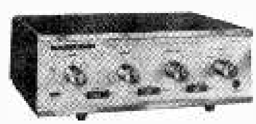


A completely new transistorised receiver covering 152–174 Mc/s. Fully tuneable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built in speaker and illuminated dial. Squelch and volume controls Tape recorder output 75Ω aerial input. Headphone jack. Operation 230V. A.C/12V. D.C. Neg. earth. **£37.10.0.** Carr. 10/-.

LAFAYETTE LA-224T TRANSISTOR STEREO AMPLIFIER



19 transistors, 8 diodes, 1HF music power, 30W at 8Ω. Response 30–20,000 ± 2dB at 1W. Distortion 1% or less. Inputs 3mV and 250mV. Output 3–16Ω. Separate L and R. volume controls. Treble and bass control. Stereo phone jack. Brushed aluminium, gold anodised extruded front panel with complementary metal case. Size 10½×3 9/16 × 7 13/16in. Operation 115/230V. A.C. **£28.** Carriage 7/6.

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PRACTICAL WIRELESS

VOL 44 No 7

Issue 741

NOVEMBER 1968

TOPIC OF THE MONTH

A Matter of Mode

SINCE time immemorial, or at least since your editor has been connected with radio (which some cynics claim is synonymous), the theme of "CW versus Phone" has simmered gently, periodically coming to the boil. Much of the comment is belligerently partisan and a lot of snide remarks are directed at the key bashers (mainly by those who have yet to pass the Morse Test).

It is contended that CW is an outmoded form of communication, an anachronism in these modern swinging times. Nevertheless, the detractors would be surprised, if only they could read Morse, at the large number of amateurs still wielding a key.

The object of amateur radio is communication and since CW is one mode it is not unreasonable to expect licensees to be able to use it. The Morse Test is retained by every country (at least for h.f. band usage) as a necessary hurdle to overcome. One might as well argue that telephony operators should not be expected to pass the RAE!

On the practical side, CW is by far the most efficient method of communication and occupies far less bandwidth than telephony (even SSB). When a band is "dead" to the telephony-only operator, the key pounders are usually able to keep going. During periods of poor conditions, it is often the *only* way to get through and the operator unable to switch to this mode is really only half an amateur.

With telephony, a contact between two stations in different countries requires that one or another of the operators must know both of the languages concerned. Most English amateurs are not linguists and it is arrogant to expect all foreign amateurs to know our language. This barrier does not exist to such an extent on CW because the international codes and abbreviations permit contacts which at least provide the basic information required at each end.

On the other hand, telephony can have many advantages and we would be the first to admit this. Let us, therefore, kill off the concept of "CW *versus* Phone" and substitute "CW *and* Phone". Both have their place in amateur radio and all stations should be equipped to handle *both* modes of communication.

W. N. STEVENS—*Editor.*

NEWS AND COMMENT

CONSTRUCTIONAL

OTHER FEATURES

DECEMBER ISSUE WILL BE PUBLISHED ON NOVEMBER 8th

NEWS AND COMMENT...

JET KING MINI BLOW TORCH

The Walter Kidde Company Limited has introduced, in the U.K., the Jet King blow torch and soldering tool.

This pocket-sized unit will allow you to solder or braze with precision in "tight spots" inaccessible to the usual tool. It is suitable for radio and TV work, repairs around the house, model making, etc.

The Jet King is completely portable and self-contained and gives approximately 45 minutes continuous burning with each butane charger. It is available in all leading departmental and hardware stores and garages. The cost is 35s. complete with two chargers. Refill chargers are readily available in packs of two for 6s. 6d.

SWITCH CATALOGUE

Arcolectric Switches Ltd, Central Avenue, West Molesey, Surrey, England, announce their Catalogue No. 137. It describes their complete range of products and replaces all previous catalogues. It is divided into seven sections.

Section D covers transformer signal lamps. The remaining sections covering switches, neon indicators and signal lampholders are generally as before, but include some new styles and types.

BELLING-LEE TERMINALS

A new series of miniature terminals, with a current rating of 10A and a breakdown voltage greater than 4kV d.c., is announced by Belling & Lee Limited.

Known as type L1726, these new terminals are only a quarter the size but have all the features of the standard style which they resemble in appearance. These include a captive head available with a choice of six standard colours, a socket in the top for plugging in auxiliary miniature connections to extra monitoring equipment, and a cross-hole in the clamping gap which accepts wires up to 1·9mm diameter (0·075in., i.e. 15 s.w.g. solid wires or 40/·0076in. stranded conductors).

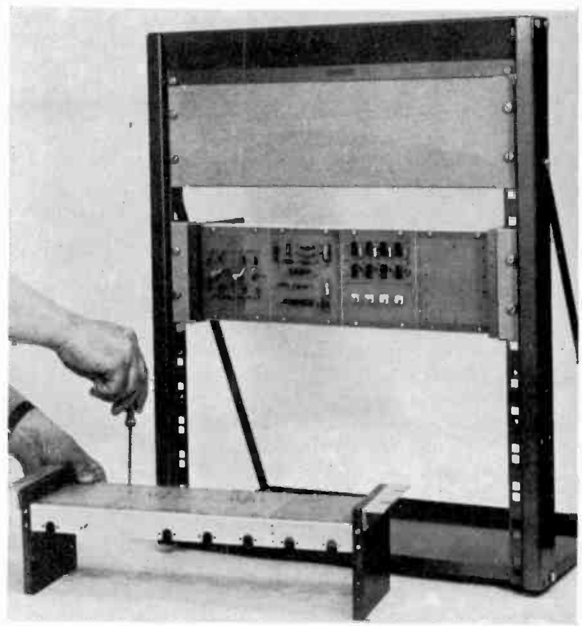
RADIO AT THE EDINBURGH INTERNATIONAL FESTIVAL

Lothians Radio Society, GB3EIF, operated a demonstration Amateur Radio Station during the period of the Edinburgh International Festival 1968 (17th August to 7th September).

The station was located at the Heriot Watt University, Mountbatten Building, Grassmarket, Edinburgh 1, and was operational on the bands 80—10m using s.s.b. equipment. An additional Station was operational on 2m using phone/c.w.

A special Q.S.L. card was issued to confirm all Q.S.O's and there was an exhibition of equipment built by members of the society.

ELECTRONIC LABORATORY KIT



A.P.T. have introduced a new "Lektrokit" No. 6 electronic construction kit for laboratory and educational use. It consists of a bench rack with two chassis assemblies (see picture) on which discrete components and integrated circuits can be mounted and wired. A front panel of grey enamelled aluminium alloy is also provided for indicator lamps, meters, switches, and other controls.

The base tray can be used to carry power supplies or other auxiliaries, and there is space for an additional chassis assembly or front panel if required.

This kit enables laboratory experimental circuits to be neatly stacked vertically instead of the usual sprawl across the bench, and allows immediate "shelving" of a rig if a need arises to clear the bench space for other work.

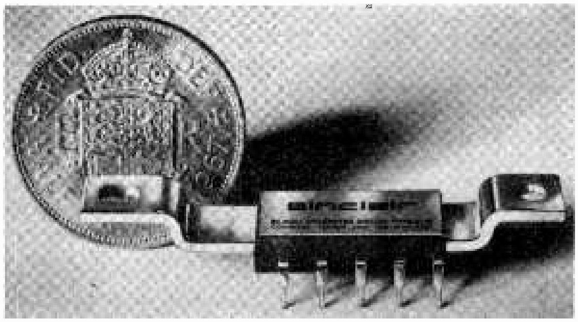
The price of the Lektrokit No. 6 is £7 10s. and further details are available from the manufacturers, A.P.T. Electronic Industries Ltd., of Byfleet, Surrey.

STEREOPHONY FOR THE NORTH

From 10 August the stereo programmes on Radio 3 were extended to a large part of Northern England. The transmissions are on 91·5Mc/s from Holme Moss.

NEWS AND COMMENT...

MICRO Hi-Fi



Sinclair Radionics have introduced the world's first monolithic integrated circuit hi-fi power and preamplifier. The complete unit, known as the IC-10, measures only 1 x 0·4 x 0·2in. and the circuit which this package contains is a chip of silicon just one-twentieth of an inch square by one-hundredth of an inch thick which contains 13 transistors (including two power types), 3 diodes and 18 resistors.

The circuit is complete in itself requiring only the addition of tone and volume controls and a power supply which may be battery or mains. Output power is 10 watts peak and 5 watts r.m.s. continuous. Distortion is less than 1% at full output and frequency response is 5c/s to 100kc/s$\pm$1 dB.

The preamp section contains 3 transistors with cut-off frequencies in excess of 500Mc/s so that it may be used as an r.f. or i.f. amplifier in addition to its normal audio application. The power amplifier is a 10 transistor circuit with a class AB output stage and closely defined quiescent current which is independent of temperature because of the extremely close thermal coupling between the output transistors and the bias diodes. The gain of the entire unit is accurately defined by built-in negative feedback loops and the circuit may be operated down to d.c. for special applications because direct coupling is employed throughout.

The amplifier will operate on any power source providing between 8 and 18 volts and is suitable for driving speakers of any impedance between 3 and 15 ohms.

The IC-10 is guaranteed for 5 years and costs only 59s. 6d. complete with a comprehensive instruction manual.

ROBERTS "IC" PORTABLE

Roberts Radio Co. Ltd. have launched their 2-band portable receiver type RIC.1. It is the first British radio receiver to employ a tiny monolithic integrated circuit. This device embodies most of the active components between the aerial and the output stage and a crystal filter is used for selectivity.

BOOKLET ABOUT THE RRE

The Royal Radar Establishment at Malvern, Worcs. is the largest centre for electronics research and development in Britain. It has now produced a booklet entitled "RRE Activities Guide" which gives an overall view of the programme of work at Malvern, from basic physics research to the development of advanced electronic equipment.

Copies of the booklet are available free from the Industrial Applications Unit, Royal Radar Establishment, Ministry of Technology, St. Andrews Road, Great Malvern, Worcs.

BRITAIN HELPS U.S. AIRLINE

Pan American World Airways is using a Mufax Courier facsimile communications system, supplied by the Muirhead Group of Beckenham, for sending facsimile copies of messages from nine transmitters in widely dispersed departments at Heathrow to the airline's European Telecommunications Centre on the south perimeter road. From there, the messages are transmitted over Pan Am's private teleprinter network to its stations throughout the world.

SOLDERING SAFETY

Weller have now introduced a range of simple, safe bench holders for both their industrial (TCP-1, W60D, W100D) and their consumer soldering irons (SP25D, SP40D, SP80D).

Prices range from 16s 0d. and, in addition to the holder and base, each kit includes a sponge for the easy cleaning of the soldering iron tip.

COLOUR CODING OF CABLES AND CORDS

It was announced recently that the Government have decided to make regulations under the Consumer Protection Act requiring the core colours of three-core flexible cords fitted to domestic electrical appliances, when offered for sale in Great Britain, to comply with the following international coding recently agreed by most of the countries of Europe:

Green-and-yellow striped core, Earth; Brown core, Live; Light blue core, Neutral.

HI-FI IN DUSSELDORF

The high fidelity audio fair "Hi-Fi 68" opened at Dusseldorf, West Germany on August 30 to September 3. One hundred and twenty three companies from nine different countries including Japan, America and the United Kingdom took part. Demonstrations of Hi-Fi were given in sixty specially sound-proofed cabinets.

PICO AMP DIODE

SGS-Fairchild have just announced their BAW30 miniature (TO 46) diode. It has a reverse current of only 10pA (V_R=10V). Capable of handling forward currents up to 100mA, this diode has a power dissipation rating or 125mW at 25°C. Other ratings include a breakdown voltage greater than 35V at a reverse current of 1μA, forward voltage drop of less than 1V at 10mA forward current and a capacitance of less than 1·3pF at zero reverse voltage. Fuller details from SGS-Fairchild, Planar House, Walton St., Aylesbury, Bucks.

Transistor Gram Amplifiers

R.F. GRAHAM

TRANSISTOR record playing equipment is easily made, and the amplifier and speaker may be separate items or contained in the same case as the turntable mechanism. Economical gram motor units to run from a 9V or similar dry battery are easily obtained, and the player is then portable and needs no mains supply. It is also quite feasible to employ a mains-driven turntable assembly, feeding its output to a transistor amplifier.

Low Volume Circuits

For single speaker reproduction of records or headphone listening to instructional records etc. a very simple amplifier is adequate. The circuit shown in Fig. 1 easily gives enough volume for this, with a 33/45 r.p.m. crystal pickup. VR1 is the volume control.

The OC72 operating conditions are set by the biasing components for a collector current of about

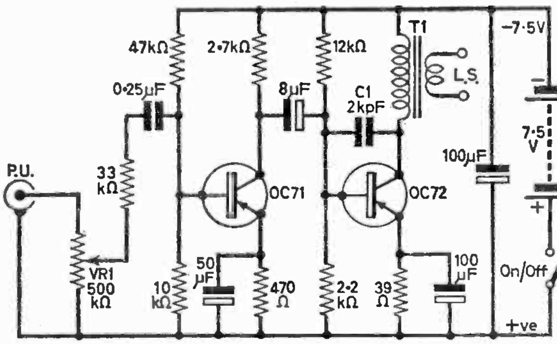


Fig. 1: Circuit of a two-stage amplifier.

15-20 mA. T1 can be a transistor type output transformer as used for push-pull output stages, with the centre-tap connection simply ignored. Alternatively a 70Ω or similar speaker may be connected from the collector to the negative supply line. Personal phones or headsets can also be connected in this way. Low-impedance speakers (such as 2/3Ω units) must be connected to T1 secondary.

C1 may be changed in value to modify tone. If the motor is for 6V or 9V, this may also be used for the amplifier.

Push-Pull Output

For many purposes an output of about 500mW is enough and can be obtained by using two OC81 or equivalent transistors. Figure 2 shows a driver and push-pull circuit of this type. For a smaller output two OC72 or similar transistors may be used, with an OC71 as driver. With OC72 output transistors R1 is 2·7kΩ and R2 100Ω. A two-stage amplifier of the type shown in Fig. 2 can give excellent volume with a fairly large output type pickup. Many ordinary crystal pickup units are satisfactory.

The volume may well be adequate with T1 omitted and the pickup volume control connected as in Fig. 3. The 100µF capacitor is then not required, and the base of the driver is taken direct to the junction of the 47kΩ and 12kΩ bias resistors.

Pickup Matching

A crystal pickup is intended to work into a high-impedance load, while the input impedance of the first transistor in circuits such as Figs. 1 and 2 is quite low. Impedance matching may be arranged by a transformer, e.g. T1 in Fig. 2, or a resistor, R1 in Fig. 3. A transformer transfers the pickup output to the transistor base with greater efficiency, allowing maximum volume with a given pickup and number of transistors. The ratio of T1 is not too critical, but it needs to have a high primary inductance.

In Fig. 3 R1 presents a high-impedance load at any setting of the volume control but also causes a loss of signal strength. R1 may be reduced in value if some drop in quality is not very important and this increases volume. With the arrangement shown in Fig. 3 an additional stage of amplification is usually needed. However, the few components and transistor needed may easily cost less than a matching transformer while the chances of picking up interference such as motor noise by the transformer are avoided. So this technique is often preferred unless a suitable transformer happens to be to hand.

With all circuits the pickup can be permanently

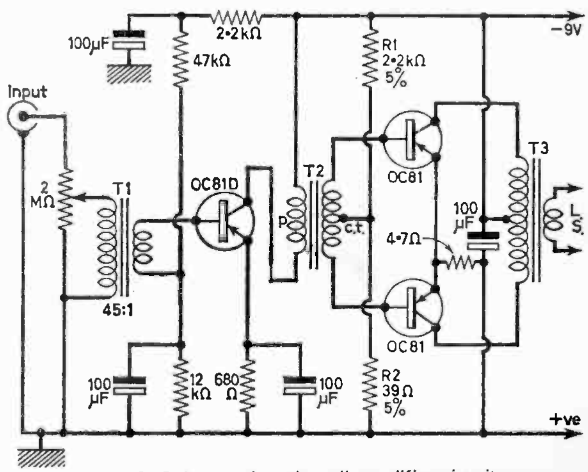


Fig 2: Driver and push-pull amplifier circuitry.

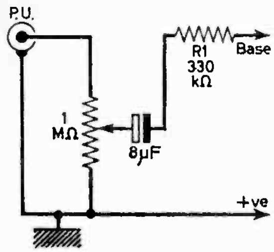
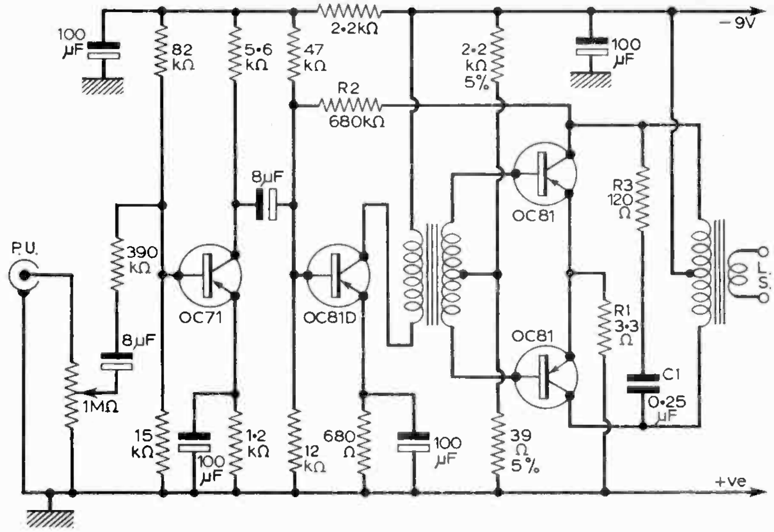


Fig. 3 (above): Matching circuit for high-impedance pickup.

Fig. 4 (right): One-watt amplifier circuit with the impedance matching circuit of Figure 3 incorporated. A crystal type pickup may be used that has an output of approximately 300mV.



connected or have a coaxial plug to fit a socket on the amplifier. The latter allows the same amplifier equipment to have other uses, such as with a radio tuner. The outer brading of the pickup lead is the "earth" or battery positive connection.

One-Watt Amplifier

For very many purposes an output of up to 1 watt is adequate and does not impose too much drain on a dry battery supply. Two OC81 or equivalent transistors will provide this output using the circuit in Fig. 4. A high-gain preamplifier stage follows the pickup, boosting signal strength for the driver stage. A crystal pickup with a nominal rated output of about 300mV is suitable.

For operation at maximum volume each output transistor should be in a clip which is bolted to a heatsink. The latter can be made from pieces of 16s.w.g. aluminium about 3in.×2in. A flange is bent on the aluminium so that each plate stands vertically.

The same circuit can be used with outputs less than 500mW without heatsinks. R1 can then be changed to 4·7Ω.

Negative feedback can be omitted by not including R2, R3 and C1. Or R2 may be omitted or changed in value and C1 and R3 included. If R2 is present C1 and R3 should not be omitted. Feedback improves quality and if volume permits R2 may be reduced to 470kΩ.

The OC71 preamplifier stage in Fig. 4 can be added to the circuit shown in Fig. 2 or other circuits where the pickup output or method of matching results in insufficient signal to drive the output stage. In these circumstances good results should be secured with almost any ordinary driver plus push-pull output circuit.

Complementary Push-Pull

A transformerless circuit operating directly into a 15Ω speaker is shown in Fig. 5 and is very satisfactory for record reproduction. A reasonably large speaker unit is best and can give excellent reproduction and more than adequate volume for domestic purposes. The output transistors may be damaged by using a speaker of wrong impedance. The first stage is a high-gain amplifier, coupled by C3 to the driver stage which is directly coupled to the output transistors. The NKT279.S1 transistor provides compensation for the effect of heat on the operation of the driver and output transistors, the 50Ω resistor being initially adjusted so that the output transistors draw 1·5mA to 2mA with no signal. Current peaks to 20-30mA at good volume.

Volume Control

The volume control may be mounted at any convenient position in the cabinet. Screened leads run from the pickup to the volume control and from the latter to the amplifier. These leads can be soldered, with a little extra length so that the amplifier can be taken from the cabinet if necessary. Should an amplifier be constructed as a separate unit for use

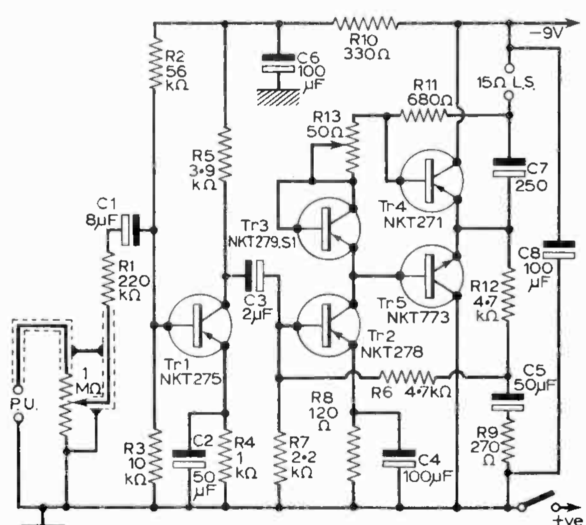


Fig. 5: Transformerless amplifier operating directly into a 15Ω loudspeaker.

with a pickup, radio tuner, etc. the volume control is generally fitted to the amplifier case. A coaxial or other connector allows any equipment to be plugged into the amplifier input.

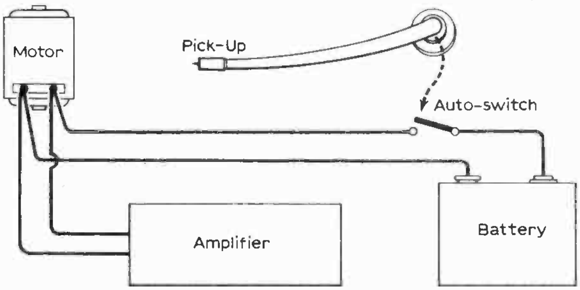
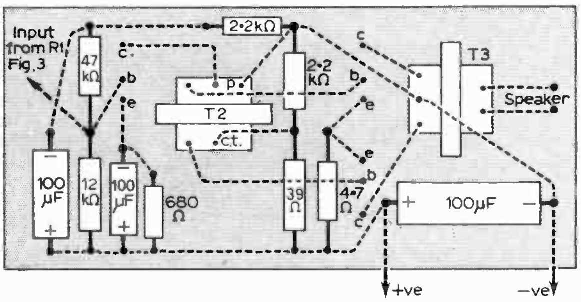


Fig. 6: Utilising the gram auto-switch to control the amplifier.

Fig. 7: Component layout and wiring of the amplifier shown in Figure 2.



On/Off Switch

For a separate amplifier the on/off switch may be incorporated with the volume control and placed in one battery lead. If the amplifier is installed permanently in the player the automatic switching device normally found for the motor can be used to switch on the amplifier also. Then when the record is finished both motor and amplifier are automatically switched off. Figure 6 shows the circuit for this. Polarity to motor and amplifier must be correct and errors will be avoided by fitting the proper type of battery connectors.

Battery and Motor

The current drawn by the motor depends on its voltage and other factors, but about 15mA from a 9V supply should be expected. This is easily within the capacity of a PP9 or similar battery, or a supply made up from non-miniature torch cells or batteries.

With push-pull output stages the current peaks depend largely on the volume but will generally be around 20-40mA. However battery drain falls to a much lower level when strong audio signals are not present.

Interference

With normal care motor interference need not be picked up by the volume control or associated input circuits. Leads here should be screened, dressed away from the motor, and the volume control case earthed to battery positive. The metal parts of the turntable unit should be similarly earthed.

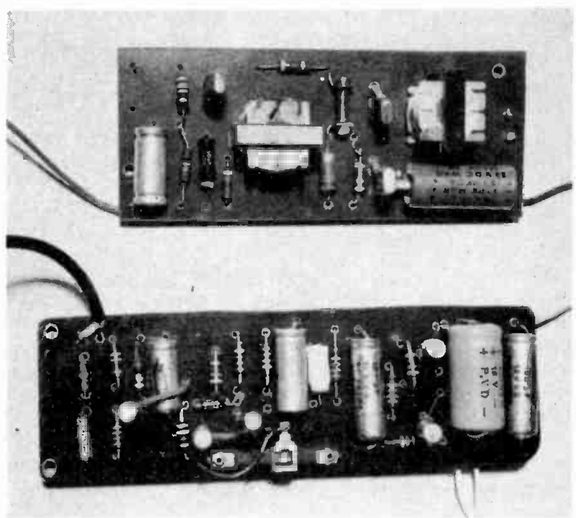
Interference from the motor may also reach the amplifier through the common battery circuit. A 100μF or similar large value capacitor across the battery supply points at the amplifier (as C8 in Fig. 5) helps avoid this. Earlier stages of the amplifier are generally fed from a negative line which has a series resistor and capacitor (as in all circuits except Fig. 1) so do not cause trouble.

Should any form of higher frequency interference arise a capacitor effective at high frequency can be shunted across the 100μF electrolytic. Small 200pF disc ceramic capacitors can be tried or an 0·5μF paper or similar component. Small suppressor chokes may also be included in the leads to the motor only. These can be made of a few score turns of 26s.w.g. or similar wire. Some motor units have ferrite beads on the motor supply leads to give a similar effect.

If motor interference should arise with some particular set of equipment a simple test is to use a separate battery temporarily for the amplifier. If the interference ceases it is caused by the common battery circuit. If it continues it is picked up by the volume control or other input circuits.

Pickup

Most turntable units have a suitable crystal pickup fitted. The turntable assembly and pickup must of course be chosen to suit the speeds required. Popular crystal pickups of this kind supply quite



Upper photograph shows the 3-transistor amplifier (Figure 2) and below it is shown the amplifier circuit depicted in Figure 5.

a large output and changing from such a unit to a low-output or high-quality transcription pickup will often make it necessary to add an extra transistor preamplifier stage.

Amplifier Construction

The amplifiers can be assembled on 1/16in. thick paxolin sheet with the components on one side and the wiring on the reverse. Figure 7 is a suitable layout for the circuit in Fig. 2. The ends of the resistors and other components pass through small holes. The panel is then turned over and component interconnections made with 26s.w.g. tinned copper wire with 1 mm. sleeving as necessary. Snip off excess resistor and other leads. Transistors are inserted with leads through the holes shown.

It is convenient to solder on thin red flex for battery positive, black for battery negative, and twin of some other colour for the speaker. Also a screened lead for input. The amplifier can be fixed at some convenient position in the case by two or three small screws.

Figure 8 shows a suitable layout, with wiring, for the circuit in Fig. 5. R13 is a miniature preset resistor and its slider is set to give the no-signal current previously mentioned.

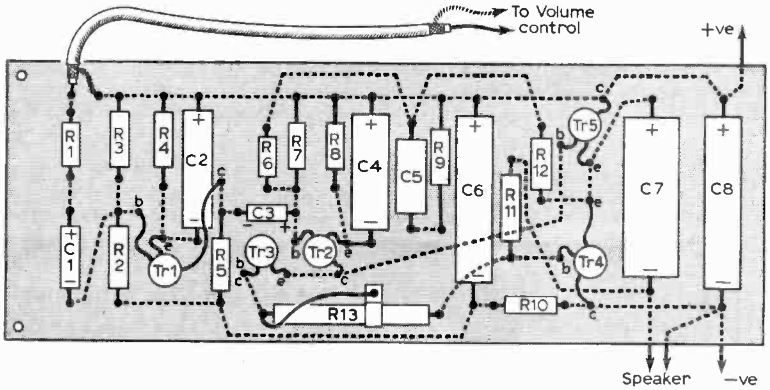


Fig. 8: Component layout and wiring of the amplifier in Figure 5.

No particular difficulty is likely to be met in making and using small audio amplifiers of the type described in this article. Where two transistors are employed in push-pull (as for example in Fig. 2) these are best obtained as a matched pair. If purchased separately their actual characteristics may not be sufficiently similar. With a directly coupled circuit such as that shown in Fig. 5 it is recommended that Tr2, Tr3, Tr4 and Tr5 are purchased as a matched set.

Where the push-pull operation of an output pair such as that in Fig. 2 is unsatisfactory this can generally be corrected by slightly changing the value of R1 or R2. In commercial equipment one of these resistors may be preset. For example R2 in Fig. 2 may be 50Ω, allowing adjustment for optimum value. Alternatively a preset resistor or fixed and preset components in series might allow R1 to be adjusted a few hundred ohms each side of 2·2kΩ. ■

THE G.P.O. LICENSES 100,000 PRIVATE RADIO TRANSMITTERS

Over 100,000 radio transmitters for private two-way communication are now licensed by the Post Office in the U.K.

What began 20 years ago as a modest experiment in "business radio" has now grown into a popular facility with a wide variety of users, ranging from ambulances, taxis and motoring organisations, to doctors, vets, public utilities (electricity, gas, water, etc.), organisers of sporting events and mountain rescue teams.

There are 75,000 land-based transmitters for private mobile radio. Over 60,000 of these are in vehicles, enabling, for example, maintenance vans on their rounds to keep in constant touch with central control points. Over 6,000 are small portable sets, such as those used by road and building contractors. About 7,000 are the base stations controlling mobile networks—fixed transmitters, operated from an office or a control point.

The Post Office recently added to the list a few licences to use radio for training blind people to be more independent, and for teaching deaf children to speak.

Over 2,300 more transmitters licensed for private communication around our shores are carried by ships of various types from tankers to yachts. Nearly 100 lighthouses use radio. British aircraft (including gliders) and their ground stations account for nearly 2,500 more.

Use of mobile radio by police and fire services brings the total to over 100,000.

The accommodation of so many transmitters has been possible by using v.h.f. and more recently u.h.f. The war years gave considerable experience in v.h.f. communication and advantage has been taken of this and of subsequent technical developments. Radio frequencies cannot be made but they can be used more and more economically: for example, the frequency space required for one private land mobile radio channel has been progressively reduced so that eight channels can now be fitted into the space which 15 years ago would hold only one. This is a little known revolution achieved with the co-operation of industry, users and the Post Office. Receivers contribute to this economy. They must respond well to the wanted signal while rejecting signals on other frequencies, otherwise they limit the number of transmitters which can be used.

These 100,000 transmitters are not of course the whole story. There are also 16,000 licensed radio amateurs who are qualified to use transmitters in this country. Another 14,000 licence holders use radio to control model vessels, vehicles or aircraft. Seven hundred paging systems are in use, mostly the short-range "bleepers" for calling staff in a hospital or in a factory, etc. And there are nearly 3,000 induction communication systems, most of which are a variant on the paging system. They are used on smaller sites, such as single buildings, by a variety of users.

All these have to be fitted into the frequency spectrum in an orderly way, together with long-range services, broadcasting, navigational aids, satellites, and so on. This is why the Post Office emphasises to those who want to use radio how essential it is to get a licence and to use the right sort of equipment. The licence is not just another piece of paper. It is the result of careful planning, national and international, and it explains what has to be done to fit in with the many other users.

LETTERS...

The Editor does not necessarily endorse the views expressed by correspondents.

