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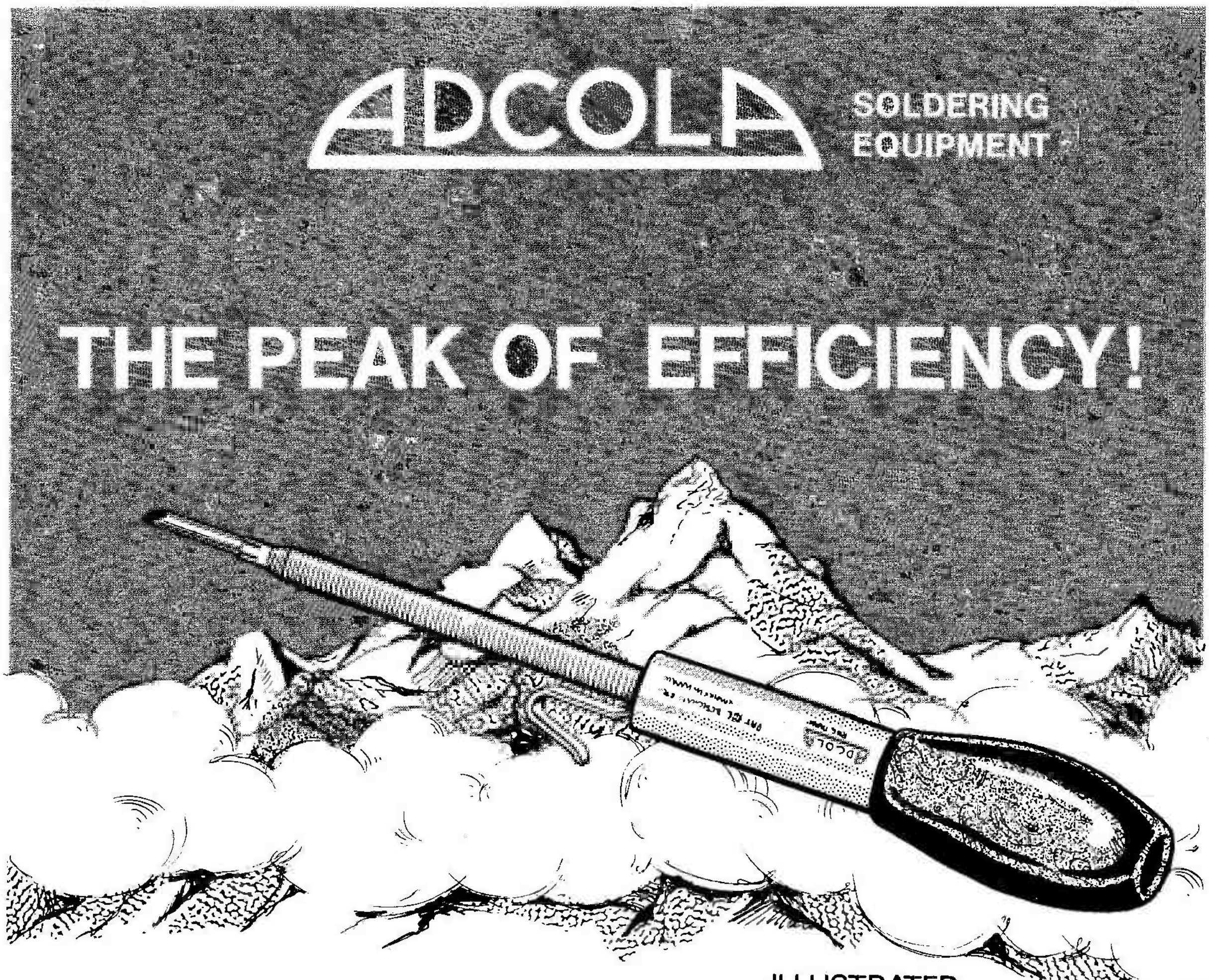

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Model 64. $\frac{3}{16}''$ Bit
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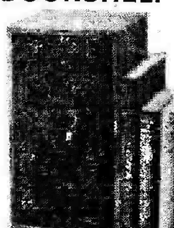
P.W.12

Lasky's Radio

SPEAKERS

FOSTER CRITERION HI-FI BOOKSHELF SPEAKER SYSTEM

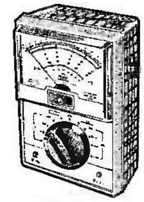


This extremely high quality bookshelf speaker system by the world famous Foster Co. of Japan incorporates an acoustical suspension woofer and cone tweeter in a sealed infinite baffle enclosure with handsome oiled walnut finish. The performance of the Criterion is superior to many larger and far more expensive units and at Lasky's special purchase price is quite without equal! SPECIFICATION: Air suspension type 6½in. bass-midrange woofer with rolled cloth edge. 2½in. HF cone type tweeter. Frequency range 65–20,000c/s. Maximum power handling 15W. 8Ω impedance. Cabinet constructed from ⅝in. laminate with oiled walnut veneer finish; size 13¾ × 7⅞in. square. Dark green woven acoustic gauze. Phono input at rear. List Price £12.10.0 each.

Lasky's Price £8.8.0 or 2 for £16 Post 1—7/6 2—12/6

TEST EQUIPMENT

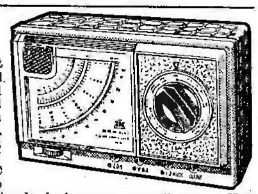
TTC Model C-1000



A really tiny 1,000 O.P.V. pocket multi-tester with "big" meter performance. Precision 2 jewel meter movement. Hand calibrated to ±3% accuracy on full scale of d.c. ranges, 4% on a.c. ranges. 2¼in. square meter. SPECIFICATIONS a.c./V ranges: 0-10, 50, 250, 1,000V at 1K/O.P.V. a.c./V ranges: 0-10, 50, 250, 100V at 1K/O.P.V. D.c. current: 0-1-100mA. Resistance: 0-150K/ohms (3,000 ohms centre scale). Decibels: −10 to +22dB. Operated on one penlight cell. Two colour buff/green case—size only 3¼ × 2¼ × 1in. Click stop range selection switch. Ohms zero adjustment. Complete with test leads, battery and instructions with circuit data.

Lasky's Price 39/6 Post 2/6

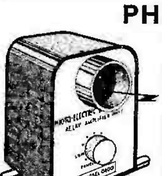
TTC Model C-1051



A completely new design 20,000 O.P.V. pocket multimeter with mirror scale and built in thermal protection circuit. Exceptionally large easy to read meter with D'Arsonval movement. Colour coded scales. Single positive click-in, recessed selection switch for all ranges. Ohms zero adjustment. Range spec. AC volts: 0-6-30-300-1200 V at 10K/ohms/V DC volts: 0-3-15-150-300-1-2KV at 20K/ohms/V. Resistance: 0-60K-6megs. DC current: 0-60μA-300mA. Decibels: −20dB to +17dB. Hand calibration gives extremely high standard of accuracy on all ranges. Uses one 1½ V penlight battery. Strong impact resistant plastic cabinet—size only 4⅝ × 3¼ × 1½in. Two colour buff/green finish. Complete with test leads and battery. Original list price £5.5

Lasky's Price 75/- Post 2/6

PHOTO ELECTRIC RELAY



TTC MODEL Q4001 Photo Relay System —comprising "exciter" lamp and relay unit. Any interception of the light beam instantly triggers the relay which in turn will operate light, alarm bell or buzzer, electronic counter, heavy duty relay or electric motor. Many useful applications in the home, office, shop, factory, etc. Operates on 240V. A.C.; exciter lamp 12V. 20W. effective up to 15ft. in daylight or 50ft. at night. Very simple to install. In strong metal cases size (each) 6 × 4½ × 3in. Complete with mounting brackets wire and instructions.

Lasky's Price £7.19.6. Post 5/-

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FAMOUS AMERICAN MADE BRAND TAPE AT RECORD LOW PRICES

	s.	d.		s.	d.
3in. Message tape, 150ft.	2	6	5¾in. Standard play, 850ft. PVC	11	6
3in. Message tape, 225ft.	3	9	5¾in. Long play, 1200ft. Mylar	15	0
3in. Message tape, 300ft.	7	6	5¾in. Triple play, 2400ft. Mylar	45	0
3¼in. Triple play, 600ft. Mylar	10	0	7in. Standard play, 1200ft. Acetate	12	6
4in. Triple play, 900ft. Mylar	17	6	7in. Standard play, 1200ft. Mylar	12	6
5in. Double play, 1200ft. Mylar	15	0	7in. Long play, 1800ft. Mylar	19	6
5in. Long play, 900ft. Acetate	10	0	7in. Double play, 2400ft. Mylar	25	0
5in. Standard play, 600ft. PVC	8	6	7in. Long play, 1800ft. Acetate	15	0
5in. Triple play, 1800ft. Mylar	35	0	7in. Triple play, 3600ft. Mylar	50	0
5¾in. Double play, 1800ft. Mylar	22	6			
5¾in. Long play, 1200ft. Acetate	12	6			

P. & P. 1/- extra per reel. 4 reels and over Post Free. Special quotes for quantities.

SPECIAL INTEREST ITEMS!

NEW *LASKY'S EXCLUSIVES*

FANTAVOX MODEL TV-1008 VHF AIRCRAFT BAND AND AM RECEIVER

The first pocket size Receiver of its type allowing you to "tune-in" anywhere to the entire air-to-ground, ground-to-air communications band covered by 108–137Mc/s in addition to full AM medium wave band cover of 535–1605Kc/s. An extremely sensitive 10 transistor and 2 diode, superhet circuit plus 1 variable capacitor and 1 thermister. Intermediate frequencies: AM-455 Kc/s; VHF-10·7Mc/s. Output power: 200mW. 2½in. Permanent Dynamic 8 ohm speaker, earphone also provided for "silent" listening. A built-in ferrite rod aerial is provided for AM reception and a fully directional telescopic antenna for VHF reception—the latter when collapsed neatly clips across the top of the set. Power is from 4-1·5v penlight cells and a jack socket for connection to a suitable AC converter is also provided. The Model TV-1008 is extremely well made and finished in grey plastic with metallic blue speaker baffle, chrome telescopic antenna; attached wrist strap is also provided. Size 6⅝ × 3¾ × 1½in. Complete with batteries, magnetic earphone, instructions and circuit data.

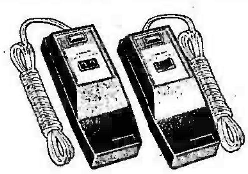
Lasky's Price £11.10.0 P. & P. 5/-

MIDLAND Model 10-502 VHF AIRCRAFT BAND CONVERTER

An entirely new item for the radio enthusiast bringing instant reception of the ground-to-air, air-to-ground waveband. For use with any standard AM or FM radio covering 535 to 1605Kc/s, 88 to 108Mc/s respectively—with no electrical conversion or connection required. The Model 10-502 (self powered by one 9V (PP3 type) battery) is merely placed close to the receiving set and then tuned over 110 to 135Mc/s which covers the whole aircraft communications band. Volume and reception effectiveness is adjusted by moving both sets to the most favourable position and balancing the vol. controls of each accordingly. The Model 10-502 has a smartly designed black plastic cabinet with brushed metal front panel and 18in. chrome telescopic antenna, size only 4 × 2⅞ × 2⅜in. (inc. knobs). Complete with battery and full instructions.

Lasky's Price 79/6 Post 3/6

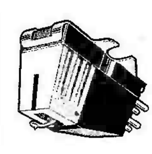
REMOTE CONTROL SWITCHING SYSTEM



An extremely compact, simple to use and install remote switching system for use with a wide range of mains operated equipment. High freq. signal from the transmitter is relayed to the remote switching unit via the AC mains circuit into which the units are plugged—providing instant on/off—off/on control of appliance. Spec.: 3 transistor and 1 diode circuit. Frequency 190Kc/s (pre-set). Power 220/240V AC, 50/60c/s. Max. power of equip. to be switched—300W plastic cabinets size: 5¼ × 2½ × 1⅝in., each with neon indicator lamp. Comp. with flex and instructions.

Lasky's Price £7.19.6 Post 5/-

STEREO MOVING MAGNET CARTRIDGE Model AD-76K



Lasky's are first again with this new high compliance moving magnet stereo cartridge that really breaks the quality/price barrier. The performance of this cartridge is equal to others costing many £'s more and will bring out all the subtleties of the finest microgroove recordings and is suitable for use with all the latest high sensitivity amplifiers. SPECIFICATION: Diamond Stereo LP stylus. Compliance 10×10^{-6}cm/dyne. Frequency response 20–20,000c/s. Channel separation 20dB. Output 7mV. Tracking pressure 2 grammes ±0·5grm. Standard ½in. mounting. Total length (inc. pins) $1^{3}/_{16}$in. Replacement Diamond stylus available. Fully guaranteed.

Lasky's Price 85/- Post 2/-

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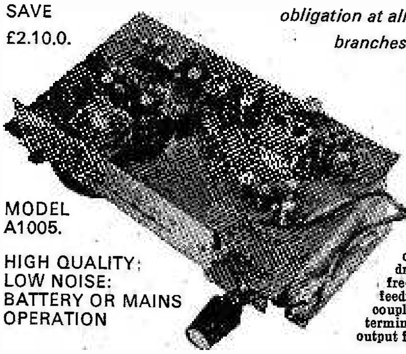

MODEL A1005.

HIGH QUALITY:
LOW NOISE:
BATTERY OR MAINS OPERATION

STEREO DECODER

Model A1005M. Simple instructions to convert any FM tuner. Max input 100 m volts. Power supply 8–14 volts. Mains or batt. (5mA at 12V.) Output 1·5 x input. 4 transistors (2 each) 2SB–202; 2SB–186. 7 diodes IN34 (six) IN60 SAVE 34/- **5 Gns.**

Keen offer if purchased with A1005 tuner making STEREO TUNER 11 gns.

This beautifully compact 6 transistor machine (size 6 x 4 x 2½in.) will give quieter, more interference free reception. Months of use from a standard 9 volt battery or its small power requirements can be drawn from any amplifier. Low noise freq. changer. Smooth 2 gang tuning feeding no less than three I.F. stages coupled to a double-tuned discriminator terminating in an L.F. stage giving ample output for all quality amplifiers.

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Mullard Matched Output Kits OC18D and 2-OC81 **12/6**

R.F. Kits OC44, OC45 (2) 3 transistors. **11/-**

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AF186	16/-	OA81	2/6	OC74	7/6
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3 lbs. (post 3/-) 9/-
7 lbs. (post 5/-) 17/6
14 lbs. (post 6/-) 29/-

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We offer you fully tensilised polyester/mylar and P.V.C. tapes of identical quality hi-fi, wide range recording characteristics as top grade tapes. Quality control manufacture. They are truly worth a few more coppers than acetate, sub-standard, jointed or cheap imports **TRY ONE AND PROVE IT YOURSELF.**

Standard Play			Long Play		
3in	150ft.	2/3	3in	225ft.	2/9
4in.	300ft.	4/6	4in.	450ft.	5/6
5in.	600ft.	7/6	5in.	900ft.	10/6
5¾in.	900ft.	10/6	5¾in.	1,200ft.	13/-
7in.	1,200ft.	12/6	7in.	1,800ft.	18/6
Double Play			**Triple Play**		
3in.	300ft.	4/-	4in.	900ft.	13/-
4in.	600ft.	8/-	5in.	1,800ft.	25/-
5in.	1,200ft.	15/-	5¾in.	2,400ft.	34/-
5¾in.	1,800ft.	19/6	7in.	3,600ft.	44/-
7in.	2,400ft.	27/-	**Quadruple Play**		
			3in.	600ft.	8/6

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Post Free less 5% on three reels.
Quantity and Trade enquiries invited.
NOTE. *Large tape stocks at all branches.*

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Latest black and silver metal finish. Consisting of centre cabinet size 16½in. x 13in. x 8in. deep with lift up lid together with two 10 x 6 speaker cabinets which clip on ends of main cabinet size 4½in. x 13in. x 8in. making overall size of 25½in. x 13in. x 8in. High quality chrome fittings. Will take almost any autochanger or tape deck. Approx. half price at **£3.19.0**

Ditto, but less chrome, takes 7 x 4 speaker. **£2.19.9**

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1% to 5% 100Ω to 5mΩ.
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6BR7	10/-	10F1	9/6	807	9/6	EF40	9/6	PCC88	12/-	UBC41	9/6
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6BW6	12/6	10LD11	10/-	956	3/-	EF42	7/6	PCC189	11/-	UBF80	7/6
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6J5GT	5/6	12Q7GT	6/6	DL96	8/3	EL42	10/6	PL82	7/6	UF80	8/-
6J7G	5/-	14S7	17/6	DY86	7/-	EL81	9/-	PL83	7/-	UF85	8/6
6J7GT	8/6	19AQ5	5/6	DY87	7/6	EL84	7/6	PL84	7/6	UF86	9/-
6K7G	3/6	20D1	9/-	EABC80	7/-	EM80	7/6	PY31	7/6	UF89	7/6
6K7GT	5/6	20F2	9/6	EAF42	9/-	EM81	8/6	PY32	9/9	UL41	11/6
6K8GT	8/6	20L1	15/-	EB41	6/-	EM84	8/-	PY33	10/6	UL84	7/9
6L1	9/6	20P3	12/-	EB91	3/6	EM85	11/-	PY80	6/6	UM80	7/-
6L6G	9/6	20P4	15/-	EBC33	8/6	EM87	10/-	PY81	6/6	UU9	7/6
6L18	7/6	25L6GT	7/-	EBC41	10/6	EY51	8/-	PY82	6/6	UY41	8/-
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6P25	13/-	30C15	14/-	EBF80	7/6	EY88	8/6	PY88	8/6	VR105	7/6
6Q7G	6/6	30C17	14/-	EBF83	8/-	EZ40	9/-	PY800	9/-	VR150	7/6
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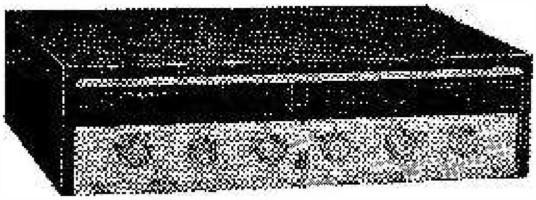

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Cabinet £4.10.0. extra

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 ● $\pm$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 $3\frac{7}{8}$" H x $15\frac{1}{4}$" W x 12" D. ● Custom install it in wall, your own cabinet, or use as a free standing unit. ● Build it in 20 hours.

Kit K/AR-14 (less cab.) ..	kit	£54.0.0. P.P. 13/6
A/AR-14 (less cab.) ..	..	£75.0.0. P.P. 13/6

Cabinet extra: Teak or Walnut finish £4.10.0

Kit K/AR-17 **£39.0.0** P.P. 10/6

Ready to use A/AR-17 **£59.0.0** P.P. 10/6

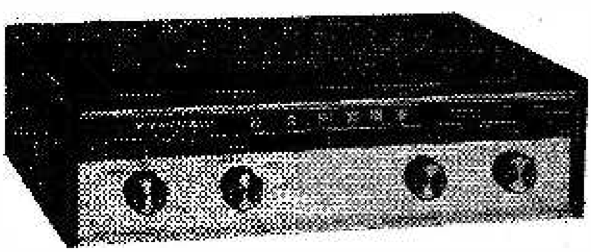
Cabinet £3.10.0. extra

Unbeatable Value in a 14 Watt FM Stereo Receiver, AR-17

● 28 transistor, 7 diode circuit for natural transparent sound, instant operation, long trouble-free life. ● 14 watts music power, 10 watts RMS from 25–35,000 Hz at $\pm$1dB. ● Automatic stereo indicator light. ● Adjustable phase control for maximum separation. ● Complete front panel controls. ● Flywheel tuning. ● All critical circuits including FM "front-end" factory assembled and aligned. ● Circuit board assembly. ● Compact $10\frac{3}{8}$" D x 3" H x 12" W. ● Front panel stereo headphone jack.

Kit K/AR-14 (less cab.) ..	kit	£39.0.0. P.P. 13/6
A/AR-14 (less cab.) ..	..	£59.0.0. P.P. 13/6

Cabinet extra: Teak or Walnut finish £3.10.0



Kit K/AR-27 **£22.10.0** P.P. 10/6

Ready to use A/AR-27 **£32.0.0** P.P. 10/6

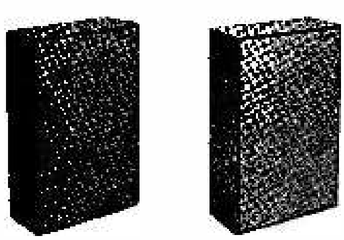
Cabinet £3.10.0 extra

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. ● $\pm$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.

Kit K/AR-27 (less cab.) ..	kit	£22.10.0. P.P. 10/6
A/AR-27 (less cab.) ..	..	£32.0.0. P.P. 10/6

Cabinet extra: Teak or Walnut finish £3.10.0



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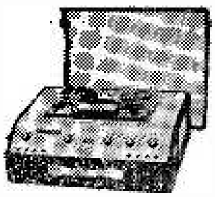

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FOR THIS SPECIFICATION

$\frac{1}{4}$ track stereo or mono record and playback at $7\frac{1}{2}$, $3\frac{3}{4}$ and $1\frac{7}{8}$ips. Sound-on-sound and sound-with-sound capabilities. Stereo record, stereo playback, mono record and playback on either channel. 18 transistor circuit for cool, instant and dependable operation. Moving coil record level indicator. Digital counter with thumbwheel zero reset. Stereo microphone and auxiliary inputs and controls, speaker/headphone and external amplifier outputs . . . front panel mounted for easy access. Push-button controls for operational modes. Built-in stereo power amplifier giving 4 watts rms per channel. Two high efficiency 8 x 5in. speakers. Operates on 230V a.c. supply.

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

Latest Portable Stereo Record Player, SRP-1

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12 x 12 watts output.
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£32.16.0. *less cabinet.* P.P. 10/6
Cabinet £3.16.0. extra
Ready-to-Use A/TSA-12
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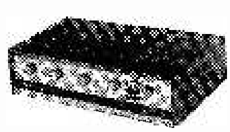
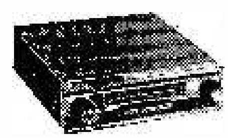


FOR THIS SPECIFICATION

17 transistors, 6 diode ± circuit. 1dB, 16 to 50,000 Hz at 12 watts per channel into 8 ohms. Output suitable for 8 or 15 ohm loudspeakers. 3 stereo inputs for Gram, Radio and Aux. Modern low silhouette styling. Attractive aluminium, golden anodised front panel. Handsome assembled and finished walnut veneered cabinet available. Matches Heathkit models TFM-1 and AFM-2 transistor tuners.

Full range power . . . over extremely wide frequency range. Special transformerless output circuitry. Adequately heat-sinked power transistors for cool operation—long life, 6 position source switch.

High-performance CAR RADIO, CR-1



Superb long and medium wave entertainment wherever you drive. Complete your motoring pleasure with this compact outstanding unit.

8 Latest semi-conductors (6 transistors, 2 diodes). For 12 volt positive or 12 volt negative earth systems. Powerful output (4 watts). Pre-assembled and aligned tuning unit. Push-button tone and wave change controls. Positive manual tuning. Easy circuit board assembly.

Instant operation, no warm-up time. Tastefully styled to harmonise with any car colour scheme. High quality output stage will operate two loudspeakers if desired. Can be built for a total price.

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This De-Luxe, 7 transistor, 3 diode portable radio covers long and medium wave-bands with an easy-tune dial and uses battery-saving circuitry to ensure longer life and more hours of listening pleasure. Choice of Brown or Black real leather case.
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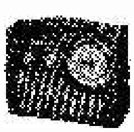
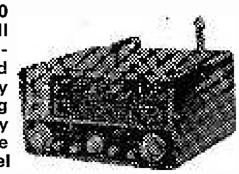


UXR-1

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).
Kit K/UXR-1 £12.8.0. colour case. P.P. 4/6
Ready-to-Use A/UXR-1 £14.8.0. P.P. 4/6
Kit K/UXR-1 £13.8.0. real leather. P.P. 4/6
Ready-to-Use A/UXR-1 £15.10.0. P.P. 4/6

'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.



Kit K/GC-1U
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£46.8.0. P.P. 10/6

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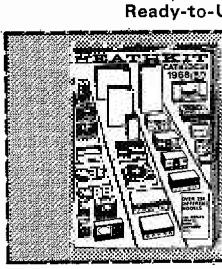

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7"	1200ft.	15/–	1800ft.	17/6	2400ft.	26/–

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5"	600ft.	12/6	900ft.	17/–	1200ft.	27/6
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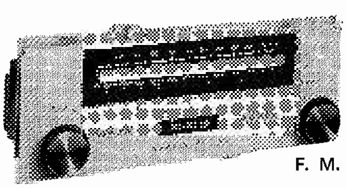
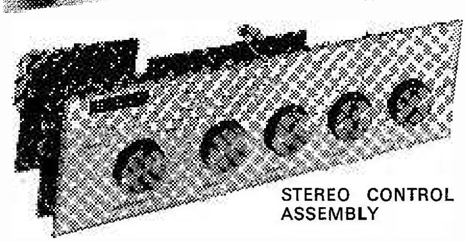


F. M. TUNER



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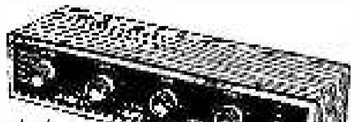
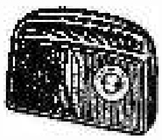


Controls: Selector switch Tape speed equalisation switch ($3\frac{3}{4}$ and $7\frac{1}{2}$ i.p.s.). Volume. Treble. Bass. 2 position scratch filter and 2 position rumble filter.

Specification: Sensitivities for 10 watt output at 1KHz. *Tape head:* 3mV (at $3\frac{3}{4}$ i.p.s.). *Mag. P.U.:* 2mV. *Cer. P.U.:* 80mV. *Radio:* 100mV. *Aux.:* 100mV. *Tape/Rec. output:* 100mV. Equalisation for each input is correct to within ± 2dB (R.I.A.A.) from 20Hz to 20KHz. *Tone control range:* Bass ± 13dB at 60 Hz. Treble ± 14dB at 15KHz. *Total distortion:* (for 10 watt output) <1·5%. *Signal noise:* <—60dB. A.C. mains 200–250v.

Size $12\frac{1}{2}$in. long, $4\frac{1}{4}$in. deep, $2\frac{3}{4}$in. high. Teak finished case. **Price 8 gns.** p. & p. free.

THE DORSET (600mW output)



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MAINS POWER PACK KIT: **9/6** extra.

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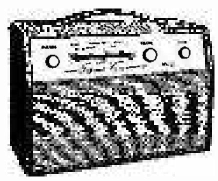

7-transistor fully tunable M.W.–L.W. portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction.

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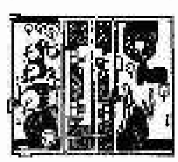
X101 10W SOLID-STATE HI-FI AMP WITH INTEGRAL PRE-AMP



Specifications: *RMS Power Output* (into 3 ohms speaker): 10 watts continuous (sine wave), 13 watts music power. *Sensitivity* (for rated output): 1mV into 3K ohms (0·33 micro-amp). *Total Distortion* (at 1Khz): at 5 watts 0·35%, at rated output 1·5%. *Frequency Response:* Minus 3dB points 20Hz and 40Khz. *Speaker:* 3–4 ohms (3–15 ohms may be used). *Supply voltage:* 24V d.c. at 800mA (6–24V may be used).

Control assembly: including resistors and capacitors.

1. Volume: PRICE **5/-**.
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3. Comprehensive bass and treble: PRICE **10/-**.

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Power Supplies for the X101:
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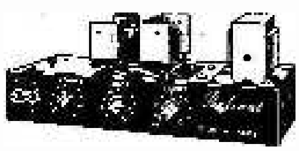

THE RELIANT 10W SOLID-STATE HIGH QUALITY AMPLIFIER

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″ × $3\frac{1}{4}$″ × 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.

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THE VISCOUNT

Integrated High Fidelity Transistor Stereo Amplifier

SPECIFICATIONS: Output: 10 watts per channel into 3 to 4 ohms speakers (20 watts monoral). Input: 6 position rotary selector switch (3 pos. mono and 3 pos. stereo), P.U., Tuner, Tape and Tape Rec. Sensitivities: All inputs 100mV into 1·8M ohm. Frequency response: 40H2—20 KH2+2db. Tone controls: Tone controls flat (Baxandall type), separate bass and treble controls. Treble 13db lift and cut at 15KH2. Bass 15db lift and 25db cut at 60H2. Volume controls: Separate for each channel. AC Mains input: 200-240v. 50-60H2. Size $12\frac{1}{2}$ × 6 × $2\frac{1}{2}$in. in teak-finished case. Built and tested.

PRICE 13½ Gns. Postage & Packing 7/6 extra.

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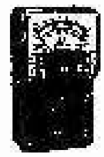
POCKET MULTI-METER



Size $3\frac{7}{8}$ x $2\frac{1}{8}$ x $1\frac{3}{8}$in. Meter size $2\frac{1}{8}$ x $1\frac{3}{8}$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 0–100kΩ. 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.

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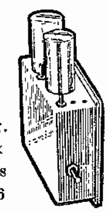

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A complete Loud Speaker system on one frame, combining three matched ceramic magnet speakers with a low loss cross over network. Peak handling power 10 watts. Impedance 15 ohms. Flux density 11,000 gauss. Resonance 40–60 c/s. Frequency range 50c/s to 20kc/s. Size $13\frac{1}{2}$ x $8\frac{1}{16}$ 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 **39/6** 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 $4\frac{1}{2}$″ x $1\frac{3}{4}$″. 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

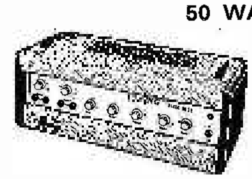
Size $5\frac{1}{2}$ x $3\frac{1}{2}$ x $1\frac{1}{2}$in. For IF and RF alignment and AF output 700 c/s frequency coverage 460 kc/s to 2 mc/s in switched frequencies. Ideal for alignment to our Elegant Seven and Musette. Built and tested. **49/6** P. & P. 3/6.

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.

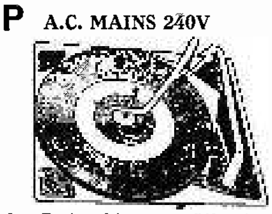
50 WATT AMPLIFIER A.C. MAINS 200–250V



An extremely reliable general purpose valve amplifier—with six electronically mixed inputs. Suitable for use with: mics, guitars, gram, tuner, organs, etc. Separate bass and treble controls.

Price 27 gns.
Plus 20/– p. & p.

RECORD PLAYER SNIP A.C. MAINS 240V

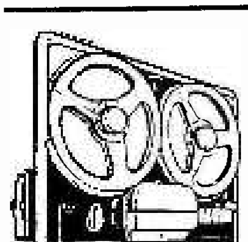


The "Princess" 4-speed automatic record changer and player engineered with the utmost precision for beauty, long life, and trouble free service. Will take up to ten records which may be mixed 7″ to 10″ or 12″. Patent stylus brush cleans stylus after each playing and at shut off, the pick-up locks itself 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.

MOTEK



3 Speed 2 track Tape Deck complete with heads, takes 7in. spool.

Incorporating 3 motors.

A.C. mains, 240 volts, listed at £21.0.0.

Our Price £9.19.6, plus 10/– P. & P.

HARVERSON'S EXCLUSIVE BARGAIN HI-FI GUITAR AMPLIFIERS

Refurbished units with a peak to peak output of approx. 20 watts. Brief spec: AC Mains 200/240v. EF86, ECC83, 2×ECL82, Bridge Rect. Two inputs via standard jack sockets for 1 or 2 guitars or mikes controlled by single volume control. Separate bass and treble controls. Tremolo with variable speed control and standard jack socket for remote control of tremolo on/off by foot switch. Standard jack socket for speaker output (3 or 15 ohm). Completely self-contained unit in attractive portable case finished in dark rexine with gold trim and folding handle. Size approx. 14¾ x 11¼ x 8in. Also capable of really Hi-Fi reproduction when used with a gram deck or radio tuner. Each amplifier is carefully tested and checked by us before despatch, and due to the fact that the cabinets are slightly store soiled we are offering them at the unrepeatable price of **£12.12.0.** Carr. 10/-. Standard Jack Plugs **2/6 each,** if required. FOOT SWITCH for tremolo on/off control complete with lead and jack plug **27/6.**

BRAND NEW 3 OHM LOUDSPEAKERS
5in. **14/**; 6½in. **18/6**; 8in. **27/-**; 7×4in. **18/6**; 10×6in. **27/6.** E.M.I. 8×5in. with high flux magnet **21/-**, E.M.I. 13½× 8in. with high flux ceramic magnet **42/-** (15 ohm **45/-**). E.M.I. 13×8in. with two inbuilt tweeters and crossover network. 3 or 15 ohms **4 gns.** P. & P. 5in. 2/-, 6½ & 8in. 2/6, 10 & 12in. 3/6 per speaker.
BRAND NEW. 12in. 15w. H/D Speakers, 3 or 15 ohms. Current production by well-known British maker. Now with Hiflux ceramic ferrobar magnet assembly **£5.10.0.** P. & P. 5/-. Guitar models: 25w. **£6.0.0** 35w. **£8.0.0.**
E.M.I. 3½in. HEAVY DUTY TWEETERS. Powerful ceramic magnet. Available in 3 or 8 ohms **15/-** each; 15 ohms **18/6** each. P. & P. 2/6.
12in. "RA" TWIN CONE LOUDSPEAKER. 10 watts peak handling. 3 or 15 ohm, **35/-.** P. & P. 3/6.
35 OHM SPEAKERS
3½in. **12/6**; 7×4in. **21/-.** P. & P. 2/- per speaker.

VYNAIR AND REXINE SPEAKERS AND CABINET FABRICS app. 54in. wide. Usually 35/- yd., our price **13/6** yd. length. P. & P. 2/6 (min. 1 yd.). S.A.E. for samples.