Noises on the bands

Regarding Mr. Meachim's letter of last month about strange noises transmitted over the ether by Amateurs, I feel that his local lads have got nothing on my lot! In my area there is an Amateur who puts his one-man band on the air! In fact he is pretty good and it is perfectly legal to do this provided he doesn't infringe the copyright laws. I suppose it is legal to have a 50-piece male voice choir on the air provided they all say their callsigns every fifteen minutes and sign their names, callsigns and addresses in the log book.

One day I was tuning around on Topband and heard someone calling CQ and he had added an echo effect by means of a tape recorder amplifier and some intricate feedback effect. It made him sound as though he were transmitting from a sewer or the Albert Hall when empty.

When he got a reply to his call, he said that since adding this gimmick the number of QSO's had increased quite appreciably.

I don't really know what comes next. My advice to all Amateurs is to scrap their G callsigns and replace them with 3W8 ones and have tape loops going in the background with the sound of exploding shells and bombs etc. This, I am quite sure would increase very considerably the number of QSO's.—**J. Creedy** (*Ramsey, Huntingdon*).

'G8' fights back

I was surprised to read Mr. E. Mason's letter in the July issue of P.W. regarding beginners' licences. The main text of his letter seemed to run down the newly licensed G8 prefixed Amateurs.

How can we call these people "All and sundry" when the only part of the Amateur exam they have not passed is the Morse Code. I fail to see how this makes them any the less intelligent than someone holding a full licence.

I suggest Mr. Mason listens to the G8's operating on 2m as I have. I am sure then he will change his mind because they have brought life and interest to a dead but interesting band.—**R. Powell** (*Reading, Berkshire*).

Those odd hours

Your Topic of the Month reminds me of those days when spare rooms, lean-to-shacks and kitchen tables all helped to give birth to what is now a massive industry.

All of us who buy P.W., in what way do we pursue our hobby? I cast my thoughts back over the past few weeks to see just what I had been doing with those odd hours.

A Sky Queen of 1953 vintage which I rescued from oblivion seemed far too nice a job to be cast aside, so I converted it to all-transistor, and now have an excellent transportable for house and garden. In the course of conversion I fitted a more efficient loudspeaker. A good loudspeaker in a solidly constructed case makes all the difference to transistor output. This project also showed me that a good frame aerial leaves a ferrite rod aerial far behind.

What to do next? Having some silicon transistors to hand, I decided to try a BBC-1 TV preamp. This went well with ST140, TIS18, BC168 and even 2G417. I was stuck for a coax socket. A B7G valve holder performed the task excellently. A bare wire was threaded through the slots in the pin socket soldering tags, drawn tight until there was a springy contact with the coax plug outer and soldered in position. The central socket was a good fit for the plug pin.

There was nothing for it other than to add another stage. I soldered 30pF beehive trimmers into the screening as tuning capacitors. With this gadget I was intrigued to find that when on the normal aerial foreign interference laid on a jazz pattern which destroyed the picture, with the preamp in circuit, with careful adjustment of the two trimmers I could obtain a watchable picture and still retain sound. I also found that on certain channels the preamp could be used to tune in on the TV sound the three v.h.f. programmes from Skriaig, Isle of Skye, at excellent volume and quality. One thing I found from these experiments was that by using miniature presets in the bottom half of the base pair of resistors, spot-on transistor operation could be obtained without any noticeable capacity side-effects.

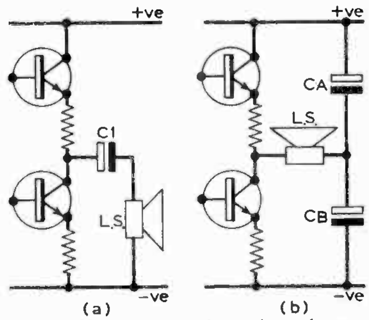
From here it was a short step to wondering what signals were obtainable at higher frequencies from the tops of our local hills. This meant something portable, and led to the searching of old issues and the construction of various super-regenerative receivers, and this project continues at the moment, with indications of success around 205Mc/s at 1000 feet.

And that, Sir, was my hobbying for the past four weeks.—**R. A. Ball** (*Ross-shire, Scotland*).

Audio thump

I feel sure that the "thump" Mr. Pinder (Questions Answered, August) complains of is almost certainly due to the output d.c. blocking capacitor charging via the speaker and not the smoothing capacitors.

Assuming the amplifier is a Class B design, fitting a thermistor would be disastrous in that the power supply regulation would be ruined. A 47Ω resistor would also spoil regulation but to a lesser degree.



(a) (b)

The best cure for the thump caused by C1 (Fig. a) is to fit CA and CB as in Fig. b. Both CA and CB are equal to half the value of C1 (probably 2000μF).

With the configuration in Fig. b, CA and CB charge in series and the thump is removed.

Circuit 'a' could employ n-p-n or p-n-p types of transistor and C1 could be connected to the power line or earth line via the loudspeaker. — **C. Boggis** (*Braintree, Essex*).

Scots ahoy!

If any readers are interested in the formation of an Amateur Radio Group in the Scottish Borders, will they please contact me?—**G. Shankie, GM3WIG** (8 *Ettrick Terrace, Hawick, Roxburghshire*).

LETTERS...

The Editor does not necessarily endorse the views expressed by correspondents.

Misconceptions

The letters of messrs Smith and Gibbins (Sept.) contain some misconceptions. Old germanium transistors of the type of OC45, XA102 and others can be persuaded to perform at much higher frequencies than quoted by the makers.

The conservative "alpha cut-off frequency" was used, meaning simply that gain is 3dB down at that frequency, not a lot, and a long way from "maximum frequency", at which gain is unity. At 5 times cut-off frequency amplification is 17dB down, a transistor of hfe 100 would still give useful gain at 20dB down.

Transistors of the same type are never sufficiently alike to make any rule invariable. β50, 6Mc/s may imply a manufacturing spread of 0 to 500βkc/s to 12Mc/s. Of these the inspectorate may pass say 20 to 100 beta, 3Mc/s upwards. In use, a 20β, 3Mc/s transistor carries the same type number as a 100β, 12Mc/s. Surplus transistors vary even worse. A combination of very high gain and exceptionally suitable base enables some individual transistors to far outperform the original specification based upon an average transistor. And even the average transistor can be stretched in performance if used with knowledge.

The upper frequency limit can be raised by up to 50% by using the transistor at the optimum current for gain (usually around 1 to 2 mA), and at the maximum allowable voltage. This is because maximum frequency is a function of both current gain and suitability for frequency.—**T. E. Millsom** (*London, N.*19).

Class "B" fights back

Regarding Mr. Mason's comments last month (July issue), he seems to be condemning the Class "B" licence rather than the proposed Beginner's Licence.

He does not appear to have given the original conception of the class "B" licence much thought.

The idea of the class "B" licence was to increase the activity on the 70cm and other u.h.f. bands (which it did admirably). Allowing the "B" licensees to use two metres is simply to increase activity on this band and thus helping to stop the reduction of amateur bandspace, which is being turned over for commercial use etc. Therefore by condemning "B" licensees, he is condemning the principles of amateur radio in general.

The "B" licence is not for beginners as Mr. Mason seems to think, it is for amateurs primarily interested in v.h.f./u.h.f. techniques.

Perhaps if Mr. Mason had bothered to listen properly on these bands, and heard the standard of operation by G8's (which is in no way inferior to "A" licensees) he may have thought differently when writing his letter.—**G. Jones, G8AXE** (*Liverpool*).

And again!

I am afraid I cannot agree with Mr. Mason's views towards class B licensees in the July issue of PRACTICAL WIRELESS. There seems to be a general feeling of prejudice against class B licence holders. Perhaps the term "B" conjures up an illusion of their being second-rate operators. This could not be further from the truth because the vast majority of them are experimenters in contrast to a large number of class A licensees who think of their rigs as a telephone substitute. I hope the time has arrived when those holding B licenses will be permitted to spread their wings and cease to be regarded as outsiders and inferiors.

Mr. Mason strongly implies that a great deal of harm would be done if class B licensees were allowed to use the bands already occupied by those holding class A licenses. He gives no reason why this should be so but I think it might be quite a good idea if A and B were to merge. Bearing in mind the fact that radio amateurs are supposed to be experimenters and not telegraph operators I feel that the morse test should be abolished. A great deal of good would result on the present overcrowded bands if the energy formerly absorbed by the morse test were diverted towards a raising of the standard of the theory examination. With such a provision co-ordination between A and B licences would result.—**T. Wright** (*N. Ireland*).

... and even more

Since the ex-P.M.G. Mr. Edward Short said that he was going to introduce a Beginner's Licence all the comments about it have been against such a licence.

As a keen S.W.L. I hope to get my ticket some day but at the moment I am tied up with "O" level studies, making it impossible to study for the R.A.E. and morse test.

It would therefore be very useful to hold a Beginner's Licence and it would also help me when I take my R.A.E. in a few years' time.—**Jonathan Waters A5438** (*London, S.*12).

Solid state

In a valved piece of equipment the actual "work" is done on an electron stream moving in a near-vacuum. The contents of a valve (other than the electrodes) are in the "gaseous-phase or state": electrons and residual air molecules.

When equipment is transistorised, the "work" is done inside a crystal of silicon or germanium. By definition, a crystal is solid; therefore the transistors are in the solid-phase or state. A physicist would say "solid-phase", an electronics bod would say "solid-state".

Incidentally, an electrolytic capacitor works in the liquid-phase! —**L. Collier** (*Billingham, Teesside*).

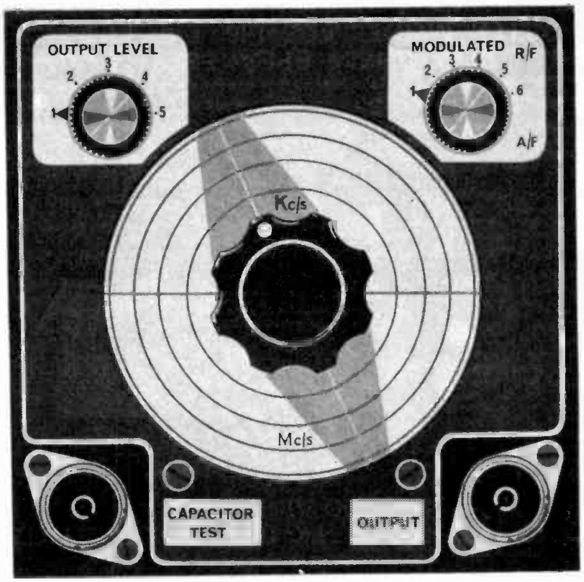
I like it!

I reply to Mr. Meachim's letter in your September issue of the P.W. I must say I feel sorry for him if he has to listen to experiment Hams Giggling and Squeaking and long drawn out conversations over Oriental Dishes and the removal of warts.

As a short wave listener myself, when I switch on I am prepared to sit back and listen to what they talk about. I find some of their topics very interesting and hope one day to join in the fun, so keep up the good work boys and whether the topic be the removal of warts, how to make a hot pot, or the birth of a baby, Big Brother *will* be listening. Of course, if one dislikes these topics, the answer is simple—switch off. Hi!—**J. Bennett** (*Nuneaton*).

transistorised SIGNAL GENERATOR

JAMES HOSSACK



FOR the serious experimenter who is also blessed with a well-equipped laboratory and unlimited funds, a high-quality signal generator is a necessity. Such an instrument may incorporate ultra-wide frequency coverage, switched modulation, calibrated signal output, provision for scope synchronisation, etc., and, according to its complexity, entail a corresponding depletion of the available monetary budget.

To those enthusiasts of more limited resources who still feel the occasional need for a test instrument which is capable of injecting a signal, of reasonably reliable frequency, into the household transistor, veteran push-button all-wave radiogram, car radio, or even the domestic TV when required to do so, the present instrument fulfils a useful purpose at modest cost.

In the re-alignment of i.f. stages of old-type valve receivers, it matters little whether the actual i.f. is 440 or 470 kc/s, so long as the various circuits are tuned to the selected frequency in such a way as to give maximum gain consistent with reasonable pass-band and freedom from "peaking" or instability and "laboratory" accuracy is not required. Similarly the frequency of 10·7 Mc/s nominally used for i.f. amplification with an f.m. receiver implies a central value located at any point between say 10·3 and 11Mc/s (too great a deviation will, of course, result in serious interference from short-wave commercials in the 25 or 31 metre bands) together with a reasonably flat response, as indicated by a metered output, for some 200kc/s either side of this point. Again, it may be desired to line-up a home constructed receiver from scratch. For any of these purposes a relatively simple instrument, on the lines of that described here, will serve the purpose admirably.

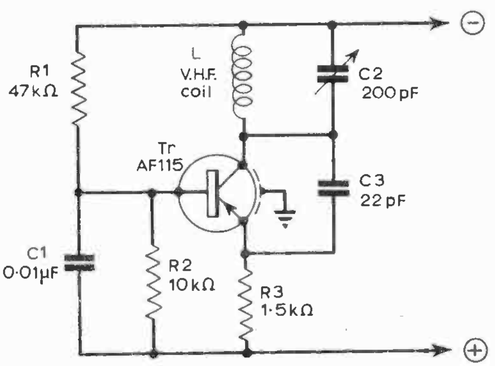


Fig. 1: Circuit of a self-oscillating mixer, as used in many f.m. receivers.

Circuit Description

Originally, the author decided to experiment with a transistor oscillator circuit on the lines of the valve generator described in the August, 1968 issue of PRACTICAL WIRELESS. In this case, signals of the correct phase to maintain oscillation were fed back over a double-triode valve, the second grid being grounded directly to chassis.

It soon became apparent that a single transistor can fulfil the same function when its base is effectively grounded, and feedback initiated between collector and emitter by simple capacitive coupling. This is, in effect, similar to the circuit used in the self-oscillating mixer stage of many f.m. receivers, and is illustrated in Fig. 1.

Unfortunately, to oscillate satisfactorily at low frequencies, a fairly large value for C3 is required, and this, in turn, imposes such heavy damping on the transistor that oscillation fails to be maintained over the full range available with C2. The position is improved considerably if a high L/C ratio is used (for example, by inserting a ferrite rod into the tuning coil) but, as quite a long rod is required at the lowest frequency range envisaged, and also since portability was considered very desirable, a different approach was adopted. This consists of the addition of a small auxiliary feedback coil for the lower-frequency inductances, and, since feedback between collector and emitter is substantially in-phase as previously indicated (witness the use of direct capacitive coupling in Fig. 1), the normal tapped coil is unsuitable. This point will be referred to later in connection with coil construction.

Coming now to the audio oscillator used for modulation, and also to provide an output for a.f. test purposes; a more conventional arrangement of oscillator circuit was found to be suitable in this case.

Generally, any tapped audio coil will provide a continuous a.f. signal if connected between transistor base and earth, with tap connected to the emitter and collector grounded. The author has found that intervalve transformers, tapped chokes, and even transistor output transformers can be induced to oscillate freely, provided careful attention is paid to base biasing arrangements. In the present arrangement a miniature driver transformer was used, the primary and secondary windings being joined at one end so that the feedback direction is correct to maintain oscillation. The correct connections are best determined by trial and error before construction is commenced, otherwise about half the completed assembly may have to be dismantled in order to reverse the connections when it is finally and frustratingly discovered, after switching on the generator for the first time, that a.f. modulation is non-existent.

Figure 2 shows the complete circuit, and a few points are worthy of special mention. First of all, due to the position of the main variable capacitor VCl, which forms part of the collector load of Tr2, it was decided to use a negative earth throughout, so that, diagrammatically, both transistors appear inverted. Secondly, the only switch required (apart from the on/off switch which is combined with the output potentiometer) is the 2-pole 6-way range switch SW1, which is designed also to function as an r.f.-a.f. switch, providing a.f. only at the output point, when in the correct position. This restricts the number of r.f. ranges to five, and also limits the upper-frequency excursion of the generator, due to the fact that the coils have a common connection to the collector at one end, the earth end only being switched. If the collector end were switched, stray capacitances would be appreciably reduced, but a.f. would not be obtainable without additional circuitry. On the other hand, the highest frequency available could probably be doubled, an additional coil range could be added in the sixth switch position, and the additional a.f. switch necessary could be designed to include an unmodulated radio frequency output also, if required.

★ components list

Resistors:

R1	47kΩ	R4	1·5kΩ
R2	10kΩ	R5	200Ω
R3	47kΩ		

All $\frac{1}{4}$-watt 10%

VR1 500kΩ

Capacitors:

C1	0·01μF	C5	120pF
C2	0·01μF	C6	10pF
C3	0·0018μF	C7	0·001μF
C4	33pF		

VC1 400pF variable air-spaced

Transistors:

Tr1 OC71
Tr2 AF115

Miscellaneous:

T1 midget driver transformer (Henry's Radio); Sw1a/b 2-pole 6-way rotary (Henry's Radio); Sw2 d.p. on/off switch; metal cabinet; 2 coaxial sockets; Veroboard; Perspex; 4 x $\frac{1}{4}$in. ferrite cores; 2 x $\frac{1}{2}$in. pointer knobs; 1 x $1\frac{1}{4}$in. knurled knob with cursor; PP3 battery.

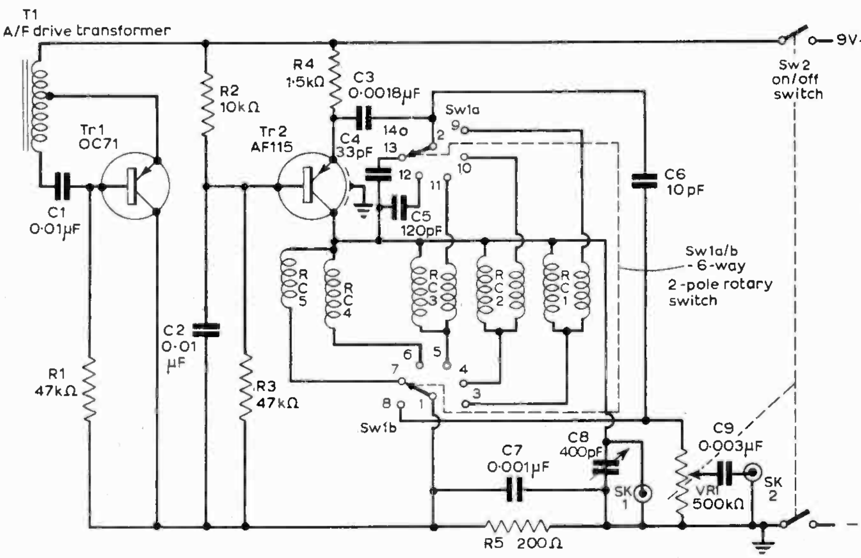


Fig. 2: Complete circuit of the transistorised signal generator.

Whilst in the present design these advantages have been sacrificed in the interests of convenience and portability—bearing in mind, for example, that an unmodulated output is unlikely to be required for simple indication tests, as opposed to accurate laboratory ones—it is not at all difficult to incorporate all the above modifications into the basic design if this is tackled at the outset, and in fact provision is made on the board layout for a sixth coil.

One further point worth commenting on at this stage is the provision of an additional output socket. This connects directly to the fixed vanes of the tuning capacitor, and enables capacity tests to be carried out on small fixed capacitors in the range 15-400pF. These tests will be described further in the section on use of the instrument. Finally, the function of R5 should be mentioned. This resistor is common to the r.f. and a.f. sections, and therefore functions as a modulation resistor, the value determining the depth of modulation obtainable. However, since the r.f. frequency is slightly sensitive to variations of the collector voltage of the AF115, some frequency modulation of the r.f. output is unavoidable, and the value of 200Ω shown was chosen to give the best compromise between modulation depth and undesirable frequency spread.

Construction

The container used in the prototype was actually an iron-clad junction box measuring 4 × 4 × 1½in. (inside dimensions). Any similar type of metal box is suitable, for example a die-cast aluminium chassis of the above dimensions would serve admirably, although a metal rear cover would be needed to avoid unwanted radiation, and also to hold the battery in position.

Commence by drilling the front of the box to take the variable capacitor VC1 (centre), together with the range switch, output control, and two output sockets, each located at one of the four corners of the front panel. The "works" proper are constructed in two sections. Firstly, the modulation portion (OC71, transformer T1, and associated components) are built on to a small piece of Veroboard ¾ × 1¼in. Since room is available here, it is worth including the AF115 base lead and base biasing components as well, cutting the former lead to a length of about ½—¾in. before soldering in position. The Veroboard layout is shown in Fig. 3. Now, place this unit on one side and obtain a rectangle of ⅛in. thick Perspex, 2¼ × 1½in. to hold the coils and other r.f. components, as well as the completed Veroboard unit, which will be mounted in position as described later.

A few words about the use of Perspex as a working material is perhaps relevant at this point. While Veroboard could, of course, have been used throughout, slightly greater difficulty would have been encountered, both with the coil mounting, and in fixing the completed generator in position inside the cabinet, bearing in mind the very small clearances available for inserting fingers, pliers, or tweezers, in order to fit nuts in position, etc. (Constructors who can boast fingertip diameters of less than ½in. are clearly at a considerable advantage when making up units of this type!) One further advantage of Perspex is its ease of working, particularly as regards thread-tapping. All that is required here is to drill a hole slightly smaller than the diameter of the bolt, insert the latter into this hole (most bolts are slightly end-tapered, so that the first thread will jam in tightly), and heat the bolt with a soldering-iron applied to its centre. After a few seconds, the Perspex will begin to soften slightly, and if the bolt is now screwed carefully clockwise, then slightly anti-clockwise, in the manner of a tap, repeating until the hole is as deep as required, a perfect thread will be formed when the Perspex has cooled. This trick is used (a) to mount the coils, by tapping threads for ¼in. ferrite cores *several threads deep only*, using a brass screw of the same thread pitch, and (b) to position fixing screws for the Perspex itself and for the other components including the Veroboard unit, by tapping either all the way through, or half-way through only, depending upon whether the connection or fixing bolt has to be insulated from chassis. The actual template used in these operations is illustrated in Fig. 4.

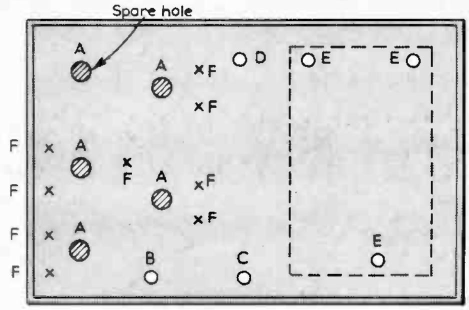


Fig. 4: Coil template made from Perspex (see text). Drilling dimensions are given below.

A *Hole drilled and partly tapped from top for ¼in. cores;* **B** *hole drilled and partly tapped from top for 6BA headless bolt;* **C** *clearance hole for 6BA bolt to hold Perspex and also take soldering tag for earth connections;* **D** *hole drilled and fully tapped for 6BA bolt to hold Perspex;* **E** *hole drilled and partly tapped from top for 8BA headless bolts to mount Veroboard on the Perspex;* **F** *wire connecting posts (see text).*

When drilling and tapping are completed, the ferrite cores are screwed into position and the Veroboard unit can then be mounted, using the 8BA headless bolts—note that the latter must be insulated from earth in the way already described.

One point concerning the Perspex board is the provision of wire "connecting posts", prepared by pressing ¾in. lengths of 18 s.w.g. heated copper wire about half-way into the Perspex in the positions shown in Fig. 4. These will remain solidly in position when cold, and are useful for anchoring the fine wire ends of the coils, and for the transistor connections. Ensure that the correct coil ends are soldered to the appropriate posts. However, take care not to overheat when soldering, otherwise they may soften, and come away from the Perspex. Alternatively, use a heat shunt in the same manner as when soldering a transistor connection.

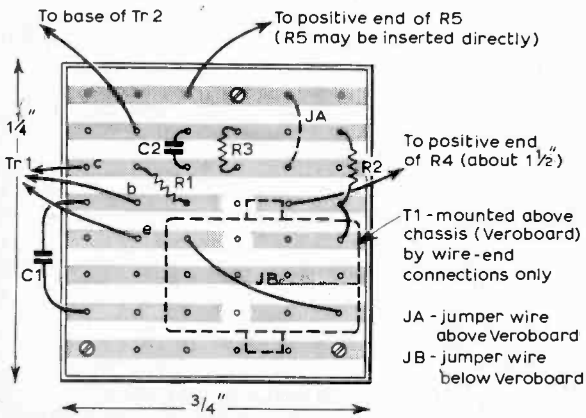


Fig. 3: Veroboard wiring and layout (copper strip side).

Winding the Coils

We now come to the rather exacting operation of coil winding, one requiring a fair amount of time, patience, and manual dexterity (see Table 1).

The coil formers are very simply made from cartridge paper or thin card wrapped once around a ferrite core and Sellotaped to form a fairly loose-fitting cylinder over the core, approximately ½in. long. A further thin band of Sellotape at either end forms "end-cheeks", and leaves a central recess about ⅛in. wide, just over ¼in. diameter and about

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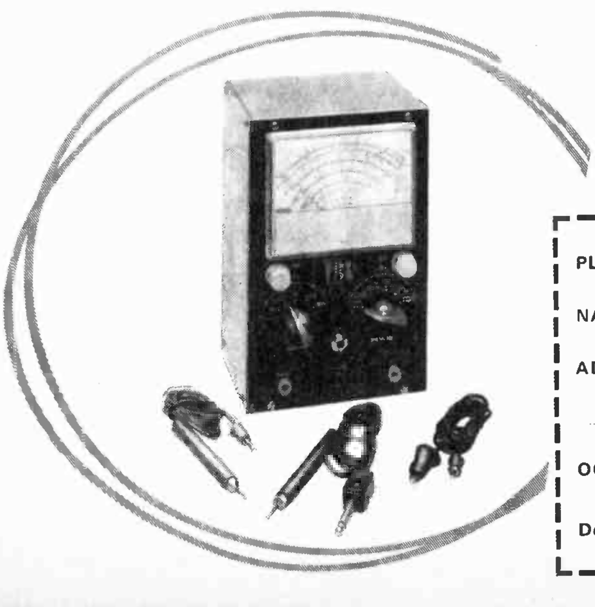

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$\frac{1}{16}$in. deep for the wire itself. It is useful to push the coil former partly over a core while winding, since this enables a better grip to be obtained. Commence with the coil for range 4 (range 5 coil is uncored, and may be self-supporting—see later). This is merely a single winding, consisting of 24 turns of 30 s.w.g. enamelled copper wire wound side by side in the available space, and held in position with Sellotape. Leave approximately $\frac{1}{2}$in. wire ends for connections.

Now proceed to the double-wound coils for ranges 1, 2 and 3. Two procedures are available here for securing correctly phased windings. The simplest is merely to wind on two separate coils, referring to the data in Table 1, and separating the four ends so that one pair of wires is joined together as in Fig. 5.

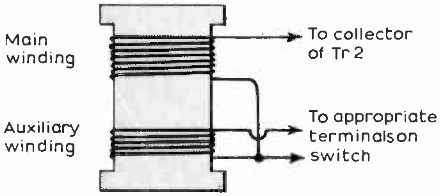


Fig 5: Interconnections for the double wound coils.

Note that the windings are in the same direction, and that the *start* of one winding is joined to the *start* of the second. The other method is to commence winding a short distance along the wire (approximate distances are indicated in Table 1), leading out the start of this winding to act as a tap. Winding is thus initially bifilar. Wind on, using this double or bifilar mode, the number of turns specified for the auxiliary winding, then lead out the short wire-end (which is, in fact, the true "start" of the wire), Sellotape in position, and continue winding with, of course, one wire, until the *total* number of turns is equal to that specified for the main winding.

Although it sounds complicated on paper, the latter method is actually very easy to carry out in practice, and enables the rather large amount of very fine wire used, for example, in coil 1, to be accommodated easily and neatly in the available space. The final operation is to cement the wire firmly in position with coil cement, and when dry, shorten and bare the three connections and test the coil by fitting it over one of the cores (it should slip easily over the latter without, however, undue play) and, if desired, connecting it into a simple transistor circuit to test for oscillation over the specified range. This last step is well worth while. Oscillation should be easily detected on a nearby receiver as heterodyne whistles present over the range in question, or perhaps as harmonics of double or treble the fundamental frequency.

Now mount all coils in position over the cores, and connect to the wire anchoring leads already described. Wire up the transistor and remaining components, and solder on flying leads approximately $1\frac{1}{2}$ or 2in. long for subsequent connection to the range switch.

Two holes should have already been drilled in the side of the cabinet adjacent to the switch to take the fixing screws for the Perspex, and, if tapped threads have been prepared as already described, no difficulty should be experienced in mounting the board in position close to the range switch, as can be seen in the photograph (interior view). Before doing this it is probably wise to check over all connections, and also to fit a small aluminium bracket inside the cabinet to hold the battery, as well as connecting up the output level control and output sockets, since these points may be rather inaccessible once the unit is in position. Finally, solder the flying leads to the switch connections and tuning capacitor, and the generator is ready for testing.

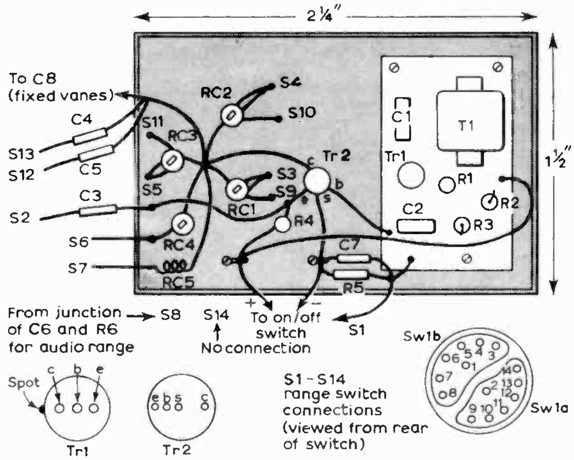


Fig 6: Layout showing the r.f. oscillator coils and audio oscillator panel.

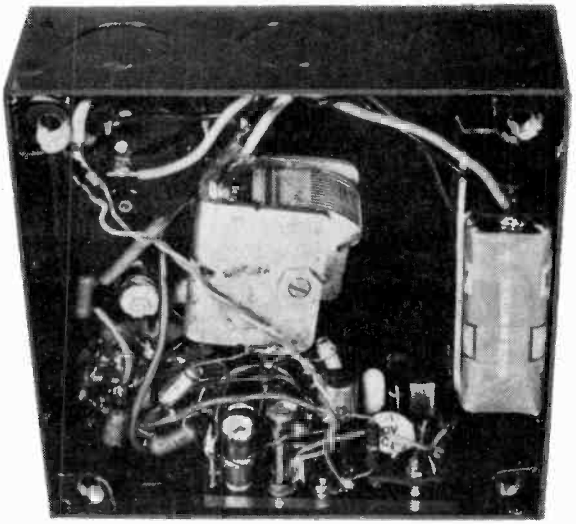
Calibration

Switch first of all to range 6 (extreme clockwise position of the switch), and test that an audio signal is appearing at the output, either with a pair of headphones or by injecting into an amplifier or the a.f. section of a receiver. The output level control should attenuate evenly from a maximum of about 200mV.

TABLE 1.