LATEST COLLARO MAGNAVOX 363 STEREO TAPE DECK. Three speeds 4 track, takes up to 7in. spools. Send S.A.E. for latest prices.
B.S.R. TD2, 4-TRACK STEREO TAPE DECK. Send S.A.E. for latest price.
QUALITY PORTABLE TAPE RECORDER CASE. Brand new. Beautifully made. Only **49/6.** P. & P. 8/6.
Dual Purpose Bulk Tape Eraser and Tape Head Demagnetiser 35/-. P. & P. 3/-.
ACOS CRYSTAL MIKES. High imp. for desk or hand use. High sensitivity. **18/6.** P. & P. 1/6.
ACOS HIGH IMPEDANCE CRYSTAL STICK MIKES. Listed at 42/-. OUR PRICE **21/-.** P. & P. 1/6.
SPECIAL OFFER! MOVING COIL STICK MIKE. Fitted on/off switch for remote control. High quality. High or low impedance. (State imp. required). BARGAIN PRICE 30/-. P. & P. 2/6.

NEW S.T.C. TYPE 25 MINIATURE RELAYS—12 volt. 4 s/p, c/o contacts. 1 amp rating. Coil resistance 185 ohms. Size approx. ¾×1¼×1⅛in. high. **10/-** each. P. & P. 1/6.
Also some similar to above but coil resistance 5,800 ohms 48 volt operation. **8/-** each. P. & P. 1/6.

SPECIAL OFFER! PLESSEY TYPE 29 TWIN TUNING GANG. 400pF + 146pF. Fitted with trimmers and 5:1 integral slow motion. Suitable for nominal 470 kc/s I.F. Size approx. 2×1×1⅝in. Only **8/6.** P. & P. 2/6.
MAINS TRANSFORMER. For transistor power supplies. Pri. 200/240v. Sec. 9–0–9 at 500 mA. **11/-.** P. & P. 2/6. Pri. 200/240v. Sec. 12–0–12 at 1 amp. **14/6.** P. & P. 2/6. Pri. 200/240v. Sec. 10–0–10 at 2 amp. **27/6.** P. & P. 3/6.
MATCHED PAIR OF 2½ WATT TRANSISTOR DRIVER AND OUTPUT TRANSFORMERS. Stack size 1¼×1⅛× ⅞in. Output trans. tapped for 3 ohm and 15 ohm output. **10/-** pair plus 2/-. P. & P.
PARMEKO 7-10 watt OUTPUT TRANSFORMERS to match pair of ECL82's in push-pull. Sec. tapped 3·75, 7·5 and 15 ohm. Stack size 2¼×1×2in. approx. ONLY **12/-.** P. & P. 3/-.
7-10 watt OUTPUT TRANSFORMERS to match pair of ECL86's in push-pull to 3 ohm output. ONLY **11/-.** P. & P. 2/6.
BRAND NEW MAINS TRANSFORMERS for Bridge Rectifier. Pri. 240v. AC. Sec. 240v. at 50mA and 6·3v. at 1·5 amp. Stack size 2¾×¾×2¼in. **10/6.** P. & P. 3/6. **(Special quotations for quantities).**

HIGH GRADE COPPER LAMINATE BOARDS
8×6×1/16in. FIVE for **10/-** P. & P. 2/-.

TRANSISTOR STEREO 8 + 8 MK II

Now using Silicon Transistors in first five stages on each channel resulting in even lower noise level with improved sensitivity. A really first-class Hi-Fi Stereo Amplifier Kit. Uses 14 transistors giving 8 watts push pull output per channel (16W. mono). Integrated pre-amp. with Bass, Treble and Volume controls. Suitable for use with Ceramic or Crystal cartridges. Output stage for any speakers from 3 to 15 ohms. Compact design, all parts supplied including drilled metal work. Cir-Kit board, attractive front panel, knobs, wire, solder, nuts, bolts—no extras to buy. Simple step by step instructions enable any constructor to build an amplifier to be proud of. Brief specification: Freq. response ±3dB. 20–20,000 c/s. Bass boost approx. to +12dB. Treble cut approx. to −16dB. Negative feedback 18dB over main amp. Power requirements 25V at ·6 amp.
PRICES: AMPLIFIER KIT **£10.10.0;** POWER PACK KIT **£3.0.0;** CABINET **£3.0.0.** All Post Free.
Circuit diagram, construction details and parts list (free with kit) **1/6.** (S.A.E.).

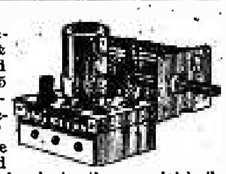
SPECIAL PURCHASE! E.M.I. 4-SPEED PLAYER
Heavy 8½in. metal turntable. Low flutter performance 200/250 v. shaded motor (90 v. tap). Complete with latest type lightweight pick-up arm and mono cartridge with t/o stylii for LP/78. LIMITED NUMBER ONLY **63/-.** P. & P. 6/6.

4-SPEED RECORD PLAYER BARGAINS
Mains models. All brand new in maker's packing.
E.M.I. MODEL 999 Single Player with unit mounted pick-up arm and mono cartridge. £5.5.0
B.S.R. UA25 with latest mono compatible cart. . . £6.19.6
All plus Carriage and Packing 6/6.
LATEST GARRARD MODELS. All types available 1000 SP25, 3000, AT60 etc. Send S.A.E. for latest Bargain Prices!
PLINTH UNITS cut out for Garrard Models 1000, 1025, 2000, 3000, AT60, SP25. With rigid perspex cover. OUR PRICE **5 gns.** complete. P. & P. 8/6.

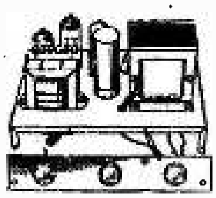
LATEST B.S.R. X1H MONO COMPATIBLE CARTRIDGE With turnover sapphire stylii suitable for playing 78, EP, LP and Stereo records with mono equipment. ONLY 22/6. P. & P. 2/-.
SONOTONE 9TAHC compatible Stereo Cartridge with diamond stylus **50/-** P. & P. 2/-.
MONO T/O CARTRIDGE. Complete with LP & 78 sapphire stylii. Brand new **12/6.** P. & P. 2/-.
FEW ONLY! ACOS GP69/1. For EP and LP **10/-,** P. & P. 2/-.

QUALITY RECORD PLAYER AMPLIFIER
A top-quality record player amplifier employing heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, Treble and Volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7″ w. × 3″ d. × 6″ h. Ready built and tested. PRICE **75/-.** P. & P. 6/-.
ALSO AVAILABLE mounted on board with output transformer and speaker ready to fit into cabinet below. PRICE **97/6.** P. & P. 7/6.
DELUXE QUALITY PORTABLE R/P CABINET
Uncut motor board size 14½×12in. clearance 2in. below, 5½in. above. Will take above amplifier and any B.S.R. or GARRARD autochanger or Single Player Unit (except AT60 and SP25). Size 18×15×8in. PRICE **£3.9.6.** P. & P. 9/6.

FM/AM TUNER HEAD



Beautifully designed and precision engineered by Dormer & Wadsworth Ltd. Supplied ready fitted with twin ·0005 tuning condenser for AM connection. Prealigned FM section covers 86–102 Mc/s. I.F output 10·7 Mc/s. Complete with ECC85 (6L12) valve and full circuit diagram of tuner head. Another special bulk purchase enables us to offer these at **27/6** each. P. & P. 3/-.
GORLER F.M. TUNER HEAD. 88–100 Mc/s. 10·7 Mc/s. I.F. **15/-** plus 2/6 P. & P. (ECC85 valves, **8/6** extra)



3-VALVE AUDIO AMPLIFIER MODEL HA34
D signed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7½″ w. × 4″ d. × 4¾″ h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, separate Bass, Treble and volume controls. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. Complete with knobs, valves, etc., wired and tested for only **£4.5.0.** P. & P. 6/-.
HSL "FOUR" AMPLIFIER KIT. Similar in appearance to HA34 above but employs entirely different and advanced circuitry. Complete set of parts, etc. **79/6,** P. & P. 6/-.

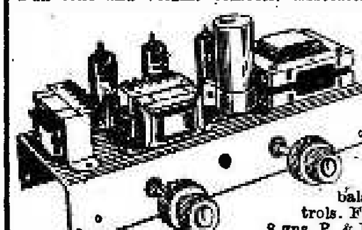
SPECIAL OFFER!

A great opportunity to purchase a first class GENERAL PURPOSE, HIGH GAIN, HIGH SENSITIVITY, PORTABLE AMPLIFIER. Completely self contained and can be used for a variety of purposes, i.e. Intercom, Baby Alarm, Booster unit for transistor radios etc., also ideal for classroom unit etc. **Works perfectly with our special offer High Impedance Dynamic Microphone (30/-).** Output 1000mw. Uses standard 9 volt battery. Smart two tone carrying case size 12×4×9in. fitted standard input jack socket, volume controls, 7×4in. speaker. Completely built and tested, brand new with full maker's guarantee.

Only 79/6 P. & P. 5/6

STEREO AMPLIFIER

Incorporating 2 ECL86s and 1 EZ80, heavy duty, double wound mains transformer. **Output 4 watts per channel.** Full tone and volume controls. Absolutely complete.



ONLY £5.9.6
P. & P. 8/-. Super De-luxe version with ECL86 valves, sep. bass, treble and balance controls. Full feedback. **8 gns.** P. & P. 8/-.

HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT Type TA1

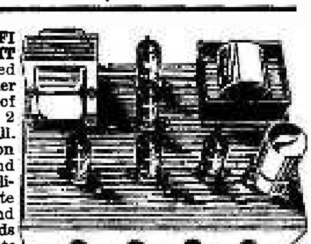
- Peak output in excess of 1½ watts.
- All standard British components.
- Built on printed circuit panel size 6×3in.
- Generous size Driver and Output Transformers.
- Output transformer tapped for 3 ohm and 15 ohm speakers.
- Transistors (GET114 or 81 Mullard AC128D and patched pair of AC128 o/p).
- 9 volt operation.
- Everything supplied, wire, battery clips, solder, etc.
- Comprehensive easy to follow instructions and circuit diagram **2/6 (Free with Kit). All parts sold separately. SPECIAL PRICE 45/-.** P. & P. 3/-. Also ready built and tested, **52/6.** P. & P. 3/-.

HARVERSON'S SUPER MONO AMPLIFIER

A super quality gram amplifier using a double wound mains transformer, EZ80 rectifier and ECL82 triode pentode valve as audio amplifier and power output stage. Impedance 3 ohms. Output approx. 3·5 watts. Volume and tone controls. Chassis size only 7″ wide × 3″ deep × 6″ high overall. AC mains 200/240v. Supplied absolutely Brand New completely wired and tested with valves and good quality output transformer. LIMITED NUMBER ONLY.

OUR ROCK BOTTOM BARGAIN PRICE **49/6** P. & P. 6/-

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2 EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3–15 Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet **2/6** (Free with parts). **All parts sold separately. ONLY £7.9.6.** P. & P. 8/6. Also available ready built and tested complete with std. input sockets, **£9.5.0.** P. & P. 8/6.

Open all day Saturday
Early closing Wed. 1 p.m.
A few minutes from South Wimbledon Tube Station

HARVERSON SURPLUS CO. LTD.

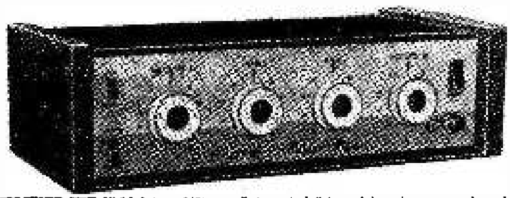
170 HIGH ST., MERTON, S.W.19 Tel.: 01-540 3985

SEND STAMPED ADDRESSED ENVELOPE WITH ALL ENQUIRIES

Please write clearly
PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. P. & P. ON OVERSEAS ORDERS CHARGED EXTRA.

BARGAIN OPPORTUNITIES FROM TRS

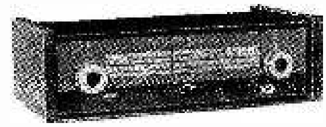
TRS STEREO 4-4 a bargain in quality amplifiers



AMPLIFIER KIT £7.19.6 (pp. 3/6)
TRS POWER UNIT £2.5.0. (p.p. 2/6)
TRS SIMPLEX CABINET £1.17.6 (p.p. 2/6)
4 prs DIN plugs and sockets if purchased separately.
Complete kit inc. cabinet/power pack DIN plugs and socket.
£12.10.0 (post free)

Integrated 5 transistor stereo amp based on newly developed Mullard 4 watt modules and BC.108 pre-amp. Suitable also for speakers from 3 to 15 ohms. With base and treble cut/boost. Response—60 to 14KHz —3dB. This excellently engineered layout requires only wiring between controls and modules. Complete with metal chassis and simplex teak-ended cabinet for instant assembly.

A NEW DE-LUXE FM MONO/STEREO TUNER FROM TRS



This advanced design computable Hi Fi mono/stereo FM tuner comes in easy-to-assemble pre-fabricated units engineered to the highest standards of efficiency and performance. Valuable refinements include switchable A.F.C., automatic noise suppression, flywheel tuning, stereo indication light, excellent audio response. Sensitivity better than 5 microvolts. Stereo can be added later if so required. Inclusion of a world-famous Gorler I.F. amplifier ensures superb performance. Excellent chassis design made specially to fit the standard TRS Simplex cabinet system. Styled to match the TRS Stereo 4-4.

S.A.E. brings full details.

Total price (for mains operation) **£29.10.0** (carr. 10/-)

- A.F.C. & A.G.C.
- Noise Limiter
- Chassis Ready Built
- Pre-tuned

Kit to make MONO tuner inc. chassis and tuning assembly (p.p. 3/6) **15 gns.**
Add-on Stereo Unit (p.p. 2/6) **10 gns.**
Power Unit (p.p. 2/6) **£2.5.0**
Simplex Cabinet (p.p. 2/6) **£1.17.6**

MAKE YOUR OWN BOOKSHELF SPEAKER

With a set of matched speakers and cross-over from TRS. Comprises modern style high efficiency 5in. bass unit with special cone assembly, X-over and 2½in. tweeter for mounting into your own cabinet or baffle system. Smooth response from 80 to 20,000 Hz. Loading up to 6 watts. Made by a world-famous manufacturer. A genuine bargain for only **79/6** (carr. 5/-).

GARRARD & E.M.I. PLAYING UNITS

LM3000 Record Player with 9T.A. Stereo Cartridge. **£10.5.0**
AT.60 Mk. II De-luxe Auto-changer, die-cast turntable. Less cartridge. **£13.5.0**
SP.25 De-luxe single record player, die-cast turnable. Less cartridge. **£11.19.6**
Brand new in makers' cartons. Packing and carriage on any one of above 7/6.
GARRARD PLINTH WB.1 in fine Teak for any of above units. (Packing and carriage 5/-). **65/-.**
Garrard clear-view rigid perspex cover (carriage 4/6), **62/6.**
CARTRIDGES AVAILABLE TO PURCHASERS OF ABOVE PLAYER UNITS—STEREO. Sonotone 9TA/HC Ceramic with diamond **49/6.** Decca Deram with diamond **92/6; MONO** Acos GP91-1 **21/-;** Goldring MX2M **26/6.**
E.M.I. 4 SPEED PLAYER Motor and 10½ T/Table unit and free-mounting pick up arm with high quality T/O Cartridge, (p.p. 5/-). **69/6.**

FREE LIBRARY TAPE WALLETS

With each reel of this fine tape by an internationally famous manufacturer we give a well made wallet in simulated leather with space for a reel each side. This is professional quality full frequency tape with metalised leader/stop foils.

5¾in. reel, 1200ft., with wallet **17/6**
5in. reel, 900ft., with wallet, **12/6**
7in. reel, 1800ft., with wallet, **22/6**

TRS MULLARD AMPLIFIERS

STEREO 10-10 Kit with valves and passive control system KIT—**£17.10.0**; BUILT **£21.** (*carr. either,* 12/6)
2 + 2 **VALVE PRE-AMP** Built, complete with valves, dial, etc. **13 gns.** (*carr.* 7/6)
5-10 MONO AMPLIFIER. Basic Kit, with valves, etc., **9½ gns** Built, **11½ gns.** (*carr. 7/6 either*).
Basic Kit with passive control system, **£11.19.6.** Built **£14.19.0** (*carr. 7/6 either*).
PRE-AMP 2 VALVE KIT £6.12.6. Built **£8.10.0** (*carr. 5/6 either*)
BASIC 5-10 AMPLIFIER AND 2 VALVE PRE-AMP Assembled, wired and tested, complete **£19.10.0** (*carr.* 10/-).
Send S.A.E for leaflet giving full technical specifications on these world famous amplifiers.

HERE'S A GREAT BARGAIN RECORD PLAYER AMPLIFIER

Ideal for building into a record player. 2 watts output with volume and tone controls. Double wound mains isolating transformer. EZ80 and ECL82 valves. Stylish two-tone escutcheon panel. Printed circuit assembly. Ready wired and tested for instant assembly. 3Ω matching o/p transformer. Recommended playing unit—E.M.I. unit at 69/6 above. Amplifier as described. **79/6**

TRS Stereo Decoder

For reception of stereo broadcasts on your existing FM receiver. Based on Mullard design. 6 Transistors. Beacon indicator. All coils prechecked and aligned. (Carr. & Packing 2/6). **5 Gns.**

TRS Power Supply Unit

Heavy duty, ready built mains power unit of great reliability and suitable for the heaviest demands, without stress or fluctuation, very easy to mount. Size: 3¼ x 2 x 2in
PU.12 giving 12V at 1.5A: **PU.24** giving 24V at 0·75A. Either model (p.p. 2/6) **45/-**

WIRE WOUND RESISTORS—COATED TYPES Stand. values 25 ohms—10000 ohms, 5w. **1/6**, 10w. **1/9**, 15w. **2/3.** SPECIAL VALUES 15K—35K ohms 5w. **2/6.**
PRE-SET WIRE WOUND POTS. Slotted Knurled Knob T.V. Type 25 ohms—30Kohms **3/3.** 50 Kohms **4/6.** Ditto carbon track 50K—2 Meg. **3/3.**
SLIDER PRESETS ¼w. 10K 2·2 Meg. **2/-** 10 ohms—5K **2/6.**
SKELETON PRESETS for P/circuit use. 100 ohms—2·5 Meg. **2/-.**
STANDARD W/WOUND POTS. Long Spindle. 100 ohms—50000 ohms each **6/-.** 100,000 ohms each **6/9.**
VOLUME CONTROLS 1¼in. dia. Long Spindles. Famous make. All values 5000 ohms—2 Megohms. Guaranteed 12 months. Log or Linear tracks. Less Sw. **3/6.** DP Sw. **5/-.** Log or Linear tracks. Centre Tapped ½ Megohm Log, 1 Megohm less Sw. **5/-. TWIN GANGED STEREO** 1¼in. dia., Long Spindles. All values 5000 ohms to 2 Megohms less Sw., ea. **8/6.** All values 100K to 2 Megohms with DP Sw., ea. **10/6.**

STEREO BALANCE CONTROLS Log/Anti-Log 5K, ½ Meg., 1 Meg., 2 Meg. ea. **9/6.**
VEROBOARD—All standard sizes including 2½ x 5in., **3/8;** 2½ x 3¾in., **3/-;** 3¾ x 5in., **5/2;** 3¾ x 3¾in., **3/8;** 2½ x 17in., **12/6.** All accessories and tools in stock.
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ALUM. CHASSIS. 18g. Plain undrilled folded 4 sides, 2in. deep. 6 x 4in. **4/6;** 8 x 6in. **5/9;** 10 x 7in. **6/9;** 12 x 6in. **7/6;** 12 x 8in. **8/-** etc.
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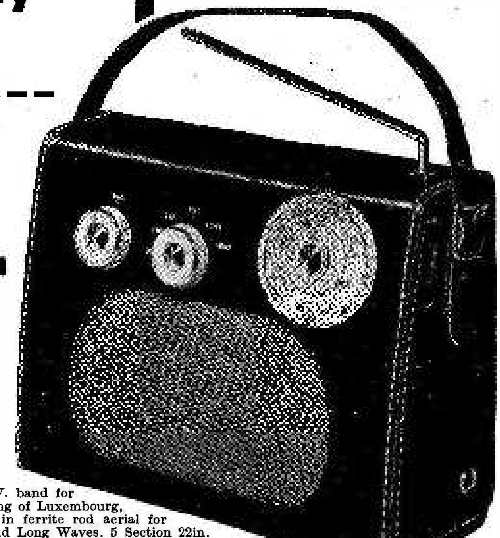


roamer seven mk IV

SEVEN WAVEBAND PORTABLE AND CAR RADIO WITH A SUPER SPECIFICATION GIVING OUTSTANDING PERFORMANCE !

7 FULLY TUNABLE WAVEBANDS—

MW1, MW2, LW, SW1, SW2, SW3 AND TRAWLER BAND.

Extra M.W. band for easier tuning of Luxembourg, etc. Built in ferrite rod aerial for Medium and Long Waves. 5 Section 22in. chrome plated telescopic aerial for Short Waves—can be angled and rotated for peak S.W. listening. Socket for Car Aerial. Powerful push pull output. 7 transistors and 2 diodes including Micro-Alloy R.F. Transistors. Famous make 7 x 4in. P.M. speaker for rich-tone volume. Air spaced ganged tuning condenser. Separate on/off switch, volume control, wave change switches and tuning control. Attractive case with hand and shoulder straps. Size 9 x 7 x 4in. approx. First grade components. Easy to follow instructions and diagrams make the Roamer 7 a pleasure to build with guaranteed results.

Total building costs **£5.19.6** P. & P. 7/6

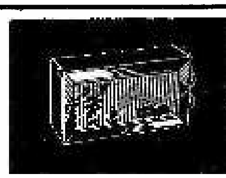
Personal Earpiece with switched socket for private listening **5/-** extra.

Parts price list and easy build plans 3/- (Free with parts).

pocket five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND (to 50 meters approx.) PORTABLE WITH SPEAKER AND EARPIECE

Attractive black and gold case. Size 5½ x 1½ x 3½in. Fully tunable over both Medium and Long Waves with extended M.W. band for easier tuning of Luxembourg, etc. All first grade components—7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, fine tone moving coil speaker, also Personal Earpiece with switched socket for private listening. Easy build plans and parts price list 1/6 (FREE with parts).

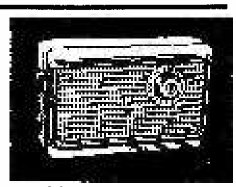


Total building costs **44'6** P. & P. 3/6

transona five

MEDIUM WAVE, LONG WAVE AND TRAWLER BAND (to 50 metres approx.) PORTABLE WITH 3in. SPEAKER AND EARPIECE

Attractive case with red speaker grille. Size 6¼ x 4½ x 1½in. Fully tunable. 7 stages—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker also Personal Earpiece with switched socket for private listening. All first grade components. Easy build plans and parts price list **1/6** (FREE with parts).

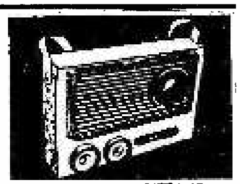


Total building costs **47'6** P. & P. 3/9

super seven

THREE WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive case size 7½ x 5½ x 1½in. with gilt fittings. The ideal radio for home, car or outdoors. Covers Medium and Long Waves and Trawler Band. Special circuit incorporating 2 R.F. Stages, push pull output, ferrite rod aerial, 7 transistors and 2 diodes, 3in. speaker (will drive larger speaker) and all first grade components. Easy build plans and parts price list 2/- (FREE with parts). (Personal Earpiece with switched socket for private listening **5/-** extra).

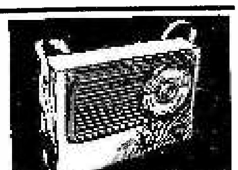


Total building costs **69'6** P. & P. 4/6

roamer six

SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive case with gilt fittings. Size 7½ x 5½ x 1½in. World wide reception. Tunable on Medium and Long waves, two short waves, Trawler Band Plus an extra M.W. band for easier tuning of Luxembourg, etc. Sensitive ferrite rod aerial and telescopic aerial for Short waves. All top grade components. 8 stages—6 transistors and 2 diodes including Micro-Alloy R.F. Transistors etc. (Carrying strap 1/6 extra). Easy build plans and parts price list 2/- (FREE with parts). (Personal Earpiece with switched socket for private listening **5/-** extra).



Total building costs **79'6** P. & P. 4/6

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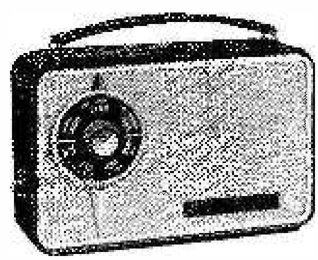
NEW LOOK melody six

TWO WAVEBAND PORTABLE



8 stages—6 transistors and 2 diodes. Covers Medium and Long Waves. Top quality 3in. Loudspeaker for quality output and also with Personal Earpiece with switched socket for private listening. Two R.F. stages for extra boost. High "Q". Ferrite Rod Aerial. Push-pull output. Handsome pocket size case with gilt fittings. Size 6½ x 4 x 2in. Easy build plans and parts price list 2/- (FREE with parts).

Total building costs **69'6** P. & P. 4/3

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TRANSONA FIVE	☐	SUPER SEVEN	☐
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Parts price list and plans for ....

Name ....

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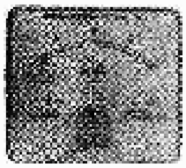
SEW PANEL METERS

Send S.A.E. for full lists. Other ranges available. Please include postage. Special quotations for quantities.



CLEAR PLASTIC METERS

5mA	37/6	300V. D.C.	37/6
10mA	37/6	15V. A.C.	37/6
50mA	37/6	300V. A.C.	37/6
100mA	37/6	S Meter 1mA	39/6
500mA	37/6	VU Meter	59/6
1 amp.	37/6	1 amp. A.C.*	37/6
5 amp	37/6	5 amp. A.C.*	37/6
10V. D.C.	37/6	10 amp. A.C.*	37/6
20V. D.C.	37/6	20 amp. A.C.*	37/6
50V. D.C.	37/6	30 amp. A.C.*	37/6

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

50µA	37/6	750mA	25/-
50-0-50µA	35/-	1 amp	25/-
100µA	35/-	2 amp	25/-
100-0-100µA	32/6	5 amp	25/-
200µA	32/6	3V. D.C.	25/-
500µA	37/6	10V. D.C.	25/-
500-0-500µA	25/-	20V. D.C.	25/-
1mA	25/-	50V. D.C.	25/-
1-0-1mA	25/-	100V. D.C.	25/-
2mA	25/-	150V. D.C.	25/-
5mA	25/-	300V. D.C.	25/-
10mA	25/-	500V. D.C.	25/-
20mA	25/-	750V. D.C.	25/-
50mA	25/-	15V. A.C.	25/-
100mA	25/-	50V. A.C.	25/-
150mA	25/-	150V. A.C.	25/-
200mA	25/-	300V. A.C.	25/-
300mA	25/-	500V. A.C.	25/-
500mA	25/-	S meter 1mA	29/6
		VU meter	39/6

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

50µA	42/6	10V. D.C.	27/6
50-0-50µA	39/6	20V. D.C.	27/6
100µA	39/6	50V. D.C.	27/6
100-0-100µA	35/-	300V. D.C.	27/6
500µA	29/6	15V. A.C.	27/6
1mA	27/6	300V. A.C.	27/6
5mA	27/6	S meter 1mA	35/-
10mA	27/6	VU meter	42/6
50mA	27/6	1 amp. A.C.*	27/6
100mA	27/6	5 amp A.C.*	27/6
500mA	27/6	10 amp. A.C.*	27/6
1 amp	27/6	20 amp. A.C.*	27/6
5 amp	27/6	30 amp. A.C.*	27/6

Type MR.52P. 2½in. square fronts.

50µA	59/6	100-0-100µA	45/-
50-0-50µA	49/6	500µA	42/6
100µA	49/6	1mA	37/6

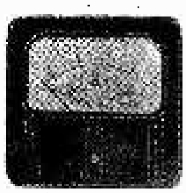
Type MR.85P. 4½in. × 4¾in. fronts.

50µA	69/6	15 amp.	49/6
50-0-50µA	59/6	30 amp.	49/6
100µA	59/6	20V. D.C.	49/6
100-0-100µA	59/6	50V. D.C.	49/6
200µA	55/-	150V. D.C.	49/6
500µA	52/6	300V. D.C.	49/6
500-0-500µA	49/6	15V. A.C.	49/6
1mA	49/6	300V. A.C.	49/6
1-0-1mA	49/6	S meter 1mA	55/-
5mA	49/6	VU meter	69/6
10mA	49/6	1 amp. A.C.*	49/6
50mA	49/6	5 amp. A.C.*	49/6
100mA	49/6	10 amp. A.C.*	49/6
500mA	49/6	20 amp. A.C.*	49/6
1 amp.	49/6	30 amp. A.C.*	49/6
5 amp.	49/6		

Type MR.65P. 3⅜in. × 3¼in. fronts.

50µA	65/-	50V. D.C.	39/6
50-0-50µA	52/6	150V. D.C.	39/6
100µA	52/6	300V. D.C.	39/6
100-0-100µA	49/6	15V. A.C.	39/6
500µA	45/-	50V. A.C.	39/6
1mA	39/6	150V. A.C.	39/6
5mA	39/6	300V. A.C.	39/6
10mA	39/6	500V. A.C.	39/6
50mA	39/6	S meter 1mA	45/-
100mA	39/6	VU meter	65/-
500mA	39/6	50mA A.C.*	39/6
1 amp.	39/6	100mA A.C.*	39/6
5 amp.	39/6	200mA A.C.*	39/6
10 amp.	39/6	500mA A.C.*	39/6
15 amp.	39/6	1 amp. A.C.*	39/6
20 amp.	39/6	5 amp. A.C.*	39/6
30 amp.	39/6	10 amp. A.C.*	39/6
50 amp.	39/6	20 amp. A.C.*	39/6
10V. D.C.	39/6	30 amp. A.C.*	39/6
20V. D.C.	39/6		

BAKELITE PANEL METERS

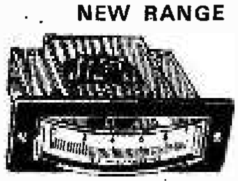


*Moving iron, all other moving coil.

Type MR.65. 3½in. square fronts.

25µA	67/6	500mA	32/6	30V. A.C.*	32/6
50µA	45/-	1 amp	32/6	50V. A.C.*	32/6
50-0-50µA	42/6	5 amp.	32/6	150V. A.C.*	32/6
100µA	42/6	15 amp.	32/6	300V. A.C.	32/6
100-0-100µA	42/6	30 amp.	32/6	1 amp. A.C.*	32/6
500µA	39/6	50 amp.	32/6	5 amp. A.C.*	32/6
1mA	32/6	5V. D.C.	32/6	10 amp. A.C.*	32/6
1-0-1mA	32/6	10V. D.C.	32/6	20 amp. A.C.*	32/6
5mA	32/6	20V. D.C.	32/6	30 amp. A.C.*	32/6
10mA	32/6	50V. D.C.	32/6	50 amp. A.C.*	32/6
50mA	32/6	150V. D.C.	32/6	VU meter	59/6
100mA	32/6	300V. D.C.	32/6		

NEW RANGE OF "SEW" EDGEWISE METERS



MODEL PE 70. Dimensions 3 17/32 × 1 11/32 × 2⅜in. deep overall. Available as follows:

50 microamp	57/6	500 microamp	49/6
50-0-50 microamp	55/-	1 milliamp	45/-
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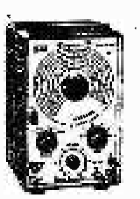
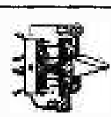
200 microamp	52/6	Post extra.	

TE-20D RF SIGNAL GENERATOR



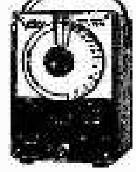
Accurate wide range signal generator covering 120 Kc/s—500 Mc/s on 6 bands. Directly calibrated. Variable RF. attenuator, audio output. Xtal socket for calibration. 220/240V. A.C. Brand new with instructions. £15. Carr. 7/6. Size 140 x 215 x 170 mm.

T.M.C. 1000 SERIES KEY SWITCHES



Brand new with knobs as follows: 1 way, 2 c/o, **7/6**; 1 way, 2 c/o 2b, **7/6**: 1 way 4 c/o, **8/-**; 2 way, 3m, 3m, **8/6**; 2 way, 2 c/o, 2 c/o, **8/6**.
Post extra. Quantities available.

TY75 AUDIO SIGNAL GENERATOR



Sine Wave 20 CPS—200 Kc/s. Square Wave 20 CPS—30 Kc/s. High and low impedance output. Output variable up to 6 volts. 220/240 volts A.C. Brand new with instructions. £16. Carr. 7/6. Size 210 x 150 x 120 mm.

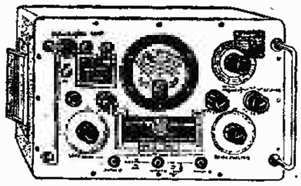
CT.53 SIGNAL GENERATORS. 8·9–15·5 and 20–300 Mc/s. Output 1µV–100mV. Mains operated. Perfect condition less charts. **£12.10.0.** Carr. 15/-.

NOMBREX TRANSISTORISED TEST EQUIPMENT

All Post Paid with Battery

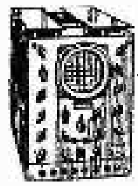
Model 22. Power Supply 0–15V DC	£14.10.0
Model 30. Audio Generator	£19.10.0
Model 31. R.F. Signal Generator.	£12.10.0
Model 32. C.R. Bridge.	£10.10.0
Model 33. Inductance Bridge.	£20.0.0
Model 66. Inductance Bridge.	£18.9.0
Model 61. Power Supply.	£6.10.0

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



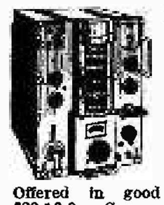
An excellent general purpose D/B oscilloscope. T.B. 2cps.–750 Kc/s. Bandwidth 5·5 Mc/s. Sensitivity 33mV/CM. Operating voltage 0/110/200/250V. A.C. Supplied in excellent working condition. **£22.10.0.** Or complete with all accessories, probe, leads, lid, etc. **£25.** Carriage 30/-.