Coil reference	*Range*	*Approx. frequency coverage*	*Wire size*	*Number of turns Main coil*	*Number of turns Auxiliary coil*	*Approx. length of aux. coil for bifilar winding* (see text)	*Coil diameter*
RC1	1	200—400kc/s	40 s.w.g.	380	65	6ft.	To fit
RC2	2	400—950kc/s	36 s.w.g.	160	35	3ft.	over $\frac{1}{4}$in.
RC3	3	1000—1800kc/s	32 s.w.g.	70	20	2ft.	core
RC4	4	7·5—16·0Mc/s	30 s.w.g.	24	—	—	(see text)
RC5	5	19—45Mc/s	20 s.w.g.	5	—	—	$\frac{5}{16}$in.

Now switch to range 1, which is the lowest frequency range. If the coil test previously mentioned has been carried out, the coverage should have been established as approximately correct, and if so, a heterodyne will be heard with the long-wave light programme at 200kc/s on an adjacent receiver. This should be close to the low-frequency end of the variable capacitor setting (vanes fully meshed), and, if it is not, carefully slide the range 1 coil out from its core a little, until the 200kc/s position is correct. This coil can then be locked in position by spotting with cement, both inside and outside the core.



Internal view of the signal generator.

At this stage, it should be stressed that only a very approximate degree of output attenuation of r.f. is possible with a simple attenuation circuit of the type used here. In fact, unless the metal cabinet is earthed directly to the earth of the circuit under test, and the output taken via a coaxial lead, attenuation will be non-existent since radiation from the cabinet will be picked up more or less directly. This is especially the case for sets with ferrite rod aerials, when strong pickup can occur over several yards. For simple frequency test of the type envisaged (including calibration) this is no disadvantage, but it could be significant, for example, when aligning i.f. stages. Hence, the use of a properly screened and earthed coaxial lead in such cases is recommended.

Now is the time to fit a simple cardboard dial and pointer knob, having first pencilled on two 0—180 deg. scales on either side of a horizontal line passing through the tuning capacitor spindle. Having determined the 200kc/s point accurately, keep the generator tuned to this position, and switch the receiver to medium wave. Find the dial reading corresponding to 600kc/s (500M.) This represents the third harmonic of the generator frequency, and sweeping the receiver dial around this area should enable the characteristic tone to be heard, indicating that the receiver is tuned to exactly 600kc/s. Being a harmonic, it may be necessary to move receiver and generator closer together, or swing the former from side to side, to ensure sufficiently strong pickup. If the tuning point now coincides with the appropriate wavelength on the receiver dial, it may be assumed that the latter is reasonably accurate, and it ought to be fairly safe to employ it for calibration purposes, at least on the first three ranges. If the fifth harmonic of 200kc/s, at a reading of 1Mc/s, is audible, a further check for receiver accuracy can be made. If the receiver calibration is obviously well out, while, in theory, it can still be used by making use of broadcast stations of known frequency, the author's recommendation is to beg, borrow or even buy an accurate receiver—preferably an all-wave one, at the same time making a mental note to re-trim the faulty receiver as and when the signal generator is fully operational.

Returning to the calibration, and assuming that the receiver accuracy is sufficient; move the generator dial slowly in the high-frequency direction, and follow the tone with the receiver dial until 660kc/s—or the corresponding wavelength in metres—is reached. Mark this spot as 220kc/s on the generator dial. Repeat the procedure until range 1 is fully calibrated. Now switch to range 2, and check the approximate coverage. The low-frequency end of this range should be close to 400kc/s, and using the receiver at the second harmonic point (800kc/s = 375M.), this reading can be accurately marked on the scale for range 2. Repeat the procedure of range 1 as far up as 550kc/s; beyond this, the fundamental will prove more useful, as the generator is now within the medium-wave band. When the coverage has been satisfactorily determined and calibration of this range completed, lock the coil on its core, as with range 1.

Range 3 also covers medium-wave for part of its spread, so a similar drill is carried out, although the extreme high-frequency end may need to be calibrated either by graphical interpolation or by using harmonics falling in the receiver short-wave band.

For range 4, a short-wave receiver is, of course, essential. This range covers the most useful portion of the short-wave band (roughly, 18-40 metres). Because of the different circuitry of the oscillator, however, the output is lower than on the first three ranges, so that direct contact with the receiver aerial (usually a whip aerial in the case of a transistor portable) may be required. A probe made up from an old coaxial plug will prove a handy accessory in this case, and will also be useful later, if it is desired to use the generator as a hand-held signal injector for directly probing around inside faulty receivers or amplifiers. Its small size makes it ideal for this application. It is stressed once more however, that the output control will not function satisfactorily in these cases.

One more point about calibration of this range—it is very easy, with some cheap non-selective short-wave sets, to pick up harmonic or image signals from the generator, mistaking these for the main fundamental. To avoid this, it is essential to carefully examine the readings obtained and, if necessary, enter them on graph paper, as, by this means, any erroneous values will be quickly spotted. As before, lock the coil in position once the calibration has been completed.

No mention has yet been made of the coil for range 5, covering the highest frequencies. This can be quite a tricky range to make operational, particularly since a fairly strong degree of oscillation is needed to provide the harmonics necessary for f.m. and TV testing. On the other hand, the connecting points to this coil are very accessible, and, once the

DRY JOINT TESTER

The most reliable way of testing for a dry joint is to measure the resistance between the component lead and the printed circuit board. Our kit for doing this comprises a large scale (3in.) moving coil meter, a variable resistance for adjusting zero setting, and a wiring diagram with instructions. The only additional items you will need are a battery, some wire, a pair of test rods. Price 19/6, postage and insurance 2/6.

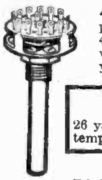
FLUORESCENT CONTROL KITS

Each kit comprises seven items—Choke, 2 tube ends, starter, starter holder and 2 tube clips, with wiring instructions. Suitable for normal fluorescent tubes or the new "Grolux" tubes for fish tanks and indoor plants. Chokes are super-silent, mostly resin filled. Kit A—15-20 w. 19/6. Kit B—30-40 w. 19/6. Kit C—80 w. 19/6. Kit D—125 w. 22/-. Kit E—65 w. 19/6. Kit MF1 is for 6in., 9in. and 12in. miniature tubes, 19/6. Postage on Kits A and B 4/6 for one or two kits then 4/6 for each two kits ordered. Kits C, D and E 4/6 on first kit then 3/6 for each kit ordered. Kit MF1 3/6 on first kit then 3/6 on each two kits ordered.

REED SWITCH

Suitable for dozens of different applications, such as burglar alarms, conveyor belt switching. These are simply glass in cased switches which can be operated by a passing permanent magnet coil. A special buy enables us to offer these at 2/6 each, or 24/- a dozen. Suitable magnets are 1/- each.

MINIATURE WAFER SWITCHES

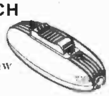


4 pole, 2 way—3 pole, 3 way—4 pole, 3 way—2 pole, 4 way—3 pole, 4 way—2 pole, 6 way—1 pole, 12 way. All at 3/6 each. 36/- dozen, your assortment.

WATERPROOF HEATING ELEMENT

26 yards length 70W. Self-regulating temperature control. 10/- post free.

BLANKET SWITCH



Double pole with neon let into side so luminous in dark, ideal for dark room light or for use with waterproof element—new plastic case. 5/6 each.

BLANKET SIMMERSTAT

Although looking like, and fitted as an ordinary blanket switch, this is in fact a device for switching the blanket on for varying time periods, thus giving a complete control from off to full heat. Also suitable for controlling the temperature of any other appliances using up to 1 amp. Listed at 27/6 each, we offer these while our stock lasts at only 12/6 each.

PHOTO-ELECTRIC KIT

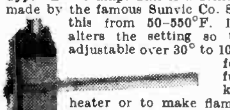
All parts to make light operated switch/burglar alarm/counter, etc. Kit comprises printed circuit. Laminated Boards and chemicals. Latching relay. Infra-red sensitive Photocells and Hood, 2 transistors, cond., terminal block. Plastic case. Essential data, circuits and P.C. chassis plans of 10 photo-electric device including auto. car parking light, modulated light alarm. Simple invisible ray switch—counter—stray light alarm—warbling tone electronic alarm—project lamp stabiliser, etc., etc. Only 39/6, plus 2/- post and insurance.

PP3 ELIMINATOR. Play your pocket radio from the mains! save £s. Complete component kit comprises 4 rectifiers—mains dropper resistances, smoothing condenser and instructions, only 6/6 plus 1/- post.

THERMOSTATS

Type "A" 15 amp. for controlling room heaters, greenhouses, airing cupboard. Has spindle for pointer knobs. Quickly adjustable from 30–80°F. 9/6 plus 1/- post. Suitable box for wall mounting, 5/-. P. & P. 1/-.

Type "B" 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50–550°F. Internal screw alters the setting so this could be adjustable over 30° to 1000°F. Suitable for controlling furnace, oven kiln immersion heater or to make flame-start or fire alarm, 8/6 plus 2/6 post and insurance.



Type "D". We call this the Ice-stat as it cuts in and out at around freezing point, 2/3 amps. Has many uses one of which would be to keep the 10ft. pipes from freezing, if a length of our blanket wire (16 yds. 10/-) is wound round the pipes. 7/6. P. & P. 1/1.

Type "E". This is standard refrigerator thermostat. Spindle adjustments cover normal refrigerator temperature. 7/6, plus 1/- post.

Type "F". Glass encased for controlling the temp. of liquid—particularly those in glass tanks, vats or sinks—thermostat is held (half submerged) by rubber sucker or wire clip—ideal for fish tanks—developers and chemical baths of all types. Adjustable over range 50° to 150°F. Price 18/-, plus 2/- post and insurance.

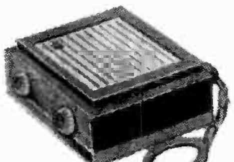
HI FI BARGAIN

FULL FI 12 INCH LOUDSPEAKER. This is undoubtedly one of the finest loudspeakers that we have ever offered, produced by one of the country's most famous makers. It has a die-cast metal frame and is strongly recommended for Hi-Fi load and Rhythm Guitar and public address.

Flux Density 11,000 gauss—Total Flux 44,000 Maxwells—Power Handling 15 watts R.M.S.—Cone Moulded fibre—Freq response 30-10,000 c.p.s.—specify 3 or 15 ohms—Main resonance 60 c.p.s.—Chassis Diam. 12in.—12⅜in. over mounting lugs—Baffle hole 11in. Diam.—Mounting holes 4, holes—¼in. diam. on pitch circle 11⅝in. diam.—Overall height 5½in. A £6 speaker offered for only £3.9.6 plus 7/6 p & p. Don't miss this offer.

BARGAIN OF THE YEAR

MICRO-SONIC



7 transistor Key chain Radio in very pretty case, size 2⅞ × 2¼ × 1¼in. —complete with soft leather zipped bag. Specification:—Circuit: 7 transistor superheterodyne. Frequency range: 530 to 1600 Kc/s. Sensitivity: 5 mv/m. Intermediate frequency: 465 Kc/s, or 455 Kc/s. Power output: 40mW. Antenna: ferrite rod. Loudspeaker: Permanent magnet type.

In transit from the East these sets suffered slight corrosion as the batteries were left in them but when this corrosion is cleared away they should work perfectly—offered without guarantee except that they are new, 19/6 plus 2/6 post and ins., less batteries. Everlasting batteries 7/- pair.

YOU NEVER NEED BUY ANOTHER BATTERY

for your transistor radio. Stupendous offer this month—a Nickel Cadmium battery stack together with a mains operated charger which you mount on the back of your set. The mains flex unplugs so the set remains completely portable. Offered for less than the cost of the batteries alone. ONLY 29/6, plus 3/6 post.

INFRA-RED HEATERS

Make up one of these latest type heaters. Ideal for bathroom, etc. They are simple to make from our easy-to-follow instruction—uses silica enclosed elements designed for the correct infra-red wavelength (3 microns). Price for 750 watts element, all parts, metal casing, as illustrated, 19/6, plus 4/- post and insurance. Pull switch 3/- extra.

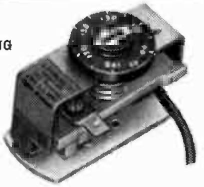
THIS MONTH'S SNIP

BREAKDOWN PARCEL

This unit is really an army telephone less hand-set. It contains the following useful items:

1. Hand operated magneto generator which will light lamps, generate shocks, etc.
2. Magneto bell, which will work with above generator or from the mains through a step down transformer.
3. Morse tapper.
4. A very sensitive change-over relay which will operate from 1½V. upwards.
5. A useful assortment of components comprising switches, jack-sockets, matching transformers, chokes, tag-strips, etc. Price 14/6, plus postage and insurance 6/6.

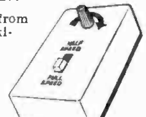
PROTECT VALUABLE DEVICES



FROM THERMAL RUNWAY OR OVERHEATING

Thyristors, rectifiers, transistors, etc., which use heat-sinks can easily be protected; simply make the contact thermostat part of the heat-sink. Motors and equipment generally, can also be adequately protected by having thermostats in strategic spots on the casing. Our contact thermostat has a calibrated dial for setting between 90 deg.–190 deg. F. or with the dial removed range setting is between 80 to 800 deg. F. Price 10/-.

DRILL CONTROLLER

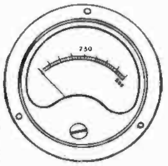


Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. 19/6 plus 2/6 post and insurance. Or available made up 25/-, plus 2/6 post.

16 RPM GEARED MOTOR

Made by Smith's Electrics, these are almost silent running, but are very powerful. They operate from normal to 240V. mains and the final shaft speed is 16 r.p.m. 15/-, post & ins. 2/9.

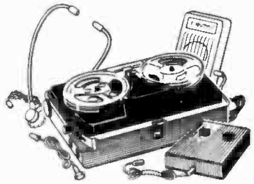
2½″ MOVING COIL METER



Meters are always being needed and they are jolly costly when you have to buy them in a hurry. So it's sensible to take advantage of this offer: 2½in. (3″ o.d.) flush mounting moving coil meters only 8/6 each. These are scaled 0·300mA but once the internal shunt is removed the f.s.d. is usually about 10mA so you can make it into almost anything by adding shunts or series resistors. These are Ex. W.D. of course but are all new and unused. Price only 8/6 each plus 2/6 post. 12 or more post free.

MAINS TRANSISTOR POWER PACK

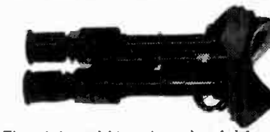
Designed to operate transistor sets and amplifiers. Adjustable output 6v., 9v., 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer rectifier, smoothing and load resistor, condensers and instructions. Real snip at only 16/6, plus 3/6 postage.



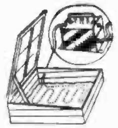
CASSETTE LOADED DICTATING MACHINE

Battery operated and with all accessories. Really fantastic offer a British made £31 outfit for only £6.19.6, brilliantly designed for speed and efficiency—cassette takes normal spools, drops in and out for easy loading—all normal functions—accessories include: stethoscopic earpiece—crystal microphone has on/off switch—telephone pick-up—tape reference pad—DON'T MISS THIS UNREPEATABLE OFFER—SEND TODAY £6.19.6 plus 7/6 post and insurance. Footswitch 18/6 extra. Spare Cassettes at 7/6 each, three for £1.

See in the Dark INFRA-RED BINOCULARS



These infra-red binoculars when fed from a high voltage source will enable objects to be seen in the dark, providing the objects are in the rays of an infra-red beam. Each eye tube contains a complete optical lens system as well as the infra-red cell. These optical systems can be used as lenses for TV cameras—light cells, etc. (details supplied). The binoculars form part of the Army night driving (Tabby) equipment. They are unused and believed to be in good working order but sold without a guarantee. Price £3.17.6, plus 10/- carr. and ins. Handbook 2/6.



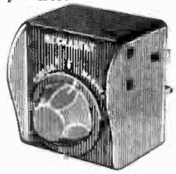
Be first this year! SEED AND PLANT RAISING

Soil heating wire and transformer. Suitable for standard size garden frame. Post and ins. 3/6. **19/6**

GANGED POTS

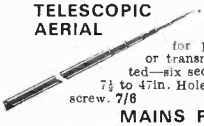
Standard type and size with good length of spindle—made by Morganite. List price is 10/- each but if you act quickly you can have them at 1/6 each. Following values in stock all "lin" 10K—10K—100K—100K—500K—500K all new and unused. Post 2/9 on first doz. then 1/- per doz. 6 doz. or more post free.

BECKASTAT



This is an instant thermostat, simply plug your appliance into it and its lead into wall plug. Adjustable setting for normal air temperatures. 13A loading. Will save its cost in a season 19/6. Post and ins. 2/9.

TELESCOPIC AERIAL



for portable, car radio or transmitter. Chrome plated—six sections, extends from 7½ to 47in. Hole in bottom for 6BA screw. 7/6

MAINS RELAYS

Type A 210/250V AC coil, 2 types, one for single whole chassis mounting, has 3 pairs heavy duty changeover contacts. 8/6 e ch.

Type B in clear plastic case on tin base, plugs into octal valve holder. 2 pairs changeover contacts. 12/6 each.

Where postage is not definitely stated as an extra then orders over £3 are post free. Below £3 add 2/9. Semi-conductors add 1/- post. Over £1 post free. S.A.E. with enquiries please.

ELECTRONICS (CROYDON) LIMITED

(Dept. P.W.) 266 LONDON ROAD, WEST CROYDON CRO 2TH

102/3 TAMWORTH ROAD, CROYDON, SURREY

remainder of the unit is functioning, a few test coils can quickly be made up on the lines indicated by the coil data table (Table 1), and wired across the appropriate points. When a suitable inductance has been found, either solder in position with stout wire, or bolt to the cabinet using a brass (not iron) fixing screw. No core is necessary.

After some trials, the following procedure for calibrating this range was adopted, and proved sufficiently accurate for the purpose. Obtain a v.h.f./f.m. receiver with a dial marked from 88 to 100Mc/s, and set this to the 88Mc/s position. Tune the generator, with a suitable coil in position, over the full range, having first, of course, connected the output to the f.m. aerial terminal of the set, and a number of responses should be heard. Select the topmost position (vanes unmeshed) and note the reading in degrees on the cardboard scale of the generator.

It is probable that the receiver is responding to the second harmonic of 44Mc/s, so that the latter figure corresponds to the signal generator frequency at the dial reading noted. Mark this point on a piece of graph paper scaled to read degrees against frequency. Now move to the second-top response, which is about 29·3Mc/s, and the third, which will be 22Mc/s, and plot these readings. Now retune the receiver to 100 Mc/s and repeat the above procedure. The tuning points this time should be 33·3, 25 and 20Mc/s, and all six points should lie on a smooth curve or perhaps a straight line. If they do not, it is probable that the coil coverage is incorrect, and either the coil should be replaced, or a new set of readings plotted, assuming different harmonics and testing for graphical linearity as before. Should a coil be wound which is found to generate a strong signal above, say, 60Mc/s, this could, of course, be used, but the lower end of the range would then in all probability not reach a sufficiently low frequency, leaving a rather wide gap at the important 13 metre band. The combination of frequencies shown for ranges 4 and 5 is, in fact, the most suitable for general receiver alignment.

After calibration has been completed for all 5 ranges, the various readings can be recorded on the instrument dial and checked carefully before being finally inked in. The original degree scale can be left on, if desired.

Using the Generator

For accurate alignment of the intermediate frequency stages of f.m. and particularly of TV receivers, an instrument of this type is not really adequate, though, on the other hand, very useful indications of circuit continuity can be obtained in many cases, enabling location of faults to be simplified. The r.f. stages of TV receivers can be induced to respond to suitably chosen second and fifth harmonics of the generator frequency in Bands 1 and 3 respectively, while direct injection of a 34Mc/s signal will serve to test the i.f. performance.

Audio amplifier faults generally fall into two classes—those in which there is a complete absence of input signal appearing at the speaker, and those in which the signal is present, but is either too weak and/or distorted. In the first case, using the generator as a portable a.f. signal injector should at least localise the fault, and may indicate directly a faulty component in the circuit. In the second case, advantage can be taken of the fact that, at least in the a.f. position, the attenuation control is reasonably linear with output, so that an idea of the gain associated with each stage of the amplifier may be obtained by noting the position of this control which is required to achieve a given volume of output from the speaker.

Finally, test facilities are available at socket 1 for ascertaining the values of small capacitors, up to 400pF, from which the marking has been removed or obliterated. A separate receiver is required. Tune the generator to the top of range 3, i.e. fully clockwise, and pick up the a.f. tone on the receiver at about 1Mc/s—the actual frequency is unimportant. Now place the unknown capacitor in position across socket 1 (it is now effectively in parallel with VC1), and turn the generator tuning anti-clockwise until the tone is again heard on the receiver. The value of the capacitor corresponds to the difference between the first and second readings. If no note is detectable, the capacitor is larger than 400pF or is faulty. This test scale should be calibrated initially by using capacitors of known value, and, when completed, by adding these markings as a separate range.

SHOW TIME '68

THIS year's radio and television exhibits, held in well-known London hotels during the period August 25th to 29th, were for the trade only, like last year's shows. All exhibitors were well pleased with the results of their efforts, some manufacturers selling their next four months' production during the first day or two.

The success of trade-only shows means that a return to a national radio and television exhibition is most unlikely. This seems a great pity in view of the current revival of interest in radio—due to the opening of local stations, the output of "pop" from Radio 1, and the increased availability of stereo programmes.

A national exhibition would also take advantage of the growth of the colour-television market, and show the public that the BBC's colour service is excellent and not to be judged by the poor displays so often seen in shop windows. (A report on the new developments seen in TV receivers will appear in the November issue of the companion magazine "Practical Television", on sale on October 18th.)

One of the first points noticed during our tour of the shows was the increased number of foreign products, mainly Japanese. There were many British items too, but the price and finish of the foreign goods certainly compete with those of home-produced equipment.

More radios and radiograms now have v.h.f. coverage, and a large number now cover one or two short wavebands. Radiograms often have provision for the addition of decoders for stereo radio reception but most makers supply these items as "extras". One wonders how long it will be before decoders are standard in all stereograms.

Cabinet styling this year reflected the current fashion, some units being painted in vivid colours and some being covered in brightly coloured leathercloth (a good example of the bringing-up-to-date of a traditional material). Designers had also obviously been hard at work trying to give an expensive appearance to the cheaper lines. This was achieved by removing much of the chrome glitter to make a more attractive product.

Some makers were pleased with their redesigned control knobs, failing to realise that most of their competitors had had the same ideas—the popular style this year was the spun aluminium knob consisting of a squat cylinder with a bevelled edge.

Tuning scales on radios are now up-to-date, with the "square" names such as "Light Programme" banished. However, the use of terms such as "BBC 1" and "BBC 2" on a radio is rather puzzling when seen for the first time—we haven't yet heard of a customer returning a radio because of a poor BBC-2 picture, but we are sure it will happen eventually!

A full review of the various exhibitions would take up too much space and would be useful only to a minority of our readers. We have therefore picked out from the vast number of new items those which we think would be of particular interest.

A range of aircraft and marine d.f. receivers was shown by Perry and Pharo. The Novapal priced at £27 covers 190kc/s to 400kc/s; 550kc/s to 1600kc/s; and 1500kc/s to 4500kc/s. This receiver comes complete with beacon charts, navigator's handbook, operating manual, beacon lists, radio logs, and carrying case. The Aviator D.F. receiver has a similar specification but also covers 103Mc/s to 136Mc/s and retails at £53 10s. 0d. The Action D.F. retails at £53 10s. 0d. too, and has two v.h.f. wavebands (150Mc/s to 175Mc/s and 30Mc/s to 50Mc/s).

Also shown by Perry and Pharo was the Pygmy 2001 which covers f.m., long and medium waves, and short waves from 25 to 190 metres, with four bandspread positions (for the 13, 16, 19 and 25 metre bands).

Sony has a pocket sized a.m./f.m. radio finished in black and silver and weighing only 9 oz. The retail price is £11. Also shown by Sony were three unusually shaped receivers the TR1819, TR1829 and TR1839, respectively cylindrical, cubic, and cigar-box shaped, as may be seen from the illustrations. They retail at £6 7s. 0d., £8 5s. 0d., and £9 8s. 0d.

The HP180 from Sony is a modular stereo system, with an output of 7W per channel, comprising gram unit, a.m./f.m. stereo tuner, and a pair of bookshelf loudspeaker units. The complete system is £125.

Sobell announced the SG685 transistorised four waveband stereogram. The cabinet is finished in teak with a black leathercloth interior. The tuner section covers l.w., m.w., s.w., and v.h.f./f.m. and uses silicon planar transistors.

The G.E.C. 836 is a new a.m./f.m. portable covering l.w., m.w., m.w. bandspread, v.h.f./f.m., two s.w. bands and two s.w. bandspread. This model has a time-zoned map of the world on the back panel and a tuning meter which is also used to check the battery. A turntable is built into the base of the set.

A clock radio from Ferguson to retail at £17 10s. 0d. combines a seven-transistor radio and a battery-operated clock which can be set to switch on the radio at any desired time. The model-number is 3163.

Portable model 6151 from Ultra covers l.w., m.w. and v.h.f./f.m. and is finished in dark grey and chrome. The price is £15 5s. 0d.

A new item from Discatron, the TR3000 Tri Combo, is a combined radiogram and cassette tape player. The record-player plays any 45 r.p.m. record and uses the now well-known Discatron linear tracking principle. The unit features a 7in. x 4in. loud-

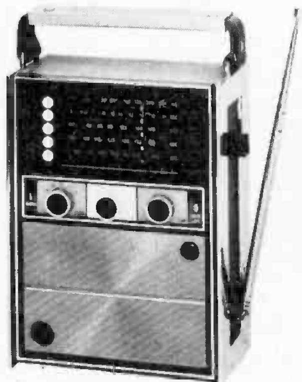
TR1829

TR1819

TR1839

Sobell SG685

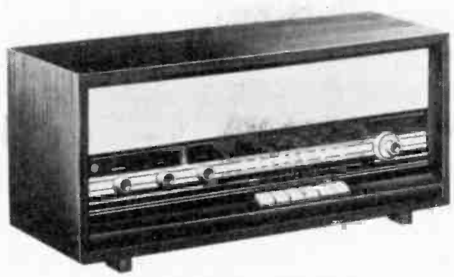
Eagle RM9
"Rhythm Master"



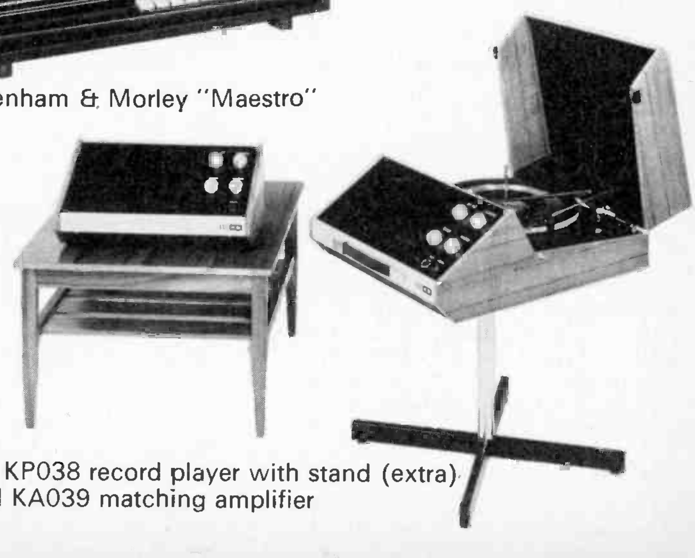
Elsworthy Electronics "Interceptor"

Dynatron HFC8

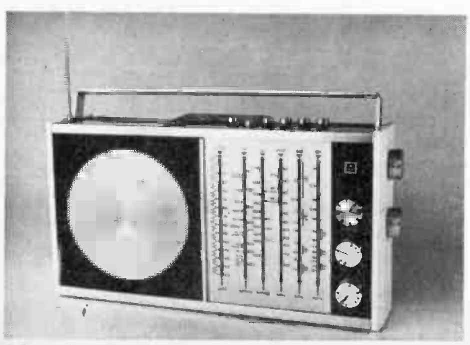
Alba 666



Denham & Morley "Maestro"



KB KP038 record player with stand (extra)
and KA039 matching amplifier



Murphy B845

speaker and full coverage of m.w. and l.w. The recommended retail price is £28 3s. 5d.

Aiwa were showing the TP.1018 tape cassette stereo auto-changer. This unit is mains operated and will play six cassettes one after the other automatically, giving up to 4½ hours playing-time (one side of each cassette). The units weigh 20½lb. and will be available next year.

An unusual item from Aiwa was a radio tuner unit in the form of a tape cassette which thus converts a cassette tape player into a radio. This unit retails at less than £5 and covers m.w.

A four-track stereo tape recorder was also shown by Aiwa (Model TP.1012) and can be operated from a.c., d.c., or a car battery.

Fidelity had a new tape recorder, the Braemar, which is available in a four-track version for 32gns., and a two-track version for 29gns. This is a 3¾in./sec. machine with 5¾in. spools. The Fidelity RAD14 is a new portable radio covering l.w., m.w., and v.h.f./f.m. It weighs 4½lb., costs 17gns., and is finished in green leathercloth.

The Interceptor from Elsworthy Electronics covers m.w., v.h.f./f.m. and short waves (6Mc/s to 18Mc/s). However, it also covers 142Mc/s to 150Mc/s, which includes the 2 metre amateur band. The set weighs 7lb. and works from batteries or mains. It has 18 transistors, slide-rule tuning, and automatic circuitry to switch to battery operation if the mains supply fails. The retail price of this receiver is 39gn.

Bosch Bluespot introduced four new radiograms: the Stockholm at 115gns.; the Santiago also at 115gns.; the Arkansas Mk. IV at 139gns.; and the Barcelona Mk. IV at 155gns. All include automatic stereo decoders and the Barcelona covers v.h.f./f.m. and three short wavebands one of which is the marine band. The other three radiograms cover l.w., m.w., and v.h.f./f.m.

Teleton Electro were showing a solid-state stereo a.m./f.m. receiver, model 7AT-1. This has an f.e.t. in the f.m. front-end, and covers 88Mc/s to 108Mc/s on f.m., and 565kc/s to 1605kc/s on a.m. The tone controls are comprehensive and high-pass and low-pass filters are included. The suggested retail price is £118 8s. 7d.

The KTR-1381 from Koyo is a new receiver covering m.w., l.w., s.w. (4Mc/s to 12Mc/s), and v.h.f./f.m. There are 13 transistors and the price is 25gns. The Koyo TKR-1651L has 16 transistors and features a built-in mains adaptor. In addition to v.h.f./f.m., m.w., and l.w., the coverage includes two short wavebands, 3Mc/s to 9Mc/s, and 9Mc/s to 22Mc/s. The retail price of this model is 37½gns.

Mordaunt-Short were showing seven loudspeaker systems ranging in price from 33 to 65gns. The MS100 at 33gns. is a bookshelf type rated at 25W music power. This unit features three loudspeakers, including the Decca Kelly 8in. flat piston. and a specially developed E.M.I. mid-range unit. The MS700 is a floor-standing system which has a bass unit and a Decca-Kelly ribbon unit. An acoustic lens is also fitted to give wider sound dispersion.

All of the Mordaunt-Short systems are designed on the infinite-baffle principle and the MS100, 200, 300 and 400 use ferrite-cored cross-over inductors in conjunction with paper capacitors.