AM/FM SIGNAL GENERATORS

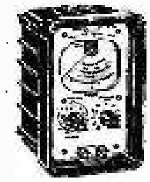
Oscillator Test No. 2. A high quality precision instrument made for the ministry by Airmec. Frequency coverage 20–80 Mc/s. AM CW/FM. Incorporates precision dial, level meter, precision attenuator 1µV–100mV. Operation from 12 volt D.C. or 0/110/200/250 volt A.C. Size 12 × 8½ × 9in. Supplied in brand new 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 19½ 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



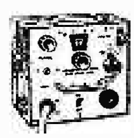
AF Absorption Wattmeter

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

COSSOR DOUBLE BEAM OSCILLOSCOPES

Type 1035. General purpose. A.C. Coupled. **£35** each. Carr. 30/-.

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.

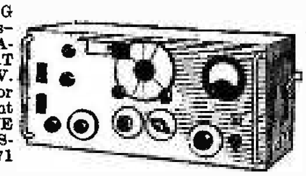
AVOMETERS

Supplied in excellent condition, fully tested and checked. Complete with prods, leads and instructions.

Model 47A **£9.19.6.**

P. & P. 7/6 each.

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/-. TF.142E Distortion Factor Meter **£20.** Carr. 20/-. 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.** TF.1371 Wide Band Millivolt Meter. Brand New **£50.**

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.

AMERICAN TAPE

First grade quality American tapes. Brand new. Discount on quantities.

3in. 225ft. L.P. acetate	3/6
3¼in. 600ft. T.P. mylar	10/-
5in. 600ft. std. plastic	8/6
5in. 900ft. L.P. acetate	10/-
5in. 1,200ft. D.P. mylar	15/-
5in. 1,800ft. T.P. mylar	22/6
5¾in. 1,200ft. L.P. acetate	12/6
5¾in. 1,200ft. L.P. mylar	16/-
5¾in. 1,800ft. D.P. mylar	2/6
5¾in. 2,400ft. T.P. mylar	39/6
7in. 1,200ft. std. acetate	12/6
7in. 1,800ft. L.P. acetate	15/-
7in. 1,800ft. L.P. mylar	20/-
7in. 2,400ft. D.P. mylar	25/-
7in. 3,600ft. T.P. mylar	45/-

Postage 2/-. Over £3 post paid.

TAPE CASSETTES

C60–60 minutes	10/3
C90–90 minutes	14/3

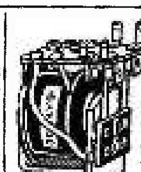
Over £2 post paid.

LUCAS 20/0/20 AMMETERS. Brand new boxed. Suitable car/motorcycle. **12/6.** P. & P. 2/-.

EVERSHED VIGNOLES SERIES II 500 VOLT MEGGERS. Perfect condition **£21.** P. & P. 10/-.

DUBILIER NITROGEL CONDENSERS. Brand new. 8 mfd. 800V. **8/6.** P. & P. 2/-; 2 mfd. 5,000V., **42/6.** P. & P. 5/-.

OMRON MK2 RELAYS



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

LELAND MODEL 27 BEAT FREQUENCY OSCILLATORS

0–20 Kc/s. Output 5 K or 500 ohms. 200/250 V. A.C. offered in excellent condition. **£12.10.0.** Carriage 10/-

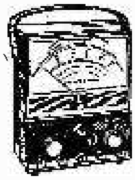
WS.88 TRANS/RECEIVERS. A and B sets available. Complete with valves. **39/6** each. P. & P. 4/6. Accessories available.

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

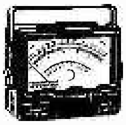
MULTIMETERS *for EVERY purpose!*

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/-.

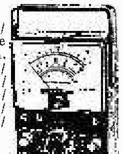
TE-900 20,000Ω/VOLT GIANT MULTIMETER mirror scale and overload protection. 6in. full view meter. 2 colour scale. 0/2·5/10/250/1,000/5,000v. A.C. 0/25/12·5/10/50/250/1,000/5,000v. D.C. 0/50μA/110/100/500 mA/10 amp. D.C. 02K/200K/20 MEG. OHM. **£15.** P. & P. 5/-.



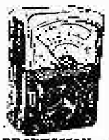
LAFAYETTE 57 Range Super 50kΩ/volt Multimeter. D.C. volts 125mV–1000V. A.C. volts 1·5V–1000V. D.C. current 25μA–10 amp. Ohms 0–10megΩ. dB −20to +81 dB. Overload protection. **£12.10.0.** Carr. 3/6.



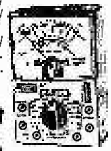
MODEL AS-100D. 100KΩ/VOLT. 5in. mirror scale. Built-in meter protection. 0/3/12/60/120/300/600/1,200v. D.C. 0/6/30/120/300/600v. A.C. 0/10μA/6/60/300mA/12 amp. 0/2K/200K/2M/200MΩ. −20 to +17dB. **£12.10.0.** P. & P. 3/6.



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.



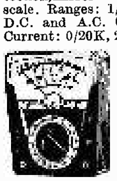
MODEL AF-105. 50kΩ/Volt. Mirror scale, built-in meter protection. 0/·3/3/12/60/120/300/600/1,200v. D.C. 0/6/30/120/300/600/1,200v. A.C. 0/30μA/6/60/300mA/12 Amp. 0/10K/1M/10M/100MΩ. −20 to +17dB **£8.10.0.** P. & P. 3/6.



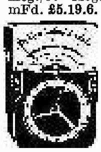
PROFESSIONAL 20,000 opv LAB. TYPE Multitester. Automatic overload protection, mirror scale. Ranges: 1/10/50/250/500/1,000 volts. D.C. and A.C. 0–500μA, 10mA, 250mA. Current: 0/20K, 200K, 2 megohm. Decibels: −20 to +22dB. **£5.19.6.** P. & P. 2/6.

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.

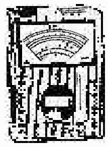
MODEL TE-70. 30,000 O.P.V. 0/3/15/60/300/600/1,200v. D.C. 0/6/30/120/600/1,200v. A.C. 0/30μA/3/30/300mA. 0/16K/160K/1·6M/16 Meg. μ. **£5.10.0.** P. & P. 3/-.



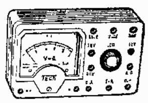
MODEL TE-80. 20,000 O.P.V. 0/10/50/100/500/1,000v. A.C. 0/5/25/50/250/500/1,000v. D.C. 0–50μA, 5/50/500mA. 0/6K/60K/600 K/6 meg. **£4.17.6.** P. & P. 3/-.



MODEL 250J. 2,000 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.



ADVANCE TEST EQUIPMENT

Brand new and boxed in original sealed cartons

VM.76	**VALVE VOLTMETER** R.F. measurements in excess of 100 Mc/s and D.C. measurements up to 1000V. with accuracy of ±2% D.C. range 300 MV to 1 KV. A.C. range 300 MV to 300 V RMS. Resistance ·02–500 MΩ. Price £72.
VM.78	**A.C. MILLIVOLT METER** Transistorised 1 MV-300V. Frequency 1 c/s to 1 Mc/s. Price £55.
VM.79	**UHF MILLIVOLT METER** Transistorised. A.C. range 10 MV-3V. D.C. current range ·01μ/A–3MA. Resistance 1 ohm–10 megohms. Price £125.
H1B	**AUDIO SIGNAL GENERATOR** 15 c/s–50 Kc/s, sine or square wave. Price £30.
J1B	**AUDIO SIGNAL GENERATOR** 15 c/s–50 Kc/s. Price £30.
J2B	**AUDIO SIGNAL GENERATOR** As per J1B except fitted with output meter. Price £35.
TT1S	**TRANSISTOR TESTER** £37.10.0

Carriage 10/- per item.

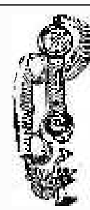
NO.76 TRANSMITTER

2-12 Mc/s. Crystal Controlled (not supplied). 807PA. Operation 12V. D.C. (Rotary transformer). 9 watts output. C.W. only. New condition. **72/6.** Carr. 12/6.

FIELD TELEPHONES TYPE L

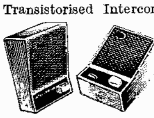
Generator ringing, metal cases. Operates from two 1·5V. batteries (not supplied). Excellent condition. **£4.10.0** per pair. Carr. 10/-.

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/-.

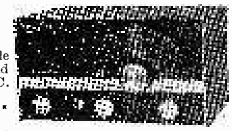
MODEL ZQM TRANSISTOR CHECKER

It has the fullest capacity for checking on A, B and Ico. Equally adaptable for checking diodes, etc. Spec: A: 0·7–0·9967. B: 5–200. Ico: 0–50 microamps 0–5mA. Resistance for diode 200Ω-1MΩ. Supplied complete with instructions, battery and leads. **£5.19.6.** P. & P. 2/6

CREED MORSE REPERFORATORS

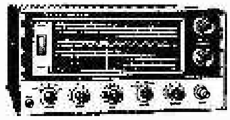
TYPE 7W/3 200/240v. D.C. Brand new **£15.** Carriage 30/-.

UNR-30 4-BAND COMMUNICATION RECEIVER



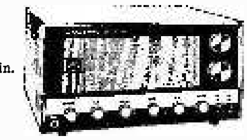
Covering 550 Kc/s–30 Mc/s. Incorporates variable BFO for CW/SS/B reception. Built in speaker and phone jack. Metal cabinet. Operation 220/240V. A.C. Supplied brand new, guaranteed with instructions. Carr. 7/6 **13 gns.**

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



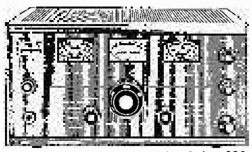
8 Valves, 5 bands incorporating 2 MECHANICAL FILTERS for exceptional selectivity and sensitivity. Frequency coverage on 5 bands 150–400 Kc/s, 550/1,600 Kc/s, 1·6–4·0 Mc/s, 4·8–14·5 Mc/s, 10·5–30 Mc/s. Circuit incorporates R.F. stage, aerial trimmer, noise limiter, B.F.O. product detector, electrical 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



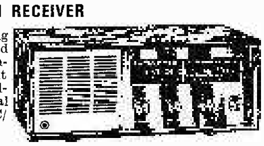
5 BAND AM/CW/SSB AMATEUR AND SHORT WAVE. 150 Kc/s—400 Kc/s and 550 Kc/s—30 Mc/s. F.E.T. front end ● 2 mechanical filters ● Huge dial ● Product detector ● Crystal calibrator ● Variable BFO ● Noise limiter ● S Meter ● 24 in. Bandspread ● 230V A.C./12V. D.C. neg. earth operation ● RF gain control. Size 15in.×9¾in.×8½in. Wt. 18 lbs. EXCEPTIONAL VALUE £45. Carr. 10/-. S.A.E. for full details.

TRIO COMMUNICATION RECEIVER MODEL 9R-59DE



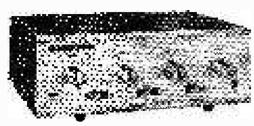
4 band receiver covering 550 Kc/s to 30 Mc/s, continuous and electrical bandspread on 10, 15, 20, 40 and 80 metres. 8 valve plus 7 diode circuit. 4/8 ohm output and phone jack. SSB-CW ● ANL ● Variable BFO ● S meter ● Sep. bandspread dial ● IF 455 Kc/s ● Audio output 1·5 W. ● Variable RF and AF gain controls. 115/250V. A.C. Mains. Beautifully designed. Size: 7×15×10in. With instruction manual and service data. **£39.15.0,** carr. paid. **SPECIAL OFFER— Trio Communication Type Headphones.** Normally £5.19.6. OUR PRICE **£3.15.0** if purchased with receiver.

LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER



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.

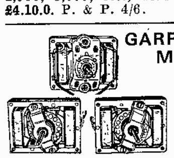
GARRARD DECKS

Brand new and guaranteed.

1000 mono	£6.6.0
1025 mono	£7.10.0
1025 stereo	£7.19.6
2025 TC less cartridge	£7.19.6
SP25 Mk.II less cartridge	£12.10.0
A70 Mk.II less cartridge	£12.12.0
LAB80 Mk.II less cart, with base	£27.10.0

Carr. 7/6 each.
Wooden Plinths for Garrard Series 1,000, 2,000, 3,000, etc., with perspex cover. **£4.10.0.** P. & P. 4/6.

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/-.

RECORDING HEADS

Reuter ¼-track. As fitted to Collaro Mk. IV and Studio Decks. High imp. record playback, low imp. erase. Brand new. **19/6** pair. **Miniflux** ½ track, record **12/6.**
Cosmocord ½ Track Heads.

High imp. record/playback	65/-
Low imp. erase	20/-

Marriott ½ Track Heads.

High imp. record/playback	65/-
Low imp. erase	20/-

Post extra.

★ TRANSISTORISED FM TUNER ★

6 TRANSISTOR HIGH QUALITY TUNER, SIZE ONLY 6×4×2½in. 3 I.F. stages. Double tuned discriminator. Ample output to feed most amplifiers. Operates on 9V battery. Coverage 88–108Mc/s. Ready built ready for use. Fantastic value for money. **£6.7.6.** P. & P. 2/6.
Stereo multiplex adaptors **5 gns.**

HOSIDEN DH04S 2-WAY STEREO HEADPHONES

Each headphone contains a 2½in. woofer and a ⅞in. tweeter. Built in individual level controls 25– 18,000 c.p.s. 8Ω imp. with cable and stereo plug. **£5.19.6.** P. & P. 2/6.

AUTO TRANSFORMERS

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

150 W.	£1.12.6. P. & P. 3/6.
300 W.	£2.7.6. P. & P. 3/6.
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/-.

G.W. SMITH & CO (RADIO) LIMITED
Phone GERRARD 8204/9155
Cables: SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

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

PRACTICAL WIRELESS

VOL 44 No 8

Issue 742

DECEMBER 1968

TOPIC OF THE MONTH

No Title

MANY writers say that finding a telling title for a piece of prose is the hardest part of the exercise. Certainly, with a good heading in front of you, the task becomes lighter, more purposeful, for the headlines contain the terms of reference for what follows. It's rather like the chicken and the egg teaser—what comes first, title or text?

One writer who adopts the title-first gambit is our columnist Henry. When we approached him to take on a regular feature he sat, pondered, then sprang to life with the suggestion "Practically Wireless". Very apt, he claimed: "practically" (in a practical manner), "wireless" (wireless), "by Henry" (one of my pet names used specifically by the wife when about to ask awkward questions). In effect, he went on, a column dealing with practical aspects of wireless written to provoke discussion and controversy.

And we fell for it, not realising that even the neatest of titles can boomerang owing to different connotations of the words. Consequently, Henry has had to endure the occasional quip that although his *critiques* are sometimes *practically* wireless they often don't make it. And last week, a reader suggested that Henry was none other than the proprietor of one of our well-known advertisers and was thus riding two horses at once!

But whatever the merits of the title, there is no doubt that the feature has done the job intended. Henry effects a deliberate light-hearted approach, but regular readers will know that underlying the humour lurk penetrating and shrewd thrusts born of an intimate knowledge of what goes on in the world of radio and electronics.

Alas, even the best of contributors have their black sides. Aided and abetted by his accomplice Pax (another pseudonym, not a new detergent), who has provided the illustrations, he has conspired to work in scurrilous (and libellous) digs at your editor which have been eliminated only by the utmost diligence.

This month, however, they have been allowed to get one through the censor, simply as a generous salute to the fact that they have now passed the 50 mark. Congratulations, and may the next 50 episodes be as entertaining. Finally, not having the genius(?) of Henry we were stuck for a title for this leader. Hence the title! W. N. STEVENS—*Editor.*

NEWS AND COMMENT

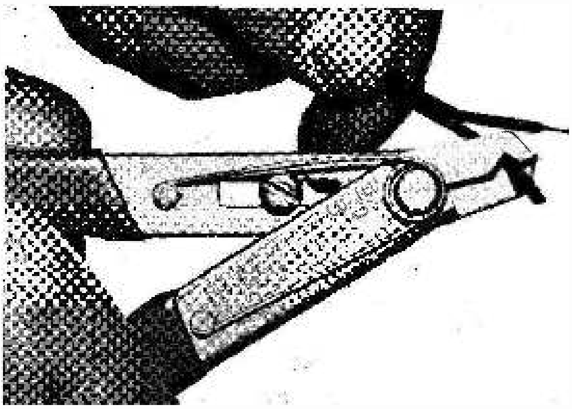
CONSTRUCTIONAL

OTHER FEATURES

JANUARY ISSUE WILL BE PUBLISHED ON DECEMBER 8th

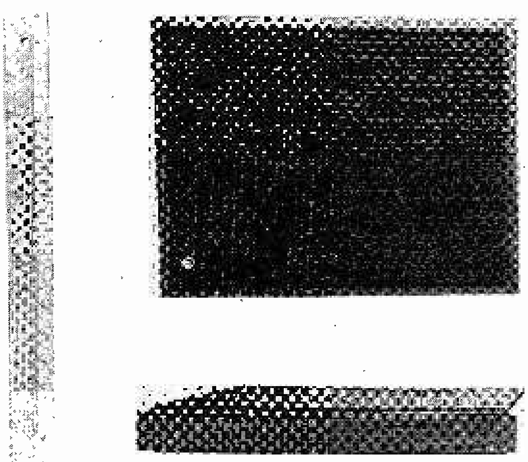
NEWS AND COMMENT...

NEW "BIB" TOOL



Multicore Solders Ltd., Hemel Hempstead, Herts., introduce their Model 6 Bib wire stripper and cutter. It enables insulation to be removed without nicking the wire and the aperture setting for different diameters is simply adjusted by a sliding screw set in one of the handles. This cutter also features two cutting positions—one for normal flex and the other for cutting wire after it has been connected to a tag or bolt. Price of the Model 6 is 8s 6d.

MINIATURISING HI-FI



Oakland Trading Co. of London announce the new P.20 speaker unit.

The unit has an excellent response value within a frequency range of 40c/s to 20kc/s, but what is surprising is that the P.20, complete in a solid teak waterproof cabinet is only 21 inches deep. This will certainly enable the enthusiast to miniaturise his installation.

It has sensitivity rating of 85dB/M for 1W and a power capability of 20W peak (10W r.m.s.).

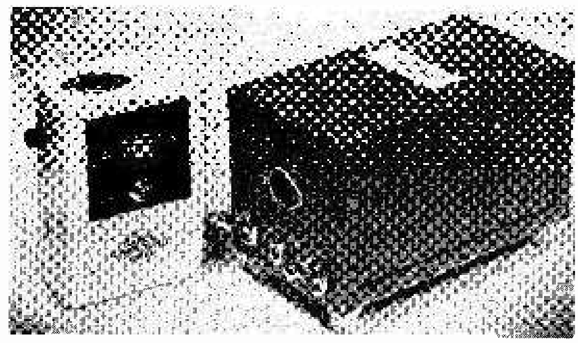
The P.20 measures 18 inches high by 14 inches wide.

Further details from: The Oakland Trading Company, 68 Lupus Street, London, S.W.1.

BETTER RADIO 2 IN SCOTLAND

A substantial improvement in the signal strength of Radio 2 in parts of Southern Scotland is expected following the installation of four new broadcasting transmitters ordered recently from the Marconi Company by the BBC. The equipment radiates the Radio 2 signal in the medium waveband and provides a service to hundreds of thousands of listeners in Glasgow and Edinburgh areas.

NEW SYNCHRONISER FOR TAPE AND FILM



Now, with the introduction of new low-cost equipment from "Carol" Cinesound, recording anywhere in lip-sync precision with the movie film is possible and incredibly simple. The additional recording unit R.1 required is not much bigger than a packet of cigarettes.

This has been achieved by making two entirely separate, but compatible units, a Record Model R.1 and a Playback Model P.1.

The Record Model R.1 is battery operated. The Playback Model P.1 has its own mains operated power supply. These units will operate with most tape recorders, projectors and cameras.

You can film and record every shot with natural sound as it actually happens. Or, you can record at home using your projector with the Model R.1 to make precisely synchronised sound tracks.

The P.1 automatically generates a continuous tone when operating, and this tone is broken only when the camera or projector starts to operate. Editing, therefore, is extremely simple because if the tape recorder is allowed to run for a second or two before filming each shot, the sync. track can be subsequently monitored and the start and finish of the sound track to each shot located precisely.

Also, the camera produces its own synchronising track and therefore both spring-driven and electric cameras may be used at any normal film or tape speed. This is a truly versatile system requiring no special processing nor expensive special tape, but for those who prefer perforated tape, it may be used to form, in effect, a pre-recorded synchronising track.

Only a single modification is required to the camera and that is to provide a simple switch contact which will "make" once every frame to produce the necessary synchronising pulse. The total cost of Models R.1 and P.1 is only £19 16s. 3d.

NEWS AND COMMENT...

PUBLIC: FOR THE USE OF

Recently declassified by the USAF and US Navy is a RCA transistor which is said to provide an output of up to 800W at frequencies to 1Mc/s.

This device, which is still some way from being put on the market is reported to be based on new transistor technology and employs fused or laminated semiconductor materials. Ultrasonic cutting rather than photo-etching techniques are used and glass hermetic sealing is employed.

SATELLITE POST

No, it's not beaming letters to a satellite and sending them round the world, Thailand have issued a postage stamp with a satellite pictured upon it. It is to mark the start of satellite communications in the country following the completion of an earth station by General Telephone & Electronics International. The stamp shows a yellow satellite against a sky of dark blue.

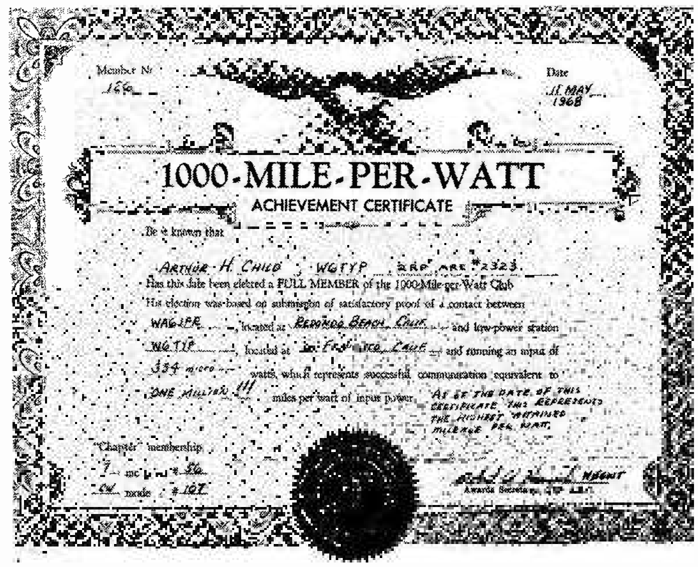
The ground station is also shown together with a section of S.E. Asia and along the top of the stamp, the words "satellite communications" are printed in English and Thai.

CHANGES FOR AMATEUR U.H.F. BAND

The GPO have informed the RSGB that changes will be made to the British Amateur u.h.f. band which is at the moment 427 to 450Mc/s. The band will be split up into two segments—425 to 429Mc/s and 432 to 450Mc/s.

Under the 1959 Geneva Radio Regulations, this section of the frequency allocation is devoted on a primary basis to the radio-location service and on a secondary basis to the amateur service.

HOW ABAHT THIS THEN?



Partridge Electronics, makers of the "Joystick" aerials, have forwarded a print of a certificate sent to them by Arthur Child, W6TYP of San Francisco. Using 354 microwatts, W6TYP established radio communication over 354 air miles, representing the distance of 1,000,000 miles per watt. He used a Joystick antenna to achieve this remarkable performance.

SOLDERING TIPS FROM WELLER

With every Weller "Expert" soldering gun comes a useful booklet on soldering hints and tips. This booklet is fully illustrated. A comprehensive chart is included that shows the correct flux for various base metals, and this is followed up with the six golden rules of soldering.

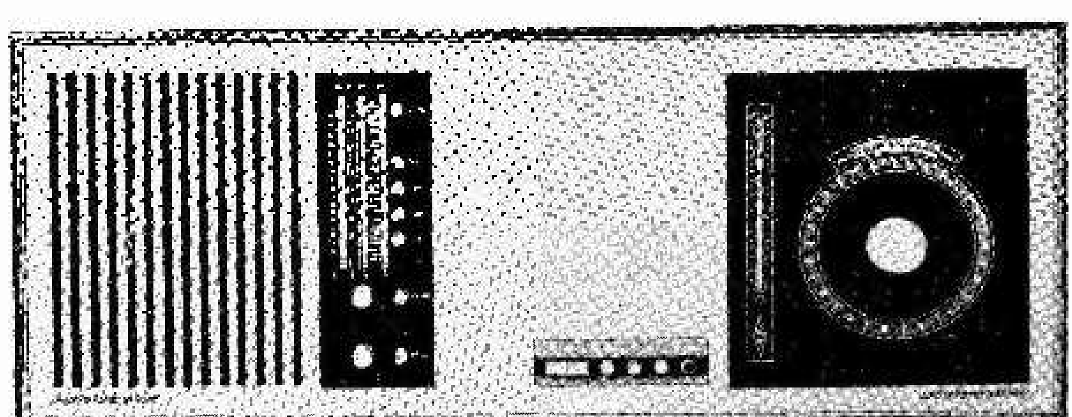
126 TRACK TAPE RECORDER GIVES 46 HOURS CONTINUOUS PLAYBACK

From Shield Laboratories Ltd., 44 Lullington Garth, Woodside Park, London, N.12, we have received details of a combined 4 waveband radio and **126** *track tape recorder giving 46 hours of continuous unrepeated playback time, plus the facility of instantaneous track selection. This equipment incorporates a total of 27 transistors and 15 diodes. Covering V.H.F.–F.M./Long Wave/Medium Wave/Short Wave, with exclusive "Auton Control" to give precise station tuning. A 4 inch wide magnetic tape accommodates 126 separate tracks of 22 minutes each (length of time of a standard LP record). Each track is able to playback so that you need not touch the machine for* **46** *hours. it automatically rewinds after each playback period. Tape speed 3¾in./sec. frequency response 40–14 000c/s. Pause control. Automatic erase. Internal 10 inch wide range loudspeaker plus tweeter. Push-pull 10 watt r.m.s. audio output. External adapter (includes preamplifier) for microphone or record player and can be used as a radiogram or straight through amplifier. Cabinet size is 31 x 13 x 11in. Further details from Shield Laboratories Ltd. 01-445-2825 (evening) or 01-445-0749 (day) 24 hour telephone answering service.*

SCHAUB LORENZ

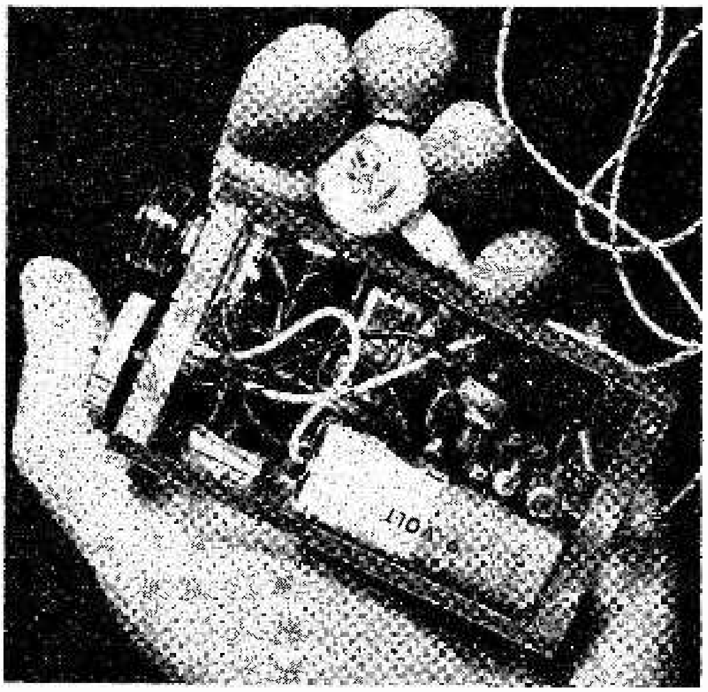
"MUSIC CENTRE"

MODEL 5001



THE MINI-3

R.F. GRAHAM



THIS receiver uses a well tested circuit employing three transistors and two diodes in a five-stage reflexed circuit which gives very good headphone volume. The receiver, with a miniature 9V battery, occupies a case having internal dimensions of only 1$\frac{3}{4}$ × 2$\frac{7}{8}$ × 1$\frac{1}{4}$in. External dimensions are of course a little greater depending on the thickness of material used. It could be accommodated in a box of different size and shape allowing something already to hand to be used: a metal box is unsuitable.

Figure 1 shows the circuit, with Tr1 acting as r.f. amplifier and also as audio amplifier after signal detection by D1 and D2. Tr2 and Tr3 are directly coupled audio stages, with Tr3 giving adequate output for all ordinary listening with a personal phone.

VR1 allows full control over regeneration which is very important for best sensitivity. The on/off switch is incorporated with VR1. VC1 is a compression type capacitor for small size. Its capacitance range is obtained over several turns of a small knob. A midget solid dielectric variable capacitor could be used instead.

Current drain is about 3mA from an ordinary miniature 9V battery, easily obtainable. The receiver also works satisfactorily with a 6V supply

All the components except VC1, the aerial, L1, VR1 and C2 are assembled and wired on a small paxolin panel. When completed the panel is inserted in the case and connected with flying leads to VC1 and the other items just mentioned.

Ferrite Aerial

The aerial input winding L1 is wound with 34 s.w.g. enamelled wire on a ferrite rod aerial 1$\frac{5}{8}$in. long and $\frac{3}{8}$in. in diameter. A single layer of paper is first wound on the rod. The wire is secured near one end at point A, using adhesive. Fifty-four turns are wound side by side and a small loop is then twisted for the tapping. A further 12 turns are wound, continuing in the same direction, and the wire is fixed at B. The loop and coil ends are scraped and tinned.

If the case is not as shown (Fig. 4) and a longer rod can be accommodated this will increase signal pickup. Ferrite rod material cannot be sawn by ordinary means but is brittle and snaps easily: it can thus be gripped lightly in a vice with a little padding at the point where the break is wanted.

Ready-made windings (for superhet receivers) can generally be employed. The existing base coupling winding usually has very few turns and is removed or ignored. The main winding then furnishes the section from A to the tap and some thin insulated wire is used to add the turns required for the tap to B section. These turns may if necessary be on top of the existing coil, but must be in such a direction that A to B is effectively one continuous winding.

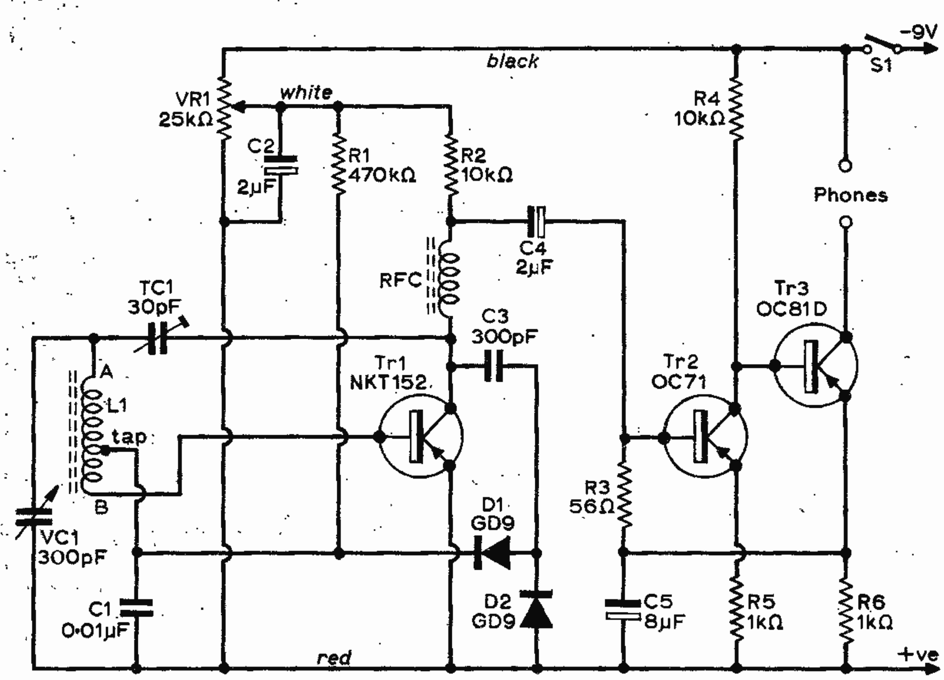


Fig. 1: Circuit diagram of the Mini-3. R3 is 56kΩ not 56Ω.