The Dynatron HFC8 tuner/amplifier record-player covers three wavebands and includes a stereo decoder. There is a choice of a Garrard auto-changer or single-player at retail prices of £92 0s. 0d. and £94 10s. 0d. respectively.

Pye's International 3042 has 11 transistors and covers l.w., m.w. and seven s.w. bands, five of which have bandspreading. This receiver operates from a.c. or d.c. mains and is priced at £41 0s. 0d.

Also on view was the Pye "Picadilly" 6000 which covers l.w., m.w., v.h.f./f.m., and s.w. from 1·6Mc/s to 27Mc/s in four bands. Electronic bandspreading is featured and the receiver is powered from six 1·5V cells.

Highlight of the Sinclair show was the new IC10 integrated circuit 10W amplifier. This is priced at 59s. 6d. including instruction manual containing a number of useful circuits and ideas. The size of the unit is only 1in. x 0·4in. x 0·2in., but the output is 5W r.m.s., with a frequency response from 5c/s to 100kc/s. To convert the IC10 into an audio amplifier, only tone and volume controls are needed. The power supply can be 8V to 18V.

A new five waveband radio from Murphy, the B845, covers m.w., l.w., v.h.f./f.m. and s.w. from about 5·5Mc/s to 22Mc/s. A logging scale is provided and there are separate bass and treble controls. The retail price of this model is 38gns.

The RR380 from Philips combines a l.w./m.w. portable radio and portable cassette tape recorder. Automatic recording-level control gives optimum results from microphone, pick-up, or radio. The price of the complete unit is 36gns.

Alba showed their 666 a.m./f.m. portable which uses nine transistors and five diodes. The retail price of this model is £17 10s. 0d.

Telefunken exhibited a new version of their stereo tape recorder 204. The new three-speed 204TS has VU meters, a transparent cover, and the carrying handle is now at the top. The M250 hi-fi is a two-track stereo recorder operating at 7½in./sec. There are facilities for echo and the price is 150gns. Matching audio units will be available later.

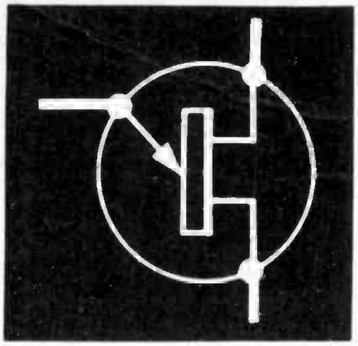
Denham and Morley showed two new table mains radios. The "Maestro" with seven valves covers four wavebands—l.w., m.w., v.h.f./f.m., and s.w. (15 to 50 metres). The a.m. and f.m. tuning are separate and sockets are fitted for tape recorder, pick-up, external aerials, and extension loudspeakers. The "Melody" covers l.w./m.w. and v.h.f./f.m.

Radionette showed the Kurer 1001, a twelve-transistor a.m./f.m. portable with press-button controls. Two telescopic aerials and separate bass and treble controls are features and the receiver retails at 39gns.

The "Bolero Stereo 40" from B.M.B. is a stereo record-playing system having an output of 5W per channel, A Garrard 3000LM auto-change deck is fitted and has a Sonotone 9TAHC stereo cartridge. The system will retail at 69½gns.

The KP038 from ITT K-B is a portable record player finished in natural teak with black and silver grille. A matching amplifier (KA039) is available for stereo, and a pedestal stand is an optional extra. The KP038 retails at 34gns. and the KA039 at 15gns.

Eagle products showed a very interesting item, the RM9 "Rhythm Master" which electronically generates the sounds of percussion instruments ranging from the bass drum to the cymbal, and produces the sounds in nine rhythms including waltz and bossa-nova. The unit operates from 240V a.c. mains and the output is suitable for feeding to an amplifier. ■



UNIJUNCTION TRANSISTOR CIRCUITS

C.R.BRADLEY

THE unijunction transistor differs from the ordinary p-n-p and n-p-n transistors in having only a single p-n junction. It is very similar to the junction diode with the difference that the p-n junction is made near one end of a bar of n-type material with leads at both ends called the base 1 and base 2 connections. The circuit symbol and an equivalent circuit for the unijunction transistor are shown in Fig. 1. The diode in the equivalent circuit represents the p-n junction and its anode lead is called the emitter connection.

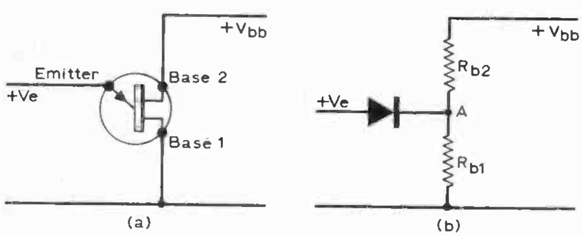


Fig. 1: (a) Unijunction transistor circuit symbol. (b) Equivalent circuit of a unijunction transistor.

If base 1 is earthed and a positive voltage Vbb applied to base 2 a small current flows due to the resistance of the n-type bar (5 to 10k Ω). The voltage at point A will be a fixed fraction of Vbb viz: [Rb1/(Rb1 + Rb2) Vbb]. When Ve is less than this voltage the diode is reverse biased and practically no emitter current flows. But if Ve exceeds this emitter current will flow. This injects holes into the bar which act as current carriers and the resistance of the bar drops to a very low value.

The transistor may be used as an on/off switch, the on condition being:

$$\text{Ve greater than } \frac{\text{Vbb Rb1}}{(\text{Rb1} + \text{Rb2})}.$$

The main characteristics of the unijunction transistor as a switch are: (1) Fast switching time with low emitter current. (2) The ratio Rb1 : Rb2 is fixed by the construction of the transistor and the on condition is virtually independent of temperature. (3) High peak current capacity. (4) Unlike a thyristor the unijunction may be switched off by removing the triggering (emitter) voltage.

Relaxation Oscillator

The oscillator circuit shown in Fig. 2 has a variety of uses and operates as follows. At the start assume that the emitter is at earth potential and the unijunction is off. The capacitor C now slowly charges through resistor R. When Ve reaches the firing voltage the emitter suddenly conducts and the capacitor discharges through the unijunction. Current also flows from base 2 to base 1 and is limited to a safe value by R1. The emitter current falls very quickly as the capacitor discharges and the unijunction switches off again. The cycle of operations is then repeated and the circuit continues to oscillate at a frequency fixed by the values of the RC combination. A sawtooth waveform is available at the emitter and short negative-going pulses may be taken from base 2.

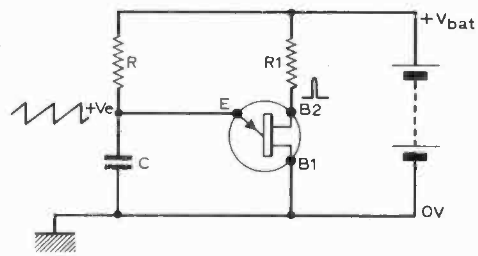


Fig. 2: Unijunction relaxation oscillator. The frequency of oscillation is determined by the values of R and C.

The frequency of oscillation may be varied by adjusting R and C. For high frequency oscillation use a low value for R and a small one for C; conversely for low frequencies use a large R and a large C value. A very wide range of frequencies is possible but R and C must lie within the following limits:

(1) If the value of R is too high it cannot supply enough current to switch the unijunction on. It also has to supply any leakage current drawn by C which, if possible, should be a low-leakage (i.e. non-electrolytic) type. The maximum value of R with which a 2N2646 unijunction would oscillate reliably was found to be about 1·5M Ω (Vbat = 30V).

(2) If the value of R is too low it will supply the triggering current continuously and the unijunction will not switch off. If the base-base current is not limited sufficiently by R1 the unijunction will be destroyed. Under the same conditions as above the minimum safe value of R with a 2N2646 was found to be about 1k Ω.

(3) If C is too large the peak discharge current may be damaging to the unijunction. For C values above a couple of μF a resistor of at least 1 Ω per μF should be put in with series C.

These limitations are not very severe and (2) is the main one that has to be borne in mind—otherwise one will waste a lot of unijunctions!

Code Practice Oscillator

The audio oscillator shown in Fig. 3 is designed for morse code practice and is an ideal exercise for the

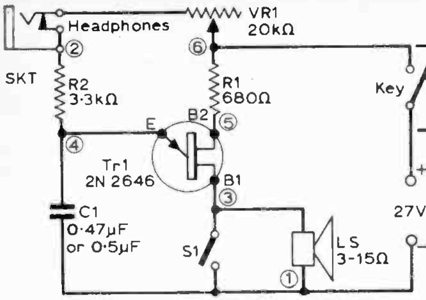


Fig. 3: Unijunction code practice oscillator. VR1 is the tone control. S1 provides speaker muting.

★ components list

R1 680Ω ¼ W, 10%
R2 3·3kΩ ¼W, 10%
VR1 20kΩ carbon pot
C1 0·47 or 0·5μF paper
S1 s.p.s.t. slide or toggle switch
SKT Closed circuit jack
LS 3–15Ω speaker, any size
Tr1 2N2646 or equivalent

Three PP3 type batteries, terminal strip, battery clips, wire etc.

beginner. It is so simple that it can hardly fail to work first time! There is no need for an on/off switch as the circuit draws no current when the morse key is not depressed. If a pair of test leads are connected across the key as shown the device will double as an audible continuity tester. The layout shown uses a break-off terminal strip and the whole instrument could be wired without a soldering iron.

Unijunction Metronome

This simple application of the unijunction oscillator is useful for any kind of music practice. It gives loud rhythmic beats similar to a mechanical metronome. The circuit is shown in Fig. 4 and like all these circuits will work with unijunctions other than the 2N2646 specified (e.g. UT46, 4JD5E29, TIS43, BEN3000) although the timing components may have to be adjusted. If doing this double the value of R1 and put a warning milliammeter in series with the battery for protection against condition (2) above while experimenting.

The values of C1, R2 and VR1 were selected to give

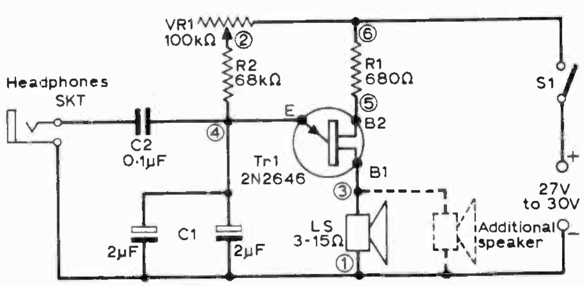
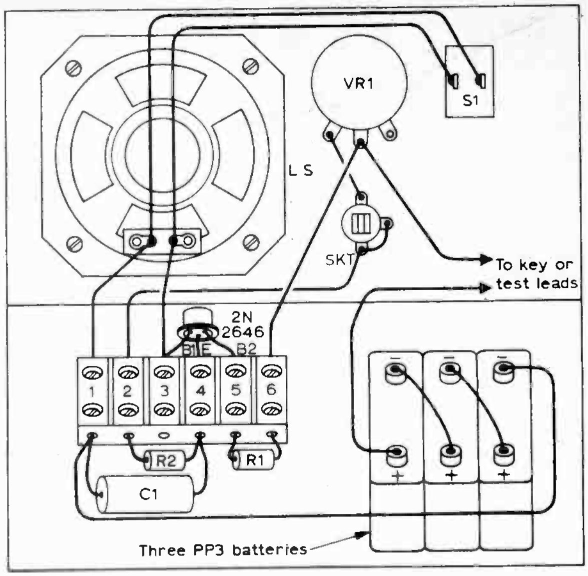


Fig. 4: Unijunction metronome. VR1 gives a range of 90–220 beats per minute. An output suitable for feeding into an amplifier is available from the headphone socket. A suggested layout is given overpage.



Suggested layout for the unijunction code practice oscillator.

a range of 90 to 220 beats per minute, suitable for most musical purposes. VR1 should be an ordinary logarithmic carbon potentiometer wired to give *decreasing* frequency with clockwise rotation. This is to avoid a compressed scale at the high-frequency end. The author used a pair of 2μF electrolytics for C1 as these were more readily available than a 4μF unit, but a 4μF paper or electrolytic type would be equally suitable.

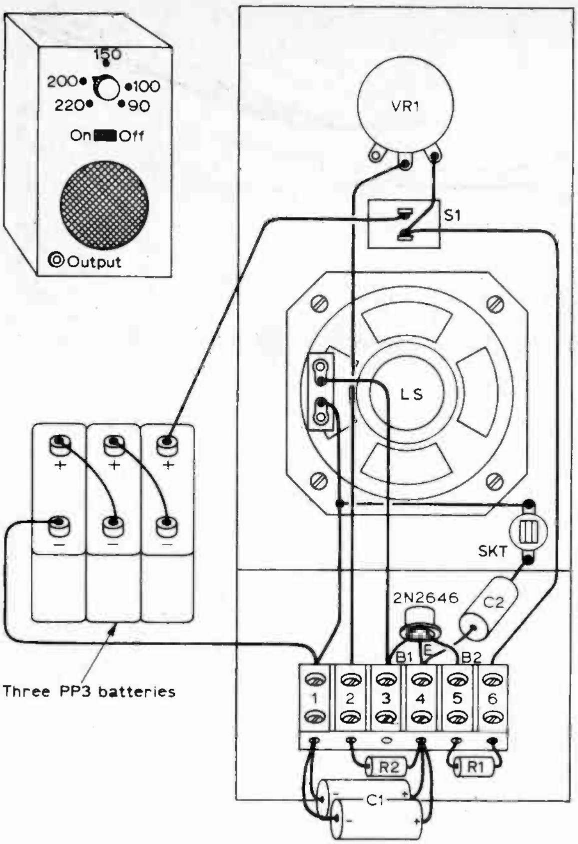
The metronome will give loud beats that can be heard above most musical instruments. If a 12in. speaker is used there should be ample volume, or several speakers can be wired in parallel as shown. Headphones can be used for loud pop music practice although in this case the metronome beats may be injected into a guitar amplifier (see Fig. 4). Volume may also be increased by increasing the supply voltage although this experiment is not advised unless one is prepared to destroy a unijunction finding out its maximum ratings!

As the batteries wear out the volume drops but the beat frequency remains virtually constant. Layout is not critical and the circuit may be wired on the same lines as the code practice oscillator. Fit a large pointer knob to VR1 and draw a calibrated scale 90–220 using a stopwatch. The range actually obtained may differ from this slightly due to component tolerances and slight adjustment of R2 value may be necessary. Increasing it to 82kΩ will give a slower range of beats.

★ components list

R1 680Ω ¼W, 10%
R2 68kΩ ¼W, 10%
VR1 100kΩ carbon pot
C1 4μF 30V or above electrolytic
S1 s.p.s.t. slide or toggle switch
SKT Open circuit jack
LS 3–15Ω speaker, 4in. or larger
Tr1 2N2646 or equivalent

Three PP3 batteries or mains power supply, terminal strip, battery clips, wire, etc.



Suggested layout for the unijunction metronome.

The metronome may be run from three PP3 batteries (27V) or from the mains power supply circuit shown in Fig. 5. Battery life should be 2–3 months with normal use.

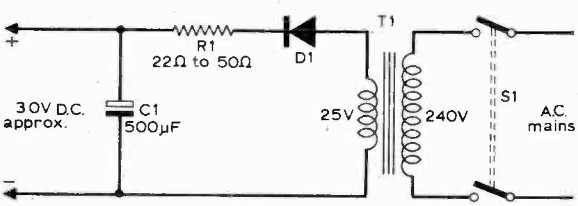


Fig. 5: Simple unregulated power supply suitable for use with all the circuits given in this article. Extensive smoothing is not required.

★ components list

R1	22–50Ω ½W
C1	500μF 50V electrolytic
D1	Silicon rectifier, 50V p.i.v.
S1	Mains d.p.s.t. on/off switch
T1	Mains transformer, 25V a.c. secondary

Monophonic Electric Organs

These organs are often seen in these pages and need not be described at length here, the idea being to run an audio oscillator at musical frequencies selected by a keyboard (or see PRACTICAL WIRELESS July–September 1968 for a Portable Keyless Organ). These organs usually use a two-transistor multivibrator oscillator circuit but a unijunction relaxation oscillator could be used with these advantages: (1) A wider range of frequencies is available by varying one resistor. (2) Two different waveforms are available from one oscillator (sawtooth wave from the unijunction emitter—a "coarse" sounding note; and narrow pulses from base 2—a buzz or whining sound). (3) The oscillator will drive a speaker directly (at medium volume) without amplification. (4) Lower current drain: no current is drawn when no note is played.

A very simple unijunction organ circuit is shown in Fig. 6. This may be used to drive a speaker directly and/or deliver two different signals to an amplifier. The mechanical details of the keyboard are left to the constructor, as is the layout which is not critical. This is a monophonic organ so that only one note may be played at a time.

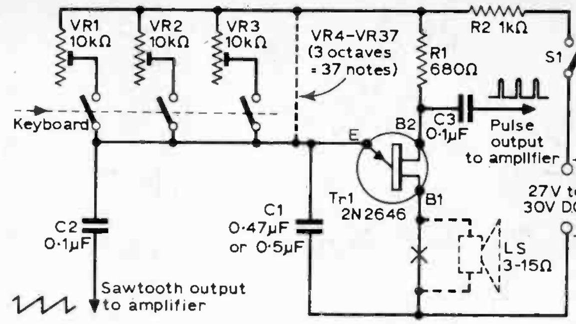


Fig. 6: Unijunction organ oscillator. VR1–VR37 are tuning resistors for each note. The circuit will drive a speaker directly at medium volume.

★ components list

R1	680Ω ¼W, 10%
R2	1kΩ ¼W, 10%
VR1–VR37	10kΩ skeleton presets
C1	0·47 or 0·5μF paper
C2	0·1μF paper
C3	0·1μF paper
S1	s.p.s.t. on/off switch
LS	3–15Ω (if used)
Tr1	2N2646 or equivalent

Three PP3 batteries or mains power supply, keyboard, etc.

TO BE CONTINUED

AUDIO SUPPLEMENT

No. 2 — TRANSDUCERS

THE transducer is a device which changes one form of energy to another. A pick-up cartridge converts the energy of a moving stylus to minute voltages; microphones receive pressure and velocity variations in the air and produce voltage changes; loudspeakers act in reverse, being powered by current and voltage and moving the air to give sound. Our final example, the tape recorder head can either produce a varying magnetic field when current passes through it, or a current from its windings when a varying magnetic field passes across the gap in its magnet.

The principles are well known, but the problems that arise in audio matters are mostly due to the non-linearity of the conversions. From an electro-mechanical point of view, most transducers are "linear" in that the output is proportional to the input but various loss factors enter when we consider frequency conversion and correction is often needed in the electronic circuits to which transducers are coupled to compensate for this "frequency-consciousness".

Of the four classes of transducer mentioned above, three work normally within the bounds of the classic transducer pattern. Types are: (a) piezo-electric (b) moving conductor (c) variable magnetic field and (d) electrostatic. The exception is the magnetic recording head which we shall consider separately.

Piezo-electric effects have been known since Kelvin postulated permanent polarisation of certain crystals in 1878 and the Curie brothers investigated piezo-electric effects in crystals in 1880. Woldenar Voigt laid down much of the basis of crystal physics long before a practicable application was found. Perhaps the earliest example was the underwater sound detector of Paul Langevin during the First World War—though even this was preceded by a British patent taken out by L. F. Richardson in 1912. The real growth of piezo-electric development occurred in the "Twenties" when Sawer and Tower founded the Brush Crystal Corporation.

Before 1939 only quartz and Rochelle salt were used as crystal resonators and gramophone pick-up units. But the piezo-electric effect can be demonstrated in 20 of the 32 crystal classes. The underlying principle is similar but applications depend on the limiting factors of cut-off frequency temperature sensitivity and the humidity effect. For commercial transducers types are limited to three kinds of crystal. These are: (a) Ammonium dihydrogen phosphate (A.D.P.) (b) Sodium potassium tartrate (Rochelle salt) and (c) Polycrystalline barium titanate (ceramics).

A.D.P. has a higher volume sensitivity than Rochelle salt but a very low dielectric constant. It is responsive to humidity changes but is fairly stable with temperature changes. The great drawback is a high and variable conductance which gives it a high cut-off frequency. (At frequencies below resonance crystal transducers behave as generators in series with a capacitor terminated with a resistance). Matching must be into an impedance of 10MΩ and above and this limits its usefulness.

Rochelle salt is humidity-conscious and varies widely in its characteristics because of the temperature sensitivity. Much depends on the conditions under which transducers are made. Excess moisture must be excluded. But when units such as microphones are hermetically sealed, Rochelle salt units are effective, and have the advantage of cheapness. It has the highest electro-mechanical coupling coefficient of any commercially-available piezo-electric material. The electrical load into which it matches must be high compared with the reactance of the crystal. More about this, and the barium titanate characteristics when we discuss pick-ups.

Microphones

Cheapest and most popular microphones that need be considered are the crystal types, with Rochelle salt of quartz crystals, acted upon by mechanical movement as the air fluxes a diaphragm which stresses the crystal and produces an e.m.f. *Thus, the crystal microphone is pressure-operated.*

It has different methods of construction, the simplest type being a dimorph, or two slices as shown in Fig. 1(d), made this way to give extra voltage, the e.m.f., from each half adding. Upper frequency response is little more than 6kc/s, making these units applicable for speech, but unsatisfactory for musical reproduction. By sealing two dimorphs in a cavity, leaving an airspace, the mechanical connection is eliminated and frequency response may be extended to 10kc/s or more. It is quite possible to improve upon this by careful selection of crystal and construction, but costs rise disproportionately.

Microphone sensitivity can be plotted as the voltage obtained from a constant sound source at various angles around the unit. This "polar diagram" is drawn in one plane, but extends all round, and the theoretical polar diagram for a pressure-operated microphone is as Fig. 1(a). *This is modified by the shape of the microphone housing, and, in practice* *by the frequency of the sound source.*

At low frequencies the air strikes the one-sided diaphragm at more or less equal strength whether approaching from the front or back but higher frequencies do not permit the pressure change—there is not enough time for the diaphragm to respond—and the response becomes more and more unidirectional. *So the circle of Fig. 1(a) becomes elliptical as the frequency of the sound source rises.*

A crystal microphone is effectively a generator in series with a capacitor when matched into its appropriate load. The reactance of the capacitance varies inversely with the frequency and C forms a potential divider with the load Z. At lower frequencies C is significant the reactance is greater and more signal is lost across C. Cable capacitance must also be taken into account and as typical values might be 150pF per foot for the response to be no more than 3dB down at 40c/s matching impedance should be 8MΩ or greater with a microphone capacitance of 500pF. *So bass response is lost if the load impedance is not high enough.*

High impedance lines are prone to hum pick-up and this is another limiting factor in the use of crystal microphones. Coupling into the low impedance of a "conventional" transistor circuit is poor so bootstrap inputs with directly coupled pairs of transistors have been developed to accommodate high impedance sources.

Carbon microphones are also pressure-operated devices but their inherent noise level and the restricted frequency response make these applicable to limited uses such as telephones and they need not be considered here.

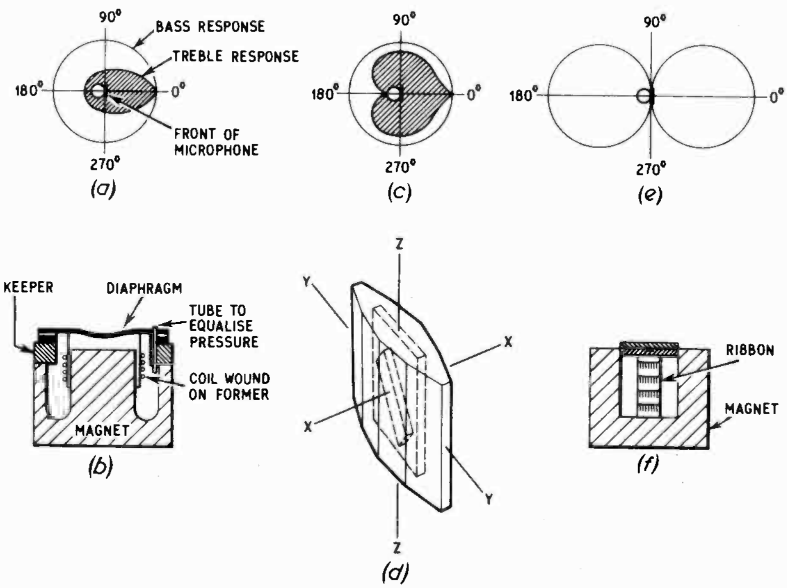


Fig. 1: (a) Polar diagram of pressure-operated microphone. This is "flat" section: microphone is senstitive "upwards and downwards" as well as in forward plane. (b) Sectional diagram of moving coil transducer. The equalising tube is employed to prevent back pressure affecting the performance. (c) Cardioid polar diagram, available for many moving coil microphones. (d) Crystal units cut from the basic crystal in the manner shown. The hard line shows the shape of the original crystal, the line-dotted shape is the basic plate, with force lines as shown, X, Y and Z, and the dotted slice is the final cut from the crystal to give bimorph properties which produce e.m.f. from mechanical stresses. (e) Figure-of-eight polar diagram, typical response of ribbon microphone. (f) sectional view of basic ribbon construction.

Moving coil microphones

Perhaps the most popular type of general purpose microphone is the moving coil unit whose general construction follows the sectional diagram Fig. 1(b). This is also a pressure-operated device essentially robust and capable of a very good frequency response when well designed. Ideally the polar diagram is as (a), the microphone being omnidirectional at low frequencies and more directional from front and rear as the frequency of the sound source increases. Modifications to the housing and types of baffle permit the moving coil microphone to achieve a cardioid polar diagram as in Fig. 1(c). *By fitting an acoustic labyrinth to the microphone, it can also be made into a very effective unidirectional unit.*

The principle is simple. A coil is wound on a cylindrical former to which a cone-shaped diaphragm is attached. The former sits in the annular gap of a magnet. Air movement causes the cone to move, cutting lines of force with the coil, into which an e.m.f. is induced.

Frequency response of a good MC microphone can extend from 40c/s to 15kc/s, and resonances due to the mechanical system can be reduced to quite small proportions—although for all but the best types, these are still limiting factors. The impedance is low, and the output voltage is lower than that obtained from a crystal microphone, and for this reason a transformer is often built into the microphone housing, as in Fig. 2. The output is raised and the matching impedance may be 200Ω, 600Ω or 50kΩ in typical devices. Very often higher quality microphones have an inbuilt switch that allows the user to select low, medium or high impedance matching.

Other factors that must be considered when choosing a microphone are the sensitivity and the front-to-back ratio. The latter specification is given in decibels, a typical figure of 15 to 20 being quoted for MC units, with values from unity to 20 or more for ribbon and capacitor microphones, specially constructed for directional responses.

Sensitivity may be quoted in microvolts per micro-Bar (μV/μBar), the Bar being a unit of air pressure, decibels relative to a stated voltage reference, or simply in microvolts. The reference level is made to equate with 0dB, and can be expressed as the voltage produced at a certain sound pressure, or the output across a load of known impedance. Thus 0dB can be 1V with a sound pressure of 1 dyne per square centimetre (1V/dyne/cm^2) and the microphone sensitivity will be a minus decibel rating. *Thus —60dB means that the microphone would generate approximately 1mV when subjected to a sound pressure of 1 dyne/cm^2.*

Another common reference level is 0·001W across

600Ω (which works out to 775 millivolts). So the same microphone with −60dB rating would give 0·000775 volts or 0·775mV. Where the output is in volts or fractions of a volt this will generally be the standard implied. To work out the voltage from the "minus dB" specification we use the following formula:

$$E_1 = \frac{E_2}{\text{antilog dB/20}} \quad \left(\text{because dB} = 20 \log \frac{E_2}{E_1}\right)$$

$$\text{thus } E_1 = \frac{0{\cdot}775}{\text{antilog } 60/20} = \frac{0{\cdot}775}{1{,}000} \text{ volts}$$

Ribbon Microphones

The conventional ribbon microphone is a pressure gradient operated device. A very thin corrugated ribbon usually of aluminium is suspended between the poles of a magnet and protected by acoustically transparent grilles. Movement of the ribbon is caused by the difference in pressure between the front and the back and the polar diagram is thus a figure-of-eight as in Fig. 1(e). This makes the ribbon microphone especially useful for stage and studio work where sounds from the side directions can be virtually excluded. Actors can come in and out of sound focus by merely moving a foot or two sideways!

By fitting acoustic pads the bi-directional characteristic can be modified to a cardioid response. The very good frequency response and the sensitivity to transients (short-term sounds) makes these microphones suitable for much high fidelity work. But the construction renders these instruments more vulnerable to damage and they are not suitable for outdoor work unless well shielded from the wind.

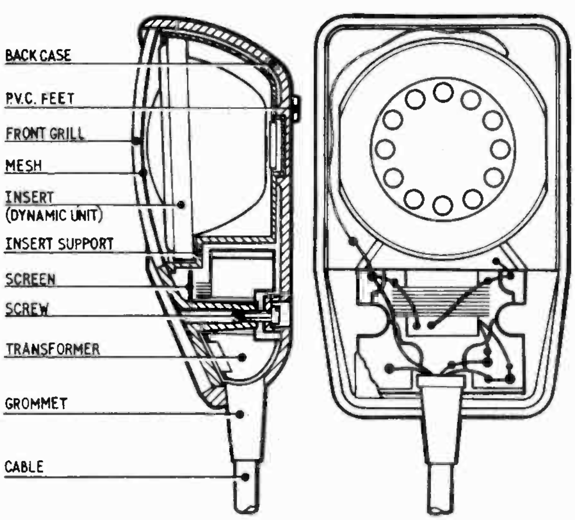


Fig. 2: Basic construction and circuit of typical moving coil microphone with inbuilt transformer.

Because of the excellent frequency response of the ribbon microphone bass will be accentuated if the sound source is too close. Impedance and output voltage are low for the basic unit and it is common practice to build a transformer within the shell of the microphone. Units with a terminal impedance of 30-50Ω are common requiring further transformer matching to most amplifier inputs.

Capacitor Microphones

Again a pressure-operated type as is the moving coil, the capacitor (or condenser) microphone can be made to very high quality specifications with a frequency response extending well beyond anything required for normal audio work. A diaphragm forms one plate of a capacitor, a rigid piece of metal the other. A polarising voltage is required, and as $V=QC$, Q being unable to change rapidly, the capacitance is very nearly proportional to the voltage, and movement of the diaphragm gives a voltage variation in time with the sound. A flat response of 20c/s up to 15kc/s and more can be obtained with quite normal capacitor microphones —although these units are not cheap. *Response can be omni-directional, bi-directional or cardioid, depending on construction.*

A three-plate capacitor can be used, with a diaphragm on either side of a perforated plate. As the diaphragms are mechanically coupled by the air between them, they move simultaneously. With one diaphragm polarised, a combination of pressure and pressure gradient operation is obtained, and a cardioid response. Polarising the second diaphragm to aid the first, produces and omni-directional polar diagram, and when the two oppose, a figure-of-eight polar diagram. Impedance can be low or very high, and output is comparable with MC units.

Pick-up Cartridges

Some of the widest price variations in the high fidelity market are encountered as we take a look at the range of gramophone pick-up cartridges available. These can be of the three first types of transducer we considered: (a) piezo-electric, (b) moving coil or (c) moving armature (-variable reluctance). The cheapest types are generally in bracket (a) and these can be further sub-divided into crystal and ceramic units, with the latter giving less output but capable of high quality.

Rochelle salt crystals are of the general dimensions 0·5 x 0·25 x 0·03in. and ceramic' (barium titanate) bimorphs 0·7 x 0·1 x 0·03in. and a practical stylus length may be as little as 1cm. Normal capacity is between 500 and 1500pF. Compliance (freedom to move) of the crystal is lower than required for good tracking and the construction demands very precise engineering the actual crystal being supported on resilient pads within the cartridge body.

The resonant frequency of such a system is given by the formula: $f_r = \dfrac{1}{2\pi\sqrt{(M.Cm)}}$

where M is the effective mass or the moment of inertia and Cm the effective compliance. *The resonant frequency is lower for cantilever than for torsional units.*

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ECL80	1/6	PL38	6/-	6K7	1/9	30P12	5/-
EF50	1/-	PL81	4/-	6K25	5/-	30F5	2/6
EF80	1/6	PY33	5/-	6U4	5/-	30FL1	5/-
EF91	9d.	PY81	1/6	6V6	1/9	6/30L2	5/-
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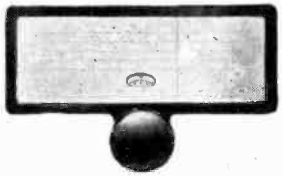

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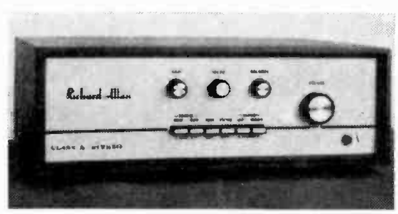

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The output voltage from an ideal pick-up cartridge would be proportional to the velocity of the stylus. With sinusoidal recording movement of constant velocity the peak amplitude of the recorded groove (and thus peak displacement of stylus) would be inversely proportional to frequency. So if low frequency signals of large amplitude are to be recorded the groove spacing must be large. As this would reduce playing time per disc and impose serious tracking problems—about which more later—the ideal velocity characteristic is modified. Maximum amplitude of stylus travel at low frequencies is limited and some bass boost is necessary in the amplifier to compensate. *This is one reason for equalisation which differs according to the type of cartridge in use.*

Another factor is the low power content of the highest frequencies (small amount of actual stylus travel) which can become comparable to the noise signal caused by mechanical discrepancies. To overcome this the treble is pre-emphasised during recording. Acceleration of the stylus due to pre-emphasis is proportional to frequency. This accentuates the tracking problem still more with great differences between grooves at the outer edge and toward the centre of the disc. So the recording characteristic has to take account of this factor.

For similar reasons the recording characteristic and this the equalisation that must be applied varies according to the speed of the record. Standardisation of equalising curves was proposed at the CCIR conference in Philadelphia in 1954 and the Recording Industry Association (RIA) conforms using standard sizes for microgroove dimensions and stylus radii, as follows: Coarse groove 78 r.p.m., 0·006in max groove width with 0·001 stylus radius and a groove angle of 80 to 93 degrees (taking the groove as a V-section). Fine Groove, 33 and 45 r.p.m., similar groove angle, with 0·002in groove width at top and radius of 0·003in. Stylus radius is then limited to 0·002—0·003in for coarse and 0·0008 to 0·001in for fine groove replay.

Because crystal and ceramic cartridges are capacitative by nature the matching is into a high impedance, and equalisation is necessary. To obtain what is known as a velocity characteristic, the ceramic cartridges can be matched into a lower impedance, dispensing with subsequent equalisation. There is one snag which is seldom mentioned, however, and this is the capacitance versus temperature anomaly of crystal designs. Low frequency correction will be a function of temperature and cartridges thus forced into the velocity mode can exhibit wide differences in performance according to the ambient temperature and humidity.

Magnetic Cartridges

Before discussing other factors that affect the playing of discs, and design of cartridges, we should take a brief look at the alternative types of transducer, the moving coil and variable reluctance cartridges.

These are generally of lower output but much better frequency response, with resonances that affect replay less, and capable of lighter playing weight, which reduces many mechanical drawbacks. They are thus more expensive and better engineered, and within the type there are very wide differences in structure and quality—and price.

Many of the early pick-up cartridges were of the moving-iron type, doing their job quite successfully, almost by the brute force assistance of their weight, which kept the stylus in the groove despite its low compliance. There is as much difference between the modern variable reluctance types and these older versions as between a racehorse and a Suffolk Punch. *Modern pick-ups are capable of tracking at one or two grammes and have compliances of 15 or 20 times 10^{-6} dynes/cm^2.*

Of the modern types the variable reluctance cartridge is currently leading the quality field. There are two main designs the single-ended reed system and the balanced armature cartridge. The basic principle is of an e.m.f. generated by the change in flux through a fixed coil. The magnetic circuit is energised by a magnet in which the reluctance (the magnetic equivalent of electrical resistance) can be varied by displacement of an armature.

The e.m.f. generated is proportional to the number of turns on the coil the magnetic force the area of the polepiece and the velocity of the armature and inversely proportional to the spacing between armature and pole. Armature velocity is governed by the driving force i.e. the movement of the stylus imparted by the varying groove of the rotating disc. But mechanical impedance and the reflected electrical impedance due to normal transducer action also affect the velocity and thus the output. *An improved method of variable reluctance design is the balanced armature configuration.*

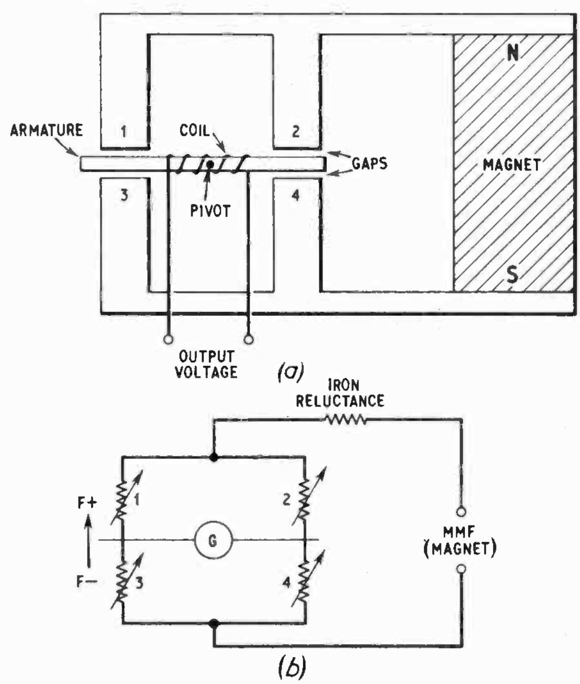

Fig. 3: Sectional diagram of balanced armature transducer, with (b) electrical analogy of the magnetic circuit. This design is widely used for variable reluctance cartridges. F denotes the mechanical force employed to move the armature.

If the armature is symmetrically disposed between four gaps as in Fig. 3 (a) a balanced magnetic bridge is obtained. Less restriction on the armature results. The electrical analogue of the magnetic circuit makes this clear. Figures 4 and 5 are also of interest to the user with the unique Decca cartridge an example of a different approach to the problem of non-linearity inherent in the variable reluctance design.

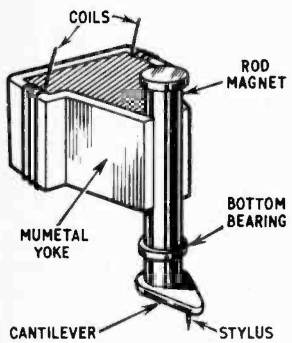

Fig. 4: Simplified diagram of typical moving magnet type of pickup.

With a stereo cartridge two sensing coils are needed the groove walls being cut so that the stylus follows lateral variations for the left channel and vertical variations for the right channel. (This is necessarily a simplification—the actual shaping of the curve is a combination of the two modulations the principle of addition and subtraction of forces being used to sort out the channel separation.) In

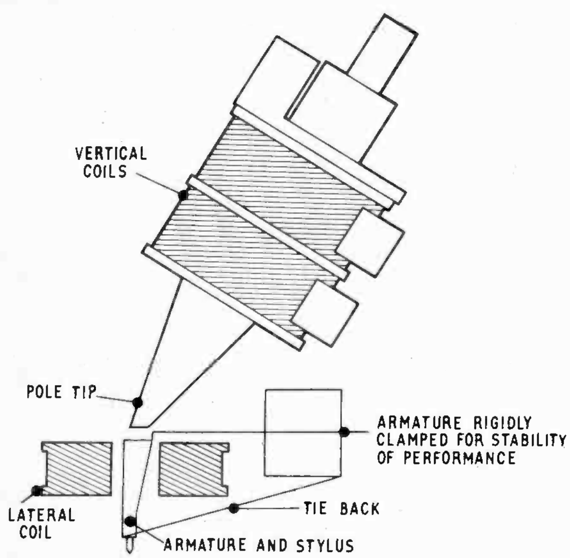

Fig. 5: Principle of the Decca ffss Mk 4 cartridge.

the *ffss* pick-up, the sensing coils are at right angles, one coil being lateral and two coils vertical. Sum and difference voltages are thus produced. An inverted "L" armature is employed, with vertical compliance provided by the flexibility at the top of the "L" and lateral compliance by the freedom of the "L" to pivot. The armature is made of magnetic alloy, with low internal damping. This keeps the resonance of the mechanical circuit below 10c/s, and this is further controlled by the pickup arm design.

Tip mass resonance for the low tip mass of 1mgm is kept high, about 30kc/s, and frequency response is well defined. In the later versions, even this aspect has been considered and damping is applied at the armature clamp. The vertical tracking angle is at the now accepted standard of 15 degrees, which means that the stylus 'prods forward' from the vertical by this angle when seated correctly in the groove and with the arm correctly set. *Arm and head setting is vital for reduction of distortion and protection of records.* More will be said about this in the following section on measurement and testing.

Pick-up Terms

Some of the language of the hi-fi enthusiast needs explanation to those entering the field. In explaining the terms, we may be able to throw some light also upon the reasons for certain parameters.

Compliance we have already noted is the freedom of the stylus to move. The stylus is moved by the shaping of the groove, so a force is exerted upon it. To keep it in the groove, a sufficient *tracking weight* is needed. The two things go hand in hand; the lower the compliance, the greater the tracking weight that will be needed. Similarly, the greater the modulation amplitude (and hence the stylus displacement), the more tracking weight will be needed. For any given set of conditions, there will be an optimum weight. Reducing this arbitrarily can be a mistake, allowing the stylus to "jump" in the groove and causing damage to the groove walls.

Compliance is measured as the distance of movement caused by a force. The unit force is 1 dyne, which is approximately a thousandth of a gram. Distance is measured in millionths of centimetres. So the compliance will be so many times 10^{-6}cm/dyne. For stereo cartridges both vertical and lateral compliance must be stated. The higher the compliance figure, the "better" the cartridge, other things being equal (which, of course, they never are).

Stylus mass or *tip mass* must also be considered. This should not be confused with playing or tracking weight, which may be 1 or 2 grams, or even more. Tip mass should be as low as possible, and will be measured in milligrams. Many makers do not publish this specification, but it matters immensely, and, in the opinion of some authorities, is the most vital single factor in pick-up design.

In general, it can be said that for any given tip mass in milligrammes, the *tracking force* or *playing weight* is a similar figure in grammes. The cartridge cannot be considered alone, and the friction of the arm must also be taken into account, so that the actual playing weight will in many cases be more than this figure.

The three factors already mentioned are governed by manufacturing methods, and for any given set of circumstances, i.e. modulation level, speed, groove disposition at beginning or end of record, etc., these will be slightly modified. The end result will be a compromise. Too great a departure from the optimum will result in groove deformation, and this can happen on the first playing and is irrevocable. *Hence, it is a mistake to lend a disc to someone whose equipment may be set to different playing weight, or whose cartridge has less compliance or pick-up arm more stiffness than one's own.*

At higher than optimum weights, the stylus pressure generates enough heat to temporarily liquify the portion of groove wall over which it passes, and as it cools, the wall takes on a distorted shape, which will always be there. The *elastic limit* of the record material is a fixed amount, and is a factor of playing weight relative to tip size, measured in lbs./sq. in. *The lower the stylus contact area, the lower the tracking force that should be used.*

Dust and cutting swarf that may remain in a groove also complicate matters, and there is the fallacy that some records, which may have inherent distortion, sound better when played with a greater tracking weight. The effect is caused simply by the brute force blanking of transients. Very often, the true answer would be more meticulous care of discs. Many cleaning agents can be used, and even a simple disc preener or swab will prevent much groove deformation, if regularly used.

Frequency response is determined largely by the tip mass. About 10kc/s may be available from a 4 milligram stylus and this response can be doubled with a 1mg stylus. The lower frequency limit is determined by the resonance between the pickup's compliance and the combined mass of cartridge and arm. Other undesirable resonances can occur within the frequency range to upset the "flatness" of the response in badly designed systems. Damping can improve matters and *distributed mass* is a designer's way of reducing unwanted resonances. Compliance, tracking weight, tip mass and the overall damping are taken into account, and the reaction force at the stylus can be measured at various frequencies throughout the range to produce an *impedance curve*, which can often be a bit of an eye-opener.

Temperature can alter tracking weight requirements. In a very cold room a crystal or ceramic cartridge may need greater tracking weight. In some cases, a *decoupled stylus* is used to take advantage of temperature and other relevant changes.

Sensitivity is measured in r.m.s. volts for a certain stylus velocity. Thus, we find specified: XmV/cm/sec. This means that for each centimetre per second of stylus velocity there will be an output of X millivolts, and explains why a cartridge of specifications say 3mV/cm/sec will match a pre-amplifier and fully load it when the sensitivity, say 7·5mV, of the amplifier input is two or three times the basic output of the cartridge.

Normal recorded velocity on discs is taken to be 5cm/sec; so a pickup with 1mV per cm/sec will be expected to give an output and match a pre-amplifier with the sensitivity of 5mV. Output is not the most important criterion. *As a general rule, the better the quality of the pick-up, the less its output voltage.*

Trackability is the degree of correctness with which the stylus can trace out the groove, in exact relation to the cutter which produced it. Cutters are not pivoted like pick-up arms, but move laterally across the disc, keeping the cutting head always at right angles to the groove. The inward motion of the arm should thus lie as nearly as possible along a radial line from edge to centre of disc, with the pick-up mounted so that the stresses due to the rotation are compensated. There are various adjustments that can be made, differing between arm and head makers, as can be seen from the accompanying illustration. In the next part we shall look at some of the important adjustments and methods of checking tracking. In general, the longer the arm, the less the curvative of the pick-up motion and the better the tracking, but this also depends on arm shape, balance, pivot stiffness and several related factors.

Tracking error is affected by the size of the stylus, as is *scanning loss*. This is the loss of high frequencies because of the relationship of stylus size to the actual wavelengths of the recorded sounds. *It is more evident at the centre of the record, where physical wavelengths are smaller. Scanning loss is reduced by the use of stylii with smaller radii.*

Stylus sizes (radii) for microgroove records may be 1 mil. (25μ) mono and $\frac{1}{2}$ mil ($1{\cdot}3\mu$) for stereo. '*Compatible*' stylii designed to replay either mono or stereo with the stereo channels of the cartridge paralleled for mono operation are generally 0·7 mil (18μ). The use of the smaller stylus can help reduce scanning loss and tracing distortion but only if the arm will track at less than about 3 grammes. On older discs and some earlier stereo records *bottoming* may occur with the stylus sitting too deeply in the groove. *This can be avoided to some extent by using bi-radial or elliptical stylii.* These have a major radius of 0·7 to 0·8 mil across the groove with the edges contacting the groove walls having the minor radius of 0·2 to 0·3 mil. Elliptical stylii can help reduce distortion effects due to overmodulation at high frequencies.

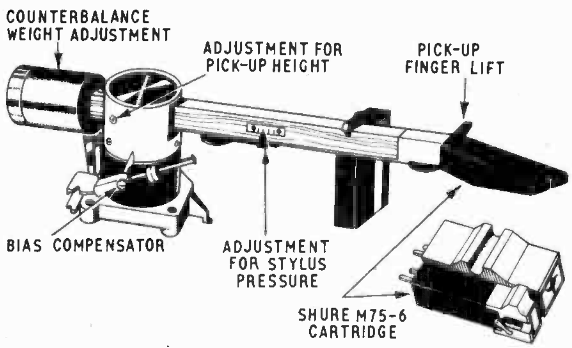

Fig. 6: Various adjustments on pick-up arm can be seen in this view of the popular Lab 80, with the recommended Shure M75 cartridge.

Pinch effect is a form of tracing distortion more noticeable on mono records occurring where the groove walls move in phase. The groove will be narrower in the middle of the sideways travel of the cutter. This presents a narrower groove to a spherical stylus twice every cycle causing it to ride up and down twice for every lateral cycle. *Using a stereo pick-up to replay mono records can produce second harmonic distortion unless the two channels are paralleled to cancel out the vertical motion's effect.*

Needle talk can also result from the unwanted movement of the stylus in the groove. This is the noise of the pick-up playing when the amplifier is

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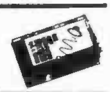

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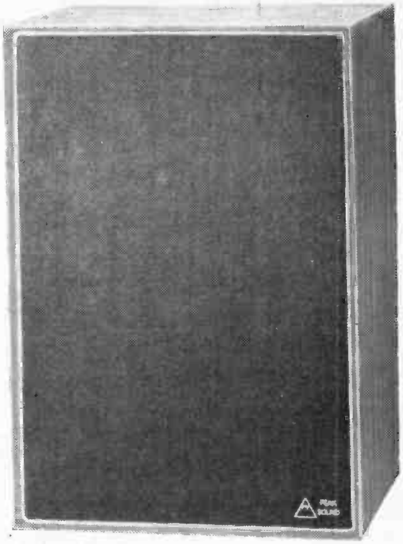

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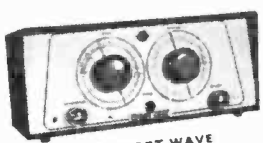

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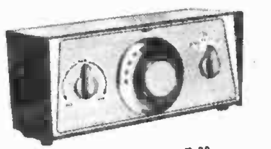

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turned down and can be caused by the reaction of the disc to the movement of the stylus. *Excessive needle talk at high frequencies is generally caused by high tip mass and at low frequencies by low compliance.*

Surface noise can be misleading. With modern vinyl records played at less than 3 gm weight noise due to the frictional effect of the stylus in the groove should certainly be 70dB or so below the normal signal and generally inaudible. Some discs are notoriously 'noisy'. But, less frequently realised and of equal importance, the structure of pick-up arm and playing deck can add much to the relaying and amplification of so-called surface noise. *Thin-walled pick-up arms and lightweight plates add much to the noise problem.* Unwanted resonances complicate matters still further.

Decoupled stylus is a term obtaining more recognition. A flexible member couples the stylus arm to the static parts of the pickup, acting as a kind of shock absorber. By further decoupling the rondel (stylus shank) from the stylus arm, an even lower tip mass can be produced. The problem is to decouple in this way and still avoid the loss of high frequencies, and of stereo separation.

Anti-skating devices are used to compensate for the natural inward pull of the pick-up arm, and take the form of *bias correctors.* More will be said about these in the section devoted to measurement and performance checking. Low pivot friction is needed to counteract stiffness, and this allows the forces exerted on the stylus to become more evident in one direction and to change according to the angle of the arm. Bias correctors thus act to compensate for a changing *side-thrust. A longer arm can reduce side-thrust caused by the 'drag' of the moving disc.*

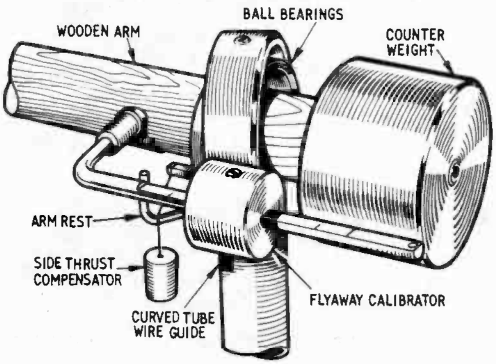

Fig. 7: Pritchard pick-up system employs thread-and-weight compensator device to equalise the pressure on both walls of the groove. Ball and cup bearings in gimbals reduce vertical and lateral friction. Playing weight is adjusted by patented 'flyaway' calibrator.

Rumble can originate in the action of the turntable. It will be reduced by good bearings, a heavy turntable and generally good engineering. But some rumble is inevitable: this does not mean it should be heard. It can be further reduced below audibility by good pickup damping and good arm design, and by the solid mounting of the playing deck so that physical transmission of sound back to the stylus is avoided. Rumble below 30c/s will not normally be heard, and if the lower resonance of the pick-up system can be arranged to be just above this frequency, the falling response below this resonance will help cancel out rumble. But adequate damping is needed to cancel out the resonance, and this is a question of overall design.

Vertical response of the pick-up is most concerned with rumble sensitivity. If the vertical cut-off frequency is higher than the lateral, some improvement can be gained. Moreover, if the vertical inertia of the arm is greater than the lateral inertia, even more protection against rumble is given. Pick-ups often have a vertical to lateral compliance ratio of 1:3, giving a lateral response flat to about 25c/s, a stereo response to about 30c/s and a vertical response that cuts off at about 45c/s.

Loudspeakers

Perhaps the best-known form of transducer is the loudspeaker, and of the various types, the moving coil design is by far the most popular. But this is by no means the only type of loudspeaker design to achieve success. Gilbert Briggs, in his immensely readable book(s) on loudspeakers cites many examples of basic design beginning with the original moving iron and balanced armature types and the horn attached to a telephone earpiece which was surely the earliest attempt at electro-acoustic amplification. Of the types one or two have been passed over lightly, but are beginning to come back into fashion with improvements in materials and development. Among these may be mentioned the electrostatic speaker, the ribbon speaker and the Ionophone design.

Moving-Coil Speakers

Figure 8 shows a cross-sectional view of a typical twin-cone loudspeaker of good quality. Although possessing several special features, it embodies the fundamentals of moving-coil design. The coil is attached to a cone-section diaphragm, and is suspended in the annular gap of a fixed, permanent magnet. Currents through the coil cause flux-cutting of the magnetic lines of force and the cone moves, driving a body of air before it to produce the sound. This is the inverse to the principle of the moving coil microphone, which we studied earlier in this section.

Modern loudspeaker magnets are of ceramic material, with a high flux density. The type illustrated in Fig. 8 has a flux density of 16,500 gauss and a total flux of 185,000 maxwells, using a $1\frac{3}{4}$in. diameter voice coil of aluminium construction (for weight reduction) and a heavy diecast chassis. Handling 20 (British) watts of power, its frequency range is 30-16,000c/s and its fundamental resonance is at 35c/s.

One feature of this design is the plastic suspension of the cone to achieve greater flexibility. There are various points of view about cone suspension and cone stiffness, but in general we must remember that the cone itself should not contribute any distortion due to resonances. Several factors affect performance. Size is the first consideration: all other things being equal, the larger the cone, the better the bass performance. A greater diameter enables a greater mass of air to be moved and more power can be developed. But this depends also upon the cone excursion.

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Shape and angle of cone are other important factors. Circular cones are easier to make than other shapes, but elliptical and (practically) square cones are favoured by many manufacturers.

The elliptical cone is a method of obtaining the largest possible cone area in a given space. The cross-sectional shape may be straight or curved, and the use of straight cones can cause 'break-up' effects if the suspension is not specially designed to guard against this phenomenon. *Cone break-up is caused by low, damped resonances in the cone itself. This produces a rise in output at mid-frequencies.*

A flared cone can reduce this effect, but the production of sub-harmonics is then a danger. Intermodulation distortion can be caused, and again, good suspension design—and enclosure design—is needed to obtain the best results.

The angle of the cone affects directionality. Shallow cones are less directional than deep ones, but are weaker when fully powered at the lower frequencies. Ribs and corrugations in the cone can modify the above characteristics, and various means are favoured by different makers.

The weight of the cone, dependent on the material and its thickness (and rigidity), help determine the fundamental resonance frequency. *The heavier the cone, the lower the resonance, but the lower the efficiency.* Light cones with highly compliant suspension systems can lower the resonance, but voice coil centring is more difficult and cone rigidity harder to achieve. For this reason, materials of greater inherent stiffness (such as light metals) have been used in some designs. These are more common for high frequency units. Great care is needed to avoid peaky responses due to hard cones. As most of the high frequencies are radiated from the cone centre region, a compromise is possible, with the central portion stiff and the outer region softer.

Compliance is important to obtain a low resonance. This can be improved in different ways. Corrugations of the outer edges of the cone, treatment of the outer section of the cone with viscous damping agents and soft surrounds of various materials that have included leather, goatskin, velvet and expanded polyurethane foam, are all methods of obtaining low cone resonance.

As important as the cone and its suspension is the way it is enclosed. Cabinet design is a subject too large for the terms of reference of this supplement, but a few words on general principles may be appropriate. In particular, it should be remembered that the cabinet—more properly, the enclosure—should not of itself contribute to the distortion level, but must nevertheless be considered with the loudspeaker unit as a combined radiator of sound.

The criterion for one popular design was undoubtedly reduction of size for the same frequency coverage and power output as a larger unit could produce. To this end a light and rigid metal diaphragm of only 4in. diameter was employed, but with special suspension and speech coil to magnet relationship that enabled the maker to form a module capable of reproducing a claimed 20 to 20,000 c/s at low distortion, with power distribution afforded by combining the modules. Each unit handles 12W r.m.s.

Quite simple cabinets were recommended by the makers, with a single rectangular opening in the front and a port and tunnel arrangement on the inside surface. Lining of the cabinet requires complete acoustic filling. The material recommended for this model is bonded acetate fibre. Not all designs use the same filling, and care must be taken when fitting pads and filters that the right materials are chosen. Joints of the cabinet are made airtight, screwed and glued, with foam plastic sealing between the module and the top of the tunnel. A further example of acoustic wadding is given in Fig. 9, where pads of fibrous material are hung vertically in the space behind the speaker unit.

Resin-bonded Fibreglass is used by several authorities for sound absorption. The principle behind absorbents is that sound from the radiator should be allowed only in a forward direction, but it must be free to travel, so acoustically "dead" material is needed in an enclosed space to prevent the sound waves "bouncing around" the cabinet. When they are free to do this, standing waves are built up, the resonances due to the cabinet shape give enhanced sound at some frequencies and act as deadeners to others and completely upset the frequency response of the system. Moreover, the effect of the sound wave reflected from the cabinet inside to the cone of the speaker is to damp the piston action and reduce overall power. *Cabinet design is an advanced study: wherever possible, recognised designs should be followed, cabinet and loudspeaker unit being considered as a whole.*

Baffles are the plates on which loudspeaker units are mounted. They must be flat and rigid, and the material has to be chosen to have least effect on

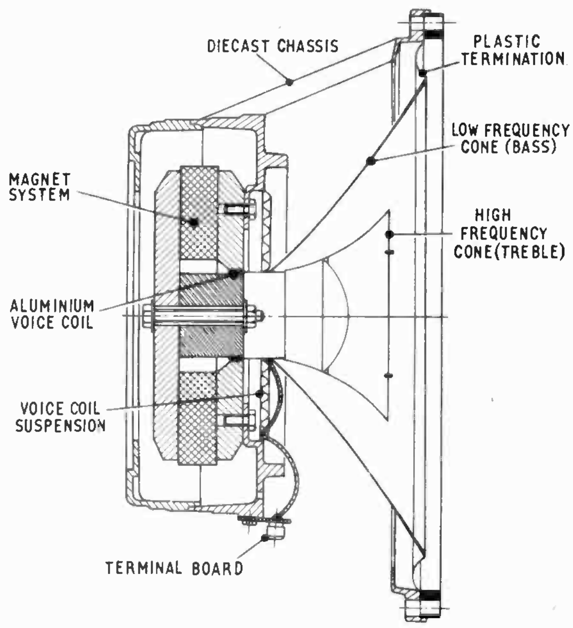


Fig. 8: Cross-section of 12-inch version of the widely used Goodman Axiom loudspeaker (twin-cone, single-unt).

the sound. Wood is still reckoned to be the best material, despite experiments with many others, including, marble, aluminium and slate. For optimum results with a given weight and cost, two sheets of plywood with sand between are recommended by a leading maker.

This is for a flat baffle, whose response tests show a fall of 6dB per octave at frequencies below the critical point determined by size. To reproduce C_3, for example, the bottom C on the piano keyboard, whose frequency is 32·7c/s and wavelength 35ft., the minimum diameter baffle suspended in free air would have to be 17 feet—rather large for the living room *Mounting a loudspeaker unit in the wall of a room is one way of achieving a near infinite baffle.*

So-called infinite baffle enclosures make use of a slightly different principle. By totally enclosing the loudspeaker, making the box airtight, and filling it with wadding, all back radiation is prevented and in theory all the radiation of sound comes from the front. But there are various parameters to be considered; cone mass, suspension stiffness, unit compliance, radiation resistance and air load reactance all modify the theory.

Surprisingly good results can be obtained from 'shoe-box' sized loudspeaker enclosures built on the infinite baffle principle. More power is needed to drive these units, and bass cut-off is generally higher than with a larger reflex cabinet, or alternative "open" design. However, where the overall system has deficiencies in the lower frequency region, this can be a good thing!

High frequency speakers, or tweeters, are directional and handle less power, so can be much smaller and of rigid construction. When added to a bass unit with a properly designed crossover unit, a good frequency coverage can be produced. The bass unit is relieved of the necessity of handling the rapid excursions of the high frequencies and less cone "break-up" will be encountered.

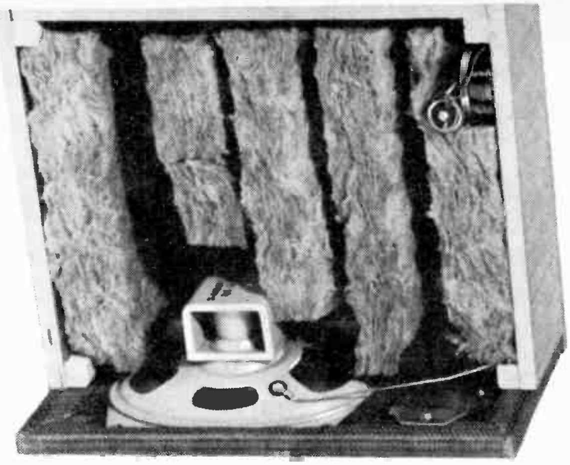


Fig. 9: Cabinet resonances are reduced (in theory, eliminated!) by inserts of special acoustic wadding in the sealed cabinet, as shown.

A tweeter will be added to an existing system in several different ways, as shown in Fig. 10. The simplest method, (a) is a high-pass filter, giving a crossover at 3-5kc/s. The capacitor should be a good paper type, but electrolytics can be used after being "d.c. aged". This is done by applying a voltage of about a quarter to a fifth the rated d.c. working voltage, first in one direction, then the other, to stabilise the electrolyte. But when modern metallised capacitors are available so cheaply, this hardly seems worth while.