Receiver Panel

The paxolin panel is only 1$\frac{7}{8}$ × 1$\frac{3}{16}$in. so resistors etc. must be of the small size commonly used for small transistor receivers. The paxolin is $\frac{1}{16}$in. thick and the holes for leads were made with a $\frac{1}{16}$in. drill. The resistors, capacitors and diodes stand vertically. One lead passes down through a hole directly under the components, the other lead being covered with 1mm. sleeving and bent over to reach a second hole as shown in Fig. 2. D1, D2 and C4 are mounted with their positive ends on top so

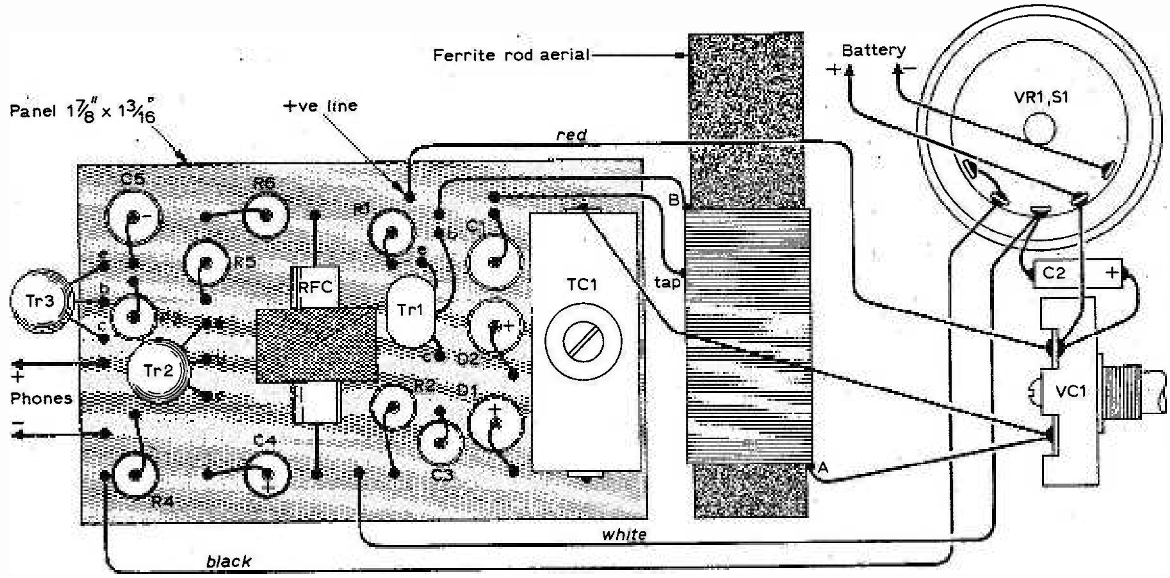


Fig. 2: Top view of paxolin board and connections to separately mounted components.

the negative ends emerge immediately under these components. C5 has its negative end uppermost.

Sleeving is also necessary on the transistor leads. The tops of the transistors are about $\frac{3}{8}$in. above the upper ends of the resistors etc. TC1 tags pass through slots made by drilling holes closely together, a central hole clearing the adjusting screw.

The panel is wired by turning it over and connecting as in Fig. 3. As there is little free space sleeving is used on nearly all wires. Transistor and diode connections must be soldered rapidly to avoid overheating. Unnecessary and lengthy heating of capacitors and resistors is also best avoided.

Pieces of thin insulated flex are soldered to the points indicated and will later be connected to VR1, VC1, and the aerial. If different colours are provided, as shown, this helps easy identification of the connections to be made later.

Phones

Excellent results are obtained with a full-sized headset but a miniature personal phone is easily carried in the pocket with the receiver. Short wire ends were left projecting at the phones points as shown in Fig. 2. When the receiver is in its case, pass the phone leads through a small hole and solder them to these points, covering the joints with sleeving.

If the phones may be changed from time to time a miniature jacket socket can be fitted to the case. The circuit is suitable for medium or high impedance phones, but not for crystal earpieces.

Other Components

VR1 is fixed to the outside of the box with an 8BA bolt, its five tags passing through holes. Should the material used for the box be too thick for the tags to pass right through, solder leads to the tags first, thread them through the holes, then fit VR1 in place.

VC2 is a compression type capacitor with fixing bush threaded for a 6BA bolt and is normally adjusted from the plates' side with a screwdriver. The bolt was removed and a longer one screwed in, the insulation and metal washers being kept as originally. A small disc or knob was then fixed on the free end of the bolt with lock nuts (a toothpaste tube cap can be used). Rotating the knob compresses or releases the plates of VC1 to alter its capacitance.

The ferrite rod was slightly shorter than the inside dimension of the box and was held with glue and a shaped slip of wood pushed between the box and one end of the rod.

The connections between the panel and other items in Fig. 2 can then be made. Figure 4 shows VC1 and VR1 in position: however, the various items could be rearranged to occupy different positions if this were more suitable for a box already available.

Leads were soldered directly to the battery. Alternatively the snap fasteners of an old battery

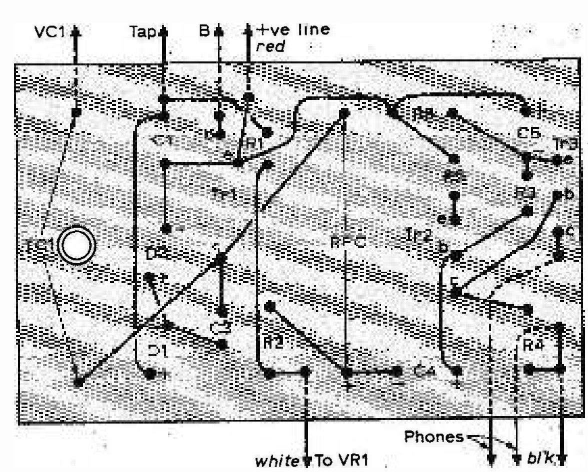


Fig. 3: Wiring on the underside of the panel.

could be used as connectors. If so remember to observe polarity as marked *on the battery itself.*

If a meter is placed in one battery lead the current drain should be zero with the receiver switched off and about 3mA when it is switched on, rising a little as VR1 is rotated. If a large current flows switch off at once and look for a wrong connection or short.

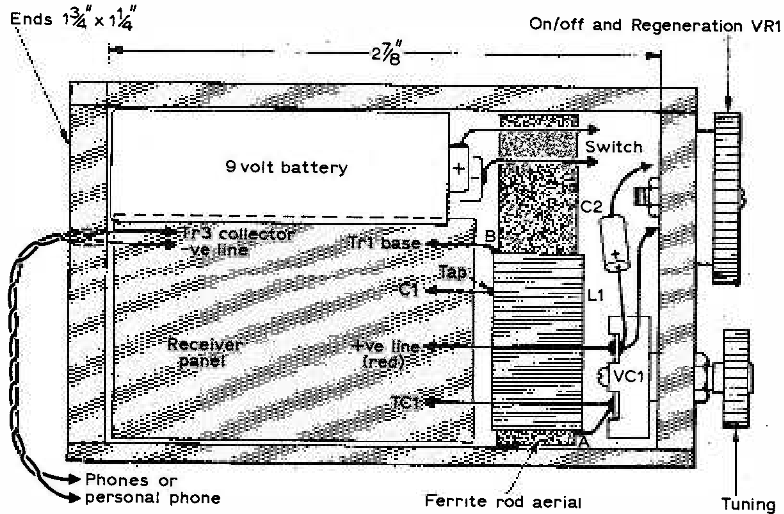


Fig. 4: Case dimensions and general assembly.

Adjustments

Regeneration arises more easily towards the high frequency end of the waveband but should be possible over the whole band when TC1 is suitably adjusted. Unscrew TC1, set VR1 about one-third from zero (off) and screw down TC1 slightly until oscillation arises on tuning through a station near the h.f. end of the band (VC1 near minimum capacitance).

If TC1 is screwed down too far oscillation arises with only a small rotation of VR1 and best volume is not obtained. But if TC1 is not screwed down sufficiently no regeneration can be obtained at the l.f. end of the band (VC1 at full capacitance).

For normal use only rotate VR1 as far as proves necessary for the volume required. Turning VR1 too far (as if it were a volume control) will cause oscillation or loss of signals. VR1 should not be rotated more than about one-half to two-thirds of its movement from the off position. If VR1 is used for critical control of regeneration, in the usual way for a t.r.f. receiver with adjustable reaction or regeneration, the receiver will be very sensitive to weak signals.

An external aerial should not normally be needed. However a few feet of thin insulated wire as a throw-out aerial can be clipped to A.

Case Construction

The box was made from clear Perspex, the ends being $1\frac{3}{4} \times 1\frac{1}{4}$in. and $\frac{1}{4}$in. thick. The sides were $\frac{1}{8}$in. material, each $1\frac{1}{4} \times 3\frac{3}{8}$in. Top and bottom were both $3\frac{3}{8} \times 2$in. This gives a case with internal dimensions of $2\frac{7}{8} \times 1\frac{3}{4} \times 1\frac{1}{4}$in. The top was held with four small screws passing through clearance holes into the ends.

Tuning Range

With the ferrite-rod aerial described tuning covers the most important part of the medium wave band. Full coverage of this band is not achieved because the minimum capacitance of the 300pF compression capacitor is higher than the minimum capacitance of a conventional tuning capacitor.

In some parts of the country it may be felt desirable to tune to the low frequency end of the band. If so some turns should be added to the aerial winding. On the other hand should tuning to the high frequency end of the band be required a few turns can be removed from this winding.

★ components list

Resistors:

R1	470kΩ	R5	1kΩ
R2	10kΩ	R6	1kΩ
R3	56kΩ	All miniature 10%	
R4	10kΩ	VR1	25kΩ with switch

Capacitors:

C1	0·01μF miniature
C2	2μF 9V electrolytic
C3	300pF miniature
C4	2μF 6V electrolytic
C5	8μF 4V electrolytic
VC1	300pF compression capacitor
TC1	30pF trimmer

Semiconductors:

Tr1	NKT152	D1	GD9
Tr2	OC71	D2	GD9
Tr3	OC81D		

Miscellaneous:

R.F.C. 5mH or similar
L1 See text
Paxolin board, wire, battery, etc.

P.W. GUIDE TO COMPONENTS

PART 1

M. K. TITMAN, B.Sc. (Eng)

Component specifications are continuously changing as research leads to the introduction of new types. This series of articles will provide up-to-date information on the types of electronic component available for use in modern circuits. In each case the ideal performance of each type of circuit element will first be outlined and the various types available then compared to this. The information to be given on construction, tolerances, size and cost will guide the novice and expert alike in selecting the best component to use.

RESISTORS are the most commonly used components in electronic circuits. They function as loads, potential droppers, current limiters, etc. Resistance is measured in ohms; kilohms and megohms being ohms multiplied by 1,000 and 1,000,000 respectively. Each resistor is marked by numerals or colour coded as shown in Fig. 1 and Table 1. A and B indicate the value, C is the multiplying factor in zeroes, and D the tolerance. In theory, a resistor should have a resistance exactly equal to the value printed or indicated on the body. In practice, however, they are selected or batch produced with various tolerances, e.g. ±10% or ±1%. In general the closer the tolerance the more expensive the component.

Ideally the resistance should not change with any external influence such as voltage, current, temperature, time, pressure, humidity, vibration, etc. In practice the resistance changes with all these parameters. The greatest resistance variation arises from temperature changes, and for this reason the maximum power dissipation of a resistor is limited. The reliability of a resistor increases enormously if the maximum power is limited to half the rated value.

Tolerances and Standard Values

Tolerances and resistor standard values are also of paramount importance to the designer. Fixed resistors are only available in the standard values shown in Table 2. The tolerance in the value sets the range of resistors available and the equipment designer must ensure that his design will operate using the standard values of resistor. In addition it must work over the full tolerance range for the resistors used. Thus a 10kΩ resistor with a ±10% tolerance can have any value between 9kΩ and 11kΩ.

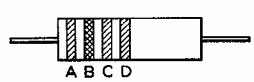
TABLE 1: RESISTOR COLOUR CODING

Colour	*Numeral*	*Colour*	*Numeral*
Black	0	Green	5
Brown	1	Blue	6
Red	2	Violet	7
Orange	3	Grey	8
Yellow	4	White	9

The various types of resistor available to the electronic designer are shown in Table 3. The table compares the various types for usage, value, power rating, tolerance, size and cost. Let us examine each type in turn, considering its advantages and disadvantages.

Carbon Composition

Carbon composition resistors were one of the earliest forms of mass produced resistor and are formed as shown in Fig. 2. They are manufactured by compressing a granulated carbon composition into a cylindrical shape. The lead out wires are attached direct to the carbon and the whole resistor is then insulated by paint, granulated ceramic etc. These resistors are still the most commonly used general purpose resistor. They are cheap, reliable, small and have a low noise characteristic.



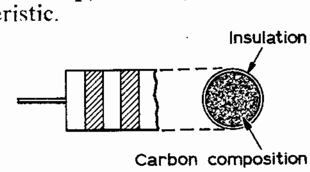


Fig. 1 (left): Colour coding. Fig. 2 (right): Carbon composition resistor.

The main disadvantage of carbon composition resistors is that the manufacturing process yields resistors with a large tolerance so that they are generally available with only 10% and 20% tolerances. Where they are available with closer

TABLE 2: STANDARD RESISTOR VALUES 5% AND 10% RANGES

10%	5%	10%	5%	10%	5%
1·0	1·0	2·2	2·2	4·7	4·7
—	1·1	—	2·4	—	5·1
1·2	1·2	2·7	2·7	5·6	5·6
—	1·3	—	3·0	—	6·2
1·5	1·5	3·3	3·3	6·8	6·8
—	1·6	—	3·6	—	7·5
1·8	1·8	3·9	3·9	8·2	8·2
—	2·0	—	4·3	—	9·1

TABLE 3: COMPARISON OF TYPES OF RESISTOR AVAILABLE

Type	*Usage*	*Range available*	*Power rating*	*Tolerance*	*Size*	*Cost each*
Composition	General	4·7 Ω—22M Ω	1/10W—2W	10%, 20%	¼W 0·2in. diameter × 0·5in.	1d.—6d.
Carbon film	General Close Tolerance	4·7 Ω—22M Ω	1/10W—1W	1%—10%	¼W 0·2in. diameter × 0·5in.	5d.—9d.
Metal oxide	High stability	10 Ω—1M Ω	1/10W—1W	0·5%—5%	¼W 0·15in. diameter × 0·4in.	2s.—3/6d.
Metal film	High Stability and Semi Precision	1 Ω—2M Ω	1/10W—1W	0·05%—2%	¼W 0·15in. diameter × 0·4in.	2/6d.—5s.
Wire wound	General High Power	0·1 Ω upwards	1·5W upwards	5%—20%	3W 0·2in. diameter × 0·4in. 6W 0·5in. diameter × 1·125in.	2/6d. upwards
	Metering	All	—	0·001%—0·1%	¼in. diameter × 1in.	5s. upwards
Variable resistors	*Carbon* Linear or Log	100 Ω—2·2M Ω	¼W—5W	—	Printed circuit and panel mounting	5s. upwards
	Wire wound Linear, Log or Multi-turn	10 Ω—100k Ω	¼W—5W	—	Printed circuit and panel mounting	5s. upwards
	Rheostats	1 Ω—100k Ω	10W upwards	—	—	10s. upwards

tolerances these are selected from the 10% or 20% ranges. This has the effect of depleting the 10% or 20% ranges of values close to the marked value. Another disadvantage is that they tend to drift with time and temperature and therefore cannot be regarded as high stability resistors.

Carbon Film Resistors

The carbon film resistor was developed as the need arose for resistors with greater stability and closer tolerance. They are more stable than composition resistors and are available in the tolerance ranges 1%, 2% and 5%. They are, therefore, more suitable for transistor circuits where closer tolerances are required, though a penalty is paid in increased cost.

They are manufactured by depositing a carbon film on to a cylindrical ceramic body as shown in Fig. 3. The ceramic body provides the rigidity and

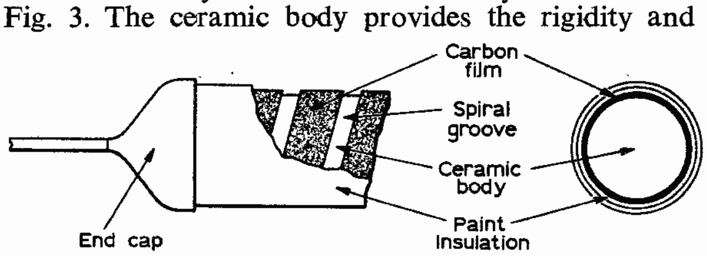


Fig. 3: Construction of the carbon film resistor.

has the same temperature coefficient as the carbon film. They are stable with time and temperature and withstand thermal shock. The exact resistance is formed by a spiral groove in the carbon film. This increases the length of track of the constant resistivity film, thus increasing its resistance. The wire connections are made to end caps fitted over the ceramic body and the whole resistor is insulated by paint or lacquer.

The main disadvantage of the carbon film resistor is its decreased reliability compared with the composition resistor. The disconnection of the end caps in certain types has been a problem, although new types insulated with hard ceramic have solved this difficulty.

Metal Oxide Resistors

Metal oxide resistors were developed to combine the high stability of carbon film resistors with the reliability of composition resistors. Thus metal oxide resistors form a semiprecision range of resistors with great stability, reliability and close tolerances. They also have lower noise levels than carbon resistors.

These advantages are outweighed in most commercial applications by their considerably increased cost, though for special circuits they are extremely useful.

They are formed by bonding metal oxide film on to a glass body and have a similar physical appearance to carbon film resistors. A spiral groove again sets the resistance value and the leads are connected by a band or cap. The whole body is insulated with a hard ceramic material.

Metal Film Resistors

Metal film resistors are used where accuracy and stability are required, especially for low values. They are used as precision resistors for meter circuits and are available down to 1Ω with tolerances of 0·05%.

Construction is by vacuum deposition on a ceramic former resulting in a similar physical appearance to

Fig. 3. Connections are made to nobel metal bands which give high stability and reliability. Insulation is by ceramic or epoxy material to give a strong resistant finish.

Wire Wound Resistors

Wire wound resistors are utilised where the power dissipation is too great for normal resistors. They have wider tolerances and are dearer than carbon resistors but can dissipate more power. Usually the increased dissipation results in an increased surface temperature and care should be taken to ensure that surrounding circuit elements are not affected by this high surface temperature (which may be as high as 300°C).

Construction is shown in Fig. 4 and is by winding resistance wire on a heat resistant former. The resistance wire is welded or otherwise joined to the connecting wire to give a strong reliable connection. The body is then insulated by heat resistant ceramic material.

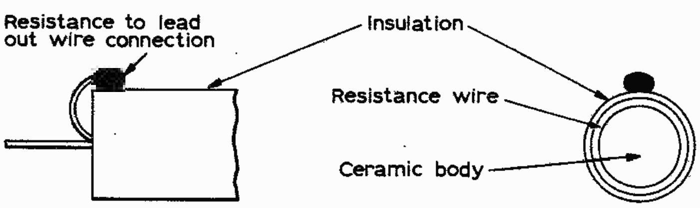


Fig. 4: Construction of a fixed wire wound resistor.

Precision wire wound resistors are used for meter shunts and standard resistances. These are wound and measured accurately and their power rating is derated to give great stability. In all cases wire having a low resistance-temperature coefficient is used.

Wire wound resistors are exclusively used below 1Ω and are readily obtained to 0·2Ω. They are reliable and are available up to 20W for printed circuit mounting. Size is determined mainly by power rating and maximum surface temperature. Reliability is increased if they are operated well below the rated power.

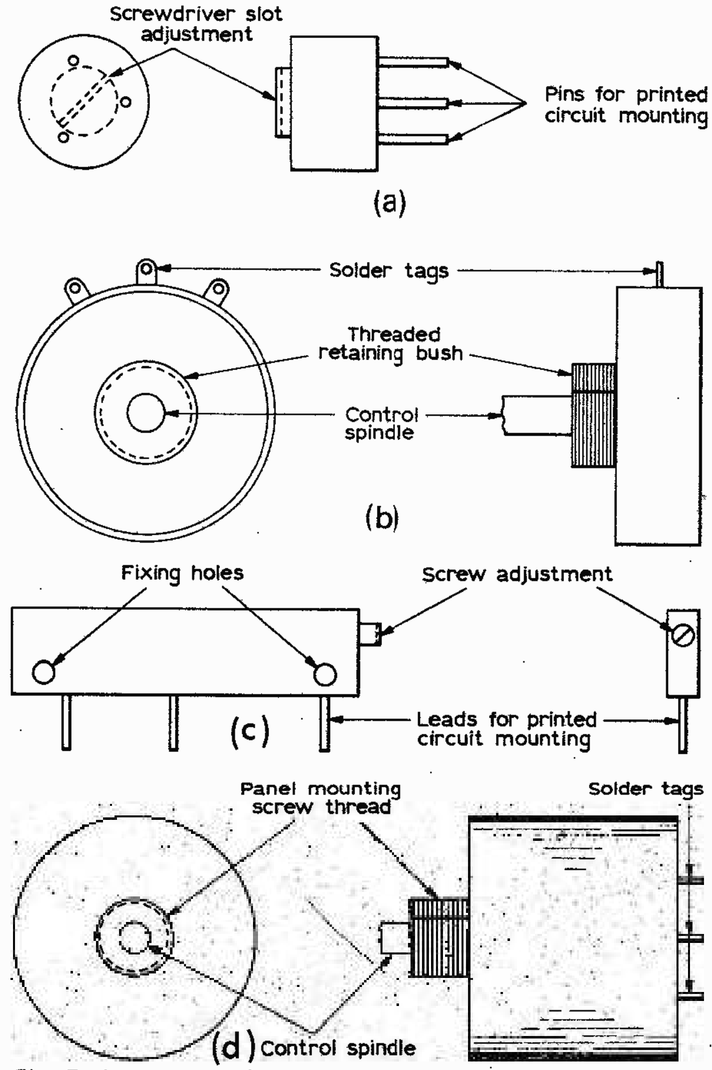


Fig. 5: (a) Printed circuit mounting potentiometer, (b) panel mounting potentiometer, (c) flat printed circuit multiturn potentiometer, (d) precision helical multiturn potentiometer.

Variable Resistors

Variable resistors or potentiometers are available in a wide variety of shapes, sizes and power ratings. Carbon or wire is again used as the basic resistance material, and in all cases a slider moves along a fixed resistance to give the variation in resistance.

Figure 5a shows a carbon printed circuit mounting potentiometer. A slider arm moves round a circular track of carbon when the spindle is rotated by the screwdriver slot. Figure 5b is a normal wire wound panel mounting potentiometer. Rotation of the spindle moves a slider across a coil of resistance wire. Similarly Fig. 5c is a printed circuit mounting multiturn wire wound potentiometer. As the adjusting screw is turned a slider moves along the screw thread and varies the resistance. Usually it is arranged to give 10 complete turns for the full range of resistance. Figure 5d is a precision helical potentiometer where 10 turns of the spindle give the complete range of resistance. This is used for precision resistance adjustments in equipment.

Both wire and carbon types are available in a logarithmic form in which the resistance varies logarithmically with rotation of the control spindle. This type is generally used for volume controls.

Carbon potentiometers give a smooth, infinitely variable variation of resistance, whilst wire wound potentiometers have step changes and are coarser. Carbon types tend to go noisy with usage whilst wire wound ones are more reliable. Failure in wire wound potentiometers is often due to breaks in contact between the slider and wire which gives an open circuit to the slider. In general, wire wound types are better where continual adjustments are made, whilst carbon types are preferable for smooth action or pre-set conditions.

Future Trends

Trends will always be towards the ideal resistor. Further miniaturisation will occur and already 1/20W resistors smaller than match heads are available. Miniaturisation is in line with the trend for integrated circuits. For this purpose multiresistor thin film circuits have been developed. These will be useful mainly for the digital designer. Lower power dissipation in integrated circuit systems will lead to a further advance in the miniaturisation of resistors.

In the short term, however, carbon film resistors are unlikely to be ousted from their present position as the standard general purpose resistor for transistor circuits. Metal oxide and film resistors will be used for reliability and stability, and wire wound resistors will be further miniaturised for circuits where power dissipation is likely.

TO BE CONTINUED

A COMBINED

Absorption Wavemeter Radiation Meter and Phone Monitor

—FOR THE H.F. BANDS

by A. D. TAYLOR, GW8PG

AN absorption wavemeter is an essential instrument in any amateur station. It is the only type of wavemeter which does not itself generate harmonics, and as everyone who has studied for the R.A.E., will know it is always used during the first tests on a new transmitter to ensure that the output of the harmonic generator stages and the p.a. are at the correct frequencies. The instrument can also be used for the rough checking of receiver calibration.

Besides its use as a wavemeter, the instrument to be described can also be employed as a radiation meter when tuning the transmitter output circuit, and as an a.m. phone monitor. The design is so arranged that those readers who have to save up to buy the components can build the simple wavemeter circuit first and then add the other refinements later. The simple circuit alone will satisfy the GPO requirement that the station be equipped with an absorption wavemeter.

THE CIRCUIT

Figure 1 shows the circuit of the instrument. Assume firstly that only the components to the left of the points marked X on the diagram have been wired.

If L1 is coupled to the p.a. tank coil of a transmitter and C1 is adjusted until the circuit resonates at the transmitter output frequency, power will be absorbed by the wavemeter tuned circuit. This will cause an r.f. current to flow in the circuit and lamp LP1 will glow, the maximum glow being obtained when the wavemeter is tuned to the same frequency as the transmitter. This system is quite adequate for checking the output frequency of the p.a. and the higher power stages in the exciter, but the energy absorbed from low power stages may be insufficient to make the lamp glow. The sensitivity can be greatly increased by adding the components shown on the right of the points marked X on the diagram. When these components are added, if switch S1 is opened, thus removing the damping effect of the lamp from the circuit, the instrument becomes a sensitive diode demodulator, the output of which is applied to jack J1. If a 0-1mA or 0-500μA meter is plugged into J1 it will act as a sensitive indicator which will allow comparative readings to be taken. If a pair of headphones are jacked into J1 the quality of an a.m. phone transmission can be monitored.

CONSTRUCTION

The coil L1 is wound on a 2½in. length of 1in. diameter paxolin tubing, though a stout cardboard tube of the same dimensions will be equally suitable. The wire used is 30 s.w.g. enamelled and the coil is secured to the chassis or box by means of two small "L" brackets fabricated from strips of brass or aluminium. It is important that the coil be mounted with the smallest winding (represented by the 6 turn tap) furthest from the chassis or box. The simplest and most inexpensive form of construction is the "L" shaped chassis made from a 4 × 6in. sheet of aluminium as illustrated in Fig. 2(a). The chassis is provided with a wooden handle for convenience in use, a simple source of this item being a handle cut from a worn-out paint brush. A second but more expensive form of construction is to use a 4¾ × 3¾in. diecast box as shown in Fig. 2(b), and to provide it with a commercially made metal handle. Whichever method is adopted, the layout is in no way

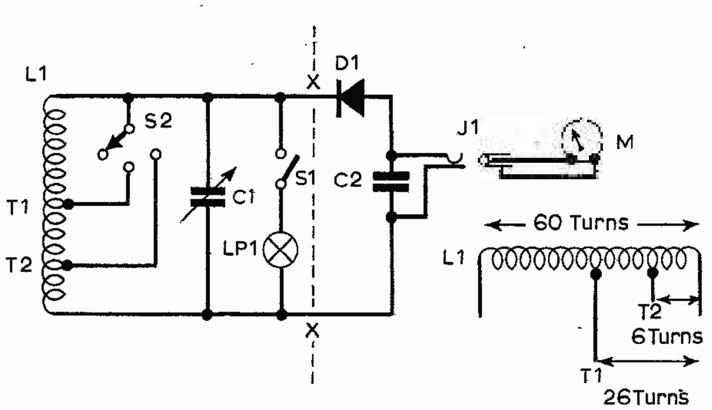


Fig. 1: Circuit diagram and coil winding details. L1 is wound on a 1in. diameter former.

★ components list

C1	150pF variable (air spaced)
C2	2200pF 350V S.M.
D1	OA81 (Mullard)
S1	SPST switch
S2	1 pole 3 way switch
Meter	0–1mA milliammeter

Miniature jack socket and plug. Diecast box 4 x 3¾ x 2⅝in. (Electroniques). LP1 3·5V 0·1A bulb and holder. Small quantity of 30 s.w.g. enamelled wire.

critical and the wiring is very simple. When the wiring has been completed a scale should be cut from stiff card and three arcs should be drawn on it with a pair of compasses, one for each position of S2. The scale is then cemented on to the chassis above the spindle of C1 (Bostik is a suitable adhesive) and C1 is provided with a pointer type control knob. If the diecast box is used and a spare micro-ammeter is available this could be mounted permanently in the box, but the advantage of the jack-in meter is that it can be common to other instruments in the station such as a multi-range test meter.

CALIBRATION

If a transmitter which has already been calibrated is available the wavemeter can be calibrated for the various amateur bands by tuning the transmitter to each band in turn, setting S1 so that the lamp is in circuit, setting S2 to the correct range, then adjusting C1 until LP1 glows at maximum brilliance. The setting then marked on the appropriate arc on the cardboard scale. Either pencil or a black ballpoint pen can be used. The method is illustrated in Figs. 3(a) and 3(b). If no transmitter is available two alternative methods can be used. A calibrated t.r.f. receiver can be tuned to the desired frequency

heterodyne receiver provided it is possible to loosely couple L1 to the local oscillator tuning coil and that the intermediate frequency of the receiver is known. The local oscillator normally operates on the h.f. side of the signal frequency, being separated from the signal frequency by an amount equal to the intermediate frequency. If, therefore, the receiver is tuned to a signal on 6,550kc/s the local oscillator will be tuned to a frequency equal to 6,550kc/s plus the intermediate frequency. If the i.f. is 456kc/s this will give 6,550 + 465 or 7,015kc/s. If under these conditions, L1 on the wavemeter is loosely coupled to the local oscillator coil on the receiver when the wavemeter is tuned near 7Mc/s violent "pulling" of the local oscillator will take place, this being indicated by movement of the received signal. It is thus possible to use this method for calibrating the wavemeter.

USE

Once the wavemeter is calibrated it can be used to check the output frequency of any stage in a transmitter by means of the methods described in the previous paragraph, and these methods can also be used to provide rough calibration of a receiver.

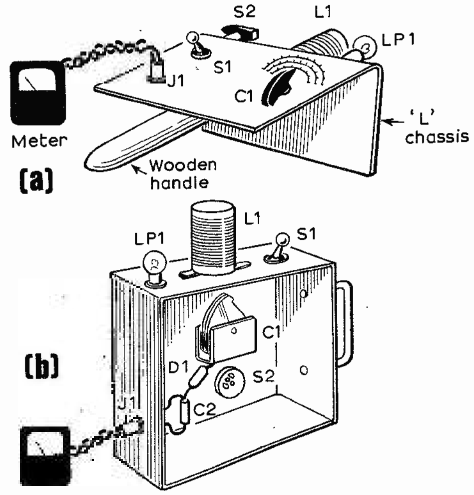


Fig. 2: (a) suggested method of construction using an L-shaped chassis.
(b) suggested method of construction using a diecast box.

FREQUENCY RANGE

With the coil suggested the three frequency ranges will be approximately:
Full coil in circuit: 1·7 to 4Mc/s.
Intermediate position of S2: 4 to 10Mc/s.
Low inductance position of S3: 10 to 30Mc/s.

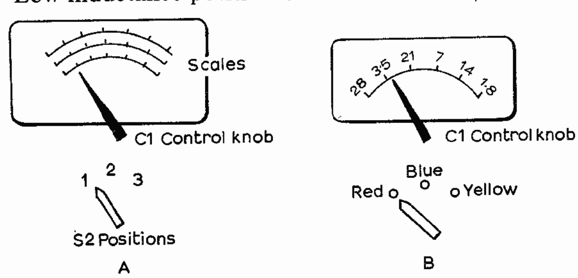


Fig. 3: (a) method of calibration if general coverage calibration is required. A scale arc is provided for each of the three positions of S2 and is calibrated at (say) 500kc/s intervals.
(b) if amateur bands only are required, each position of S2 is given a colour and a single arc used, the bands being marked in the appropriate colour corresponding to the S2 position.

and the reaction control can be advanced until the detector begins to oscillate.

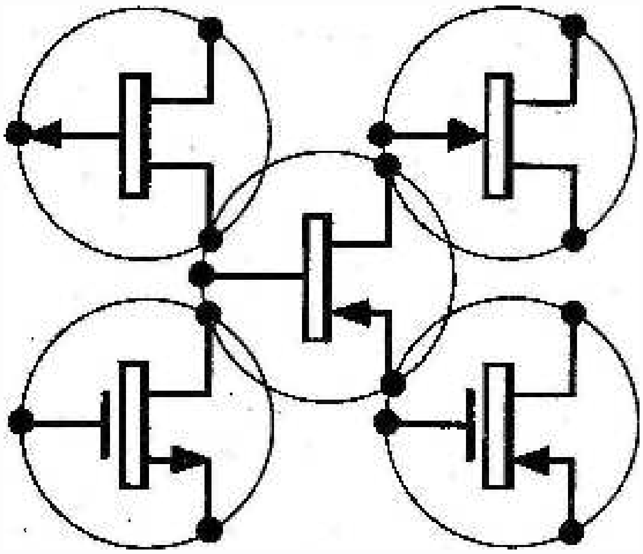
If L1 on the wavemeter is then loosely coupled to the detector grid coil by holding it two or three inches away, as the wavemeter is tuned close to resonance the detector will stop oscillating, re-starting again as the wavemeter is tuned away from resonance.

ALTERNATIVE METHOD

A similar method can be used with a super-

For use as a radiation meter, a micro-ammeter is plugged into J1, LP1 is switched out of circuit and the instrument is tuned to the desired frequency and placed a few inches away from the aerial. It is then possible to tune the transmitter up by using the reading on the micro-ammeter, maximum reading corresponding to maximum r.f. output. With the wavemeter set up in this way the quality of an a.m. phone transmitter can be checked by unplugging the micro-ammeter and plugging a pair of headphones into J1. For best output these should be of the high impedance type. ■

PRACTICAL GUIDE



TO F.E.T.s by K.ROYAL

THE field effect transistor (f.e.t. for short) differs in several ways from the more commonly used transistor that we have come to understand during the last decade. We know that the usual type of transistor possesses two "diode" p-n junctions —the emitter junction and the collector junction— and that two kinds of current carriers are involved in the working of the device. There is the *n*egative carrier which is the electron and the *p*ositive carrier which is the hole. These are usually referred to as *n* and *p* carriers respectively, after their polarities. Depending on which way round the two junctions are arranged, we get either the p-n-p transistor or the n-p-n transistor. And since *two* kinds of current carriers are involved the usual type of transistor is known as a *bipolar* transistor.