Additional types of loudspeaker of great popularity, but higher cost, include the "tweeter with no moving parts", based on the original Ionophone. An r.f. oscillator ionises a column of air which is modulated by the sound and produced via a horn. Very clean "top" is possible when this unit is properly matched.

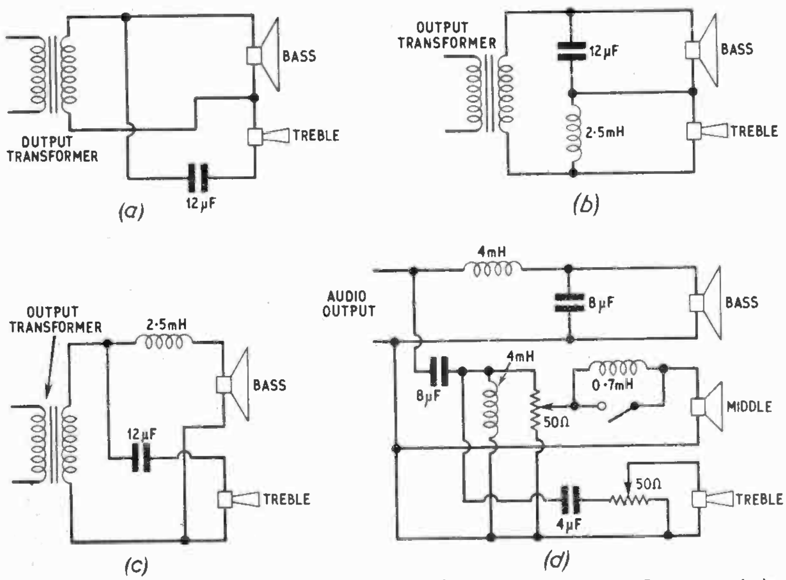


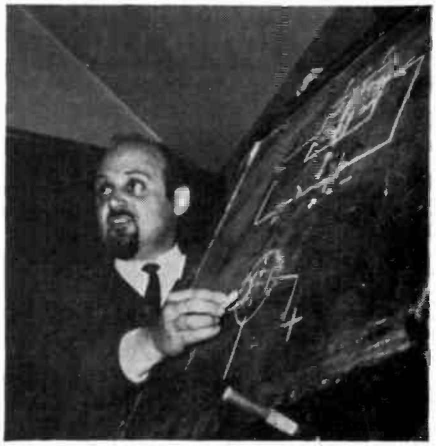
Fig. 10: Adding a tweeter. (a) simplest method, a series capacitor (15 ohms units); (b) Quarter-section series network for economy; (c) Quarter-section parallel network permits partial matching of disparate impedance units. (d) Half-section, three-speaker network, with crossover frequencies 800 and 5,000c/s, using volume controls and switch for 2 or 3-way operation.

The electrostatic loudspeaker has long been the pet of one leading company, and is capable of remarkably good wide-range reproduction. It is often difficult to match, especially to a transistorised amplifier, but well repays the extra trouble taken, and the slightly higher cost.

NEXT MONTH — SERVICING, TEST EQUIPMENT, WORKSHOP PRACTICE

CLUB SPOT

No. 21 Redbridge AMATEUR RADIO SOCIETY



SOMEONE said something to the effect that great oak trees grow from little acorns which is a pretty good description of how the Redbridge Amateur Radio Society have progressed.

In July 1967 four radio "acorns" met—G3JHY, G3JTS, G3ODS and an s.w.l. called Bill. News, like r.f., travels fast, and by the following month the number had risen to eight. The increase in membership continued but unfortunately as the membership swelled, the size of G3JTS's living room remained constant and it was decided that a larger premises was a dire need if the meetings were to continue.

After many reconnaissance delegations had prowled the district and returned empty-handed, G3ODS managed to locate a suitable room in a local church premises at a nominal rental, and the Redbridge Amateur Radio Society had found a home. The rental for the room is recouped by prising a "bob" from each member's purse as he enters the door. There are no trading stamps, but the shilling so invested does entitle the donor to a cup of tea and biscuits at half-time. If you happen to be under sixteen, it only costs sixpence.

Meetings have continued at this QTH ever since and take place on the first and third Mondays of each month except Bank Holidays. Topics vary from the time-honoured ragchews to demonstrations, lectures, junk sales and open discussions etc. The club hopes to be able to install some gear including transmitting equipment in due course so that licensed members can operate from the club while s.w.l.'s can see for themselves just how it's done.

Short wave listeners and beginners are very welcome at Redbridge, in fact quite a large number are in regular attendance. Every encouragement is given to those wanting to get an amateur licence. On Thursday evenings, chirps and tweets can be heard emanating from the QTH of G3JTS. This is a regular morse practice session and, at the time of writing, there are eight keen types in attendance. G3JTS calls a halt for a cuppa around 2050-2100hrs (clock time) and then it's heads down again for more c.w. practice.

Anyone interested in radio, whether licensed or not, is very welcome at Redbridge. The club is also very pleased to welcome visitors. It doesn't matter what you do for a living, who you are or what knowledge you might or might not possess, the only qualification to join the club is an interest in radio. The club has purposely fixed its meeting nights in order not to clash with other local groups at Chadwell Heath and East Ham.

Meetings are held at the Presbyterian Church, corner of Oakfield and Albert Road, Ilford, Essex (near Ilford Town Hall). Anyone is welcome on Club nights, or you can contact Bob (G3JHY) at 70 Kensington Avenue, Manor Park, E12, for further particulars.

By-the-way, "Not knowing much about radio" or "being a beginner" are not accepted as being a good enough excuse for *not* joining the club, so how about looking us up? Anyway, where else could you get such a lovely cuppa and biscuits for a bob?

Photographs. *Top:* G3JTS hands round the sugar bowl while G3JHY (right) stirs. *Centre:* Ken Smith, G3JIX, explains away some of the mysteries of how transistors work. *Bottom:* Some of the gang getting their bob's worth.

ON THE SHORT WAVES

MONTHLY NEWS FOR DX LISTENERS

Times GMT
Frequencies in k

THE BROADCAST BANDS by CHRISTOPHER DANPURE

THE month of October besides being the last month of the Spring/Autumn schedules is also a month when great changes occur in propagation conditions. During September there was not much change in these propagation conditions, but when October starts you will find the higher frequency bands will close considerably earlier than in September and open much later, and stations over short distances will start to skip greater distances earlier in the evening. Generally there will not be much difference between the October and November propagation conditions. On November 3 stations will change over to their Winter/Summer schedules, so the information in this column will be liable to change on that date. Now onto this month's propagation predictions.

West Africa: 0800–1400 25, 21, 17 and 15Mc/s; 1400–1600 25, 21, 17, 15 and 11Mc/s; 1600–1800 25, 21, 17, 15, 11 and 9Mc/s; 1800–2000 21, 17, 15, 11, 9, 7, 6 and 5Mc/s; 2000–0200 17, 15, 11, 9, 7, 6, 5 and 4Mc/s; 0200–0600 15, 11, 9, 7, 6, 5, 4 and 3Mc/s; 0600–0800 15, 11, 9 and 7Mc/s.

South Africa: 0800–1400 25, 21 and 17Mc/s; 1400–1600 25, 21, 17 and 15Mc/s; 1600–1800 25, 21, 17, 15 and 11Mc/s; 1800–2000 21, 17, 15, 11, 9, 7 and 6Mc/s; 2000–0200 17, 15, 11, 9, 7, 6 and 5Mc/s; 0200–0400 15, 11, 9, 7 and 6Mc/s; 0400–0600 15, 11, 9 and 7Mc/s; 0600–0800 21, 17, 15 and 11Mc/s.

East Africa: 0800–1400 25, 21, 17 and 15Mc/s; 1400–1600 25, 21, 17, 15, 11 and 9Mc/s; 1600–1800 25, 21, 17, 15, 11, 9 and 7Mc/s; 1800–2400 17, 15, 11, 9, 7, 6 and 5Mc/s; 2400–0200 15, 11, 9, 7, 6 and 5Mc/s; 0200–0400 11, 9, 7 and 6Mc/s; 0400–0600 11 and 9Mc/s; 0600–0800 25, 21, 17, 15 and 11Mc/s.

South Asia: 0800–1200 25, 21, 17 and 15Mc/s; 1200–1400 25, 21, 17, 15 and 11Mc/s; 1400–1600 21, 17, 15, 11, 9, 7 and 6Mc/s; 1600–1800 17, 15, 11, 9, 7, 6, 5 and 4Mc/s; 1800–2000 15, 11, 9, 7, 6, 5 and 4Mc/s; 2000–0200 11, 9, 7, 6, 5 and 4Mc/s; 0200–0400 11, 9, 7 and 6Mc/s; 0400–0600 11 and 9Mc/s; 0600–0800 25, 21, 17, 15 and 11Mc/s.

South East Asia: 0600–1000 25, 21 and 17Mc/s; 1000–1200 25, 21, 17 and 15Mc/s; 1200–1400 25, 21, 17, 15 and 11Mc/s; 1400–1600 25, 21, 17, 15, 11, 9 and 7Mc/s; 1600–1800 17, 15, 11, 9, 7, 6 and 5Mc/s; 1800–2000 15, 11, 9, 7, 6 and 5Mc/s; 2000–2200 11, 9, 7, 6 and 5Mc/s; 2200–2400 11, 9 and 7Mc/s; 2400–0200 11 and 9Mc/s; 0200–0500 11Mc/s only; 0500–0600 21, 17 and 15Mc/s.

North East Asia: 0800–1200 25, 21, 17 and 15Mc/s; 1200–1400 17, 15 and 11Mc/s; 1400–2400 11 and 9Mc/s; 2400–0600 11Mc/s only.

Australia via Asia: 0500–1000 25 and 21Mc/s; 1000–1200 21, 17 and 15Mc/s; 1200–1400 21, 17, 15, 11 and 9Mc/s; 1400–1800 17, 15, 11, 9, 7 and 6Mc/s; 1800–2000 15, 11, 9, 7 and 6Mc/s; 2000–2200 11 and 9Mc/s; 2200–2400 11Mc/s only; 2400–0500 Circuit closed.

AFRICA

South Africa: *R. R.S.A.* Johannesburg is now using for its Afrikaans Service on Sundays from 0756–0950 25,790, 21,535, 15,220 and 11,900. English to New Zealand from 0956–1050 is on 21,535, 17,805 and 15,220. English to Africa from 1056–1150 is now on 25,790, 21,535, 15,220 and 11,900. English to Australia from 1156–1250 is now on 21,535, 17,805 and 15,220. English Broadcast to Africa then run from 1256–1450 on 25,790, 21,535, 15,220 and 11,900, 1600–1650 on 11,900 and 9,525, 1700–1750 on 21,535 and 17,805, 1800–1850 on 21,535 and 17,805, to West Africa from 2100–2150 on 21,535 and 17,805. The North American Service from 2326–0320 is now on 15,220, 11,875 and 9,705.

ASIA

Dem. Rep. Vietnam: *The Voice of Vietnam*, Hanoi has now a Daily English Broadcast from 2000–2030 on 7,416, 10,224 and 15,018, beamed to Asia, Africa and Europe.

NORTH AMERICA

U.S.A.: According to information received by Mr. C. Pearson the *AFRTS* is now on the following schedule:

New York Service from 1330–2300 on 15,430, 1330–1630; on 21,600, 1630–2300 on 21,605—all beamed to Europe. A 24-hour service is beamed to the Carribean area from 0600–1200 on 9,755 and 1200–0615 on 15,330. The West Coast Service from Los Angeles is now from 2130–0400 on 21,500; 2130–0730 on 17,765; 0300–0800 on 15,410; 0600–1630 on 11,805; 0800–1630 on 9,700. Relay from Poro, Philippines to S.E. Asia 0645–1030 on 15,250.

EUROPE

Sweden: *Radio Sweden* is now on the following schedule until Nov. 3, 0445–0615 on 17,840; 0630–0715 on 6,065; 0830–0900 on 17,800 and 11,765; 0930–1030 on 21,690 and 9,625; 1030–1100 on 9,625; 1100–1215 on 15,315 and 9,625; 1230–1330 on 21,690 and 15,420; 1400–1530 on 21,585 and 17,840; 1600–1700 on 21,585 and 15,310; 1730–1800 on 15,240 and 6,065; 1800–1830 on 15,240;1830–1930 on 15,240 and 11,705; 1945–2015 on 6,065; 2015–2115 on 11,915 and 6,065; 2130–2230 on 11,705 and 6,065; 2245–2345 on 11,705 and 11,790; 2400–0230 on 11,805 and 11,705; 0300–0430 on 11,705. English is heard for 30 minutes at 0515, 1100, 1230, 1400, 1600, 1900, 2045, 2245, at 0030 and 0200 on 11,805 only, and at 0300. There is also a Medium Wave English Service Daily at 2245–2315 on 1,178, extended on Saturday night until 2430.

That's all for this month, deadline this month for all news is the 15th, so good listening and 73's.

GUESS what your Uncle David got this month. Two logs for forty metres and one for four metres—yes, 70Mc/s. So there is life in human form up there after all. Sad news for those who thought the world ended at 30Mc/s.

A fantastic pile of letters this month, so many that the local postman is claiming from me for his hernia! Let's start off with the comments and remarks of interest. The case of Jan Meyen Island and its prefix still rages. JX is Jan Meyen says **K. Haywood** (Lancs.) but what's NU3FYS? (The wittiest remark received will be rewarded with a dud OC71). Yes, JX is the Jan Meyen prefix warbles **S. Pitt** (Essex). Definitely, reckons **C. Morgan** (Northumberland). No, JX is the Svalbard Archipeligo JW is Jan Meyen says **R. Sherwin.** (Oh Gawd, I wish I'd never mentioned the business). **C. Morgan** queries LG5LG claiming to be—no never mind let's sort Jan Meyen out first.

Looking round the six bands generally they all seem in pretty good shape except 10 metres which stays pretty quiet at all QTH's. Fred, GC3SVK/P, was logged on topband by quite a number of listeners but some said that he was still in Guernsey and not Jersey on the 7th. Shame on you Fred, what was her name?

Twenty metres offered some very good DX and remained open for quite long consistent periods. Oceana came through most mornings around 0600 while South America peaked up in the late evenings about 2200. Fifteen appeared very good at times but patchy. Certainly there was no shortage of African and S. Americans.

FOUR & FORTY

"Thanks for your mention of the four metre contest" says **J. Ashworth** (Lancs.). He has a converted R1132A with crossed dipoles (NS and EW) at 30ft. He logged 126 stations which included E12W (20W to a 4ele), G3JIJ/P (100mW from Ingleborough Hill Summit, Yorks.), G3RLE/P (100mW from Pen-y-ghent summit, Yorks.), GW3ERB/P (15W, Halkyn Mountain, 950ft. a.s.l.), GW3ITZ/P (5 miles S.E. of Flint), GW3NUE/P (Pen-y-gaderfawl, 2,600ft. a.s.l.), GW3OXD/P (Radnor). John says that the main spots of four metre activity seem to be Southport, Liverpool, and Wirral.

F. McVerry (Lanarkshire), R1155, 75ft. long wire at 20ft. running NS sends in a FB log for 7Mc/s—CM2DC, CO3NR, CN8AW, CR6JW, CT2AP, EA6BG, EA8FF, FØKC, GB3SH, GC3GS, HBØAAI, IT1KAT, JX2BH (no comment), K7WWR, KL7FLG/P/3, LJ2X, LU2DGO, LX1SL, OK8AAA, OX3DX, OY2H, OY5NS, PI1NTB, PY6HL, PZ1CF, TA2RX, TF3OM, UL7QO, VE1AMB, VE3OE, VK7SM, W1BWN, W5OVR, W9AQW, YV1AP, ZC4RB, ZD9BE, ZS1JA, ZP3AB, 3V8AA, 4X4WN, 5N2AAX, 6W8AL, 9Y4KR.

Francis tells of G3SWZ working some 30 countries on 7Mc/s with his 1½ watt rig. Vy FB indeed.

Martin Pasek (Notts.) QP166 into an HRO, "40 metres X beam made of wire" (Cor)—LU9DM, PZ1AX, SMØKN/Ø, VK2ABZ, VK2AYC/M, VK3AC, W2RFS, YU2AKL, ZL2BCG. Martin says that ZL2BCG is also on eighty s.s.b. around 0600 and then QSY's to 7.097 ±3kc/s at 0615. The VK's peak around 0730.

FIFTEEN

J. Baker (Lancs.) PCR3, 60ft. long wire at 18ft. running NW/SE—CE3FI, CN8BV, CO8RA, CP6EL, CR4BH, CR6LL, CR7IC, CT2AC, EA6BC, EA8FF, ET3REL, FM7WE, HC2LM, HI3AGS, HK1NR, HP4BIW, HR1KS, JA1IJH, JA2IIK, JA6DZA, KG4AM, KP4AOW, KV4FC, LU2AHI, OA5AM, OD5EP, PY2DPG, PY7OS, PZ1BX, SV1CD, TJ1AL, TU2BQ, VE2BAG, YV3FB, ZC4MO, ZD8Z, ZE2KL, ZS1BV, ZS5BK, ZS6IN, 3V8AA, 4X4ZL, 4Z4HG, 5A4TH, 5N2AAF, 5W1AS, 5Z4LG, 6W8AL, 7Q7BM, 8P6BC, 9G1FL, 9G1GD, 9H1K, 9K2CC, 9M2PO, 9Q5LC, 9Y4CR, 9X5LR.

P. Starling (Essex) HRO, 30ft. of wire at 15ft.—CR6DP, EL4C, EP3MAM, ET3REL, JT1GF, KØBSZ, K1GUD, OD5BZ, PY5EC, ZC4GM, 4X4BL, 4Z4HO, 5A1TG, 5A3TX, 5A4TH, 5Z4LG, 9H1BG, 9K2CB, 9K2CC.

TWENTY

C. Morgan (Northumberland), CR150/2, 25ft. vertical, s.s.b.—AP2MR, DU1DBT, HC4PS, HP1LV, JH1DHQ/MM, K5ZSX/AM, K8LSB/P/KG6, KA2NA KH6BX, KL7EZM, KR6EB, KV4DB, PJ3CC, PY1BOY, PZ1AC, VK2ALR, VK5XV, VK6NM, VK7DK, VK9XI (Christmas Island), VP7NP, VP8HZ, VQ8CG, VR6TC, VS6DR, VU2DKZ, W4UAF/P/KH6, W7DLF, WA2FWQ/MM, WA6GZZ/AM, XE1KV, YN1GLB, ZL3UY, ZS5DC, 4Z4HF, 5H3KJ, 8P6AU, 9M2BK, 9N1MM, 9V1NR.

H. Norman (Suffolk), modified Vidor CN385, 45ft. end fed with an a.t.u. (sensible chap)—CE3BE, OA4TN, OX4WN, PJ9AQ, PY3GV, SK4AZ, VE1ASJ, VE3NL, VE6AQL, VK1RB, VK2SU, VK3VK, VQ8BCI, XE8UBL, YV5CNQ, ZP3BW, 4X4DL, 5A2EF, 5Z4KL, 9G1GD.

G. Kelly (Liverpool), R107, 35ft. vertical—all s.s.b.—CE1IU, CP1AP, CN8MT, CR6CA, CR6CA, CR7CH, CT2NAA, CX9AN, DU1HR, EL2AS, HC4WN, HC5MP, HI3ELJ, HP1QH, HR6EB/P/2, HS3MJ, JA1AE, JX1OM (snigger), JX3DH9 (titter), K1FNA/P/KG6, KL7AHB, KR6NR, LU2CF, LU8PM, MP4TCE, OA4BS, OX5AY, PX1YY, PY1TX, SVØWGG, TI2LJ, TU2BQ, VE8RCS (Weather Station on Ellesmere Is.), VE8ML, WB4IRT/AM, YE1DAN, YV4IIQ, ZB2AY, ZD8CC, ZP5CF, 9Y4VT, 806AH, 7X2ED.

R. Street (Surrey) 6-valve s'het, 5RV at 10ft.—CO2FA, CP4DA, EL2Z, FO8BY, HS3ZZ, JX1OM, K7DSB/P/KH6, VP2IA, VS6DR, YA1AP, YK1AM, ZP5JB, 4A2IH, 5U7AL, 8P6BX.

I. Stevenson (no address), GC-1U, 50ft. end fed—CT1MW, FØMI/FC/M, HBØLL, HV3SJ, K6UJW, PY7AOA, PX1UB, VE2WY, VK2SG, VK3ABE, VK4KS, WA6EWI, WN6OIV, W6CCB, W7LFA, YV5BDA, ZL3QM, ZL4BX.

CONTESTS

There's a few contests about in October; 5–6, 70cms contest; 12–13, ten metre phone contest, how about listening? 12–13, 1,296Mc/s contest; 19–20, Jamboree on the air; 26–27, 40 metre c.w. contest. Deadline for logs is 14th of this month, good listening.

PYRAMID
ALL PURPOSE SYSTEM
By F. G. RAYER

PART 3—CRYSTAL DIODE TUNER and TRANSISTOR MORSE OSCILLATOR

THE tuner is an exceedingly simple unit, giving medium and long wave coverage. With such a tuner, results depend largely on local conditions, distances to stations, and the aerial. Usually, two or more BBC stations can be expected with an indoor aerial and earth, or an outdoor aerial without earth. Volume is greatly increased by employing a fairly good outdoor aerial and earth.

If the tuner is used with the "Pyramid" amplifier, very good volume can be obtained. Such a tuner is not intended for long distance reception, or in circumstances where the single tuned circuit does not give enough selectivity. The tuner may be used with other amplifiers, or as a crystal radio, operating headphones. A reasonably effective aerial and earth will then be needed.

Construction

Figure 1 is the circuit of the tuner. The tuned windings are on a 4 x ⅜in. diameter ferrite rod, as this allows an efficient coil to be made with minimum difficulty. The medium wave section, from A to C, has 55 turns of 28 s.w.g. double cotton covered wire, about ⅜in. from one end of the rod, and wound in a pile to occupy about ½in. The aerial tapping B is 15 turns from C. The long wave section, between points D and E, has 140 turns of 32 s.w.g. silk covered wire, and occupies a pile about ⅜in. long, 2in. away from the medium wave section. The windings are connected at C and D so that all turns throughout (that is, from A to E) are in the same direction. Other wire gauges could be used, or a ready-made coil for medium waves, or medium and long waves might be selected.

The parts are assembled in a plastic box about 4½ x 4½in., Fig. 2. Holes should be drilled with care, as the material may be brittle. For this reason, large holes for switch and variable capacitor are best made by drilling a ring of small holes.

A co-axial lead takes output to the amplifier, the outer part of the plug and outer screening forming the earth return circuit. For headphone reception as a crystal set, two further terminals could be fitted instead—one connected to earth, and the other to the diode. Medium or high impedance phones (500 to 4,000Ω) are most suitable.

Aerial

Though used remote from any BBC station, it was found that a 15ft. indoor aerial gave enough volume, when an earth was added. An insulated wire can be stretched along one or two walls of a room, near the ceiling. Extremely short or poor aerials can be connected directly to point A.

Outdoor aerials are erected in the usual way, and

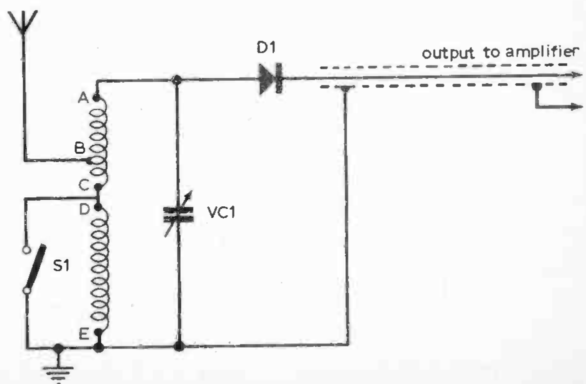


Fig 1: Circuit of the crystal diode tuner.

may be some 20 to 50ft. or so of 7/26 or other aerial wire, according to circumstances. An outdoor aerial may be required if the tuner is used with an amplifier having less high gain than the one described.

Medium wave coverage is obtained with the switch closed or "on" and long waves with it open or "off". With long aerials, tuning may be made more selective by including a small capacitor in the lead to the aerial terminal.

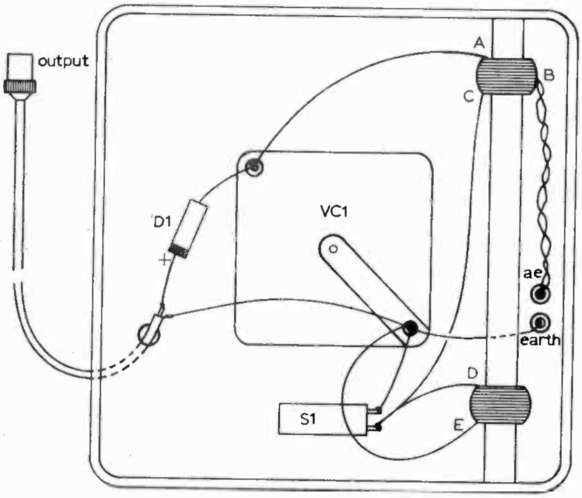


Fig. 2: Construction and wiring details of the crystal diode tuner.

★ components list

DIODE TUNER

500pF variable capacitor; knob; on/off switch; OA81 or other diode; 4 x ⅜in. ferrite rod; 28 s.w.g. and 32 s.w.g. wire; two terminals; plastic box; screened or co-axial lead and plug.

Transistor Morse Oscillator

This is a single transistor oscillator producing an audio tone for Morse code practice. It is intended to plug directly into the "Pyramid" amplifier for loudspeaker output. It could be used with other amplifiers, or by itself with headphones.

Figure 3 is the circuit, and a small driver type receiver transformer is employed for feedback, one connection of the tapped secondary being unused. Should a different transformer be fitted, connections to one winding may have to be reversed, to obtain oscillation.

Since the amplifier mentioned has high gain, output is taken from the oscillator emitter, Fig. 3. For headphones, or amplifiers requiring more input, the audio signal can be taken from the collector, through a 0·1μF or similar capacitor, as in Fig. 3. The amplifier is returned to the positive line of the oscillator with the equipment described, this connection is made by the outer part of the co-axial plug.

Construction

The parts are assembled on a small paxolin panel, Fig. 4. Dimensions could be changed to suit a small plastic box or case to hand. Components occupy one side of the panel, and wiring is carried out on the reverse. Two flexible leads run from the points shown, and are taken to the key terminals. Connections to the amplifier can be by co-axial screened lead, or twin flex. The oscillator emitter goes to the amplifier audio gain control, the co-axial inner conductor being used for this purpose.

As a 1·5V supply was found most suitable, and current required is very small, a single dry cell is soldered directly in place. The zinc case is negative. No switch is present because current is only drawn when the key is closed. All transistors tried worked satisfactorily, including cheap surplus audio types.

Audio Tone

It is only necessary to plug in as described, and adjust volume with the amplifier control. Adequate volume, according to circumstances, will result in an amplifier battery drain of about 15 to 25mA (key down). It is as well not to have volume so great that current exceeds 50 to 60mA.

If a different transformer is fitted, and the audio tone needs to be changed, the effect of using a different battery voltage can be tried. The transistor or resistor values can be changed, or a capacitor placed across one transformer winding, to reduce the frequency. These would be a matter for experiment.

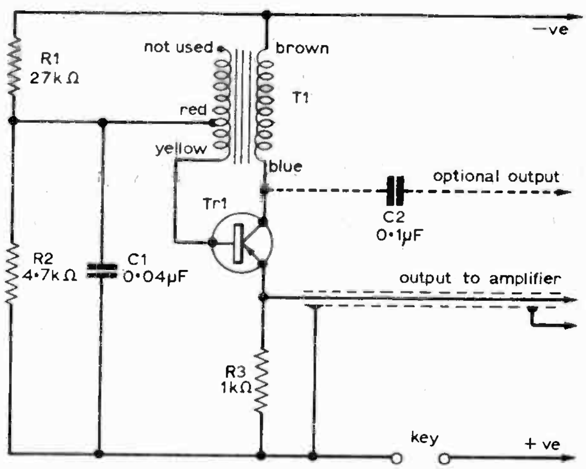


Fig. 3: Morse oscillator circuit.

Notes on Use

The audio oscillator can be used to monitor outgoing c.w. transmissions by deriving its operating current from a diode and r.f. pick-up loop. It may provide a signal in phones, or may be used with the amplifier for speaker reproduction. Either method allows a check on keying.

The "key" leads are joined together, and the battery removed. Current is then obtained from the loop and diode in Fig. 5, which is connected in place of the cell. A pick-up coil having five or six turns, 1 to 2in. in diameter, should prove satisfactory. This can be modified, if necessary, to suit the transmitter

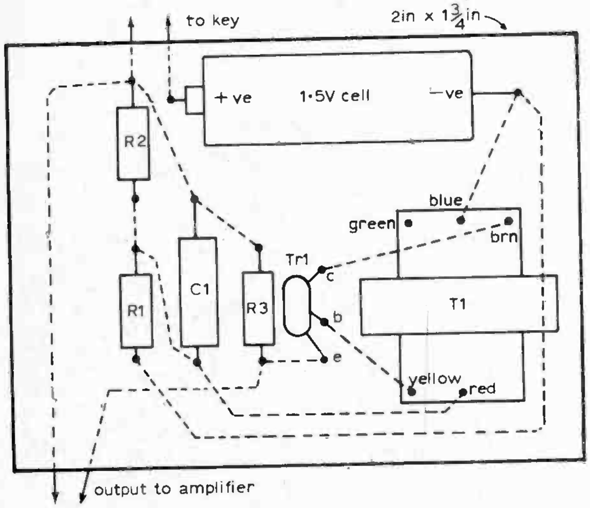


Fig. 4: Oscillator wiring and layout.

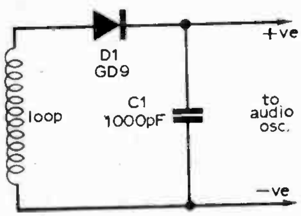


Fig. 5 (left): Loop and diode for c.w. monitoring.

power, etc. The amplifier should be switched on, and the loop approached to the transmitter tank coil or aerial tuner, until a suitable audio tone results when the transmitter is keyed. Avoid taking the loop too near the source of r.f. energy.

Not only may this damage the diode D1, but direct contact with the tank coil could be disastrous.

★ components list

MORSE OSCILLATOR

Paxolin 2 x 2¾in; audio transistor; ¼ watt resistors—1kΩ, 4·7kΩ, 27kΩ; 0·04μF capacitor; QXD1 transformer (Osmor); 1½V dry cell; screened or co-axial lead with plug.

TO BE CONTINUED

CORRIGENDA

PYRAMID—ALL PURPOSE SYSTEM
SEPTEMBER ISSUE

In Figure 1, Tr4 was drawn incorrectly. The emitter should go to R14 and the collector to the junction of R15/T2. R1 in the components list should read 2·7kΩ.