The f.e.t. differs fundamentally from the bipolar transistor in that only *one* current carrier—either *n* or *p*—is involved in its working (that is one in type, not in quantity!), and for this reason the f.e.t. is often called a *unipolar* transistor. When a f.e.t. works with electrons it is called a *n-channel* type, and when holes are used it is called a *p-channel* type.

It will be recalled that a bipolar transistor has to be biased at its emitter/base junction for forward current conduction to secure collector current. This forward biasing means, of course, that the input impedance is intrinsically low, and a signal applied at the base may look into an impedance from about 500 to 50,000Ω, depending on the exact nature of the circuit. In other words, the bipolar transistor is current operated; that is, it needs signal current into its emitter/base junction to reflect a similar, but amplified, current into the collector circuit. There are schemes whereby the input impedance of a bipolar device can be raised—by feedback and by bootstrapping for example, but these are simply artifices that fool the input signal into thinking that it is looking into a high impedance circuit, where in actual fact the transistor remains a current operated device.

The opposite to current operation is voltage operation. This means that the input impedance is truly very high and therefore passes virtually no current at all. A thermionic valve works like this when the input signal is applied between the control grid and cathode. The control grid functions on the electrostatic principle. It consists of a wire mesh across the path taken by the electrons flowing from the cathode to the anode. As its negative potential is increased (relative to the cathode) so some of the electrons arriving from the cathode are deflected back again (on the basis that like charges repel) and the number reaching the anode is reduced. The grid thus acts as an "electron tap", increasing or reducing the flow of electrons to the anode in accordance with its negative value. When it is very negative all the electrons are blocked and none pass to the anode. The valve is then biased to anode current cut-off. The control grid in effect performs its duty by "charging" to a certain potential, so the control action is almost completely divorced from current as such.

Mode of Operation

While the input circuit of a bipolar transistor is essentially a semiconductor diode in forward conduction, the input of a f.e.t. appears to a signal either like a semiconductor diode in *reverse* conduction or like the control grid of a thermionic valve, depending on its exact nature. This brings us to the next important feature of the f.e.t., which is that it, too (like the thermionic valve) is voltage operated— the opposite to the bipolar transistor.

Let us consider the thermionic valve again for a minute. We know that if this is operated without grid bias the anode current will be abnormally high. We thus establish a valve circuit so that the control grid is biased negatively to yield the correct anode current for the application in hand. There is one type of f.e.t. that works in a similar manner; that is, the output current is high when the input is devoid of bias. The input, therefore, has to be biased in the same way as a thermionic valve to secure the required output current. This is known as a *depletion-type f.e.t.*

There is another kind—called an *enhancement-type f.e.t.*—that has biasing characteristics similar to those of a bipolar transistor. With this type there is no output current when the input electrode is without bias.

F.e.t. Symbols

We must now have a look at the basic f.e.t. symbols and investigate the device electrodes. In a bipolar transistor, of course, we have emitter, base and collector electrodes; but in a f.e.t. the electrodes are correspondingly named *source*, *gate* and *drain*.

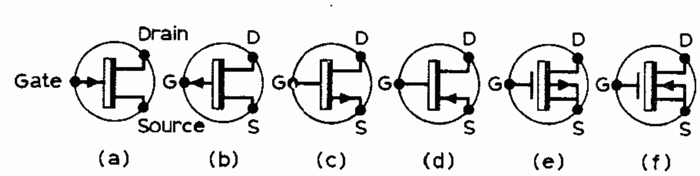


Fig. 1: F.e.t. symbols. (a) JGFET, n-channel depletion-type; (b) JGFET, p-channel depletion type; (c) JGFET, n-channel enhancement-type; (d) JGFET, p-channel enhancement-type; (e) IGFET, n-channel; (f) IGFET p-channel. It should be noted that in some literature slightly different symbols might be used, and in some IGFET symbols an arrowhead may not be included, in which case the device is generally assumed to be n-channel with the drain connected to a positive potential.

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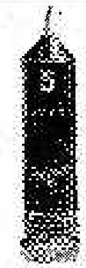

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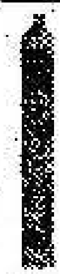

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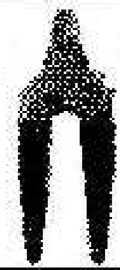

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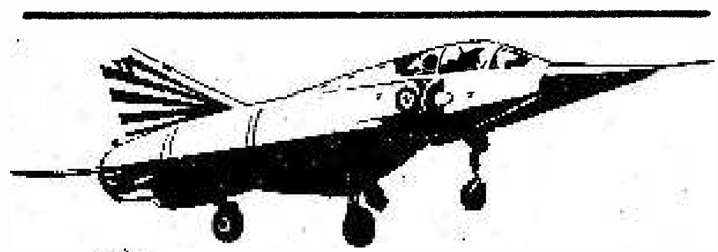

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as shown in Fig. 1. Here at (a) is given the symbol for a n-channel device and at (b) that for a p-channel device. It is noteworthy that in some literature the symbols differ slightly and the arrow-head may be found on the source electrode instead of on the gate electrode, as shown at (c) and (d), which are n-channel and p-channel symbols respectively. However, when the arrow-head is on the gate electrode, as in (a) and (b), the device is usually of the depletion-type, while when it is on the source electrode, as in (c) and (d), an enhancement-type is usually signified.

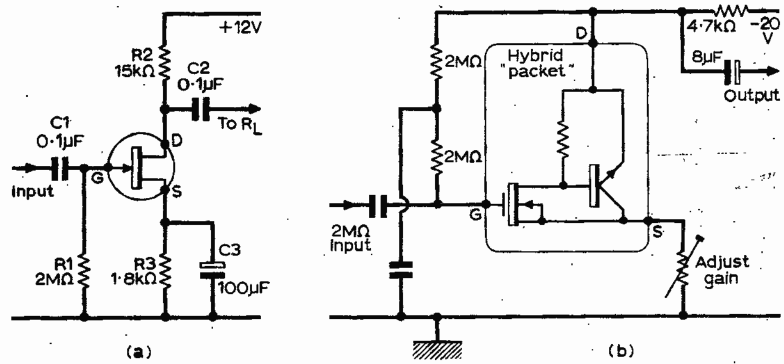


Fig. 2: (a) Simple a.f. amplifier using a JGFET of the depletion type; (b) hybrid "packet" in which a p-channel IGFET is integrated with a n-p-n bipolar transistor, giving a 2MΩ input impedance and medium output impedance with very high signal gain.

The high input impedance of a f.e.t. is a result either of the gate being isolated from the rest of the device by the reverse-biased diode effect or by a layer of insulation within the f.e.t. between the gate electrode and the channel. A device based on the reverse-biased diode effect is called a *junction-gate f.e.t.* (JGFET for short), while that embodying insulation in the gate electrode is called, as might well be expected, an *insulated-gate f.e.t.* (IGFET for short). All the symbols shown at (a), (b), (c) and (d) in Fig. 1 signify that the devices are of the junction-gate variety. Symbols for insulated-gate devices are given at (e) and (f) in Fig. 1, corresponding to n-channel and p-channel respectively. An alternative widely used name for the IGFET is the MOST or MOSTFET, which is derived from its layer construction with a *m*etal gate, *o*xide insulating layer and *s*emiconductor body—*t* for *t*ransistor of course!

Attention must now be drawn to the actual significance of the direction in which the arrow head on the symbol points. On each of the symbols on the left of the pairs in Fig. 1 the arrow points to the right. This is, in fact, the same direction in which the arrow on the emitter electrode of a n-p-n bipolar transistor points. Hence this signifies that the f.e.t. is a n-channel type (arrow pointing to the right, remember). Conversely on each of the symbols on the right of the pairs in Fig. 1 the arrow points to the left, which corresponds to the direction in which the arrow on the emitter electrode of a p-n-p bipolar transistor points, thus signifying that the f.e.t. is a p-channel type (arrow pointing to the left). As long as we remember the n-p-n and p-n-p arrow relationships on bipolar transistors, therefore, we can easily work out whether a f.e.t. is n-channel or p-channel from the symbol.

It is very important to know this because like the bipolar transistor the nature of the device determines the polarity that has to be applied to its electrodes. A *p*-n-p transistor requires a *negative* collector potential and similarly a negative potential is required by the drain of a *p*-channel f.e.t. Conversely, a *n*-p-n transistor requires a *positive* collector potential, as does the drain of a *n*-channel f.e.t.

Summary of Principles

Before continuing let us summarise the foregoing aspects of the f.e.t. to clear the air a bit!

(1) A f.e.t. has a high or very high input impedance compared with the bipolar transistor, and in this respect is like a thermionic valve.

(2) It depends for its action on one kind of current carrier—electron or hole—as distinct from the two kinds required for the working of a bipolar transistor, and for this reason is sometimes called "unipolar"; when it uses electrons it is called a n-channel type (*n* standing for *n*egative electrons) and when it uses holes it is called a p-channel type (*p* standing for *p*ositive holes).

(3) F.E.T.s are for either depletion- or enhancement-mode operation. A depletion-type has to be biased-off like a thermionic valve. The enhancement-type has to be biased-on like a bipolar transistor.

(4) There are two types of gate junction, one based on the reverse-biased diode effect called a junction-gate, and the other based on inbuilt insulation called an insulated-gate.

(5) The operating polarities of a n-channel f.e.t. are similar to those of a n-p-n bipolar transistor, while a p-channel type is connected to the supply in a similar manner to a p-n-p bipolar transistor.

Basic Circuits

So far so good, now let us have a look at some circuits. The first thing we need to know when dealing with f.e.t.s is the variety—depletion or enhancement-type. We need to know this from the biasing point of view, of course. Circuit (a) in Fig. 2 shows a common-source voltage amplifier with an input impedance of 2MΩ (determined by the gate resistor R1), using a n-channel depletion-type f.e.t. Notice how closely this follows the triode valve amplifier circuit, where R1 would be the grid resistor, R2 the anode resistor, R3 the cathode resistor, C1 the input capacitor, C2 the output capacitor and C3 the cathode bypass capacitor. Since the f.e.t. is a depletion-type it has to be biased-off like a valve and, like a valved circuit, this is achieved by the voltage dropped across the source resistor R3, the value of which is selected to produce the required bias current for the application in hand, as determined, of course, by the type of f.e.t. used. A typical bias current in this circuit might be about 0·5mA, and this would be established by adjusting the value of R3, which is not uncommonly a preset.

The gain of a f.e.t. is signified in terms of *transconductance* (g_m), or mA/V, as with a thermionic valve, while as we should know the parameter associated with bipolar transistors is *current gain* (h_{fe}) or the change of

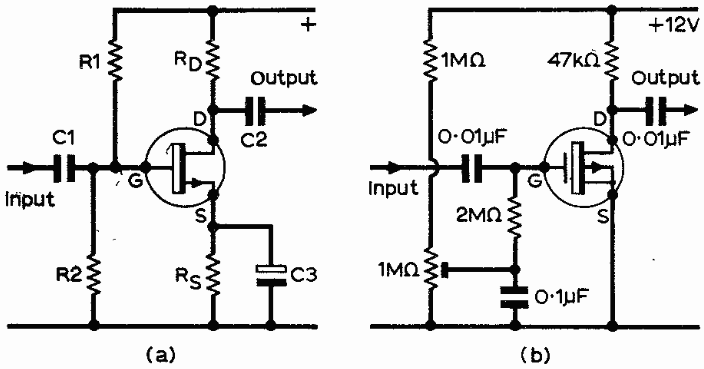


Fig. 3: (a) The biasing of a n-channel JGFET of the enhancement type; (b) alternative method of biasing an IGFET of the n-channel type.

output current with input current. Transconductance (g_m), of course, relates to the voltage mode of operation of the f.e.t. Thus the gain is a measure of the change of drain current with gate input *voltage*. F.e.t. g_ms are not all that large, ranging from about 0·5 to 6 mA/V depending on how the device is operated; generally speaking the g_m increases with drain current. It is thus possible to vary the gain of a f.e.t. amplifier by varying the value of the resistance in the source circuit.

However, it should be noted that the *voltage gain* of a f.e.t. amplifier *circuit* in the typical RC coupled configuration will rise as the drain current falls. This is because the voltage gain of, say, the stage shown in Fig. 2 (a) is equal to $g_mR_LR_2/(R_L+R_2)$, where R_L is the resistance into which the stage is loaded, and because g_m is proportional to (drain current)$^{\frac{1}{2}}$ and R_2 to 1/(drain current).

While on the subject of f.e.t. gain it is worth noting that the medium value of f.e.t. output impedance lends itself admirably for connecting almost straight into a bipolar transistor input circuit, thereby giving the best of both worlds—a very high input impedance with medium f.e.t. gain times a considerable gain increase by the action of the partnered bipolar transistor. This sort of hybrid compatibility is nowadays often exploited in commercial equipment and Fig. 2(b) shows such an arrangement employing a f.e.t./bipolar "packet". This gives a very high overall gain at a constant 2MΩ input impedance and at a medium output impedance.

Fig. 3(a) shows a simple a.f. amplifier using an enhancement-type f.e.t. This differs from Fig. 2(a) in the nature of the gate biasing. Here R1 and R2 form the gate potential-divider for biasing-on the device as with bipolar transistors.

Fig. 3(b) shows an alternative method of biasing, with the f.e.t. this time being an insulated-gate type of the n-channel variety. Sometimes the top 1M resistor is omitted. The bias is adjusted—to yield the required drain current—by regulating the variable (preset) resistor.

Performance

In this sort of straightforward a.f. amplifier circuit the f.e.t. can produce voltage gains of up to 40 or so times and in addition to the high input impedance attribute the f.e.t. generally provides lower noise working than a bipolar transistor arranged for a similar input impedance. Moreover, f.e.t. amplifiers —both a.f. and r.f. —suffer less from the effects of overloading than similar amplifiers employing bipolar devices. One big problem of the bipolar transistor in such applications is that while the circuit can be arranged to provide the highest gain and least noise for a relatively small range of input

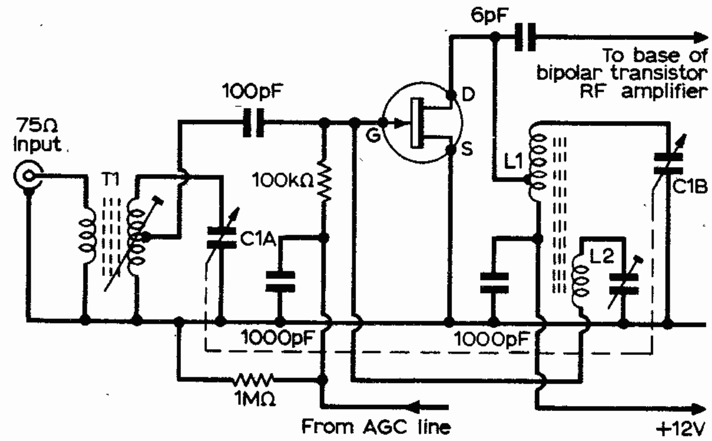


Fig. 4: JGFET arranged as a v.h.f. amplifier, tunable over Band II. The a.g.c. input is at the gate, via the 100kΩ and 1MΩ potential divider.

signal the occurrence of a signal—in band or spurious—rising above the dynamic limit rapidly pushes the amplifier into non-linearity, with a consequent rise in crossmodulation and intermodulation effects. The f.e.t. to a large extent combats these sorts of problems.

The transfer characteristic of a bipolar transistor is essentially exponential, while that of a f.e.t. is parabolic, following a square-law. That is the characteristic produced when input voltage is plotted against output current. The square-law characteristic of the f.e.t. can be useful in practical circuits for a.g.c. and manual gain control. These sorts of characteristics are already being exploited in audio equipment—for low-noise a.f. front ends with outstanding overload performance—and in radio tuners, especially of European and American designs, to produce f.m. sensitivities in the order of 2μV for some −30dB of quieting, making it possible to get good off-air stereo reception with aerial signals hitherto considered impossibly low. The f.e.t. used in the front-end of the Vortexion CBL/7T tape recorder for example has a noise figure as low as 0·1dB, which is incredible in comparison with the near optimum noise figure of 2dB given by some of the best low-noise bipolar transistors.

Typical Applications

Fig. 4 shows a circuit of a f.e.t. v.h.f. amplifier for a Band II (f.m.) tuner, using a n-channel device in the depletion mode. Again this is very similar to the triode valve counterpart, even to the extent of a.g.c. being applied at the input electrode

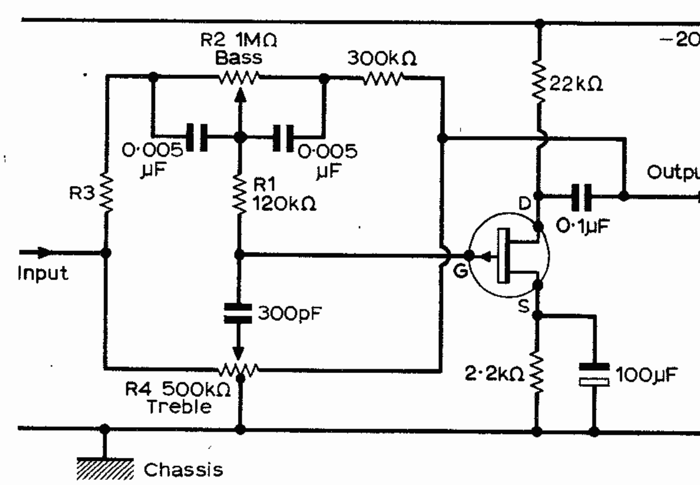
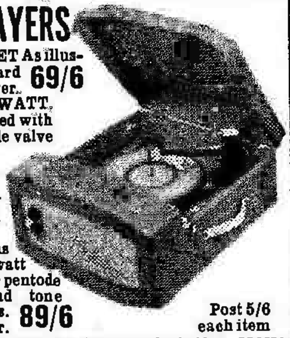


Fig. 5: A p-channel JGFET in a Baxandall tone control circuit.

DE LUXE PLAYERS



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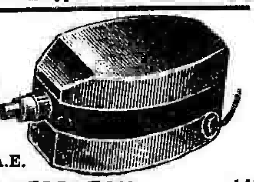

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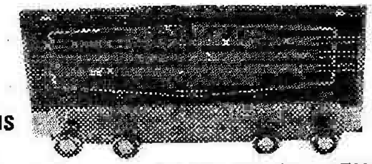

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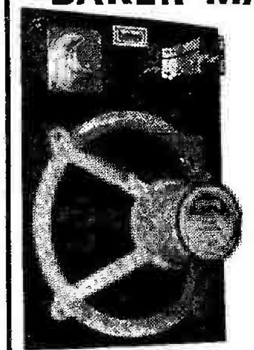

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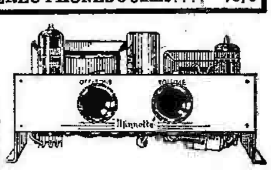

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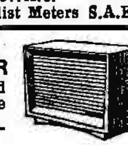

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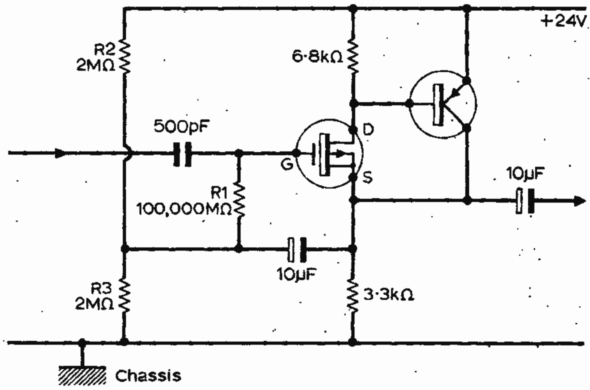


Fig. 6: Hybrid f.e.t./bipolar circuit with ultra high input impedance.

—the gate in Fig. 4. T1 is the aerial coupling transformer—which can also be arranged for 300Ω balanced input if required—and L1 is the drain tuned circuit, with L2 providing some neutralising feedback to the gate circuit. C1A and C1B are ganged.

Figure 5 shows a p-channel f.e.t. in the depletion mode operating in a typical audio application—in the Baxandall tone control circuit in fact. The bass and treble controls are rigged in the conventional network for this kind of circuit, while the f.e.t. is biased by the 2.2kΩ resistor in its source circuit. The electrolytic performs the same duty as such a capacitor in the cathode circuit of a valved amplifier (that is, bypassing audio and preventing degenerative feedback). The gate circuit is returned to chassis through the series combination of R1, R2, R3 and R4.

Finally, Fig. 6 shows a n-channel insulated-gate f.e.t. arranged to provide an extremely high input impedance—of 100,000 MΩ, fixed by the gate resistor R1—in conjuction with a p-n-p bipolar transistor for high gain, the base of this being d.c. coupled to the drain of the f.e.t. Gate biasing is handled by the potential divider R2 R3, while the 3.3kΩ resistor in the source circuit of the f.e.t. and the collector circuit of the bipolar transistor is the output load resistor. Incidentally the very high input impedance in this case is given by the nature of the f.e.t. which is a metal-oxide insulated-gate type. ■

CORRIGENDA

FET VOM—APRIL ISSUE

SW2 should have been listed in the components list as a 2-pole 3-way switch.

SIMPLE SIGNAL GENERATOR AUGUST ISSUE

D1 can be a BY100 or any other silicon rectifier with a minimum rating of 800V p.i.v. and 50mA.

In the components list C7 should be listed as 0·0047μF and not 0·0047pF.

THREE TRANSISTOR RECEIVER AUGUST ISSUE

The following corrections should be made to the components list (page 248) for the third receiver in the series "Three Simple Receivers for Beginners":

Add R11 1kΩ and C8 10μF.

R10 should be 10kΩ and C7 100pF (ceramic or silver mica) as on the circuit.

The following amendments should be made to the above chassis layout (Fig. 8):

The resistor connected between C6 +ve and point "d" is R9. C7 is omitted: it should be shown connected between the +ve end of D1 and the lug on IFT2.

PYRAMID ALL PURPOSE SYSTEM

By F. G. RAYER

PART 4—TRANSISTOR T.R.F. TUNER and RECORD PLAYER DECK

WHEN the main need is reception of the stronger BBC transmissions, a t.r.f. tuner can give excellent results. Construction is much simpler than that of a superhet tuner, and the alignment difficulties sometimes experienced with the superhet circuit are absent.

The circuit diagram, shown in Fig. 1, has an AF117 as r.f. amplifier, followed by a diode detector, both stages being tuned by the ganged capacitor VC1/VC2. This provides medium wave coverage. It was decided not to incorporate full long waveband coverage, but by switching in capacitors C1 and C5 a small band around 1,500 metres can be tuned. This method avoids the necessity of coil changing.

VR1 is the r.f. gain control, which is useful to avoid overloading if strong signals are present. Optional aerial terminals are provided to help obtain the best results with a variety of aerials.

Terminal "A" is used for a short extending telescopic aerial, or a short indoor wire. Terminal "B" is better for a somewhat longer aerial, such as a short outdoor wire, or an indoor aerial perhaps 15ft. or more in length. TC1 is adjusted for optimum results.

Terminal "C" is used for a longer aerial, or when maximum selectivity is needed. In all cases a good earth system improves reception, but is not essential.

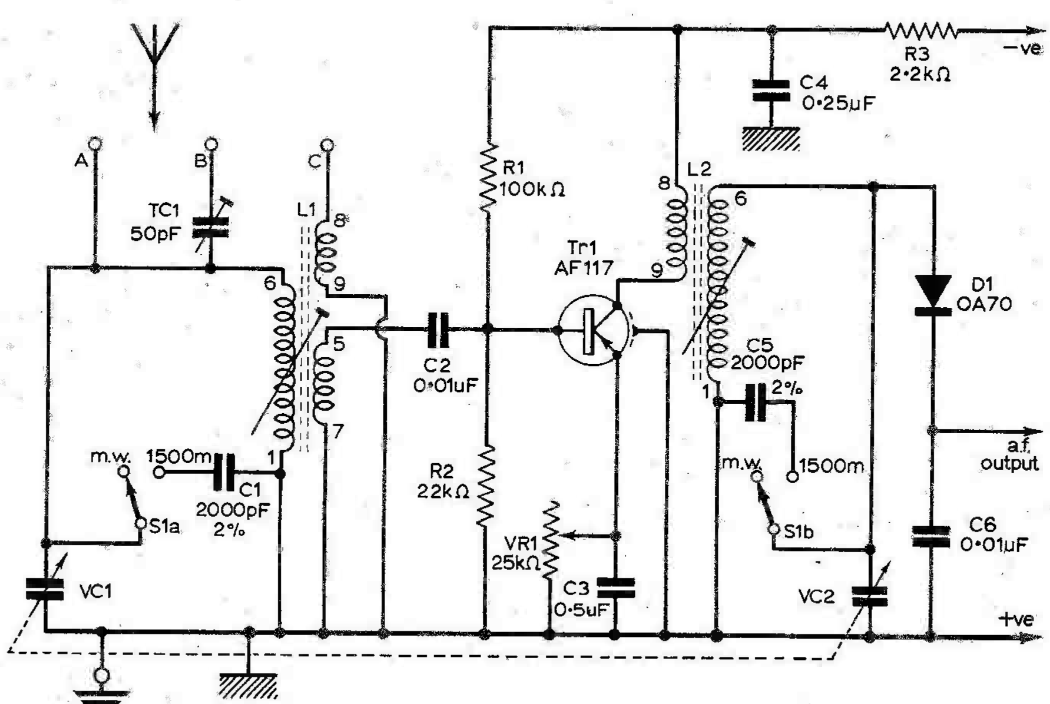


Fig. 1: Circuit of the t.r.f. tuner unit.

Audio output is taken from detector diode D1. When the tuner is used with the amplifier described earlier, the amplifier volume control functions as the diode load. Should the tuner be used with other equipment, in which no such load is present, then a 5·6kΩ resistor should be connected across C6.

The tuner may of course be used with other amplifiers than the one mentioned earlier. It will also give excellent reception, used alone with medium or high impedance headphones. It would then run from a 4·5 or 6V battery. Current is otherwise drawn from the amplifier.

Chassis, etc

As only a very small chassis is needed, this was made from a 7 × 3in. "Universal Chassis" runner. A 90-degree section is cut from each chassis flange 1⅛in. from the end. The runner can then be bent to make a chassis 4¾in. wide, 1¼in. high, and 3in. deep. This can be fitted into the cabinet specified in the components list, the chassis being cut away slightly at the front bottom corners, to clear the case flange.

Components are wired up as shown in Fig. 2. The coil canisters are used as screens, the lids being held to the chassis by the coils and a 6BA bolt with tag, which provides the "MC" or chassis points. Other leads pass down through holes in the chassis. When this wiring has been completed, the cans are screwed on over the coils.

A tag strip supports TC1, and provides tags A, B and C on which the aerial lead can be clipped.

VC1/VC2 and Alignment

If dimensions are to be as given, VC1/VC2 should be as small as possible. That specified in the components list is easily obtained, and has an integral ball drive. The drive is not essential, or could be added to a capacitor without drive. A maximum capacity of 300 to 500pF for each section will be satisfactory.

It was found that no trimmers were necessary, but should the tuning capacitor have trimmers, adjust them at the high frequency end of the m.w. band, for optimum performance.

With the circuit as in Fig. 1, place the switch in the 1500m position, set VC1/VC2 nearly fully closed, and adjust the coil cores from the underside of the chassis to tune in the BBC transmission. Then switch to medium waves, and if necessary make a compromise adjustment of the cores, for best reception around 400-500 metres.

As the second coil is loaded by the diode, losses of efficiency from slight mis-alignment are small. Should it become necessary to experiment with the tuned circuits 50pF trimmers should be fitted across VC1/VC2. Trim for best results with the tuning gang nearly fully open, and adjust the coil cores on medium waves for best results around 400-500m. Connect a 500pF or similar pre-set capacitor in parallel with C1 and C5, and adjust these pre-sets for best reception at 1500m. It is also possible to use the coupling winding on the second coil to feed the diode. This increases selectivity.

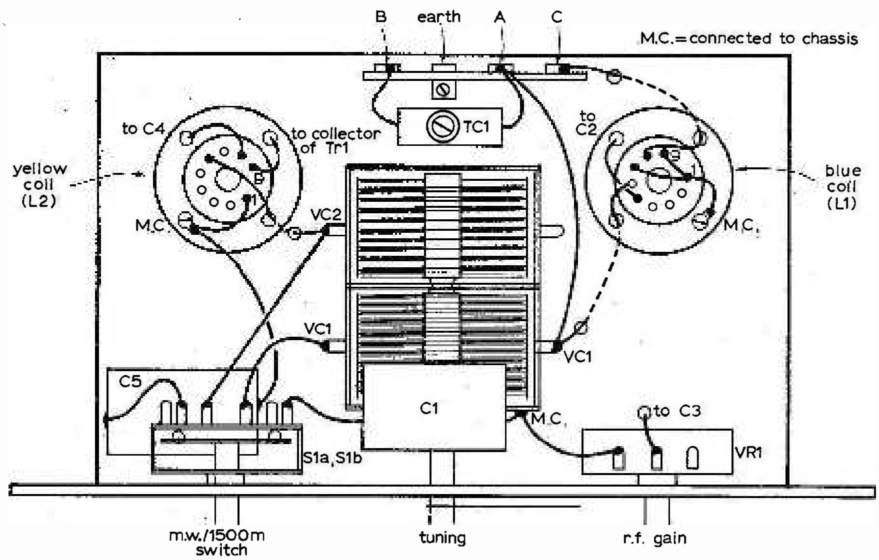
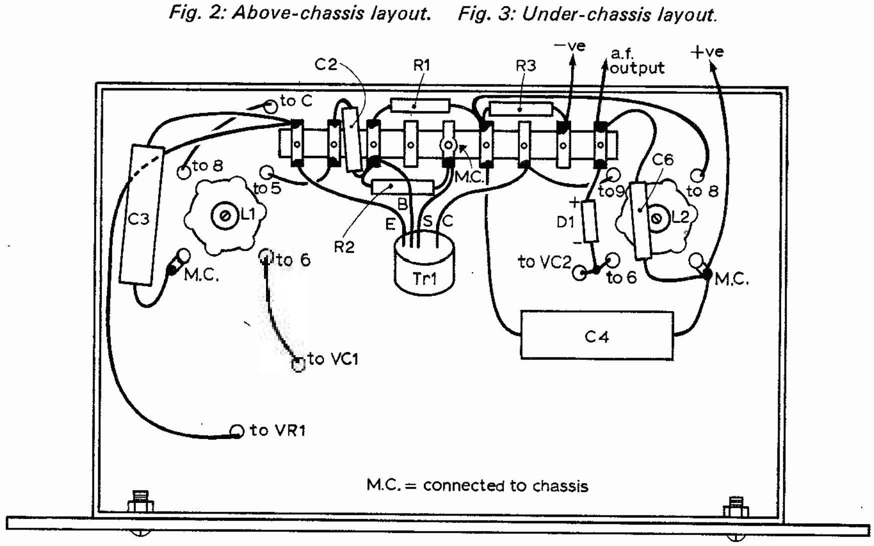


Fig. 2: Above-chassis layout. *Fig. 3: Under-chassis layout.*



Under the Chassis

Most items are supported by a tagstrip as can be seen in Fig. 3. Transistor leads E (emitter), B (base), S (screen) and C (collector) are soldered to tags, and identified by the extra space between S and C wires.

For use with the amplifier described, take a flexible lead from R3. This is fitted with a plug to insert in the amplifier socket providing the battery negative supply.

The positive or chassis return circuit is completed by the outer brading of a co-axial lead, the inner lead carrying the audio frequency output, from the junction of D1 and C6.

With leads provided in this way, it is only necessary to plug in the co-axial connector and negative plug.

If m.w. coverage only is required, omit the switch, also C1 and C5.

THE RECORD PLAYER

This is battery operated, and intended for use with the "Pyramid" amplifier, or other transistor amplifiers of similar type. The turntable unit has a 9 volt motor and a PP9 battery gives long service. It has a 2-speed auto-stop mechanism, for 33 and 45 r.p.m. records, with a crystal pick-up.

For record playing with the "Pyramid" amplifier, it is only necessary to unplug the radio tuner or other equipment, and plug in a co-axial connector from the player.

Case

This is of a simple type, constructed as shown in Fig. 4. Top and bottom consist of a 7 × 10in. piece of hardboard. Front, sides and back are ⅜in. thick wood, sawn from 3in. wide boards. The lengths of these pieces would have to be changed slightly if the wood is not of this thickness.

A piece of cardboard or paper is cut with scissors to clear the motor mechanism, and used to mark the hardboard for sawing. All items are secured together with adhesive and panel pins, the hinged back being omitted.

When the adhesive is dry, edges and corners are smoothed with a glasspaper block. Two small strips of wood keep the battery in place. Corner battens may be fitted at each corner to reinforce the cabinet.