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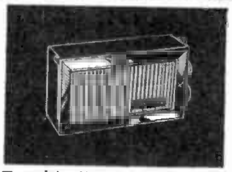

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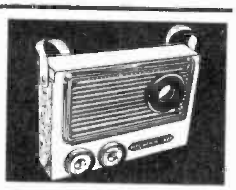

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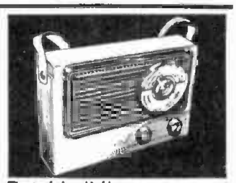

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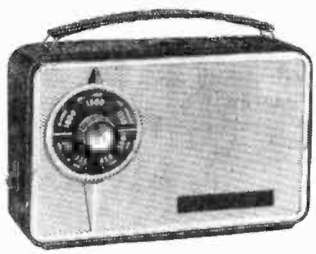
NEW LOOK melody six

TWO WAVEBAND PORTABLE



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No. 50

To the Point

HAVING trouble with your new decimal coinage? Wondering how may sides make seven? You don't know your luck, lads. To radio enthusiasts, the change from archaic, rule-of-thumb measurement to our modern, swinging, polished, simply-divisible, etc., etc., should come easy. We have been dealing in multiples and divisions of ten for longer than de Gaulle has been a General.

Working them out can be fun

It was not so long ago that I learned about the origins of Arabic numerals—those squiggly symbols on your Bingo card. Ever ready to widen the cultural interests of my readers I pass on the information that the shapes of the originals dreamed up by a great Algerian mathematician each contained the number of angles relevant to the numeral—if you drew it properly. We have now stylised them out of any semblance to the first idea but working them out can be quite fun.

Have you ever thought of the cogitation that must have gone into our component colour code? Imagine a committee sitting around a polished table, perspiration laving their bald pates, battling over the redness of two or the royal blue impeccability of six. Come to think of it they did not do a bad job. I mean black is indisputably "zero" and "one" has a brown dinginess about it, the magical number seven has an emperor's aura just as three must be orange; couldn't be anything else.

Our active P.A.L. protagonist Bernard Rogers of the Rank-Bush-Murphy research establishment has described the multilingual vote-chopping that went on while colour-TV systems were being chosen. According to him we in Britain are lucky to have settled on a system at all. Perhaps it is as well that the colour-code was already settled before colour-scales had to be agreed. (Although to be honest one wonders whether there is any real standard when one sees sets of rival manufacture receiving the same programme side by side—in a colour-TV workshop where setting-up has been done with meticulous care.

The chap in his parlour with no comparisons to make except the clash of Lulu's rosiness with the missus' choice in upholstery may not hit on this hue-change problem very quickly. But when the novelty has worn off look out for: *"Let reds down a bit—whoa! now a touch of yellow in the greens,"* etc. Every television engineer will have to carry his illuminated colour-scale in the lid of his toolbox.

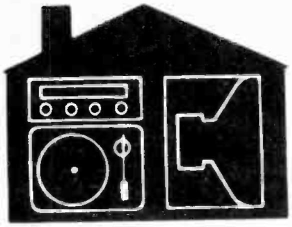
Of course the drawback is in those little qualifications "to international standards". There *are* no such animals. When in Rome the yellows and magentas look a good deal different from Aunt Harriet's puce and poppy at Scarborough. Blue skies over the Côte d'Azur would seem too dramatic for Streatham.

And in any case it is doubtful whether international standards would be gladly accepted by all. Just consider the recent hullabaloo at the Royal Society, when the Conference of Editors called for the adoption of SI in all scientific and technical journals. SI—Système International d'Unites—is a system of refinement of the original metric figuring officially adopted in 1960 and the legally accepted system in thirty countries. Britain is still testing the water—she has so much to lose. All those lovely avoirdupois units, and the Imperial measurements being

Stand on our heads again

consigned to a museum. It is unthinkable. We should have done much more lobbying. After all, the astronomers managed to retain the parsec ($30{\cdot}87 \times 10^{15}$ metres) and that's not a measurement you are likely to come across every day. More important to us, the electrical engineers lobbied successfully for the electronvolt, which is $1{\cdot}6021 \times 10^{-19}$, so you needn't forget that.

We radio bods have been talking internationally for longer than we care to remember. Change comes natural to us, and not only in the metric scale. Look at the sudden flip to all our ideas that transistorisation brought about. Negative lines at the *top*, forsooth! And now the F.E.T. boom is swinging along, and we shall have to stand on our heads again. Never mind, Joe, just so long as you remember a pint is 0·0005682615 of a cubic metre . . . .



Hi-Fi IN THE HOME

MARTIN L. MICHAELIS, M.A.

IN the course of time, the keen audiophile will accumulate many pieces of equipment which may be home made, commercial products or assembled from kits. These all tend to get tagged-on to the existing rig in the family living room in some haphazard manner. One day the wife will find that the rules of interior decoration have been abused beyond all tolerable limits. This article describes in quite general terms, the action taken by the author when this justified protest was voiced. High-fidelity sound reproduction equipment is no longer a novelty fascinating the owner and visitors alike, regardless of appearance as long as it sounds good. It has now become a commonplace feature of home life and styling is as important as the acoustic performance. Furthermore, the operating procedure for a composite equipment must be so simple that any non-technical member of the family can switch on his favourite entertainment. The necessary mains switches for the many items of equipment pose a special problem. These must be arranged such that it is not possible to leave any piece of ancillary equipment switched on indefinitely without this becoming immediately obvious.

We are not setting out to give new hints for the connoisseur to enable him to obtain just that extra response which no average person is able to hear anyway. We are addressing the average person, who will demand a good standard of reproduction, ample but not pedantic response at both ends of the frequency range, and versatile entertainment with a *domesticated* equipment. This adjective refers to home entertainment as the prime aim, as distinct from perpetual electronic patchwork. Experimenting is envisaged once and for all whilst installing the domesticated high-fidelity system, for which this article gives a few collected hints.

Functions

A complete installation will generally be called upon to cater for television, sound broadcast and recorded sound entertainment. The latter must cover tape and gramophone records, with facilities for transcription from all other sources on to tape. All functions except television should be capable of stereophonic operation. Finally, it should be possible to relay all sound programmes, whatever their origin, to one or more extension speakers in other rooms.

Equipment

The basic equipment which will provide these functions comprises a television receiver and a modern radio tuner unit. The latter will cover all desired a.m. wavebands and the v.h.f.-f.m. waveband incorporating a stereo decoder. A stereo amplifier can be built-in or provided as a separate unit.

A number of ancillary units is necessary. The internal amplifier and speaker of the television receiver are often inadequate for optimum reproduction of the television sound, so that some form of auxiliary amplifier and linkage to the main system are desirable. The radio tuner unit will be operated in conjunction with a stereo tape recorder and record player, and a stereo amplifier if not already incorporated in the tuner unit.

Loudspeakers

For all kinds of sound reproduction in the living room, it is desirable to use one and the same pair of high quality loudspeaker box units, in the usual stereophonic arrangement. Monaural radio, tape or gramophone record programmes should be reproduced with equal intensity on both loudspeakers. This *enormously* enhances the presence of any monaural programme, compared to single-speaker reproduction thereof. It is important to use the same separation between the two loudspeaker boxes, and to sit at the same position as for good stereophonic listening, if maximum benefits are to be exploited for monaural listening too.

Television sound is an exception to this rule, because it is necessary to ensure subjective coincidence between the picture and the sound source. The only way to achieve this simultaneously for all viewing positions, is to stand the television receiver on one of the loudspeaker boxes, and to arrange for the TV sound to be boosted only through this loudspeaker.

Two major questions concern the extension speakers of the composite system. Firstly, the programme running in the living room may be monaural or stereophonic. In either case, the extension speakers must bring a properly combined monaural version which is the *sum signal* of the two stereophonic channels in the living room, without disturbing the stereophonic reproduction there by introducing crosstalk between the channels or other undesirable effects. The extension speakers will be situated in rooms such as the kitchen or the nursery, where stereophonic reproduction would hardly serve any useful purpose.

Secondly, much smaller speakers serve for the extension positions. These can certainly produce the same subjective volume as a large box, but only for a restricted frequency band. Above all, they are unable to handle bass frequencies at the same relative levels as required for a large box unit. If the frequency range is not restricted, the extension speakers will hoot and rattle due to frequency selec-

tive amplifier distortion and excessive speech cone excursions, when the signal is correct for the large box units in the living room. On the other hand, if the common tone controls are adjusted to give pleasant reproduction at the extension speakers, the quality at the large box units would be unacceptably thin.

Separate amplifier

It is hardly possible to meet these basic requirements for the extension speakers without providing a separate amplifier for the purpose. This is also expedient in relation to the output loading characteristics of many types of transformerless output stages in modern transistorised amplifiers. These stages operate at high power efficiency and low distortion, but require critical load matching. The output power is *drastically* reduced if the impedance of the connected speaker is significantly greater than the optimum value. On the other hand, if the loudspeaker impedance is less than the optimum value, the power transistors are soon destroyed on loud passages. If provision were to be made for arbitrarily switching extension speakers in parallel with the main speakers, as has been customary with valve output stages, it would thus be necessary to make the impedance of the main speakers considerably greater than optimum, so that the net load impedance presented to the amplifier just drops to the optimum when all extension speakers are switched on. This means that the main loudspeakers can never receive the full peak power. It is not primarily volume, but *transient response* which then suffers. Difficult passages of complex polyphony, or powerful instruments such as an organ, will sound confused and unrealistic.

It is convenient to derive the input signal for the separate amplifier feeding the extension speakers, from the output of the main amplifier across the main speakers. The auxiliary amplifier will incorporate only preset controls, to achieve correct tone and volume matching between the main speakers and the extension speakers, and to effect re-combination of a stereophonic signal to a monaural sum signal for the extension speakers. The externally accessible

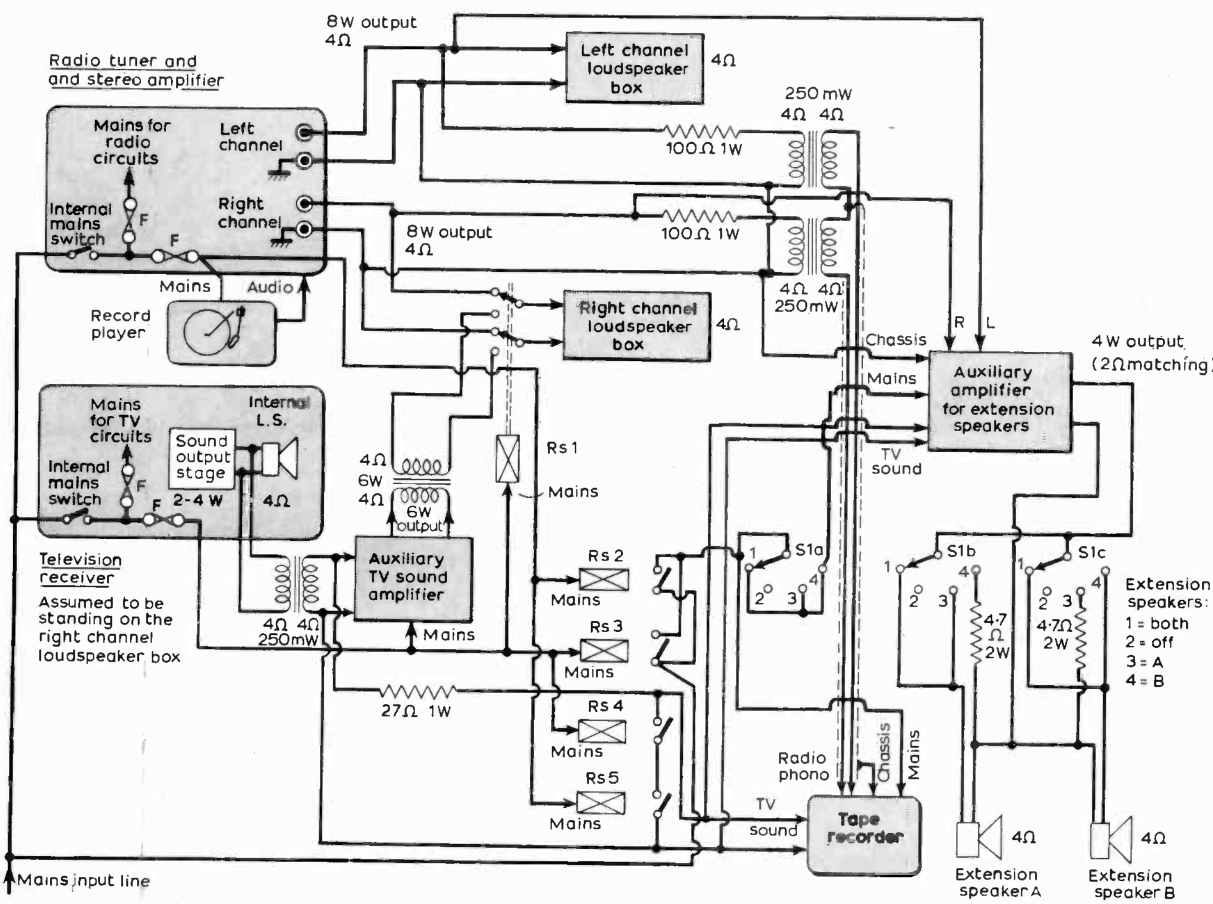


Fig. 1: Suggested interconnections of Radio, TV Receiver and Ancillaries. The auxiliary TV sound amplifier, the auxiliary amplifier for the extension speakers, the relay circuits and the associated hum-loop isolating transformers and resistors are all built into the cabinet of the right channel loudspeaker, which also carries the control knob of the extension speaker selector switch S1 on its front. The following input cables run to this composite unit: switched mains from radio tuner; switched mains from TV receiver; input mains line; combined loudspeaker output cable of radio tuner/amplifier; television sound output from TV receiver. The following output sockets are fitted to the composite unit: feed to left channel loudspeaker box; feed to extension speaker A; feed to extension speaker B; TV sound for tape recorder (monaural); radio/phono sound to tape recorder (stereo). Thirdly, the following mains outlet sockets are fitted to the composite unit: for radio tuner/amplifier; for television receiver; for tape recorder; for record player. The tape playback cable (not shown) runs direct from the tape recorder to the radio tuner/amplifier in the usual manner.

controls of the main amplifier (radio tuner) then serve jointly for all loudspeakers in the entire system.

Switching and manual controls

A particularly confusing feature of arbitrarily assembled systems is the multiplicity of uncoordinated controls on the numerous separate units. These have to be set in certain mutual ways to give correct performance, other combinations of settings making the equipment appear quite dead or even causing damage to it. An example of the latter danger is an arbitrary switching system connecting various loudspeakers to the output of one of the aforementioned load-sensitive amplifiers. The experimenter will take care to avoid forbidden switch settings, but he can hardly expect this of other members of his family, who have an equal right to use the equipment in his absence—and a right to expect it to work immediately after comprehensible actuation of few controls, without going up in smoke. Forbidden mutual settings which could cause damage to the equipment should be made impossible by using internal auxiliary relays and restricting the number of externally accessible controls.

Another confusing form of manual controls is the use of more than one control for the same function in any single channel. For example, a record player unit may be fitted with a volume control. A separate equaliser preamplifier unit will possess another volume control. The main amplifier may possess a third volume control. If all three volume controls are externally accessible, somebody need only have inadvertently turned any of them to zero, whereupon the other two will fail to produce a signal and the owner, upon coming home, is greeted with "your rig has broken down *again*". In a well-designed installation, each type of entertainment (radio, television, tape, records) should be governed by only one manual control for each function, and it is desirable to share as many controls as possible between several branches of entertainment.

The third common source of confusion is the mains on/off switching. The non-technical user of the equipment here demands an intuitively obvious switching arrangement. He correctly classes sound entertainment into two broad groups: radio and television. If the form of entertainment he desires is connected with television, he wishes to actuate a switch *on the television receiver*, nothing more. Auxiliary amplifier switching, loudspeaker selection and any necessary muting of other sources should be effected automatically with relays in the concealed wiring between the units. If the desired form of entertainment is connected with radio, including tape and records, switch-on should be actuating a mains switch of the radio tuner unit. The record player mains switching will be controlled by the pickup arm, and the tape recorder will have its own mains switch. The mains feed for both units should be controlled by the *mains switch of the radio tuner*. This ensures that everything is definitely switched off when both the radio tuner and the television receiver are switched off. These two principal units usually possess some form of pilot lamp or dial lights, so that it is obvious at a glance whether or not they are switched on. Modern transistorised radio tuners are usually compact and light, so that one very suitable position for this unit is standing on top of the television receiver. It may be advisable to make a small modification to the tape recorder to ensure that the drive mechanism is automatically disengaged when mains power is switched off at some external point. This prevents the appearance of an eccentric position on the rubber pressure wheel of the drive capstan. The simplest arrangement is to use a resting contact of a mains energised relay to discharge a capacitor through the same actuator solenoid as used to disengage the mechanism automatically at the end of the tape. A working contact of the same mains relay holds the capacitor charged as long as the mains supply is present.

Fuses

Commercial radio tuners and television receivers do not normally provide a mains outlet via the internal mains switch, so that this simple modification will have to be added. Make sure that the switch contacts are of adequate rating; otherwise fit an auxiliary relay. Do not run the switched output line via the existing internal fuse, but add a second fuse of appropriate rating in the output branch line beyond the switch. A common fuse for the internal circuitry and the new equipment connected externally would have to be up-rated to carry the combined load, which would seriously impair the degree of individual protection given for each item.

Switching the extension speakers

We have already seen that the extension speakers require their own audio amplifier. This should be switched on only when at least one extension speaker is actually in use. The author has found the following arrangement to be neat and convenient, as well as never giving rise to confusion of non-technical users.

The auxiliary amplifier is fitted with two relays and a three-pole four-way switch. The relays possess mains voltage coils rated for continuous duty. One relay coil each is connected straight to the switched mains output of the radio tuner and the television receiver. The relays each possess one maker contact, these contacts being wired in parallel and mutually in series with the mains switching wafer of the four-way switch. The mains feed is taken via this combination to the mains transformer of the auxiliary amplifier. The other two wafers of the four-way switch connect the extension speakers for two rooms (kitchen and nursery). Three positions give the functions kitchen/nursery/both and the fourth is the off position. The auxiliary amplifier obtains mains input only when the extension speaker switch is set to one of its action positions *and either the radio tuner or the television receiver is switched on*.

Simultaneous operation

Simultaneous use of the television receiver and radio tuner must be considered. Firstly, it may be desirable to relay a radio, tape or record programme to the extension speakers whilst other members of the family are watching television. The converse is hardly sensible, so that it suffices to provide another

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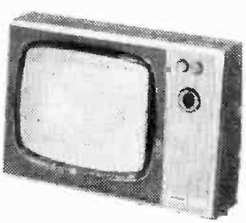

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40V	1	4	8	16	32	50
64V	0·64	2·5	5	10	20	32
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circuit energised from the switched mains outputs of the radio tuner and television receiver, sensing when both are switched on. In the latter case, the audio input from the television receiver to the auxiliy amplifier is muted by relay contacts. Only the radio output then reaches the auxiliary amplifier and is reproduced by the extension speakers.

Secondly, it may be desired to tape an interesting radio programme which is broadcast at the same time as an important television programme. This function is immediately possible when the radio tuner is switched on, irrespective of whether the television receiver is also switched on. A further logical distinction is generally also required. The tape recorder may be required to record the television sound. Thus its mains feed must be taken via the pair of relays on the auxiliary amplifier, so that it is available whenever either the radio tuner or the television receiver, or both, are switched on. Furthermore, the TV sound muting contact at the input of the auxiliary amplifier must also mute the television sound feed to the tape recorder when the radio tuner and the television receiver are both switched on.

With this arrangement, the tape recorder is ready to record television sound whenever the television receiver is switched on alone. If the radio tuner is switched on alone, or both units together, the tape recorder is always ready to record the output of the radio tuner, including the record player connected to it. This also means that taped programmes can be played back to the extension speakers whilst viewing television in the living room. If none of the tape recorder functions are required, the tape recorder is left switched off at its own mains switch. However, if this is forgotten, the tape recorder can never inadvertently be left switched on for days on end, because its mains feed is automatically broken as soon as both the television receiver and the radio tuner are switched off.

A monitoring facility is desirable in the living room for the second programme when simultaneous operation of the radio and television functions is being used. This permits brief listening-in to the second programme being tape recorded or played out to the extension speakers, for making checks and adjustments.

For this purpose, it is convenient to exploit the existing pair of stereophonic loudspeaker boxes in the living room. The switched mains output of the television receiver is used to feed the mains solenoid of a further relay fitted with two-pole changeover contacts. At the same time, the switched mains output of the television receiver feeds a second auxiliary amplifier directly. The changeover contacts of the energised relay disconnect one stereo channel loudspeaker from the main radio tuner amplifier and connect it to the output of the television sound auxiliary amplifier. The television receiver is standing on this loudspeaker box. The other stereo channel loudspeaker is left connected and will reproduce the radio and tape programmes even when the television receiver is running. This other channel loudspeaker can be silenced by turning the balance control to the appropriate stop on the radio tuner. In this arrangement, the existing balance control of the radio tuner serves as monitor volume control for the second programme. It will not affect the outgoing volume to the extension speakers, because these are fed with a sum signal which is unaffected by the stereo balancing setting. The balance control always makes equal respective boosts and cuts in the two channels, leaving the sum signal almost unchanged.

Block diagram

Figure 1 shows a block diagram of the complete equipment assembled according to the details discussed above. This is intended to be valid in general and thus emphasises the interconnections required to obtain the described intuitively obvious operating procedure. The choice of individual units (television receiver, radio tuner, amplifiers, etc.) is not subject to any fundamental restriction. Any design

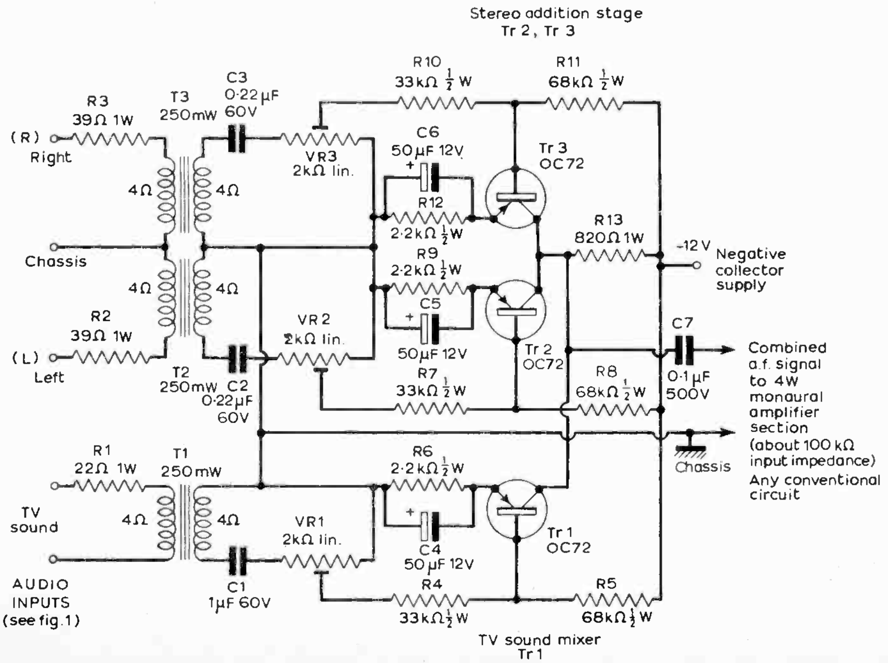
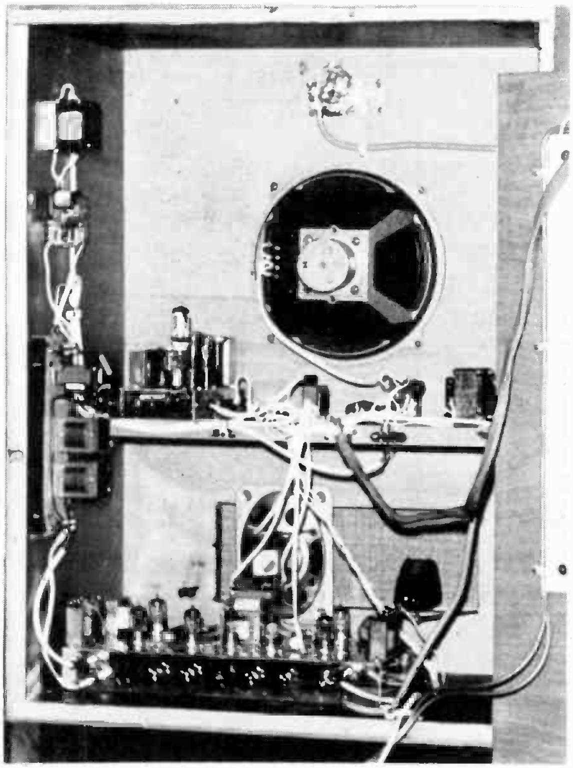


Fig. 2: The inputs mixer section of the extension speaker's auxiliary amplifier. The section from T2, T3 to Tr2, Tr3 develops a properly summed monaural signal across R13, from the stereo input. C2, C3 in conjunction with VR2, VR3 provide the necessary bass cut (see text), whilst VR2, VR3 serve to balance the addition function and the volume at the extension speakers with respect to that at the main stereo boxes. The section T1 to Tr1 mixes-in the TV sound, the output again appearing across R13. The stages beyond the components R13, C7 are conventional and may use any convenient circuit to develop 4 watts output power. The input transformers are necessary to avoid hum loops. They may be miniature components.

published in other articles in this magazine, commercial items or kit constructions are suitable in principle. In this article we do not intend to go into basic circuit details of high-fidelity and stereophonic equipment, but some remarks concerning the most desirable features for a composite installation are appropriate. The most important question is the audio power of the respective amplifiers.

Audio power ratings

The actually required input power to a loudspeaker for a given subjective volume is considerably influenced by the efficiency of the loudspeaker, by the size of the room and by the acoustic damp-



Internal view of the author's right-hand channel loudspeaker cabinet.

ing factor (furnishings). Modern high-fidelity loudspeakers often show a lower electrical sensitivity, which is the price paid for low distortion and brilliant transient response. However, the frequency is the dominant factor determining the required electrical power for a desired acoustic volume, and to a first approximation it is the only variable in this sense. Let us first of all consider the reproduction of pure sinewave tones at various frequencies. For the speech band or middle register, extending from about 200c/s to 2kc/s, we find that an electric power of 2 watts is ample with an average loudspeaker in an average room. This is sufficient for very loud undistorted reproduction with an intensity of about 85 phon. Somewhat less than 1 watt suffices for loud reproduction, 250mW for normal reproduction and about 50mW for quiet reproduction, under the same conditions and for the same restricted frequency range.

Thus it is evident that the correct rating for the extension speakers auxiliary amplifier is 4W when two rooms have to be served, so that each speaker can receive 2W.

The required electrical power increases greatly when it is desired to reproduce lower or higher frequencies with the same subjective volume. This is necessary for true high-fidelity reproduction in the living room. Whereas about 2W were sufficient to produce 85 phon sound intensity at 1kc/s, about 14W are necessary for this purpose at 30c/s, and about 10W at 15kc/s. These powers may be halved for a stereophonic installation, as far as each channel is concerned, since both channels contribute jointly. In simpler equipments it is generally unnecessary to make provision for full peak volume from each channel alone, since the majority of stereophonic effects are produced by phasing, not amplitude differences. Both channels then contribute to the volume, even though the subjective sound source may appear to lie to one side. Taking these considerations into account, it is found that a main stereo amplifier with 8W output per channel is fully adequate for an economical installation and gives ample performance for the average listener in the average living room. The critical connoisseur will not be satisfied. For him, a rating of at least 25W per channel is necessary in a more sophisticated equipment. This power does not serve to give more volume; the 25W amplifier will not sound much louder than an 8W one. The difference becomes apparent with complicated polyphonic passages with their intricate transients. Since the average power never runs the 25W amplifier close to the drive limit, smaller transient intermodulation effects are encountered and difficult instruments such as an organ will sound more realistic to the trained ear. The average musically untrained person will usually be unable to hear the difference, so that a twin channel 25W stereophonic amplifier would involve him in unnecessary expense, a twin 8W amplifier serving just as well at lower cost.

TV sound amplifier

This leaves the second auxiliary amplifier for the television sound. The television receiver will already incorporate an amplifier loudspeaker delivering and handling some 2 to 4W of audio power, but often lacking full bass. An appropriate rating for the auxiliary amplifier is therefore about 6W, and it should incorporate preset controls to give little output above 1kc/s, so that the 6W boost power are used predominantly to boost the bass and lower middle registers from 30c/s to 500c/s. The internal amplifier and speaker of the television receiver are left running and the feed for the auxiliary bass-boost amplifier is taken across the internal loudspeaker. It has been found that this arrangement gives extremely good presence and coincidence of the sound in the picture, regardless of the viewing position in the room. It is preferable if the internal loudspeaker of the television receiver radiates through the side of the cabinet with reflection from one corner wall of the room, to fan out the treble. The bass comes from the high-fidelity box unit on which the television receiver is standing. A large bass reflex cabinet is appropriate and it may be used to accommodate the auxiliary amplifiers and relay circuits on internal shelves.

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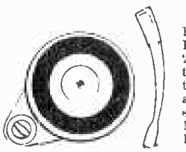

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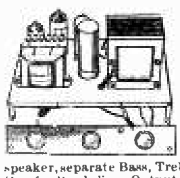

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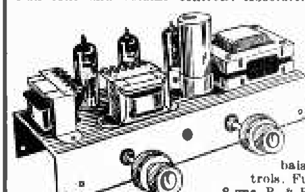

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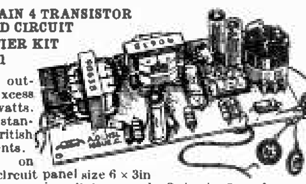

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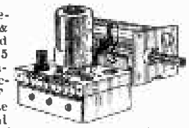

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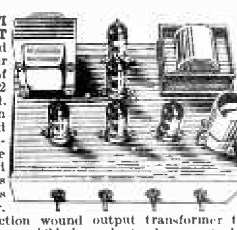

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Figure 2 shows a suitable volume and frequency matching circuit, which also effects the stereo summation to derive a monaural signal for the extension speakers without introducing crosstalk in stereophonic reproduction in the living room.

Isolating transformers

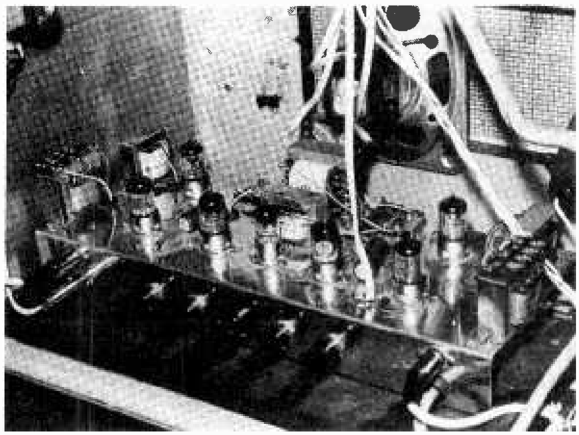
Note the audio isolating transformers in Fig. 2 and the others in Fig. 1. These are necessary to break hum loops when interconnecting the audio inputs and outputs of several pieces of equipment. Further measures necessary to avoid hum demand that the isolating transformers should not be positioned close to mains transformers from which they could otherwise pick up hum by induction, and all audio lines should be run at low impedance (normally 4Ω loudspeaker circuit impedance), so that capacitive hum pickup also remains negligible.