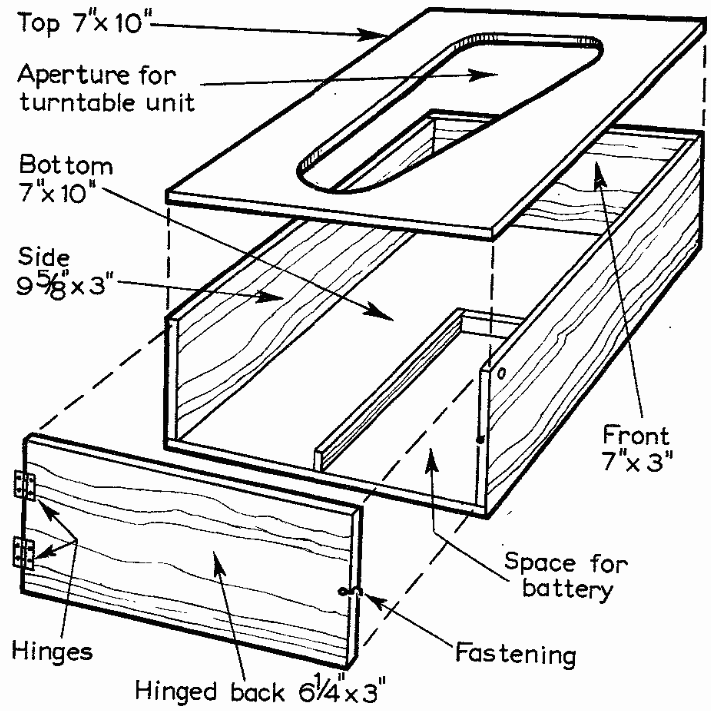
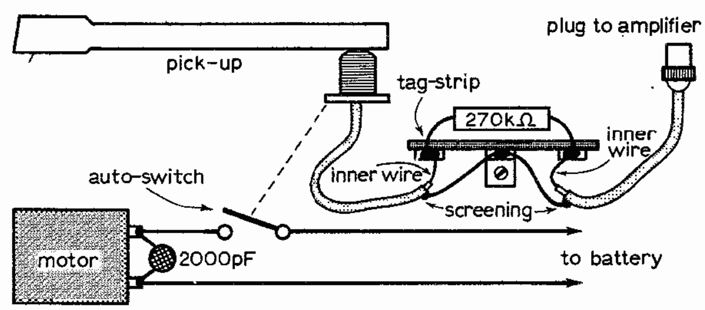


Fig. 4 (above): Case construction details

Fig. 5 (below): Motor and pickup connections



★ components list

RECORD PLAYER UNIT

9V 33/45 r.p.m. turntable unit with crystal pickup; 270kΩ ¼-watt resistor; 2000pF disc ceramic capacitor; tagstrip, coaxial lead and plug.

Case: Top—hardboard 10 × 7in.
Bottom—hardboard 10 × 7in.
Front—7 × 3in.
Sides (2)—9⅝ × 3in.
Back—6¼ 3in.
(Front, Sides, Back: All ⅜in. wood)
Hinges, etc.

T.R.F. TUNER UNIT

Resistors: all 10% ¼-watt

R1	100kΩ	R3	2·2kΩ
R2	22kΩ		

Capacitors:

C1	2000pF 2%	C4	0·25µF
C2	0·01µF	C5	2000pF 2%
C3	0·5µF	C6	0·01µF

TC1 50pF pre-set
VC1/VC2 Jackson 02 twin 365pF slow-motion, or similar

Semiconductors:
Tr1 AF117
D1 OA70 or similar

Miscellaneous:
VR1 25kΩ linear pot. Universal chassis single runner 7×3in. (Home Radio). Cabinet: Dinkicase 4 × 6 × 4in. (Electroniques). Coils: Blue and Yellow, Range 2, miniature transistor type (Denco). Knobs, tagstrips, 2-pole 2-way switch, etc.

External Finish

The case is covered with one of the self-adhesive materials which can be obtained in many colours. All dust must be wiped off first. The case is placed upside down on a piece of material large enough to cover the front and sides also, with some overlap on to the bottom. It can then be cut to fit the corners, and the bottom is covered with a separate piece. The material is turned over inside the rear edges of the top, bottom and sides at the back.

The material is cut to suit the motor opening. The back is similarly covered, and fitted with two miniature hinges and a catch. It should be checked for size first, as it needs to be slightly under the dimensions given, to allow for the material.

Other finishes would be satisfactory, including bronze or other coloured "hammer finish" paint, which results in a metallic appearance.

Various ready-made record player cabinets are available, and often have a suitcase-type lid, which closes over the turntable. This type of cabinet is usually constructed by making a box deep enough for both lid and bottom. It is afterwards sawn round to produce the lid. Bottom and lid are finished off separately, and a panel for the motor is cut to fit

—continued on page 622

AUDIO SUPPLEMENT

No. 3 — SERVICING, TEST EQUIPMENT, WORKSHOP PRACTICE

IN the previous sections of this supplement we have considered the standard and parameters of audio equipment, and discussed some of the theory from which these figures may be derived. To conclude this brief look at the audio field we must outline a few of the tests that may be carried out to prove the validity of those figures. Audio in general, high fidelity in particular, is a very subjective art. Ultimately, much depends on the judgement of our own ears. But instruments can narrow the field of investigation for us, and will often reveal subtle factors of deviation which our ears refuse to distinguish, or to which our hearing has become accustomed. The aim, then, is objectivity.

Equally important, in practice, is the matter of impedance matching, avoidance of poor joints and hum loops, and correct siting of the ancillary parts of the equipment. The room or space in which a recording is made, and that place where the result will be reproduced, affects the sound we shall hear, and our relationship with the microphone or loudspeaker system and the acoustics of the room have all to be taken into account.

In fact, both the subjective and the objective assessment of audio equipment have to be made together, and we shall endeavour, in this section, to treat both aspects in a practical manner, as the relevant points arise.

Microphones

Beginning at the input end of the audio chain, it is necessary to consider the type (and number) of microphones, the siting—in accordance with room acoustics and the type of signal we are going to record—and the matching to the following links of the chain.

Types of microphone were dealt with fairly comprehensively in the section on transducers. Comparative sensitivities and outputs have been covered and some idea of how the standards are derived was also touched upon. It should be stressed, however, that choice of microphone depends as much on the signal expected and the room acoustics as on "cold-blooded" efficiency. The ribbon microphone is perhaps the most versatile in the hands of an experienced user (an unfortunate phrase, for the last thing one wants to do is to handle a ribbon mike while recording!). It is not the most sensitive, but its extended upper frequency range, good response characteristics and selective polar diagram allow careful siting to produce good results, where other units, although having greater output voltages for the same sound pressure applied to them, will not be so selective, nor have such a good signal-to-noise ratio.

The use of an inbuilt transformer to raise the very low impedance of the ribbon unit to a line impedance suitable for matching to a preamplifier also enables us to get sufficient sensitivity to load most high fidelity input stages. But the impedance is still low enough for long lines to be used without the danger of hum pickup or the attenuation of the high frequencies by the self-capacity of the cable. For this purpose, a balanced type of connection is often used.

High quality cable is needed for a balanced input, to avoid cable noise with movement, due to the changing capacity which causes temporary imbalance. As with all balanced systems (and this includes the 300-ohm type of aerial feeder for f.m. radio inputs), preservation of balance is vital. Any cable damage will lead to hum and other noise level increase, and poor joints are even more intolerable than with single-screened systems.

The microphone can be regarded as a type of generator with a reactive shunt and series element. As low impedance devices, such as ribbon and moving coil microphones, will generally match into a pre-amplifier with greater source impedance, most of the signal generated will be fed to the preamp. The safeguard against noise is partly built-in by this factor. Where a microphone has a fairly level frequency response, extending well into the higher regions, sharp peaks will not be troublesome and the problems of acoustic feedback are lessened. Add to this the polar diagram advantage of the ribbon microphone, which allows siting with a preference for the signal and exclusion of unwanted sounds such as reflections and we can see why the reduction in sensitivity is easily offset by an improvement in acoustical efficiency. The improvement can, in practice, be too great! Where a ribbon unit is sited too close to the sound source, some bass attenuation may be required. Speakers who like to kiss the microphone should not use ribbon units.

Moving coil microphones are extremely versatile, more robust, and often give a higher output. They are the largest branch of the microphone family, and range over a wide price. By careful arrangement of the mounting and housing, a favourable response curve and polar diagram can be obtained.

Where more than one microphone is used, either as a stereo input set-up or as a combined mono input to a mixer and preamplifier, care must be taken to ensure that the two units are in phase. Normally, the polarity of microphones will be marked, or the connections arranged so that leads cannnot be crossed. Where this is not the case, or where some doubt arises through the use of dissimilar units, some experiment will be needed. The cancellation effects of out-of-phase connection will give rise to some quite unmistakable distortions, especially when the two units are sited at equal distance from the sound source.

Stereo siting can be either "co-incident" with the microphones placed close together, usually one above the other, and angled outwards to cover the sound field, or widely spaced to give a broad coverage. Each system has its advantages.

Reflected sounds can be troublesome, and a very "live" acoustic needs great care with microphone siting. Some "damping" can help—even a coat hung over a chair may reduce the unwanted reflection sufficiently to enable good recordings to be made! Room furnishings can be re-arranged, doors and windows opened to break up the reflecting areas—so long as this does not of itself introduce unwanted noise. A microphone in the centre of a flat table is often a failure. Even the most careful padding of the table top will not reduce the reflections, and the solution may be to raise the microphone or site it nearer a corner. It is in such small matters that the difference between success and failure lies.

Room acoustics will have less effect if the microphone is near the sound source. This seems obvious, but is too often disregarded when a wide sound source is to be captured. Some reverberation may be helpful to obtain "presence", and more than one microphone can be used; one sited to get the best direct sound, the other shielded as much as possible from the direct sound, and arranged to pick up the reverberations.

Ceramic and crystal units (piezo-electric), are general with cheaper audio systems, not usually employed when high fidelity is the aim. This is not to say that good quality piezo-electric devices are non-existent. But, generally, the attraction is cheapness, and some precaution is necessary to obtain the best results.

These are high impedance devices, thus limiting the length of connecting lead. The equivalent circuit is a voltage source in series with a capacitor. This works into an essentially resistive load, fairly high, but seldom as high as the microphone. As the capacitive element has a high reactance at low frequencies, any resistive damping at the input of the preamplifier will result in bass loss. This means that high impedance matching is necessary, and the possibility of hum and noise pickup is a further limitation.

Exact tests are beyond the scope of all but the best laboratories. Comparison tests and that prime tool—experience—are the standby of the average workshop.

Servicing should be limited to the checking of continuity and inter-connections. A low resistance reading will be obtained with ribbon and moving coil units, and a faint crackle will be heard as the ohmmeter is connected. Crystal units will register an open-circuit, but as the connection is made and broken, again, a faint click should be audible.

Most common cause of faults is cable breakage, and this will nearly always be at the point of greatest flexing—where the cable enters plug or microphone, or is twisted and clamped within the housing.

Gramophone Pickups

Some of the most precise test and adjustment procedures in audio work centre about the gramophone pickup. With stylus playing weights down to a couple of grams and stylus tip radii less than 0·0007in., some delicate setting up may be needed to get the best possible reproduction. We are not so much concerned here with the pickup cartridge, but with the combination of cartridge and arm and their relationship to the disc.

Figure 1 shows the sort of calculation that has to be made, for example, when mounting a pickup arm on a motor board. This precision is needed to take care of tracking angle, offset angle and sidethrust.

Because the cutting stylus is chisel shaped and tracks in a parallel fashion across the disc when this is being made, some attempt is needed to encourage the reproducing stylus to follow the same path. There have, in fact, been a few mechanisms based on diametric rather than pivoted movement, but mechanical considerations other than pure direction of stylus movement have offset any advantage that may have been gained. To achieve optimum results, a pivoted arm of infinite length would be needed. The longer the arm, the less the tracking error, but again, other considerations intervene. The angle of the plane of stylus vibration relative to the groove varies and second harmonic distortion is generated. Offsetting the head in relation to the plane of the arm reduces the "angle-of-attack" and the distortion. Allowing the tracking curve to "overhang" the centre of the disc reduces the distortion still further.

Distortion is inversely proportional to linear groove

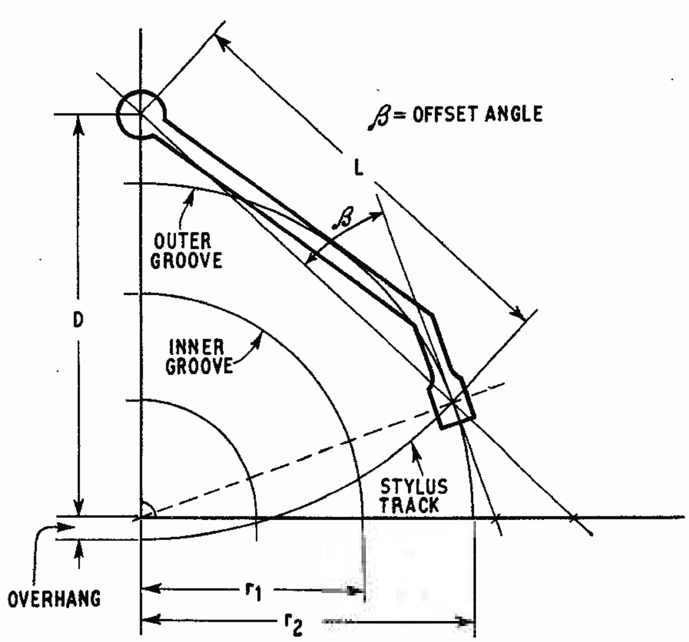


Fig. 1: Pick-up arm constants—horizontal plane.

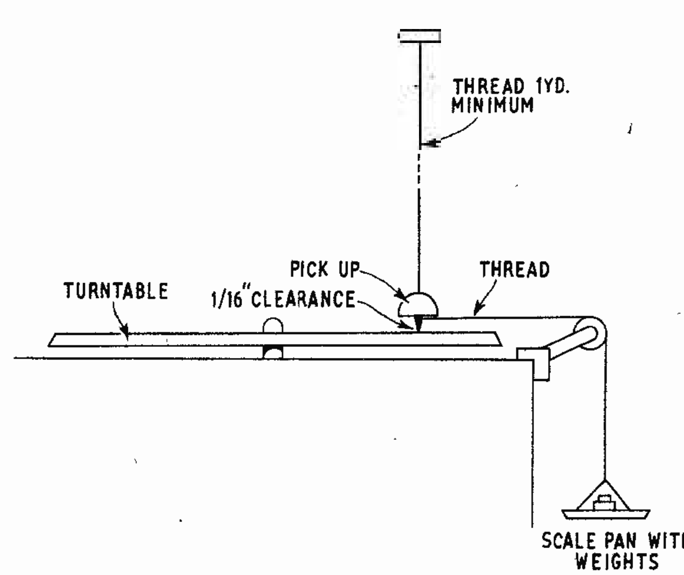


Fig. 2: Method of measuring back bearing friction.

velocity. A greater angle error on the outer grooves than the inner grooves of a disc can be tolerated. Some compromise is required. Distortion tends to be greatest at the lower reproducing speeds nearer the centre of the record: this is unfortunately the section of the recording likely to contain the greatest amplitude variations, musical climaxes, etc., and the offset angle for minimum tracking error may not be the best for minimum distortion.

Referring to Fig. 1, the formulae for overhang, D, and offset angle, β, are as follows:

$$D = \frac{r_1^2}{L\left(\frac{L}{4}\left(1+\frac{r_1}{r_2}\right)^2+\frac{r_1}{r_2}\right)} \text{ inches}$$

$$\beta = \frac{r_1\left(1+\frac{r_1}{r_2}\right)}{L\left(\frac{L}{4}\left(1+\frac{r_1}{r_2}\right)^2+\frac{r_1}{r_2}\right)} \text{ radians}$$

where L is the arm length from pedestal pivot to stylus point, r_1 the radius of the innermost groove and r_2 of the outer groove. The offset angle β is in radians. In the example given, the arm length of 7½in. and offset angle of 24½ degrees gives an overhang of 0·56in. and a total distortion figure of below 2 per cent.

To aid mounting of arms, pivot-to-spindle length is often worked out by the arm manufacturer and stated in his specifications. Templates are frequently provided and should always be adhered to where available. If the cartridge to be fitted substantially alters the stylus point position from the type recommended by the arm supplier, some compensation will be needed. Pivot-to-stylus dimension is the most important single factor in pickup-arm mounting. Some adjustment of cartridge position is often provided.

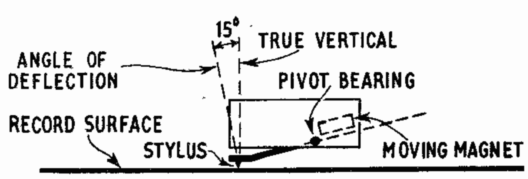


Fig. 3: Pick-up constants—vertical plane.

Adjustment of sidethrust and of stylus angle will also be found. A force tending to push the pickup toward the spindle exists and the stylus will bear more heavily on the inner wall of the groove, producing distortion especially on stereo recordings. High compliance cartridges require more compensation, and a weighted pivot, thread and weight or magnetic system will be employed to compensate for the varying forces. Stylus angle has now been standardised at 15 degrees, as shown in Fig 3, and where adjustment is provided this rake should be maintained in the playing position. For this to be accurate, the level of the arm must also be checked, so that it is horizontal in the playing position. The tendency of the pick-up arm to "skate" inwards expressed in a formula, F = 300w Tan a (dynes), where w is the playing weight in grams and a the angle from tangency. Without going too deeply into the geometry of the system, we can see that an increase in playing weight may be called for unless some anti-skating device is used. Increased in playing weight results in rapid groove deformation and loss of high frequencies, which may be "rubbed off" even at the first playing.

Friction due to the back bearing is another factor to be taken into account. It may not have any compensating adjustment, but during service every effort should be made to reduce its effect. To measure this friction, a set-up such as in Fig. 2 may be needed, with thin thread suspending the head so that the stylus just fails to contact the disc. Then the second thread runs from pickup, over the pulley to the scale pan; the head is tapped gently until it starts to move in its normal direction. The amount of weight needed to start it moving back toward the outer edge is approximately equal to the amount of extra playing weight needed to compensate for back friction.

Some arms are balanced on blade edge, some on needle point, some "float" in gimbals, some are clamped in ball-bearing races: all have arguments in their favour. All can be adjusted by the user to achieve a point of balance, and with the aid of a simple stylus pressure gauge, the actual force can be measured. To balance, simply ensure horizontal mounting with a spirit lever. Then turn the weight adjustment on the arm to zero, disconnect or remove the bias corrector, with the power off, switch to Play and set the lowering device to free the pickup arm. Then adjust the back weight until the arm is just hovering horizontally and can be gently pushed inward from the edge of the disc without seesawing. Clamp the weight, reset the compensator and set the weight adjustment to that recommended for the cartridge in use. When in doubt, err on the *slightly* heavy side: more damage to disc and stylus is done by a light loading, with the high compliance cartridges currently in use, than by over-balancing the playing weight.

Pickup arm raising and lowering devices can now be fitted independently, and there are one or two good ones to choose from. Whatever type is fitted should allow a dropping movement independent of the operator, whose action only "triggers off" the lowering device.

As important as the adjustments for correct weight and forces is the necessity to keep your records scrupulously clean. Dusty and sticky deposits in the disc groove, even the inherent dust that develops when the stylus first plays a new disc, can give much the same symptoms as mistracking—a high frequency distortion. Unfortunately, a damaged record may have the same symptoms. The clue is that increase of playing weight temporarily will cure the "dirt" problem but make no improvement to the gritty sound of a damaged record. The stylus itself can be cleaned with a drop of alcohol, taking care with this as some kinds of cleaner are solvents for the adhesive that secures the jewelled point.

The disc itself can be cleaned with a preener, a dustbug that tracks in front of the stylus, or the use of an antistatic cloth. An antistatic turntable mat is a great help in the exclusion of dust, and careful record storage will complete the necessary precautions. Discs should be in dustproof containers, such as polythene sleeves turned 90 degrees within cardboard sleeves, stacked upright and supported lightly, not flat and under pressure.

Radio Tuners

From the audio point of view, these can be regarded as a plain signal source, and the guiding parameters are those relating to radio receivers. British Standards B.S.4054:1966 can be used as a criterion, and the American equivalent IHFM-T-100 is all that is needed as a secondary reference. Factors to be regarded are harmonic distortion, signal-to-noise ratio and the rejection figure for exclusion of weaker stations, where f.m. signals are being received. As high fidelity is our guide word, we shall not regard a.m. tuners as more than an unavoidable extra!

The tuning range should include the specified bands, 87·5—108Mc/s for v.h.f., which includes shipping, police and aero services. Actual broadcasts are confined to 88·1–97·1Mc/s. For a.m. purposes the wavebands to be covered should be Long: 2,000–1,053 metres (150)–285kc/s, Medium: 571–187 metres (525–1,605kc/s) and Short: 50–11·5 metres (6–26Mc/s). There will be units that offer restricted coverage; others that have press-button selection of a limited number of stations. Choice will depend on one's listening tastes. Other factors may be more important than an extended range. If this is the prime factor, then a communications receiver will be more suitable than the average tuner—though very high quality exceptions exist, at a price!

Tuner sensitivity is expressed in microvolts at aerial input to produce the rated output (in the case of f.m. tuners, for the degree of "quieting"), and at a specified signal-to-noise ratio. American standards give a 30dB figure for the latter, and British standards are more exacting at 40dB. For stereo purposes, considerably more sensitivity is required, as we have already seen. Care must be taken when choosing or testing to allow for future development if one is operating in an area still served only by the mono signal. Pilot tone rejection is another factor that can trap the unwary, especially where the aim is tape recording. Additional 19 and 38kc/s filters may prove to be required.

Such filters can affect the frequency response adversely, and this must be taken into account when checking this specification, which is one of the "quality" factors of f.m. tuner performance. In theory it should be possible to obtain a frequency response from zero to well above the audio range, with plus or minus one or two decibel variation over the whole band. In practice, de-emphasis reduces the limits, and pilot tone considerations will further cut down response, so that a figure of 15kc/s may be regarded as adequate.

Automatic frequency control circuits vary between the token and the sophisticated, and testing has to take into account the drift to be expected over a period of use. In some designs it is necessary to render these circuits inoperative while carrying out preliminary alignment.

Because a wide pass-band is used, and peaking of intermediate frequency stages of the f.m. tuner is not possible, there is generally some reluctance to attempt re-alignment. Although this may be advisable unless the circuits are known to be badly out of tune, nevertheless, there is no mystique about f.m. tuner alignment, only the need for greater care. To be absolutely accurate, one should use a wobbulator (frequency modulated signal generator) and oscilloscope, but much can be accomplished with an a.m. signal generator covering the appropriate frequency band, a meter, and knowledge of the circuitry.

The usual procedure is to detune the final winding of the i.f. transformer chain, secondary of the pre-detector stage, and connect a meter across the detector load. The exact point of connection depends on the type of discriminator circuit. This can be either a balanced or unbalanced ratio detector or the popular Foster-Seeley configuration. An amplitude limiter circuit will almost certainly precede the detector and care must be taken to keep the generator input as low as possible to avoid limiting and misleading Megger indications—i.e. flattened "peaks". Peaking the i.f. stages too sharply will impair the h.f. response, and some detuning may help if trials are being made.

A good "rough test" of response curve symmetry can be made by slowly swinging the tuning through a fairly strong station, with the a.f.c. disconnected or switched "off". When on tune, the signal should be clear and the indicator at peak; at either side there should be a lower level but undistorted area and then a distorted area, usually quite sharp, where the signal is being rectified on the non-linear portion of the discriminator curve. Asymmetry indicates the need for re-alignment: too small a clear area indicates the need for some detuning or damping.

When aligning the r.f. end of the tuner, always check sensitivity at both ends of the f.m. band. This is a prime failing with some cheap tuners, and little can be done to improve them. The actual transmissions can be used for these tests, provided the i.f. stages have been aligned satisfactorily. Again, some reduction of signal may be needed in areas of high signal strength to avoid the masking of the limiting action, which is one of the fundamental advantages of f.m. reception in excluding amplitude variations, and much interference.

Alignment with "scope and wobbulator" is more satisfactory as the response curved can be viewed and the immediate effect of any adjustment can be seen.

Amplifiers

The audio amplifier is the heart of the system and requires the most stringent testing. Various parameters, specifications, input and output matching and some kinds of distortion have been described.

Frequency response and the overall gain characteristic is the first consideration. Unless the response is flat within specified limits and extends over the audio band, with correct "slope" at the ends of the curve, there is

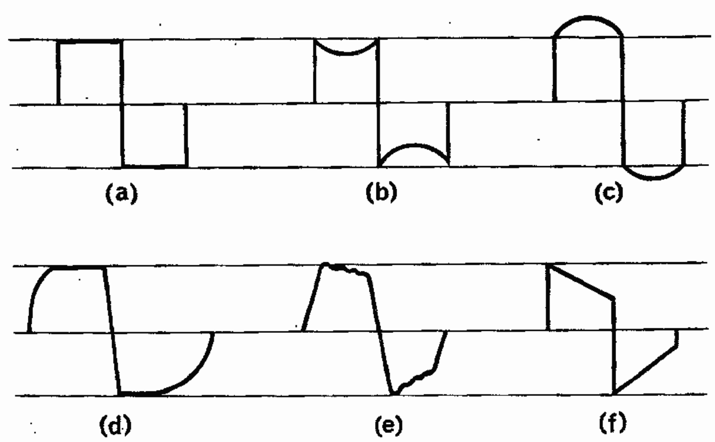


Fig. 4: Square-wave testing of amplifier: (a) square-wave input, (b) low frequency loss, (c) low-frequency boosted, (d) high frequency roll-off, (e) high frequency boosting causes ringing, (f) low-frequency phase shift.

no point in making further tests. But in this respect it must be remembered that we are concerned now with the basic amplifier and not the equalised and corrected preamplifier circuits. As we saw in previous sections, the amplifier must correct for non-linearity in the signal presented to it. We must also be able to test this correction, to ensure that a normal signal from a transducer will come out at the other end as a "flat" output. Tone controls are another matter, and should be treated separately, after the tests for true frequency response are made.

First step is to check the specifications. Although the audio spectrum may be considered to extend from 20c/s to 20kc/s, not all amplifiers have a sensibly flat response as ambitious as this. Some are deliberately limited in the interests of stability and noise reduction, especially in the case of some less expensive transistorised units.

Frequency response is measured in decibels, giving the relative gain to a standard output for a standard input at a set frequency. This should be stated in the specifications; where it is not, take the rated output as the standard, and the test frequency as 1kc/s, with the specified input as that for the unequalised input of the amplifier—usually the "auxiliary", "radio", "diode" or "tuner" input. Tone controls should be in the "flat" position, scratch, rumble and noise filters set so that no compensation is introduced and loudness controls out of circuit. Gain controls are set at maximum for all tests unless otherwise specified.

With stereo amplifiers, balance controls which are intended to have a frequency "roll-off", should be in the null position for response tests. Remember that balance controls will normally introduce an earlier roll-off at the top end of the frequency spectrum than would be indicated for monophonic amplifiers.

Tests are made with a measured input from an audio generator, the output of the amplifier being monitored by an output meter and, if possible, an oscilloscope across a load resistor equivalent to the rated load of the loudspeaker. The output meter can be a direct reading type of instrument, or a simple a.c. meter whose voltage reading can be converted to power by a normal Ohm's law formula, i.e. Power$=V^2/R$. The resistor should be non-inductive.

For preliminary tests, the loudspeaker can be left in circuit. A signal is injected to produce a 1-watt output at 1kc/s and the dB reading noted. Further signals may now be injected at spot frequencies over the specified range and variations from the noted standard can be tabulated, or entered on a graph to give a "picture" of the frequency response. Remember, this is a frequency response test and not a power response, so the input level must be adjusted to keep the output below any level which may result in distortion, hence the 1-watt preliminary standard. If in doubt, make a further set of readings to produce a lower output and compare the two sets.

Frequency response should be smooth. Peaks may indicate instability—although some amplifiers have a deliberate peak at around 2kc/s.

Square wave testing, where a suitable signal generator and an oscilloscope are available, is a quick and effective way of revealing the frequency response defects in an amplifier. A theoretical square wave has zero rise time and will look like Fig. 4. In practice, this is never achieved; there must be a finite time from the instant of the rise commencing and the reaching of peak output. Bandwith limitation accentuates this "slope". The relationship between the high frequency limit and rise time will be found from the equation: $f = \frac{0{\cdot}35}{t_r}$ where f is the frequency at which the top end of the band has rolled off by 3dB and t_r is the rise time. A really good oscilloscope is needed to show the true square wave from a high fidelity amplifier, and its horizontal axis should be calibrated in time. Wide-band d.c. scopes are most useful in this application.

Figure 4 also shows the various distortions of the square wave that will be produced by defects in the amplifier. They may be regarded as clues rather than proofs, and can greatly speed investigations.

We mentioned earlier the need for correct assessment of the equalised preamplifier when testing response curves the equipment as a whole. The principal correction to be noted is that for gramophone cartridge inputs. In these days of high-grade ceramic cartridges, and quite inexpensive magnetic types, it is not at all unusual to find amplifiers with switched correction for different types of curve. The curve shown in Fig. 5 is the RIAA recording curve which is the American standard. If we assume that a record amplifier has been designed to give a signal at the constant-velocity record head, and a uniform signal is applied to this amplifier, with the curve shown, the resulting groove will have constant amplitudes up to 500c/s, limiting the groove swing at low frequencies. Constant-velocity mode is used from 500 to 2120c/s, with the groove swing decreasing as the frequency rises. Above 2120c/s the constant-amplitude mode is again used to allow the high frequencies to overcome record noise.

Use of this recording curve for a constant-velocity cartridge requires a compensating curve as in Fig. 5 in the playback amplifier to produce a level response. To check this, an equipment setup as in Fig. 6 is used. First the output from the signal generator is fed to the "flat" input—the auxiliary socket—and then an attenuated input fed to the phono socket. Both signal and earth return leads are switched to avoid hum loops. With the switch at Aux., feed in a 30c/s input and turn

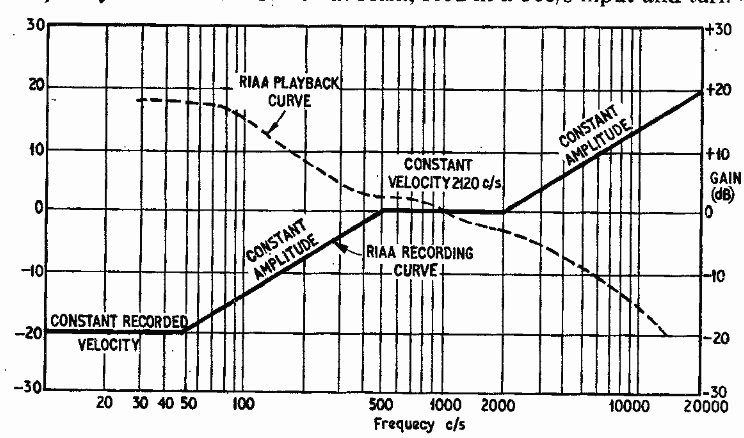
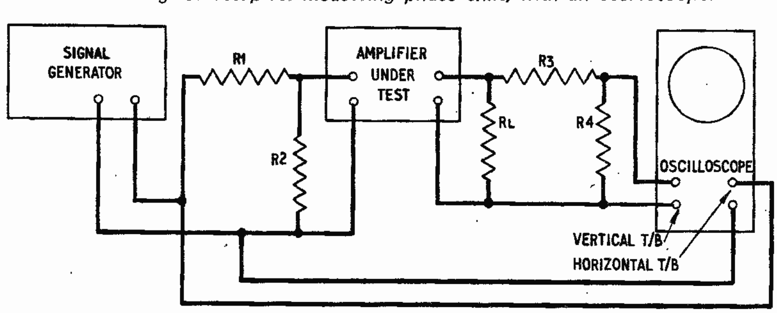


Fig. 5: RIAA recording—playback curve.

Fig. 6: Setup for measuring phase-shift, with an oscilloscope.



up the gain to distortion point, then back off slightly and note the output meter reading. Feed a 1kc/s signal to the pickup input and set the generator input for an output reading 20dB or so below the previous reading and take this as the OdB level. Make other measurements relative to this figure. A curve similar to Fig. 5 should be produced.

Constant-amplitude cartridges may be used, and these match, in theory, into the linear input. But the equivalent circuit of such a cartridge is a voltage source in series with a resistor, as we have already seen. Losses at low frequencies are determined by the load resistor. A load impedance of a couple of megohms may be needed to prevent loss of bass. In such cases, a network such as that shown in Fig. 7 may be required to match a constant-amplitude device into a constant velocity, i.e. corrected phono-input. The roll-off of the preamplifier will approximately cancel the high-frequency boost given by the network. At the lower end, the curve equalises the output from the cartridge. The dummy load resistor, R_2, can be chosen to produce the required output to match the sensitivity of the preamplifier.

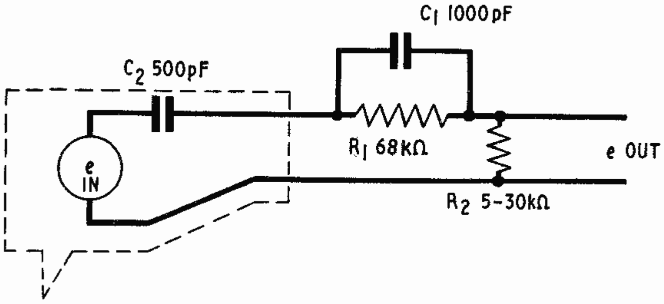


Fig. 7: Matching network for constant amplitude cartridge into pre-amp with constant velocity equalisation.

Distortion

Measurement of distortion in amplifiers is a highly sophisticated task, requiring quite expensive instruments. But much can be done with normal bench apparatus and a knowledge of the conditions. Regarding first non-linear distortion, such as harmonic and intermodulation distortion, we can sum up the conditions by producing a transfer characteristic for the amplifier, as in Fig. 8. This shows the resultant waveform of two applied sinewaves. In practice, of course, the amplifier seldom handles pure sinewaves, but carries intelligence which is a combination of many sinewaves, with their sum and difference effects. These last are the intermodulation products, and are accentuated by any non-linearity in the amplifier's response. By applying two sinewaves and measuring the intermodulation, some idea of the amplifier linearity is gained. This is a recognised laboratory method.

The effect of harmonic distortion varies as the proportions of the harmonics differ. Harmonics up to and including the sixth are not discordant in small quantities, but above this, especially the 7th, 9th, 11th, 13th, 14th, 17th, 18th and 19th harmonics, severe dissonances occur with even quite small amplitudes of the unwanted frequency. This is why a relationship between bandwidth and distortion is needed, to demonstrate which order of harmonics is causing the distortion. Overall harmonic distortion figures alone can be misleading. For example: with a 15kc/s bandwidth, harmonic distortion of 0·8% will be just noticeable. As much as 1·5% could be tolerated by most people, but 2% or more would probably be objectionable. If we now restrict the bandwidth of the amplifier to 3·75kc/s, as would be done by a speech/music switch selecting "speech", the figures alter drastically. Harmonic distortion can rise to 1·2% before it becomes perceptible, is still tolerable well over 5% and only becomes really objectionable at 12% or more. Hence the compression methods employed when relaying telephone conversations.

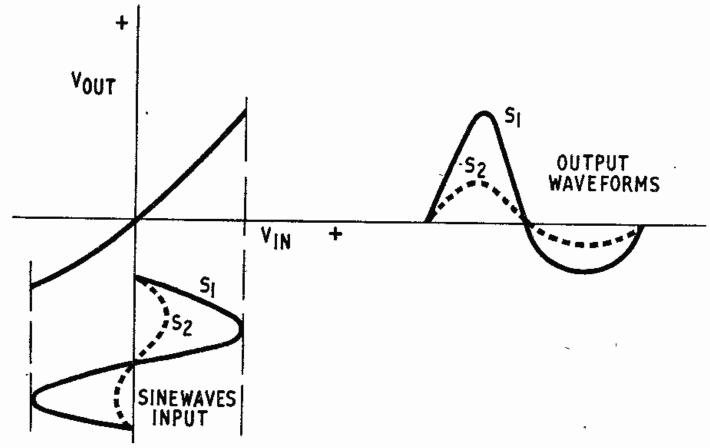


Fig. 8: Transfer characteristic of a typical amplifier, showing effect of intermodulation distortion.

At a point on the bandwidth/distortion relationship curve, intermodulation distortion becomes more unpleasant. This is principally because the intermodulation products are not harmonically related to the original signal. The frequencies produce continuing discords. The ear is itself non-linear and dissonant frequency components produce violent effects on the hearing as volume increases. But volume alone is not the *cause* of the unpleasantness. A volume whose sound level consists of pure signal plus distortion may be unbearable, but is not so when the distortion is removed and the sound level brought to the same amount as before.

The transfer characteristic of an amplifier will differ in slope and shape at different frequencies. Intermodulation and harmonic distortion although both related to the transfer function, are not directly related to each other and should be measured separately.

In practice we measure the effects of, rather than the amount, of, non-linearity. Distortion can be caused by inherent curvature in the characteristics of valves or transistors, non-linearity in transformers, push-pull stage mis-matching (with even harmonic distortion the greater culprit), and crossover distortion, particularly with transistorised Class B push-pull stages where biasing alters due to falling power supplies. Measurements of harmonic and intermodulation distortion can be divided into single signal methods for harmonic and overall distortion and double signal measurements for intermodulation. A distortion meter is necessary to separate signal from distortion without causing misleading results.

There are two approved methods of measuring intermodulation distortion. The argument applied here is that single-frequency tests alone do not reveal a true picture of non-linearity, and a measurement of intermodulation distortion gives a better assessment of the amplifier's performance. The two methods are (a) Comite Consultatif International Telephonique, and (b) the type of test employed by the Society of Motion Picture and Television Engineers. Differing results are obtained, and the method must be stated when specifications are given.

In the CCIF method, two sinewaves of equal amplitude are applied, the frequencies being close together (10 to 20% difference is usual). A peak reading voltmeter monitors output, a low-pass filter rejects the original signals and distortion is read by the second meter. The reading is of peak intermodulation distortion, and omits odd order intermodulation products and some sum components, which are also stopped by the low pass filter. It is therefore most useful for upper frequency band testing. The most important practical precaution is to avoid making the two frequencies so close that the difference frequency is below the frequency response (3dB point) of the amplifier.

Method (b) uses two test tones widely separated in frequency and the amplitude of the low frequency tone is four times that of the high frequency tone. Normally 1kc/s and 10kc/s would be the test tones employed. The band-stop filter (high pass) prevents the low-f tone getting to the measuring meter, while the carrier frequency high-f, is passed to a conventional carrier-level meter, a demodulator and finally a low-pass filter, the resultant amplitude of the demodulated signal being the intermodulation product.

Power output of an amplifier should be stated with regard to other specifications, as we have already discussed at some length. Having determined what the actual power output should be, from the quoted specifications, measurements should be made with suitable test equipment. An undistorted input, sinewave, squarewave or modulated signal, is fed to the "flat" input and an output voltage across a restrictive load equivalent to the loudspeaker load. Refinements are the oscilloscope to view the waveform and a distortion meter to make a direct reading of the harmonic distortion level. Continuous sinewave power is then calculated simply by dividing the square of the a.c. voltage by the resistance of the load.

As the amplitude of a sinewave varies throughout the cycle, the average value of power output, (because maximum voltage is equal to r.m.s. voltage $x\sqrt{2}$) will be the square of the r.m.s. voltage divided by the resistance. $P_{av}=E_{rms}{}^2/R$. Similarly, peak power, which would be the output if the amount of power developed at the peak of the sine wave were to be extended through the complete cycle, is twice the average sine-wave power output.

But amplifiers are not designed to deliver sinewave power alone. Indeed, a continuous sinewave of any size through many transistor amplifiers would damage them. Square wave testing may help show up many of the defects, while still enabling a power test to be made. If an audio frequency square-wave is fed to the amplifier and the gain turned up until as near a rectangular shape is displayed on the oscilloscope, then the peak-reading voltmeter connected across the output, the power can be calculated from: $P_{(peak)}=E_{max}{}^2/R$. But as most meters are designed to indicate peak-to-peak voltages, and $E_{p\text{-}p}$ is $2E_{max}$, the peak power will then be the square of the peak-to-peak reading divided by four times the load resistance.

Music power measurement assumes no change in power supply voltage with signal level, and tests should include a laboratory type regulated power supply to ensure this condition. The resultant power reading (sine-wave) is the IHF power rating, and will be higher than the original sinewave power. Peak IHF or peak music power is twice the former figure (which explains the need for caution when accepting manufacturers' claims for output power). By the same code, precautions are needed when checking power rating of transformerless transistorised amplifiers, whose power output increases inversely with the resistance of the output-load. A lower resistance (or lower impedance loudspeaker) than specified should never be used to attempt to get better figures.

Testing amplifier sensitivity is a different matter from checking the power output. We are now concerned with the level of input needed to produce the rated power, which will be the level at a certain percentage of distortion. If there are no definitions of the power rating, we take it that the power figure is this rated output. Thus, a 10-watt amplifier that requires 150mV at 1kc/s, at the auxiliary input to produce 10 watts of output power can be said to have a sensitivity, at that output of 150mV, to measure this, suitable test equipment should be utilised.

With the gain control at maximum and all other controls set for linear amplification, a 1kc/s input is applied and the generator output set so that the rated output appears across the load. Output power is derived from the square of the output voltage reading divided by the load resistance. The input voltage is then the sensitivity. Do not confuse output power with sensitivity. Two dissimilar amplifiers with the same "sensitivity" rating may be deceptively different from that expected. One has to determine what input is needed for the same rated output power, when the lower powered unit may well turn out to be the more sensitive. This can be important when we need to consider the amplifier's safeguard against overload.

Phase distortion is considered very important by some authorities. As an amplifier stage shifts the signal through 180 degrees, the deviation from a linear phase shift will cause non-linearity. All frequency components will not be shifted by the same amount. Some delay is caused by capacitative and inductive elements of the amplifier circuit. This becomes more evident with complex waveforms, and depends on harmonic content.

Other amplifier tests include those for hum and noise, for parasitic oscillation, and for overload. While these figures may not always be specified, the tests for them can be made with the foregoing bench rigs, and by using commonsense interpretations of the measured ratings.

With stereo amplifiers, the separation between the two channels becomes an important rating. There should be as little leakage as possible from one channel to the other, for any input or output condition The appropriate test equipment should be used, taking care to keep the unmeasured channel correctly loaded, then throwing the change-over switch so that the output on the channel with no input is read—the dB difference between the two output readings being the separation. Always reverse and retest.

Tape Recorders

Much of the testing previously outlined will apply also to tape recorder amplifiers, with the added problem of recording bias and erase current, which can affect distortion, output level, and residual noise. Some idea of the way in which this occurs is seen from the simplified diagram, Fig. 9. Correct adjustment of bias amplitude, correct frequency, and a good sinewave form are all needed to ensure distortion ratings within the maker's specifications. Erasure should be clean, with residual tape noise again below the dB figure stated, and this will only be gained when the erase current is adequate—all other factors being in order.

The azimuth setting of the record and playback heads is important for good frequency response and adequate output. Test tapes have been produced with bands of "white noise"—i.e. combination of all frequencies within set portions of the audio spectrum at equal amplitude—which sound like a hiss with a pronounced low level rumble when properly reproduced. By tilting the head for maximum output, the

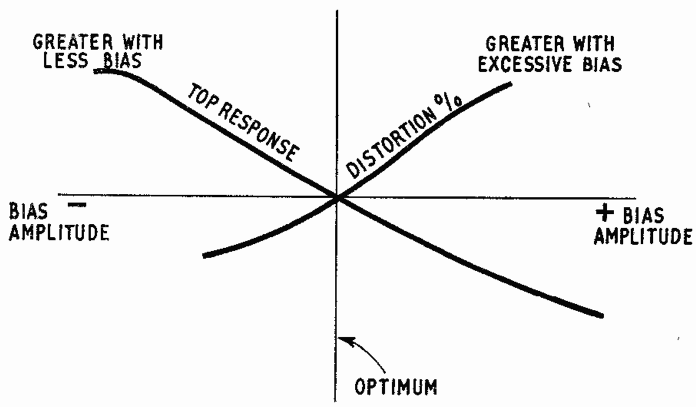


Fig. 9: Bias setting is important for tape recorder adjustment.

correct azimuth can be obtained. Aurally, the rumble aids alignment, and by using a tape with a portion of track erased, height and setting of tape heads can be checked.

As we saw when considering other transducers, the

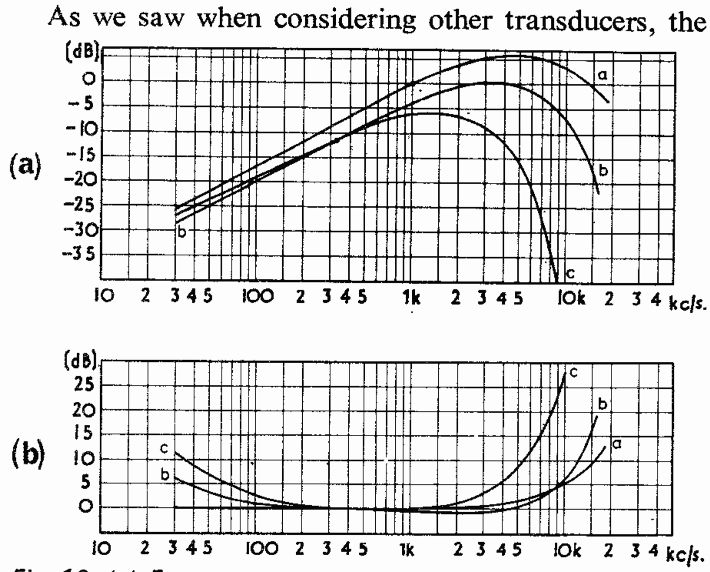


Fig. 10: (a) Frequency response of combined record playback head with 100kc/s bias, recorded with constant a.f. current at 1kc/s, and at three speeds, 19, 9·5, and 4·75cm/s, a, b, c. (b) Recording current boost required with combined heads to obtain the curves of (a).

response of the tape amplifier is not flat. Figure 10 shows the response curves, which are different at different speeds, and **(b)** shows the recording current boost needed to obtain these curves.

Mechanical considerations enter into matters when we check tape recorders. Unless the mechanism is correct, work on the amplifiers is useless. Regular and accurate speed is vital. Variation from the speed regularity at a low rate (wow) causes an objectionable wobble of the test tone, or the programme, and at a high rate (flutter) a harshness becomes apparent.

Wow and flutter percentages can be derived by making tests with a frequency modulated derivation of the input signal, carefully limited and detected. Special meters for the purpose are available, and lately a model has appeared on the market at less than £50.

Loudspeakers

There is little we can do when testing except ensure that the maker's ratings are not despoiled. Principal factor is the efficiency, and Fig. 11 shows a typical graph of relationship between the power input to a loudspeaker and the sound pressure that is actually produced—a concept that has to be grasped before any assessment of loudspeaker quality can be made. Doubling the power to a loudspeaker only increases the sound by 3dB, which is hardly noticeable to the ear—but this also depends on the frequency at which the test is made and the power level at which we commenced—as we demonstrated at the outset of this supplement. It often pays to use a higher efficiency speaker (one with greater flux density) and employ a lower power.

Room acoustics have to be taken into account also, and this again is a subject which exceeds our present terms of reference. Reverberation times differ greatly for different rooms and for different placing of loudspeakers in the rooms, even for different placement of furniture. Room dimensions affect the resonances, and apart from avoiding rooms in which the dimensions coincide, to give marked resonances, there is little we may wish to do structurally.

Table of room dimension ratios (Volkman) for optimum listening conditions:—

Type of room	*Height*	*Width*	*Length*
Small	1	1·25	1·6
Medium	1	1·6	2·5
Large	1	1·25	3·2

It is worth noting that most of the room changes made to aid heat preservation, double-glazing, plasterboard ceiling on builders' insulation board, wood-block floors with part carpeting, clinker or breezeblock walls in place of brick and plasterboard, all improve acoustic

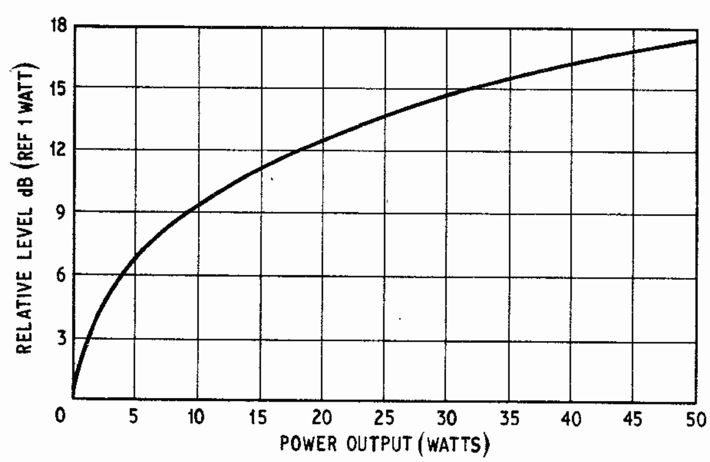


Fig. 11: Loudspeaker efficiency. Graph showing relationship between power input and sound pressure, reference 1 watt.

conditions. But these are incidentals to our present survey; the scope of this audio supplement was intended to aid understanding of audio matters and to facilitate testing. Articles on various aspects of audio will appear from time to time in the main body of the magazine and the supplement can be regarded as a preparation to a better appreciation of these, as well as a source of reference. ■

LETTERS...

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

Another Son of Silence . . .

I have had the same experience as A. Trowbridge—always "instant silence" on trying out each transistor set I make. Decided to make up the transistor tester as described in an earlier issue. Tested the transistors I had used and found that three of them had "gone for a Burton". Whereupon I felt like going out for a "Johnnie Walker". The latest of the silent sets is the Reflex Front End for 1·6 to 5Mc/s, but I managed to coax some sound out of it in the way of motor-boating. Perhaps a penny of some sort will drop some day but in the meantime, like Mr. Trowbridge, it's back to valves.—**D. Smith** (*Stockport*).

. . . and a Dad

As a "Dad of Constant Silence" how encouraged I was to read Mr. Trowbridge's letter (October). No longer need I feel alone in my shame as we all sit in frozen immobility with breath held while I try to distinguish whether it is a station I hear in the headphones or my hair growing.

I have tried simple circuits—crystal, transistor and one-valve from many sources, including the otherwise incomparable PW, and the only faintly audible signal I ever heard was an intimate mixture of at least two broadcast stations obtained with a 3in. dia-tapped coil, one OA81 and headphones only.

However, I've never tried a large super set and if Mr. Trowbridge is really tiring of his, I'll gladly send him my 3in. home-wound coil in exchange for one of his super sets—and pay the carriage.—**D. Hannaford** (*Brighton*).

Some advice . . .

Regarding A. Trowbridge's letter may I suggest he perseveres with transistors. After many false starts I finally achieved success on two PW designs for transistors. The first was the single transistor receiver (June '68). Having achieved results on this I decided to try the 300mW transformerless amplifier (June '66). Much to my surprise* this worked as an excellent straight amplifier using a crystal mike. The next step was to couple the receiver to the amplifier. This was completed successfully and I now have an excellent little receiver. Both units provided great interest, and excellent experience in my transistor construction.—**J. A. Ennis** (*Saltash*).

**Thanks for the back-handed compliment!—Ed.*)

. . . and comfort

I am writing to comfort those poor readers who think that they are very unlucky with their equipment. I decided to build a really good portable record player, with 6 watts output, a 10 × 6in. speaker, and a good deck. The amplifier turned out to be the best audio oscillator I have ever come across. Adjusting the bass, treble and volume controls provided any noise from a motor bike to a VC10. I discovered that this was due to the fact that the whole thing was earthed at the wrong place on the right electrical wire. Why that should matter beats me.

After that, the reputable deck developed a nasty habit of engraving extra grooves on records, at 90 degrees to the existing ones. As if that wasn't enough, the loudspeaker has developed an intolerable "fuzzing" when anything was played through it. Just in case I could replace that, the cabinet warped horribly.

Have I made my point? No? Well, I mended a 30 watt bass amplifier not very long ago, and an output valve exploded (how?) not long afterwards. The amp always did smoke a bit, but exploding!? May be I should take up stamp collecting . . .—**R. Sterry** (*Reading*).

Subject for discussion

How naïve can a reader be, when he thinks that amateurs ought to concentrate on radio for a subject to talk about on the air? The idea is to communicate, mainly. The most boring operators are those that describe in detail what they did, heard, constructed, etc. But somebody who can cure my warts at 70 miles or so on 80, is the man for me. And a good curry recipe is worth all the agony I suffered in an evening class for the R.A.E.!

"Giggles and squeaks", how awful. Has R. Meachim ever thought of the Invalid and Bedfast Net and its wonderful work; some of the members even guffaw and laugh out loud. The devils; they should be discussing microwave circuits in solemn and portentous voices. As a short-wave listener since 1928 and a licensed amateur since 1964 I advise R. Meachim of London, N.12 to keep off the air, he will only be a bore of the worst kind.—**Zach Nichols** (*Ickenham*).

★ ★ ★

In reply to Mr. Meachim's letter (September), I think that he is in the minority of S.W.Ls. when he finds radio amateurs a bunch of irresponsible gigglers. A licensed amateur is at liberty to talk on any subject of which he, or the person or persons with whom he is in contact, has had direct experience, provided that the message is not of a business, advertisement or propaganda nature or on behalf of any social, religious or commercial organisation.

Mr. Meachim states (and quite correctly), that the purpose of a licence is for the self-training and advancement of radio knowledge of the licensee. This somewhat stuffy concept goes back to the days of the early amateurs whose only purpose was to improve radio communication; these were the forerunners of radio today, but now, few amateurs do any original experimenting. Today, an amateur can operate within the terms of his licence, enjoy amateur radio, and advance his knowledge of radio and operating technique very little. Amateur radio is not an apprenticeship to becoming a professional wireless operator; it is a hobby in its own right, and as such does not have to be taken too seriously.

As to the implication that amateurs are irresponsible, all I can say is that Mr. Meachim has not opened his eyes (or ears) to the rest of the world. Most amateurs are courteous and always willing to fit in with others, and they also keep their equipment in good order, well aware of the dangers it could cause to other services. I could hardly see irresponsible people forming such a useful and able body of men as the Radio Amateurs Emergency Network.

On the same page was a letter by a Mr. Curtis attributing a large part of his success in the R.A.E. to listening to "the intelligent discussions on the 80 metre amateur band". If Mr. Meachim does not like the subjects discussed, he

LETTERS...

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

should remember he has not been asked to listen!—**H. Dearing, A 5554 RSGB** (*Waltham Cross*).

Polarity poser

I have always understood that the terms Negative and Positive referred to the direction of electron progression but I'm rather puzzled by the marking of those terminals, of either battery or rectifier diode which are connected to the anode load resistors and so to the anodes.

We are assured that the connection at the earth end of the cathode bias resistor is negative, and the other end positive because of the voltage drop across it, that the cathode is negative in respect to the anode, and the anode end of the anode load resistor is negative in respect to the h.t. supply end. A chain of positive to negative connections.

But what happens when we get to the h.t. battery or rectifier diode. We connect the positive end of the load resistor to the positive terminal of the battery and the negative terminal to the negative connection to the cathode resistor. Is this merely a persistence of the old positive-to-negative flow of current?—**H. C. Loxley** (*Warwick*).

How Solid is Solid?

Mr. Gibbins gave an adequate definition in his letter (PW Oct. 68) of the term solid state as one of the three phases of matter—solid, liquid and gaseous states. But he did not draw the conclusions necessary when the term is applied to electronics.

Most electronic apparatus consist of both active (valves, transistors, etc) and passive (resistors, capacitors, etc.) components. The term "solid state" is applied to an apparatus when the conduction process present in the active devices involves the motion of charge carriers within the solid state of matter (i.e. a transistor). An electronic valve involves the motion of charge carriers in a cloud of other charges—space charge—and this phenomenon is conduction in the gaseous state. A valved equipment could well be called "gaseous state".

I do not at all go along with Mr. Gibbins' deduction that the term solid state is incorrectly applied. There are doubtless liquid and even gaseous semi-conductors (in the broadest meaning of the word) but those that technology uses in the construction of active devices are exclusively solid state, and thus we can rationally apply the term solid state to electronic equipment.—**P. Goodhart** (*London, W.4.*)

Re-activating Mercury Cells

The article which appears in the October issue contains a number of inaccuracies. The author states that "cells in good condition give a useful life of two or three days and thus cost 1s. 0d. to 1s. 6d. per day to run". The useful life depends entirely on the current drain placed upon the battery powering the device and a cost per day figure is therefore meaningless.

Some hearing aids using Mallory RM675H cells, with drains of around 0·5mA, will last for more than 300 hours which on a basis of 10 hours per day use will give 30 days of service.

Mr. Stott goes on to state that "many (cells) are not sold in good condition and that their useful life is accordingly shorter". We at Mallory take great pains to ensure our cells are sold in good condition and the useful life of our product is uniformly consistent. With this emphasis on quality the shelf-life of our batteries is at least two years and their condition does not deteriorate during this period.

Later in the article it is stated that "when new, the mercury cell should have a voltage of 1·4V and has a reputed life of 35-40mA". The most popular hearing aid cell—the RM675H—has a capacity of 160mA so that if the current drain is 1mA it will give 160 hours of service, over four times the life quoted by Mr. Stott.

We appreciate the possibility of re-activating hearing aid cells but would like to point out there are many difficulties and dangers in so doing. When a voltage of more than 1·7V is applied to the terminals of a cell, the electrochemical system contained therein will generate gas and there is a strong possibility of explosion. The number of "cycles" possible is also very limited, while this is aggravated by the fact that recharging and even re-activation is virtually impossible once the cell is discharged to any appreciable extent.—**Dr. A. Gilmour** *(Manager of Engineering, Europe Mallory Batteries Ltd)*.

The Author Replies:

I have had no opportunity to test all hearing aids on the British market. *Which* (January 1968 issue) says the battery life of the fourteen hearing aids tested by them (with one exception) varied from 20 to 90 hours. The exception used secondary cells. There is a wide difference between an average life of 55 hours and Dr. Gilmour's 160 hours.

The Royal National Institute for the Deaf says batteries "last anything from *one a day* to one a week" (*Hearing Aids* p. 10 Q. 40). At one a day the present costs can amount to 17s. 6d. a week. Only one make seems to claim a battery life of 300 hours, which the makers say is achieved by the use of a special circuit; the price of the hearing aid is greatly enhanced accordingly. The "cost per day" figure may be meaningless to Dr. Gilmour, but it is what matters to the user, and I think in view of the foregoing my estimate of the *practical* cost per day was not unreasonable.

Dr. Gilmour does not say what are the "difficulties" of charging mercury cells. So far as "dangers" are concerned I refer to this twice in my article: in paragraph 11 I point out that the voltage used in commercial "chargers" is 3V. Has he objected to the sale of these chargers which are still being sold at 38s. 6d.? I also point out that the number of cycles is limited (paragraph 14). But even two cycles are worthwhile with mercury cells at 2s. 6d. By implication Dr. Gilmour says that 1·7V may safely be applied to a RM675H type cell. I have never suggested that more than 1·5V should be used; where then is the danger?

So far as accidents are concerned I happen through an oversight to have left six mercury cells in boosters for a period of over three months. The state of the Leclanché cells tested on an ex-WD battery tester (which draws a fairly heavy current) is still "good for all purposes". There is no visible damage to the mercury cells.—**L. B. Stott** *(Lincolnshire)*.

practically wireless commentary by HENRY

No. 51

Faint Praise

IT can hardly have escaped the notice of vigilant readers that the publication date of this issue falls very near that red-letter day of all anarchists, November the Fifth.

Anarchy is very much the fashion nowadays—so who do we want to blow up? No, you can come out from under that table, Mr. Editor. No point in wasting our fireworks. There is already an effigy hanging in the market place: the Postmaster-General, no less.

Mr. Stonehouse has said he is likely to be the last PMG. At the rate of turnover this office has seen of late, perhaps this possibility of a settled administration is to be welcomed. But before we throw our hats (stovepipe?) over the hedges, let us take heed of the implied threat in the turning of a much abused public service into a commercial company.

"We could make four times the profit," boast that famous non-entity, A. Spokesman. That's as may be. Four times the profit simply means, to us, that what we paid indirectly is likely to be extorted directly, by higher prices all round for those services we have come to regard as our right. We have felt the thin end of this wedge already, with the infamous two-tier postal service.

Looked at from any point of view, our postal service can be proved one of the best in the world. The sheer bulk of deliveries, our modern dependence on paperwork, is what has brought about the need for streamlining the system. It is only logical to attempt a sorting of the wheat from the chaff. More important mail has to be shunted through quickly; less vital fodder can wait. At the same time, some price increase was inevitable. *Ergo,* raise the stamp levy on the faster stream—but what a jumping cracker that idea turned out to be!

Come out from under that table, Mr. Editor.

The trouble, ironically, was lack of communications. That guy for all seasons, the Public Relations Officer, appears to have smouldered over the presentation rather than bursting it upon a public eager to hear of progress, but reluctant to stomach change! Any good businessman could have explained that the right approach was to offer a faster service at a higher rate, and quash utterly any suggestion of holding back the mails in order to achieve—or maintain—the upper tier.

No wonder one newspaper, in an inspired leader, announced a number of mythical two-tier services, including a new £6 television licence that would enable viewers to see programmes while they were transmitted, whereas the old £5, second-class, licence would allow us to watch the Epilogue at 7 a.m.

Who's joking? In these days of near perfect videotape, we are practically getting canned TV now. About the only programmes that appear "live" are boring discussions that could as easily be slotted into those advertisement spaces the lordly Doctor tries hard not to admit he has toyed with.

As an afterthought—why use postage stamps at all? Now that envelopes are to be standardised, could not they be segregated by colour or shape, or a metallic marker, to achieve the same object at less capital costs?

Dependence on paperwork

Hastily retreating from that bonfire, lest the philatelists ignite it beneath me, let's dial a number or two on the telephone service. To judge from the vitriolic comment in some evening papers, it is nothing but a guessing game with numbers. Those of us who have depended upon it for years, and have seen the services in other countries, will realise that what we already have is getting near the best.

We are not speaking now of the offshoot services: dialling a different pop tune every night and all day Sunday, or asking for recipes that Jimmy Young has overlooked. The telephone service covers a mass of communication engineering that helps keep the wheels of commerce and industry turning. The PCM system alone is a "first" of which Britain can be proud—or will be, when exchanges like the experimental "Empress" on test at Kensington gain a wider public ear.

Henry's damp squib seems to have backfired. I have been praising the PMG with faint damns, which is not what was intended. A glance at recent editorials will show that the radio fraternity—at least, *our* sector of it—has little to thank the stonewalling gentleman and his ilk for.

PRACTICAL telephone SYSTEMS

C.H.MOLLER

OFTEN the need arises in the house or office for a simple, cheap and efficient means of communication between two points. This could in its simplest form be merely two loudspeakers from old radio sets connected together. Whilst this may be satisfactory in quiet surroundings, more often than not a louder output is required. This can be obtained in one of two ways. An amplifier of some sort may be used, or a carbon microphone and battery driving an earphone.

The tendency in commercial home intercom systems at the moment is to employ a transistor amplifier with two loudspeakers and a press-to-speak switch to change the direction of amplification. The author has experimented with this type of system and found that in certain cases it is undoubtedly preferable, though in the majority of cases it may be very much simpler to use a carbon microphone as is used on large telephone networks.

These can be obtained very cheaply on the surplus market and yet the number of circuits available to the home constructor for using them seems very limited. As a result the author has designed a number of circuits employing surplus equipment which with slight modification to cater for individual needs should fit most applications.

Using standard handsets

The first system was devised for use over short distances using standard handsets. The constructor can easily make quite attractive stands for the telephone at great saving, as handsets are very much cheaper than complete desk telephones. The range of this system is rather limited because of the use of d.c. signalling. As lamps take a relatively large current the battery voltage will soon become unreasonably high to maintain a reasonable lamp brightness and an alternative method should be used.

Figure 1a shows the basic operating conditions

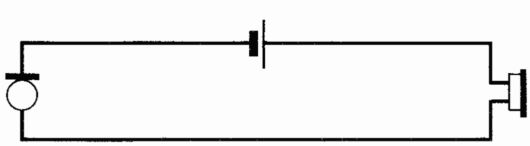


Fig. 1(a): Basic circuit for one-way communication using a carbon microphone and earpiece.

for one-way communication with a carbon microphone and earphone. For a $1\frac{1}{2}$V battery the quiescent current should be between 5—25mA depending on the quality of the carbon microphone. The second circuit (Fig. 1b) shows its adaptation for two-way conversation.

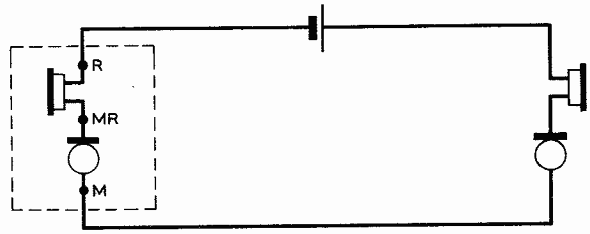


Fig. 1(b): Modification of the circuit shown in Fig. 1(a) for two-way conversation using two handsets. R is receiver connection, M microphone connection, MR common connection.

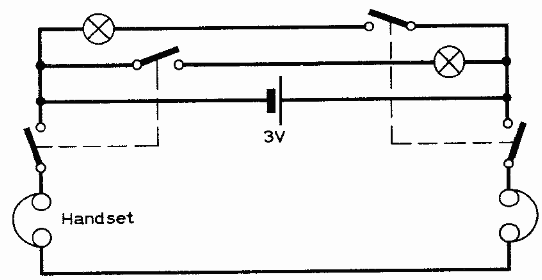


Fig. 2: Practical version of the previous circuit using a lamp calling system operated by switches.

Figure 2 shows a practical application of the circuit incorporating a lamp calling system. If bells are used instead of lamps a break switch will have to be incorporated at each end to silence the bell when the telephone has been answered.

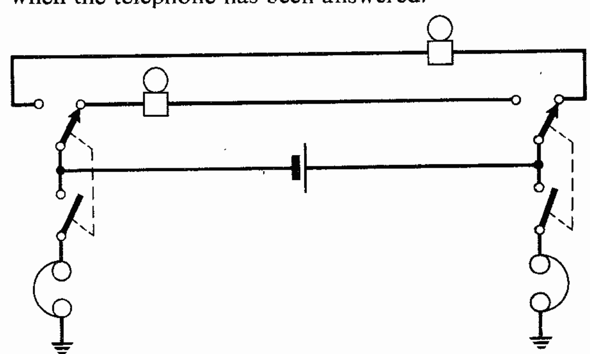


Fig. 3: A further modification, using a bell calling system.

Whilst the circuit of Fig. 3 is primarily designed for only two telephones it is possible to operate it on a "master-and-slave" principle, although if this is desired an automatic selecting system will probably prove more convenient.

A simple handset stand

A suitable telephone handset stand can be made in about half an hour from a piece of Perspex approximately $12\frac{1}{2}$ x 4 x $\frac{1}{8}$in. The Perspex should be warmed gently (too rapid warming will result in blistering) over a gas flame or electric heater and

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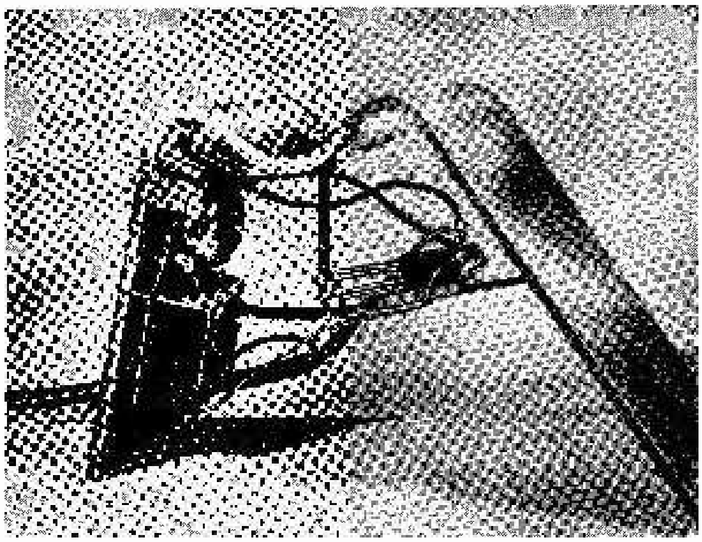

Telephone handset stand made from a sheet of Perspex. The switching follows the circuit shown in Fig. 3.

bent at the lowest temperature possible. It should then be quenched in cold water for at least a minute, maintaining the Perspex in the required position for as long as possible. Drilling should be done after bending, as holes will cause lines of weakness along which the Perspex will tend to bend.