Pseudo-bass

In Figure 2, C2 and C3 in conjunction with VR2 and VR3 produce the necessary bass cut to prevent overloading of the auxiliary amplifier on bass components of the full frequency range signal, whilst preserving the same subjective volume.

A peculiar property of the human ear is that it will regenerate the fundamental of a rich spectrum of harmonics, even if this fundamental is absent in the actual sound radiated by a loudspeaker. For example, the bass fundamental of a guitar is subjectively heard, even if the loudspeaker is not objectively radiating this frequency. The physiological sensation is not quite the same as when the fundamental frequency is actually present in the radiated sound, but only the musically trained ear can hear the difference in the absence of a direct comparison. Almost any normal individual can certainly hear the difference if the two instances are played to him in quick succession, so that he will derive much more pleasure from listening to an equipment giving the full frequency range reproduction. But without musical training he tends to forget the difference when listening to other equipments with inferior frequency range, provided that harmonic distortion is low. The ear is much more sensitive to harmonic distortion, or more correctly cross-modulation distortion, in the absolute sense, although even here it is astonishingly tolerant if rhythm or speech message content of the signal are more important than harmony.

All these facts and considerations taken together mean that the reproduction from the extension speakers gives a very good impression easily mistaken for high-fidelity, after passing the full frequency range signal through the circuit of Fig. 2 and then giving it amplification with level frequency response. To the untrained ear, the difference becomes immediately apparent *only* when moving quickly from the extension speaker to the living room where the same programme is being reproduced with the full frequency range. Modern portable radios operate on the same physiological principle, coupled with good exploitation of cabinet and speaker resonances, to give a powerful impression of pseudo-bass from quite small units.



Close-up view of some of the amplifying equipment mounted at the bottom of the loudspeaker cabinet.

Choice of relays

The relays in Fig. 1 should be substantial devices with the greatest possible contact pressure, especially when incorporated in one of the loudspeaker boxes. Otherwise the contact resistance can become poor and modulated when the loudspeaker is running very loud. Relay contacts in loudspeaker circuits are called upon to carry high currents at low voltages. This calls for particularly heavy contacts. Wherever available, two or more identical contact sets should be connected in parallel. If relays with mains operated solenoids are unavailable, use low-voltage a.c. types with a suitable transformer. If any type of available a.c. relay produces an audible buzz disturbing quiet listening, check whether this is merely due to a loose coil bobbin on the core assembly. If so, a few spots of Durofix or a wedge of paxolin will generally cure the trouble. If not, d.c. relays must be substituted and fed via a transformer, rectifier *and reservoir capacitor*. Make quite sure that all relays are rated for continuous duty, i.e. that they may be energised for any length of time without overheating. The author has sometimes found that optimum reliability in the face of high acoustic levels inside the cabinet is obtained by using an energising current slightly below the nominal value, i.e. by insertion of a series resistor determined by trial and error. This strikes a compromise between contact pressure and elastic stability by virtue of cooler running.

Stereo phasing

Correct phasing is important when using two loudspeaker boxes for stereophonic reproduction. The speech cones must move inwards and outwards *in step* when the speakers are physically and electrically identical, which is the ideal case. Identical electrical connections then correspond to the correct phasing. If physically or electrically different speaker units are used on grounds of styling or availability, very good stereophonic reproduction is still possible in most cases. Any difference in sensitivity is easily corrected with the balance control on the radio tuner. With non-identical speakers, equal electrical phasing and cone movement does not necessarily produce equal sound pressure phasing in the room. In many such cases, *either* electrical phasing will produce a correct stereophonic effect over certain listening areas, whereby one phasing gives only a small, usually very asymmetrically located listening area, whilst the other one gives a much larger area roughly corresponding to the normal central zone obtained with two identical speakers. There is no simple way of determining the correct case by inspection. The decision must be made in the following manner by listening.

Tune the radio to the strong hiss between two stations on the v.h.f.-f.m. band, and adjust the volume of this hiss to be loud and crisp. Explore the room to determine the region in which the hiss appears to be coming from a point source on the line between the speakers. At all other points in the room, the hiss will appear to be coming from nowhere in particular, often exerting pressure on the head from above or the rear, or of course it will appear to come from one speaker if approached too closely. Now reverse the connections at one loudspeaker and repeat the exploration. The correct polarity is the one which produced the larger and more central region of sound source impression on the line between the speakers. This test must be made in the *monaural* setting of the radio tuner, because the decoder phasing is unreliable in the absence of a signal.

If the test does not prove decisive for either electrical phasing, try the effect of slight movement of furniture or a slight change of the mounting height of one loudspeaker.

Combination phasing

The signals from the stereo channels fed via the circuit of Fig. 2 to the combination stage must be electrically in phase. This is easily checked by running a monaural signal from the radio tuner and noting the effect of the balance control on the volume at the *extension* speakers. When the phasing is correct, the balance control should have very little if any effect on the extension speaker volume. If the phasing is incorrect, the extension speaker volume will drop considerably in the central setting of the balance control. In such a case, reverse the connections to *any one* of the four windings of T2 and T3 in Fig. 2. ■

CQ! CQ! CQ! CQ! CQ! CQ!

EQUIPMENT REQUIRED

. . . crystals and coils for the No. 46 transceiver.—S. Molony, 137 Cavehill Road, Belfast 15, N. Ireland.

. . . R109 A.T. set in working order. Will exchange all-wave Avo oscillator in working order.—N. R. York, 124 Burnbridge Road, Old Whittington, Chesterfield.

BOOKS WANTED

. . . the 1964–65 copy of *Radio and Television Servicing*.—E. Tinsdale, 292 Dewsbury Road, Leeds 11, Yorkshire.

. . . *Radio and Television Servicing* for the years 1963–64 and 1964–65.—W. D. Williams, 34 Hermes Crescent, Wyken, Coventry, Warwickshire.

. . . the 1959–60, 1960–61, 1962–63 volumes of *Radio and Television Servicing*. Will sell or exchange for: 1946–53, 1946–55, 1948–53, 1953–54, 1955–56 and 1956–57 volumes. —B. Hunt, 54 Old Road, Bromyard, Herefordshire.

ISSUES FOR DISPOSAL

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. . . large number of issues of *Practical Wireless*, *Practical Television*, *Practical Electronics* and *Radio Constructor*.—E. Matthews, 63 The Oval, Otley, Yorkshire.

. . . *Practical Television* issues from December 1966 to date.—G. Vayle, 3 Baptist Hill, St. Marybourne, Andover.

. . . back issues of *Practical Wireless* from 1955 onwards.—H. Walker, 9 Masters Road, Leamington Spa, Warwickshire.

. . . many back issues of *Practical Wireless*, *Practical Electronics*, *Radio Constructor* etc.—A Moore, Aylescott, Burrington, Umberleigh, N. Devon.

INFORMATION WANTED

. . . hints, tips, circuit diagrams to convert ex-Govt. B44 Mk. 3 for 4m operation.—D. Dobson, G3XFM, "Woodhaven", 50 Middlethorpe Drive, York.

. . . details on how to convert a TV set into an oscilloscope.—G. Thompson, 41 Council Houses, Norby, Thirsk, Yorkshire.

. . . circuit diagram or any information on the PCR3 receiver.—G. Griffiths, 12 Beach Close, Holyhead, Anglesey, Wales.

. . . any information on the R.1355 type of headset and any details of mods. to it.—D. Garner, 52 CulversWay, Carshalton, Surrey.

. . . service sheet or circuit diagram for Hallicrafters S.38 (110V).—A. Lynch, 9 Webb Close, Langley, Bucks.

. . . any information for modifying the R220 set for continuous tuning.—C. Bray, Homeleigh, Trevowah Road, Crantock, Newquay, Cornwall.

. . . will buy or borrow handbook or service manual for the Trio 9R-59 communications receiver.—J. Bailey, 13 Heywood Road, Alderley Edge, Cheshire.

. . . any information, circuit or handbook for the R109 receiver.—B. Watson, 32 Lancaster Crescent, Downham Market, Norfolk.

. . . details for converting the BC-454-B for DX use. Also details of PSU and output.—G. Udell, 86 Overdale, Parkfield Estate, Swinton, Lancs.

. . . circuit and constructional details of the Jason wobbulator.—J. Gardner, Stable Cottage, Meonstoke, Southampton.

. . . any information on the PCR receiver (mods etc.). This one has audio gain, aerial trimmer, tone control, r.f. gain, a.v.c. on/off switch and a 3in. hole which may have accommodated a meter.—H. Rimmer, 29 Compleg Avenue, Poulton-le-Fylde.

. . . circuit and data for Philco model 131 radio.—G. Hall, 17 High Street, Wedham Market, Ipswich, Suffolk.

. . . any information on a receiver type B46.—S. Goodwin, 67 Paines Lane, Pinner, Middlesex.

. . . any information, circuit diagram, service manual, etc. on the ACE radio model 600 9-band valve receiver.—R. Simmons, 154 Alderwood Road, Eltham, London, S.E.9.

. . . buy or borrow the manual of Radio Compass Unit BC4336 made for the US Army. Any information on this unit would be appreciated.—M. Hughes-Jones, Penvearn, West Trewirgie, Redruth, Cornwall.

. . . operations handbook and complete circuit diagrams for the CR300 communications receiver and power pack.—R. Goad, 15 Cleveland Road, Southsea, Hants.

. . . any information on the BC624 set which covers 2 to 4 metres.—S. Davis, 33 Pollard Close, Jenny Clift Estate, West Hooe, Plymouth, Devon.

. . . details of the tuning unit type TCR13/14.—A. Alden, 66 Medcalf Road, Enfield, Middlesex.

. . . buy or borrow a copy of the blueprint for the wiring of the White Ibbotson Teleprojector, type 2418. This is now taken over by the Rank Organisation but they have no gen.—H. Feil, 116 Falmouth Gardens, Redbridge, Ilford, Essex.

. . . any information, however slight, on Indicator unit type 248, part of Monitor 56 Ref. No. 10QB/6325 modification RMC/2671/1.—D. Rayner, 5 Elm Street, Hyde Park, Leeds 6, Yorkshire.

. . . detailed information and circuit diagram for Cossor tape recorder CR1603A. Also information and circuit diagram for the Baird TV series 660 model 23in.—Z. Nadeem, 5 Edgware Avenue, Leeds 8.

. . . any information at all on what I am led to believe is an RMH24 receiver.—C. McEntee, 68 Abyssinia Street, Belfast, Northern Ireland.

. . . information and circuits for Mixer unit type 13 with VCR139A and mains power unit and also Monitor unit type 101 with separate power unit and cathode probe using a CV1587 tube.—A. Neilson, 14 Allenby Square, Old Swan, Liverpool 13, Lancashire.

. . . any information on converting TV sets to oscilloscopes.—G. Johnson, 3 Bixley Road, Ipswich, Suffolk.

. . . the circuit and any other details of a Japanese transistor set, model 7 5-P1. It is a seven-transistor two-band superhet with frequency range of m.w. 540–1,600kc/s and s.w. 12Mc/s–39Mc/s. The i.f. is 455kc/s.—C. McIntyre, 38 Flint Street, North Ipswich 4305, Queensland, Australia.

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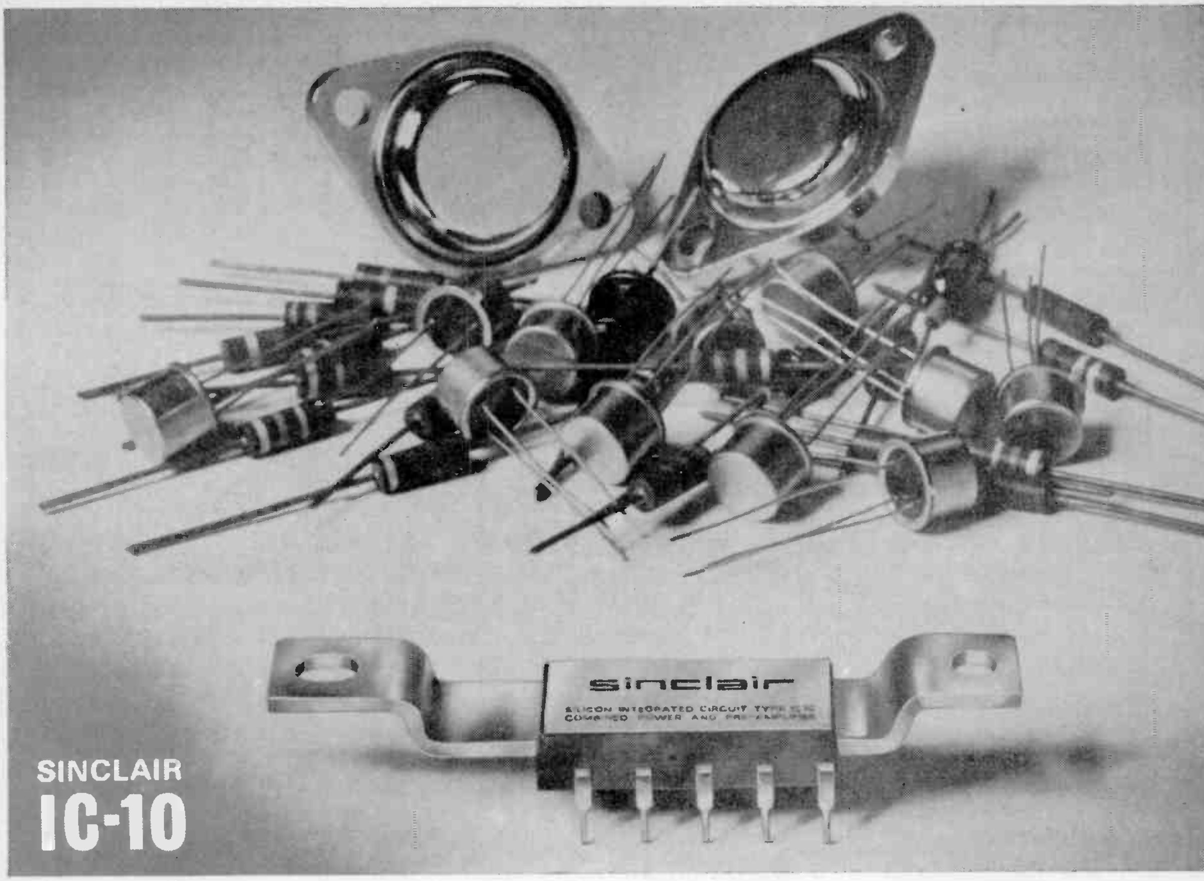

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Size	1 x 0.4 x 0.2 inches.
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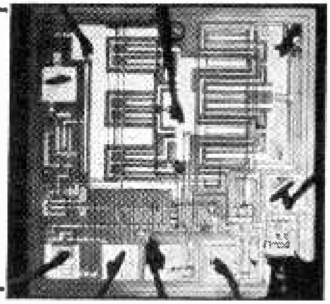
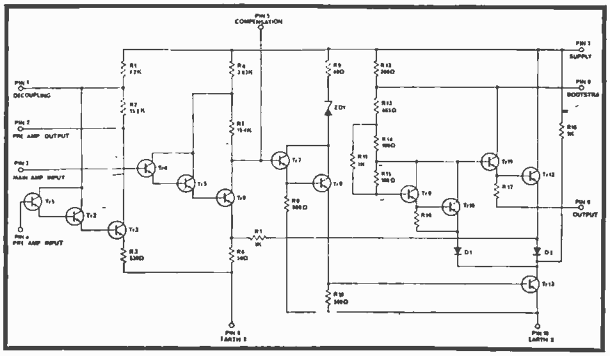
ABOVE SHOWS ACTUAL SIZE OF IC-10. TO RIGHT. VIEW OF AMPLIFIER MAGNIFIED 625 TIMES.





■ Circuit Description

The circuit diagram of the IC-10 is shown on the right. The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. The output stage operates in class AB with closely controlled quiescent current which is independent of temperature. A high level of overall negative feedback is used round both sections and the amplifier is completely free from cross-over distortion at all supply voltages. Thus battery operation is eminently satisfactory.

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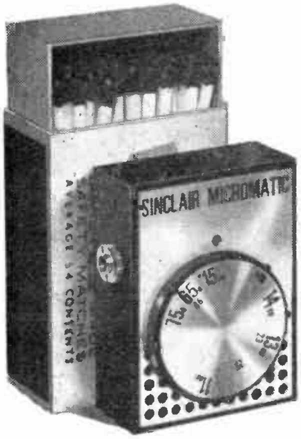

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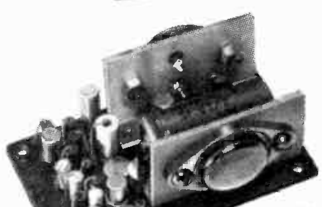

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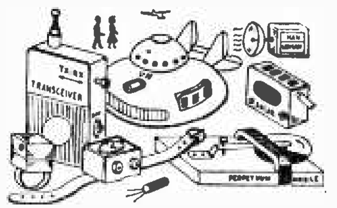

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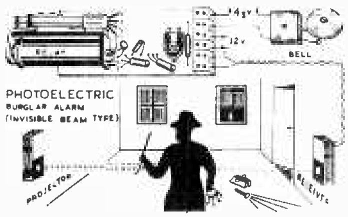

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Versatile Invisible-beam, Relay-less, Steady-light Photo-Switch, Burglar Alarm, Door Opener, Counter, etc., for the Experimenter.

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Versatile recording facilities. So easy to build—so easy to use.

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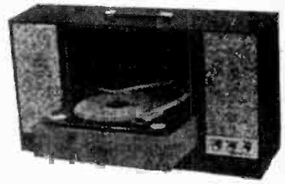

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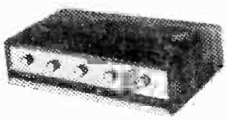

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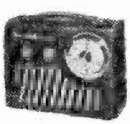

UXR-1

PORTABLE UXR-1

This luxury 6-transistor, 1 diode receiver covers long and medium wavebands. Its robust case is now available in real brown leather or choice of colours: Navy blue, coral pink, lime green (please state second choice).

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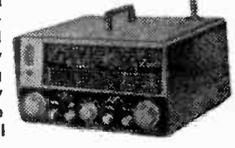
'Mohican' General Coverage Receiver, GC-1U



Powerful 10 transistor, 5 diode circuit. Tunes 580 to 1550 kHz and 1·69 to 30 MHz in five bands. Bandspread on all bands. Fixed-aligned ceramic IF trans-filters for best selectivity. Pre-assembled and aligned 'front-end' for fast, easy assembly. Built-in 6 x 4in. speaker. Tuning meter for pin-point tuning. Completely self-contained for portability—can be operated on 230 volt AC with Model K/UBE-1. Kit £2.17.6. extra.

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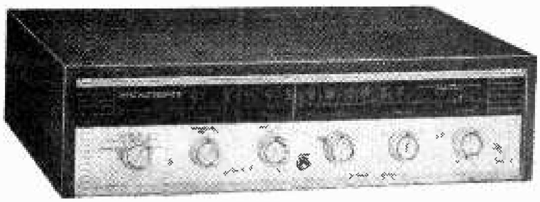

Kit K/AF-14
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Cabinet £4.10.0. extra

Top Value in a 30 Watt FM Stereo Receiver, AR-14

● 31 transistor, 10 diode circuit for cool, instant operation with the transparent, natural sound only transistors can deliver ● ±1dB, 15 to 50,000 Hz at 10 watts per channel continuous (20 watts total), 15 watts per channel IHF music power (30 watts total) ● Wide-band FM/FM stereo tuner plus two preamplifiers and two power amplifiers. ● Front panel stereo headphone jack. ● Compact—just 3⅞" H x 15¼" W x 12" D. ● Custom install it in wall, your own cabinet, or use as a free standing unit. ● Build it in 20 hours.

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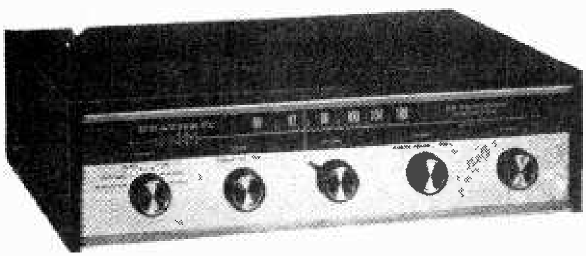
A/AR-14 (less cab.)	.. ..	£75.0.0. P.P. 13/6

Cabinet extra: Teak or Walnut finish £4.10.0



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Cabinet £3.10.0. extra

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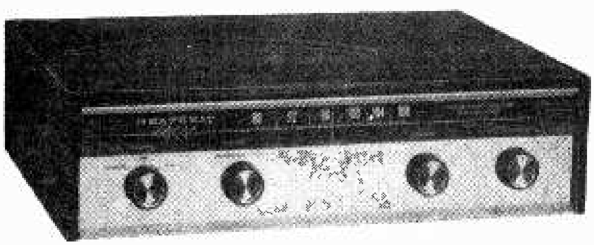
A/AR-14 (less cab.)	.. ..	£59.0.0. P.P. 13/6

Cabinet extra: Teak or Walnut finish £3.10.0



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A Quality Table Radio FM Mono Receiver, AR-27

● 13 transistor, 6 diode circuit for high-fidelity sound reproduction, long life, low heat, freedom from hum, and service-free operation. ● 7 watts music power. ● ±1dB, 25 to 60,000 Hz at 5 watts. ● Input connectors for phonograph and auxiliary signals. ● Complete front panel controls. ● Flywheel tuning. ● Preassembled and prealigned FM tuner, all other critical parts factory aligned. ● Easy, circuit board assembly. ● Compact bookshelf size. ● 3-way installation . . . wall, free standing or in a suitable cabinet. ● 117 v. A.C. or 210/240 v. A.C., 50 Hz operation.

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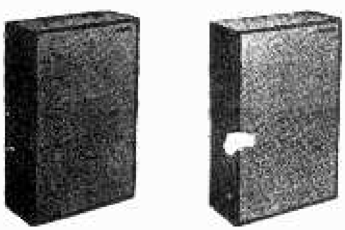
Cabinet extra: Teak or Walnut finish £3.10.0



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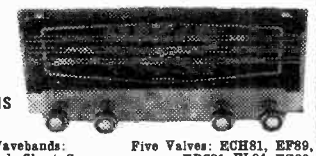

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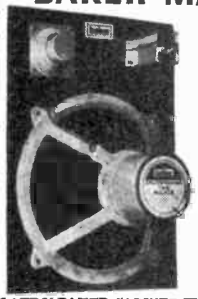

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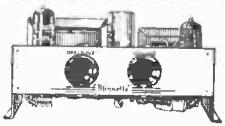

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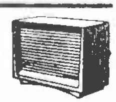

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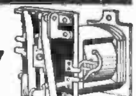

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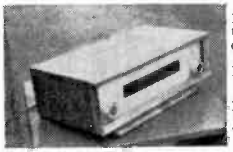

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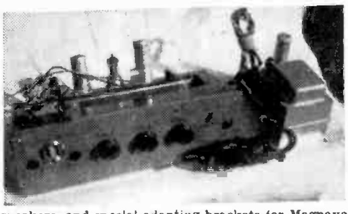

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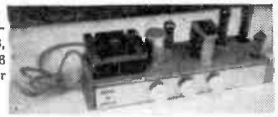

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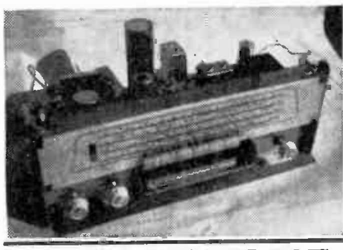
6 PUSH-BUTTON STEREOGRAM CHASSIS



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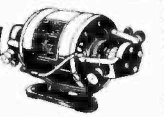

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8¼"	6⅞"		17	9	1	1	6	1	5	0
10¼"	7⅞"	1	3	0	1	8	0	1	11	9
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14¼"	3⅞"	1	0	6	1	5	0	1	7	3
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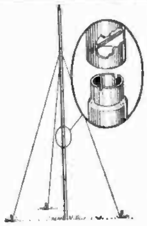

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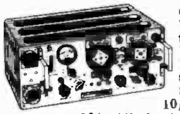

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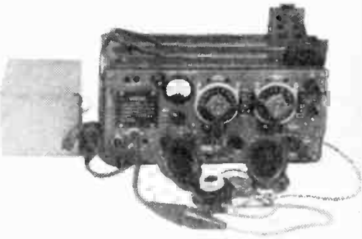

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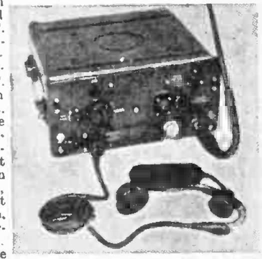

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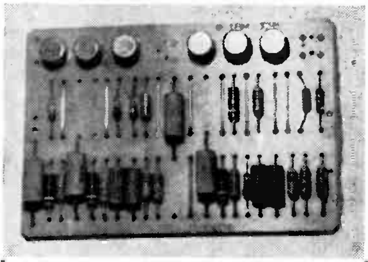

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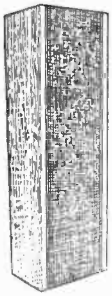

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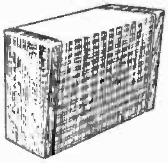

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PY83	6/6
PY88	7/6
PY800	9/-
PY801	9/-
QU37	27/-
SP41	5/6
SP61	5/-
TP22	10/-
TT21	35/-
TT22	35/-
U19	40/-
U20	12/-
U22	8/-

U25	14/6
U26	14/6
U31	8/-
U33	30/-
U76	4/-
U81	10/-
U281	8/-
U282	8/-
U403	8/-
U404	5/-
UABC80	6/-
UAF42	9/6
UBC41	8/6
UBC81	8/6
UBF80	6/6
UBF89	7/-
UBL1	8/6
UC92	6/-
UCC85	7/-
UCF80	9/6
UCH21	9/6
UCH42	9/6
UCH81	6/6
UCL81	10/-
UCL82	7/-
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UF9	10/-
UF41	9/9
UF42	10/-
UF43	10/-
UF80	7/-
UF85	7/3
UF89	7/-
UL41	9/6
UL84	6/6
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VU39	9/-
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VU133	8/-
W76	7/-
W107	7/-
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Z759	25/-
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RCA Type CA3020
Integrated Circuit Audio Amplifier in TO5 encapsulation (size of a small transistor), equivalent to seven n-p-n silicon transistors, 3 diodes and 11 resistors. Power output 550mW. Total harmonic distortion 1%. Will operate on voltage from 3 to 9 volts. 30/- plus 2/- p.p.

SILICON POWER RECTIFIERS

1N5054—1000 p.i.v., 1·5A wire ended	3/6
BYZ10—800 p.i.v., 6 Amps, stud mounted	9/-
BYZ12—400 p.i.v., 6 Amps, stud mounted	5/-
BYZ13—200 p.i.v., 6 Amps, stud mounted	7/6
BYZ19—as BYZ13, but reversed polarity	7/6
DD000—50 p.i.v., 500mA wire ended	3/-
DD006—400 p.i.v., 500mA wire ended	6/3
DD058—800 p.i.v., 500mA wire ended	7/6
DD226—400 p.i.v., 1A wire ended	6/6

The construction of amplifier using the above integrated circuits had been described in March issue of P.W. Please note that we only supply the IC's and no other parts are supplied by us.

LOW and MEDIUM CURRENT THYRISTORS

3/40, 400 p.i.v. 3 amp, stud mounted. Gate voltage 3·0v. at 20mA max.	7/6
BLUE SPOT, 200 p.i.v. 5 amp, stud mounted. Gate voltage 3·25v. at 120mA max.	12/6
GREEN SPOT, 400 p.i.v. 5 amp, stud mounted, Gate voltage 3·25v. at 120mA max.	17/6

HIGH CURRENT THYRISTORS

CR80-021A, 80 amps, 25 p.i.v.	23/-
CR100-201A, 100 amps, 200 p.i.v.	35/-
CR100-215A, 100 amps, 250 p.i.v.	40/-
CR100-301A, 100 amps, 300 p.i.v.	45/-
CR100-351A, 100 amps, 350 p.i.v.	50/-
CR100-401A, 100 amps, 400 p.i.v.	55/-
CR100-501A, 100 amps, 500 p.i.v.	75/-

AVALANCHE SILICON RECTIFIERS

Type RAS508AF, 960 p.i.v. at 6 amps, max., stud mounted 10/6

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Glass dry reed inserts approx. ⅜in. dia. x 1in. long with axial leads. One "make" contact of 100mA capacity at 50V. Can be operated by permanent magnet or 30–50 Amp-turns relay coils. PRICE 18/- per doz. post free.

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2AP1—2in. screen. EHT 500 to 1000V. Typical sensitivity at 500V. X—220mm/V; Y—260mm/V. USM11 Base. Overall length 7⅞in. 40/-
3BP1—3in. screen. EHT 1500V. Typical sensitivity X—150mm/V; Y—200mm/V. B14A Base. Overall length 10⅛in. 55/-
5CP1A = DG13-2—5in. screen, with P.D.A.; EHT 4000 and 2000V. Typical sensitivity X—275mm/V; Y—325mm/V. B14A Base. Overall length 16⅞in. 100/-
All the above tubes have 6·3V heaters and are suitable for general oscilloscope to use.

GERMANIUM POINT CONTACT DIODES

CG4E = CV448 2/-; OA5 3/-; OA6 4/-; OA7 4/-; OA47 2/6; OA70 2/-; OA79 2/3; OA81 1/9; OA85 1/6; OA90 2/-; OA91 2/-; OA95 2/-.

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OC43	9/-
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OC76	5/-
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OC78D	3/3
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OC84	5/-
OC122	12/6
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OC141	12/6
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OC171	5/6
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The PW Britannic Two; The PW Mercury Six	(May 1962)	6/-
Beginner's Short Wave Two; S.W. Listener's Guide	(Nov. 1963)	5/-
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This coupon is available until 8th November, 1968 and must accompany all queries in accordance with the rules of our Query Service.

PRACTICAL WIRELESS, NOVEMBER 1968

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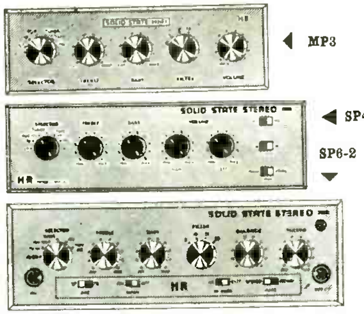

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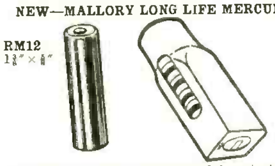

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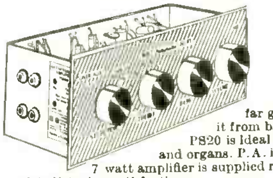

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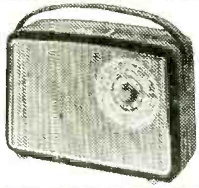

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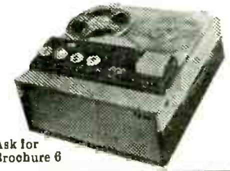

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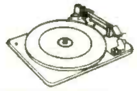

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