The contacts are obtained directly from GPO type plunger switches. It is necessary to put a small piece of Perspex or Paxolin ($\frac{1}{2}$ x $\frac{1}{4}$ x $\frac{1}{8}$in.) between the two sets of contacts. Glue this into place. The screw should also be glued on to the top of the top contact. Mount the whole contact assembly on a piece of heavy metal strip spaced from it by another small piece of Perspex. On the prototype units two standard mushroom feet were glued in the instep for the handset to rest on, ensuring rather more silent operation than otherwise.

The finished units have a pleasing appearance despite the visibility of the contacts etc. inside the unit. No doubt however the more inventive constructor could devise a means of producing side pieces for the units. I found it difficult to bend the Perspex with sufficient accuracy to enable a standard template for cutting out the sides to be made, i.e. each side piece had to be made individually.

High-impedance battery circuit

In general the designing of circuits is much simplified by the use of a completely different basic audio circuit (Fig. 4). In this the battery, which normally has a very low impedance, is made to have a high impedance to audio signals by the choke, whilst still supplying the current to drive the carbon microphones. In practice the choke is often a relay coil which may then be used for signalling purposes as well.

The circuit shown in Fig. 5 utilises both the choke

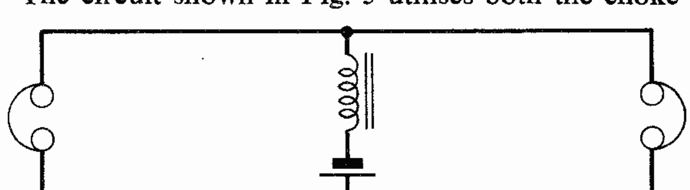

Fig. 4: Basic audio circuit with choke in series with battery.

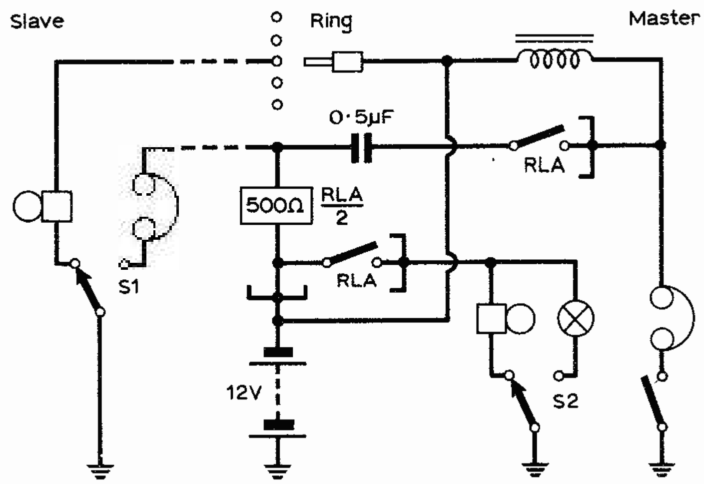

Fig. 5: Practical circuit based on the system shown in Fig. 4 and incorporating a relay ringing system. This arrangement requires an operator or master station.

d.c. circuit principle and a relay ringing system, but requires an operator or master station and only provides for one conversation at a time. Master-to-slave, slave-to-master and slave-to-slave operation are possible.

Operation of master-slave circuit

When any one of the slave stations operates S1 (this may be either a toggle switch or, preferably, a switch operated by the weight of the telephone handset) the relay RLA associated with that particular station will operate, owing to the d.c. circuit now existing through the handset, and close both the relay contacts. The lower contact provides the current to ring the master bell. When the master answers, i.e. operates S2, his d.c. circuit is made via the choke and the speech circuit is completed through the 0·5μF capacitor. The slave station can then ask the master station to ring the number desired, which is done simply by inserting the calling plug in the appropriate socket. When the other slave station answers the operation is repeated, but as all the speech circuits go to a common point, i.e. the master, there is no need of further connection. When the two sub-stations have finished their conversation the light on the master station will go out, reminding the operator to disconnect the calling signal if he has not already done so.

Because it is very simple this system suffers from a few inherent disadvantages. There is first no privacy in the system at all; that is to say a person at any station is at liberty to lift his receiver and overhear any conversation that happens to be going on at the time. Secondly it only allows for one conversation at a time. Despite this it is a very simple system that is quite reliable and quite cheap to build.

Using standard desk telephones

The need often arises to provide communication between two points at short notice. Whilst rigging up systems as so far described can be a relatively lengthy business, if two standard desk telephones are available and only two telephones are required the job can be done very quickly.

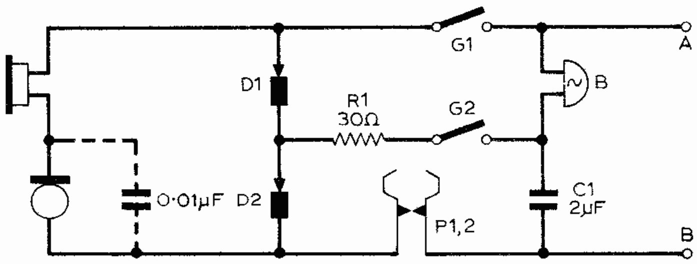

Fig. 6: Basic desk telephone set circuit.

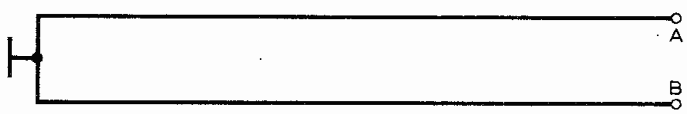

Fig. 7: Shorthand way of showing the circuit of Fig. 6.

The basic circuit of a desk telephone is shown in Fig. 6. Figure 7 shows a shorthand form of this. G1 and G2 are contacts normally open when the handset is on its rest and make when it is removed. D1 and D2 are "off-normal" contacts on the dial assembly and are normally open. As soon as the dial is moved away from its normal position these two contacts make. P1 and P2 are the pulse contacts, which are normally closed but break a number of times on the return of the dial, equal to the number dialled.

Dialling

When the handset is removed G1 and G2 make. G1 completes a d.c. loop to the exchange via the handset and operates RLA (Fig. 8). (In a large exchange the operation of RLA will probably set off a train of equipment to provide the subscriber with a free line.) The dial is then turned, making D1 and D2, and on the return stroke P1 and P2 break the d.c. circuit the appropriate number of times and release RLA for short pulses. These may be used to operate selecting equipment although in this automatic circuit no dialling is necessary. R1 and C1 act as spark suppression for the pulse contacts; R1 also prevents the magneto bell tinkling during dialling.

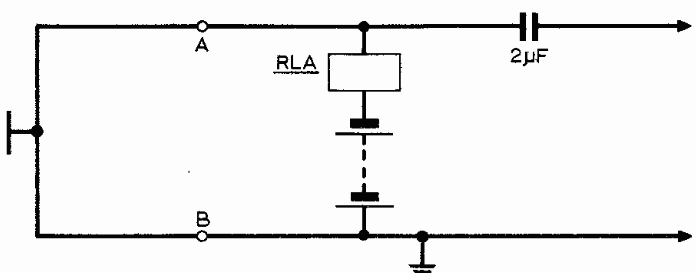

Fig. 8: When the handset is lifted G1 and G2 (Fig. 6) close operating relay RLA at the exchange.

When the other subscriber has been selected an a.c. ringing signal is sent down the line and via C1 operates the magneto bell. This is a bell, usually with two gongs, which rings when fed with about 20V at 15mA a.c. of about 16—50c/s. Normally they are set for 25c/s and will not work well at any other frequency. This can easily be remedied by applying the appropriate ringing signal to A and B and moving the two gongs closer together or farther apart until the point at which most satisfactory operation is found.

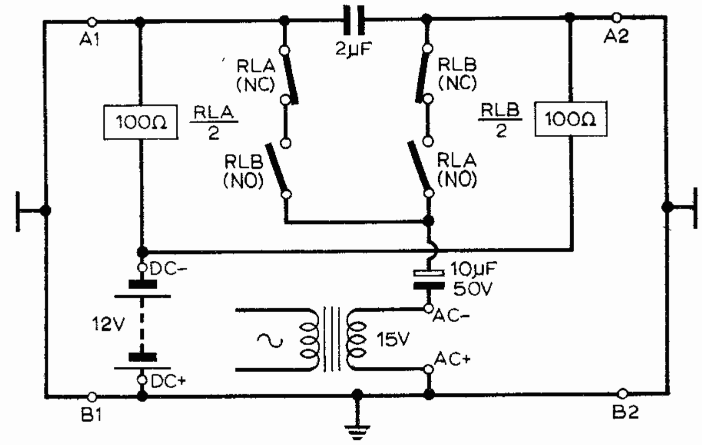

Fig. 9: Circuit for two-way communication using a pair of standard desk telephones.

The author's interchange unit incorporating RLA, RLB and the 2μF and 10μF capacitors. The housing is a plastic lunch box.

Many telephones have modifications to the arrangement depicted in Fig. 6. For example some have small transformers to prevent one hearing too much of one's own voice in the earpiece. These coils may be left in providing that this does not cause too severe impedance mismatching with other telephones. If removing the coils, take care! The 30Ω resistor R1 is often carefully concealed in the form of a non-inductive winding in the transformer. If need be this may be satisfactorily replaced by a 33Ω 1W carbon resistor. Also an 0.01μF capacitor may be incorporated in the casing of the 2μF capacitor and will probably be connected across the carbon microphone. This is to prevent long lines from picking up stray r.f. and may be left in.

Two-way desk telephone circuit

Figure 9 shows the basic arrangement for operating two standard desk telephones. This needs only one wire for each telephone and is fairly independent of the resistance of the wires etc. If required as a field telephone it may be run off a car accumulator and two hand-ringing generators (one at each end). At home it may be run off a train transformer (suitably smoothed) or a bell transformer. Used in this way it can make a very compact and neat unit. The author has had this system working for a long time at home and it has been very satisfactory.

The relays used are the GPO 3000 type, having a 100Ω coil and one make and one break contact. ■

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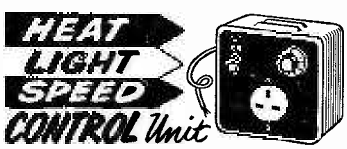

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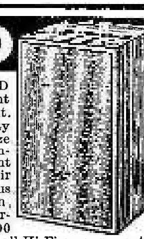

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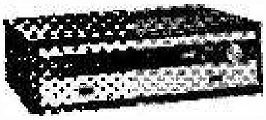

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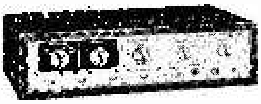

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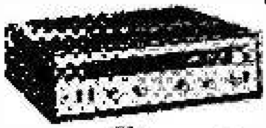
For the perfectionist. Powerful 64-Watt-IHF Amplifiers. 46 semi-conductors. Full controls. Factory assembled FM Front-end, FM-AM IF Circuits, transformers and coils. Response ± 1dB, 20–20,000 Hz. Hum and noise 55dB. Kit £62. 8. 4. Teak case extra £8. 12. 7. (inc. PT.) Tuning heart extra£20. 1. 4. (inc. PT.)



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22 Transistors. 14 diodes. Response ± 2dB, 50 Hz to 15 kHz. Hum and noise —60dB. Range 87·5 to 108·5 MHz. Kit £55. 18. 2. Teak case extra £8. 9. 6. (inc. PT.) Tuning heartextra£20. 1. 4. (inc. PT.)

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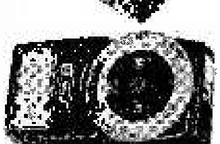

KG275A CdS Exposure Meter Kit

Takes accurate readings even in moonlight. Covers ASA Speed Ratings 6 to 12,000: shutter settings 1/4,000 second to 30 minutes. Cine settings 4 to 128 frames per sec. Incident or reflected light readings. Kit £10. 7. 6. (inc. PT.) Hard case £2. 8. 3. (inc. PT.) extra. Soft case £1. 6. 5. (inc. PT.) extra.

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BATTERY ELIMINATORS, replacement for PP9, **29/11** P.P. 2/-; PP3, **19/11** P.P. 1/6.

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ON THE SHORT WAVES

MONTHLY NEWS FOR DX LISTENERS

Times GMT
Frequencies in kc/s

THE BROADCAST BANDS by CHRISTOPHER DANPURE

WELL, the cold winter days are with us again, and here are this month's propagation predictions for the main circuits to the U.K.

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, 5 and 4Mc/s; 2000-2200 17, 15, 11, 9, 7, 6, 5 and 4Mc/s; 2200-2400 15, 11, 9, 7, 6, 5, 4 and 3Mc/s; 2400-0600 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; 2000-2200 17, 15, 11, 9, 7, 6 and 5Mc/s; 2200-0200 15, 11, 9, 7, 6 and 5Mc/s; 0200-0400 11, 9, 7 and 6Mc/s; 0400-0600 11 and 9Mc/s; 0600-0800 15Mc/s only.

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

South Asia: 0600-1000 25, 21, 17 and 15Mc/s; 1000-1200 25, 21, 17, 15 and 11Mc/s; 1200-1400 25, 21, 17, 15, 11 and 9Mc/s; 1400-1600 21, 17, 15, 11, 9, 7, 6, 5, 4 and 3Mc/s; 1600-1800 15, 11, 9, 7, 6, 5, 4 and 3Mc/s; 1800-2000 11, 9, 7, 6, 5, 4 and 3Mc/s; 2000-2200 11, 9, 7, 6, 5 and 4Mc/s; 2200-0200 9, 7, 6, 5 and 4Mc/s; 0200-0400 9, 7, 6 and 5Mc/s; 0400-0600 11 and 9Mc/s.

South East Asia: 0600-1200 25, 21, 17 and 15Mc/s; 1200-1400 25, 21, 17, 15, 11 and 9Mc/s; 1400-1600 25, 21, 17, 15, 11, 9, 7, 6, 5 and 4Mc/s; 1600-1800 17, 15, 11, 9, 7, 6, 5 and 4Mc/s; 1800-2000 11, 9, 7, 6, 5 and 4Mc/s; 2000-2200 11, 9, 7, 6 and 5Mc/s; 2200-2400 11, 9, 7 and 6Mc/s; 2400-0400 9Mc/s only; 0400-0600 weak signals on 9Mc/s.

North East Asia: 0800-1100 25, 21, 17, 15 and 11Mc/s; 1100-1200 17, 15 and 11Mc/s; 1200-0200 11 and 9Mc/s; 0200-0600 11Mc/s only; 0600-0800 15 and 11Mc/s.

Australia (via Asia): 0600-0800 21Mc/s only; 0800-1000 25, 21 and 17Mc/s; 1000-1200 21, 17 and 15Mc/s; 1200-1400 21, 17, 15, 11 and 9Mc/s; 1400-1600 17, 15, 11, 9, 7, 6, 5 and 4Mc/s; 1600-1800 15, 11, 9, 7, 6, 5 and 4Mc/s; 1800-2000 11, 9, 7 and 6Mc/s; 2000-2200 9Mc/s only; 2200-0600 circuit closed.

West Coast of South America (North of Chile): 1200-1400 25, 21 and 17Mc/s; 1400-1800 25 and 21Mc/s; 1800-2000 25, 21 and 17Mc/s; 2000-2200 17 and 15Mc/s; 2200-2400 15 and 11Mc/s; 2400-1000 11 and 9Mc/s.

HAPPY EVENT!

On November 18th, the "Happy Station" programme of *Radio Nederland* celebrates 40 years of short wave bands broadcasting. This programme is today still produced and presented every Sunday by Edward Startz and is believed to be the longest running short wave radio programme.

The secret of its popularity is that it keeps politics out of the programme, and just plays music for all tastes, and at the end of each programme there is a mailbag with answers to listeners' letters. On November 17th there is a special anniversary programme, so be sure to listen, as there is a special QSL card for the 40 years' celebration, and also a special leaflet has been issued telling in brief about the history of the Happy Station programme.

You can hear the Happy Station every Sunday in the British Isles and Western Europe at the following times, 1030-1150 GMT on 11,730 or 9,715, 6,020 and 5,980 and from 1430-1550 GMT on 6,020.

Now on to this month's DX-tips.

EUROPE

Sweden: Starting November 3rd, *Radio Sweden* transmits its morning programmes to Europe from 0930 onwards on 6,065, English is at 1100-1130.

Switzerland: The evening programme to the British Isles from the Swiss Shortwave Service, Berne, is now heard on 9,665 and 6,015 from 1930-2030.

AUSTRALASIA

Papua: *Radio Milne Bay* with 250 watts is now on 3,235 in English and Pidgin from 0700-1200 and 1700-2000.

AFRICA

Angola: *Emissora Oficial,* Luanda, now operates on 4,820 with 100kW from 0500-0745 and 1855-2400, on Sunday mornings does not close until 0200.

Somali Rep: *R. Somali,* Hargeisa, now operates on the new frequency of 11,675, heard recently around 1500.

CARIBBEAN AREA

Haiti: *Radiodiffusion Haitienne* has been heard on a new frequency of 5,075 at 2330.

SOUTH AMERICA

Chile: *La Voz de Chile,* Santiago, has been heard on 6,150 in parallel with 9,690 at 0400.

Uruguay: *Radio Oficial,* SODRE, has been heard again on 15,272, transmits daily from 1130-0230.

Many thanks for tips this month to Sweden calling DX-ers. Deadline this month is **November 10th,** 73.

THE autumn has arrived—thank goodness. With any luck the summer doldrums should leave us and the bands can get cracking.

Twenty metres has, of course, proved its worth being almost a 24 hour band. Early mornings are the time to catch Pacific DX—VK and ZL, with the smaller islands coming in quite consistently, VR6 and KH6, KB6 etc.

Top band, after faithful service as a favourite talk-in band for summer mobiles, can now get down to the more serious business of the winter trans-atlantics. You'll need to be able to read c.w. for these but the callsigns are usually sent very slowly—5 w.p.m. Listen around band edge from 1·800 to 1·805kc/s for W and/or K stations

Ten metres, definitely the biggest disappointment, has stirred a little. Openings to Africa have appeared and even a South American path opened up on a couple of occasions. There are a number of local G nets on ten, so it might be worth a listen to keep up to date with local Ham news. Leicester has such a net and, so I hear, does Hatfield in Hertfordshire.

No news of any exotic expeditions have come in. **J. Moore** (Leicester) queries LG5LG heard in QSO with F0JH. He called himself "Ernie" and claimed to be at a children's home in a "small Scandinavian state" (probably Earls Court!).

K. Proctor (Yorks.) says that for anyone with time and patience to spare, he recommends 40 metres. The DX is certainly there, as I've mentioned before, and the band should improve now the colder weather is here.

LOGS

Ken, G8APJ (E.10) noted my remarks *re* two metres and promptly sent in a log. He doesn't specify the gear or the antenna but it should be pretty good judging by the log—DL0ER, F5NS, F9FT, F9NL, GW5BI, GW8UM, ON4RY, PA0AFG, PA0CML, PA0VVH. Ken tells of G3PFM hearing an EA3 on the band.

M. Pasek (Notts.), QP166 into an HRO, wire "X" beam for 7Mc/s logged this bunch on 40 between 0600 and 0730, all s.s.b.—CM2DC, CO2FA, HK6BMS, PY1CLI, VK2AGW, WK2BKL, VK3-AHT, VK3XM, ZL1AGD, ZL1AQ, ZL2AAG, ZL3DD, 8P6AN(c.w.). On 80, his best were—ZL2BCG and ZL3RK, both s.s.b.

K. Proctor (Yorks.), HA500 plus pre-selector, 20ft. base—loaded vertical (homebrew) plus a.t.u. winkled out these on 40 s.s.b.—CT1GD, CT2AP, CE3DM, CN8AW, EA3JE, ET3USA, HB9AIW, I1IJ/P—IP1 (zone 33) OX3DX, PY7LAV, TL8BD (at 5 and 9 plus 15dB), VK3OZ, VP2KF, YV4QB, YV5CIL, ZC4MO, ZS1JA, 3A2MJC, 4X4TB, 5A5XO (a.m.), 4U1ITU, 8P6BH, 9M2DQ, 9Q5EP, 9Y4KR, 9Y4TO. A very f.b. log and certainly beats my best on 40. Any other braves like to have a go?

20, 15 and 10

The old favourites, 15 and 20, have supplied a steady stream of DX for the past few months.

J. Moore (Leicester), CR100/2 plus 60ft. end fed, says his station cost him about £14, so listening in on 14Mc/s makes it a quid-a-meg? Pickings from the s.s.b. log—CE3FI, EP2DA, F0HI/FC/M, HB0LL, HB0AAI, G3ODO/KL7, HC4WM, HS3HB, JA2BTV, JX1DM (Jan Meyen—I hope!), K1FNA/KG6, KH6BX, KL7GCK, KP4AST, PY2BNQ, TG9AG, VE3EQK, VE4CN, VK2LT, VK2APP, VK3BM, VK4DO, VK5WO, VK7RX, VQ8CS (Mauritius), VR6TC, ZL2AAG, ZL4BX, 3V8AA, 4A1FFC, 4X4YL.

S. Mummery (Bromley) has attained the ripe old age of 13. He roams 20 metres with a B34 and a 66ft. end fed. Not content with this he logs stations to wit—CR4AJ, CT1TU, EA4DO, EI7AY, HB0LL, IP1OK, KH6BX, KZ5TI, LX1SL, TF2WKP, VK2AFN, VK3AOF, VK3AOV/P, VK4GY, VK5XW, VK7SM, VP9MI, VR6TS, VS9MB, ZB2AY, ZL1DAS, ZL2ABY, ZL3DO, 4U1ITU, 4X4YP, 5A3IJ.

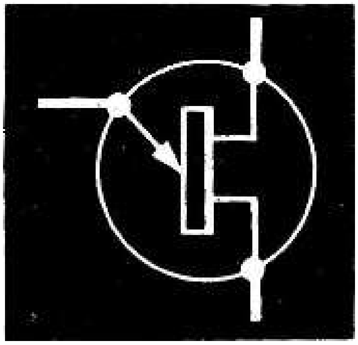
P. Baker (S. Wales), HE30, 150ft. long wire, shovelled up a nice haul on 15 metres—CE1DF, CE0AE, CO2FM, CP6HI, CR4BC, CR5SP, CR9AK, CT2AV, DU1FH, EA9AQ, EL2B, EP3AM, HB0AAI, HK2RB, HK0BKX (San Andres) HL9KW, HP1CT, HR6EB, HV3SJ, KA1IJ, KG4AM, KH6BX, KP4BCL, KR6KN, KV4DB, LU1DAB, MP4MBC, OA4NG, OX3DX, PX1YY, SV0WN, TJ1AL, TU2BQ, VK2AGW, VE7LB, G3UHR/VO2, VK9DS, VP2DAJ, VP8JH (South Orkneys), VQ9DH (Seychelles Islands), VR1L, VR2CC, VR6TC, VS5AT (Brunei), VS6DR, VS9MB (Maldives), VU2DKZ, XW8AX, YS1XEE, ZD3D, ZD5V, ZD8Z, ZE1CS, ZP5KN, 3V8AA, 4A1WF, 5A1TG, 5H3JL, 5N2ABF, 5Z4LG, 6W8AL, 7Q7AM, 8P6CC, K0BAC/8P6, 8R1P, 9G1DM, 9J2BC, 9K2BC, 9M2DQ, 9Y4GS, 9V1NY. You should have seen his log for twenty!

W. Thomas (Worcester) sends in the best 10 metre log. Yes, there are signals there. Bill used a BC348 with an RF24 plus 50ft. end fed to hook—CR6KI, OD5CS, ZE1CB, XE2JA, ZS1JA, 9G1FL, all on a.m. On s.s.b.—CR6JI, CR7IC, CX8DM, ET3USA, HS1AF, KV4AD, KZ5AO, LU3DTV, LU7CK, VP8JC, ZD7DI, ZD9BE, ZS2LM, ZS5LB, ZS6BCI, 4A1WS, 5Z4AA, 7Q7WW, 9J2BK, 9K2BV. If you didn't do quite so well on ten don't worry—I listened at just the wrong times too.

CONTESTS

Six contests chalked up on my shack wall. November 9th—10th, R.S.G.B. 7Mc/s DX Phone Contest; 9th—11th, ARRL SSB Phone Contest; 16th—17th, second 1·8Mc/s Contest; 16th—18th, ARRL SS Contest (c.w.); 23rd—24th, CQ WW DX Contest (c.w.); December 1st, fourth 70Mc/s c.w. contest.

Please drop me a line if you hear anything of interest. Deadline this month is the 18th.



UNIJUNCTION TRANSISTOR CIRCUITS

C.R.BRADLEY

PART 2

LAST month the basic operation of the unijunction transistor was described and some simple, practical circuits based on the use of the unijunction transistor as a relaxation oscillator were given. Some further practical circuits using unijunction transistors are featured this month.

Calling Systems

The circuit in Fig. 7 was found useful in a large sub-divided house to enable the occupants to recognise their own particular door buzzer tones. A unijunction transistor Tr1 is used in a buzzer circuit which draws about 1/30th the power of a conventional bell or buzzer. Each occupant's bell-push on the front door produces a different toned buzz. The circuit could also be used in a house to identify callers at the front, back (and side) doors. Again layout is not critical and batteries or the mains power supply may be used. The preset potentiometers are adjusted to give four distinctly different tones.

The circuit in Fig. 8 is a door buzzer system which

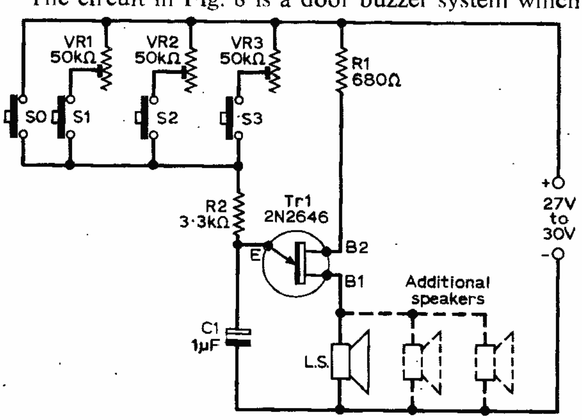


Fig. 7: Multitone calling system. VR1–VR3 are adjusted to give different pitched buzzes.

★ components list

R1	680Ω ¼W
R2	3·3kΩ ¼W
VR1-VR3	50kΩ skeleton presets
C1	1μF 30V electrolytic
S0-S3	Door bell-pushes
LS	3-15Ω speaker, any size
Tr1	2N2646 or equivalent
Battery or mains power supply	

was installed in a block of flats at a considerable saving over a conventional bell system. There is no limit to the number of speakers in the system. As

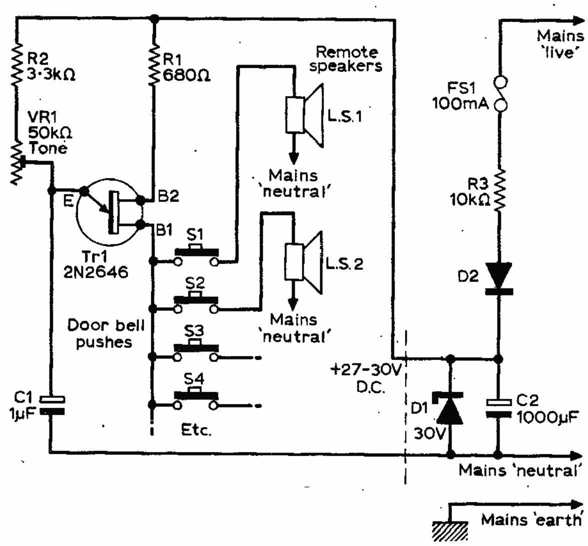


Fig. 8: Multispeaker buzzer system. Note importance of safety precautions in text if using the non-isolated power supply shown.

★ components list

R1	680Ω ¼W
R2	3.3kΩ ¼W
R3	10kΩ 5W
VR1	50kΩ skeleton preset
C1	1μF 30V paper or electrolytic
C2	1000μF 30V electrolytic
D1	30V 1W zener diode
D2	400V p.i.v. silicon diode
S1-S3 etc.	Bell push-switches
LS1, LS2 etc.	3-15Ω remote speakers
FS1	100mA
Tr1	2N2646 or equivalent
Fuseholder, wire, etc.	

this was a permanent installation a very simple non-isolated power supply was used. Capacitor C2 is trickle charged through R3 and D2 up to a potential of 30V when the zener diode conducts away further current. If this power supply is used it *must* be connected to the mains with the polarity as shown or the wiring will become dangerously "live".

Ensure that all exposed metal associated with the buzzer system is earthed. Note that each speaker is returned to mains neutral. This is an economy on wire as only single core cable is required to connect each speaker to the circuit. A testmeter or neon screwdriver should be used to ensure that no connection is made to the live side of the mains.

If R3 is increased to 33kΩ 5W and C2 reduced to 500μF then the power supply will only hold enough charge to drive the circuit at full volume for a few seconds. One must then wait a few seconds before the buzzer can be used at full volume again. This feature of decaying volume would prevent annoying over use of the buzzer by callers.

Timing Circuits

If the values of C and R in Fig. 2 are both large one can obtain extremely low frequency oscillation. For example if C is 1,000μF and R is 100kΩ the circuit will fire about once every 3 minutes. If C is a good quality electrolytic used well within its voltage rating (for low leakage current) then the period will remain constant. Supply voltage changes and temperature variation have little effect on the period. For this reason the unijunction is excellent for use in timing circuits in which it acts as a one-shot oscillator.

Photographic Timer

The circuit in Fig. 10 is a photographic timer which will switch on an enlarger for a preset period of 1 second to 1 minute. The operation is as follows: S1 ("on") is pressed to open and the relay de-energises. C1 now charges slowly through R1 and VR1, the latter having been set for the required period. During this time the enlarger lamp draws current through the relay contacts RL2. When C1 reaches

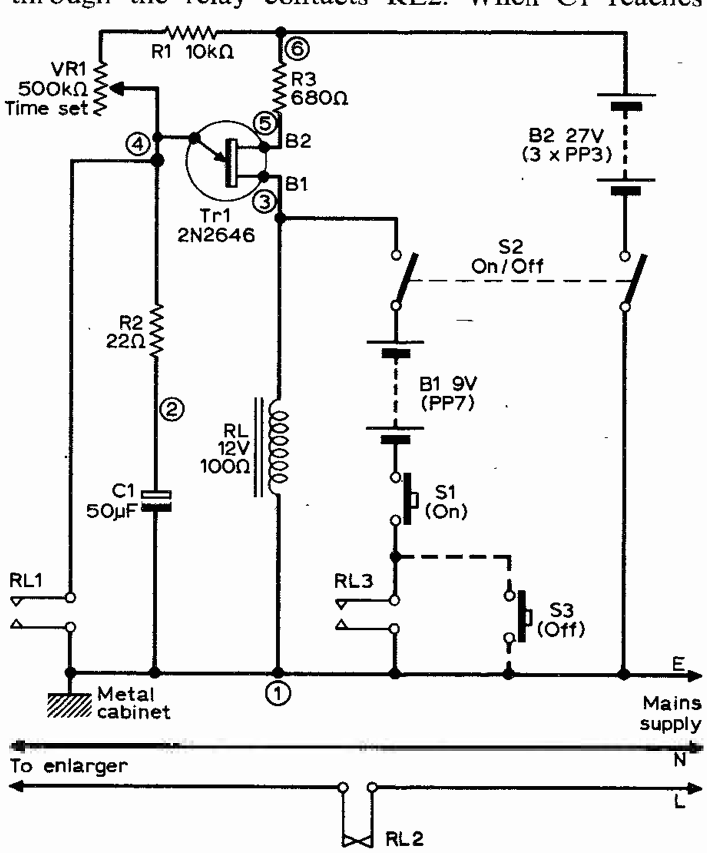


Fig. 10: Photographic enlarger timer. Pressing S1 de-energises the relay for a time set by VR1. While the relay is de-energised the enlarger is on.

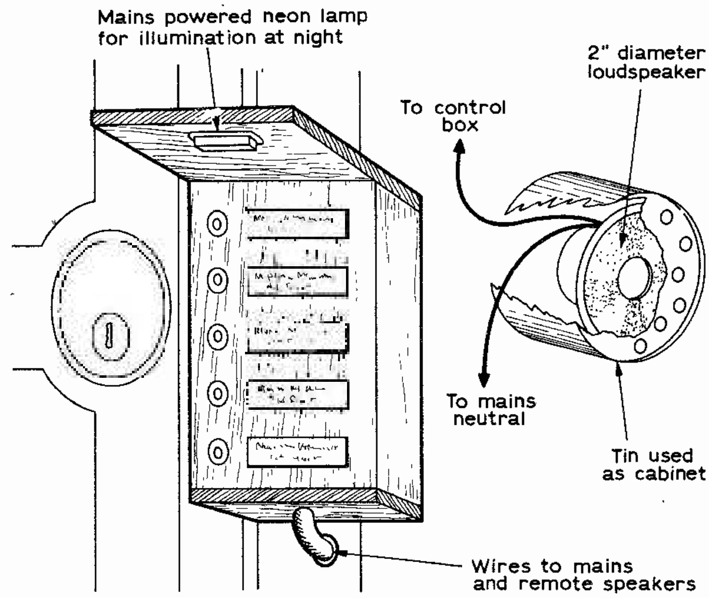


Fig. 9: Constructional details of the multispeaker buzzer system.

the unijunction firing voltage it discharges through the unijunction and the relay, causing the relay to energise. Once the relay is energised it is held closed by B1 until S1 is opened to start another timed period. When the relay is energised the contacts RL1 discharge C1 to ensure that it has zero charge at the start of each timing period.

R2 limits the peak discharge current through the unijunction. It may be reduced if the relay does not close properly. VR1 should be an ordinary logarithmic track potentiometer wired to give increasing period with clockwise rotation. This gives a better spaced scale than a linear type would. The scale is very non-linear but can be calibrated easily using a stopwatch. The maximum period may not be exactly 1 minute but will probably be within 2-3 seconds of this. For most photographic purposes this will not matter. Similarly, the minimum period may not be 1 second

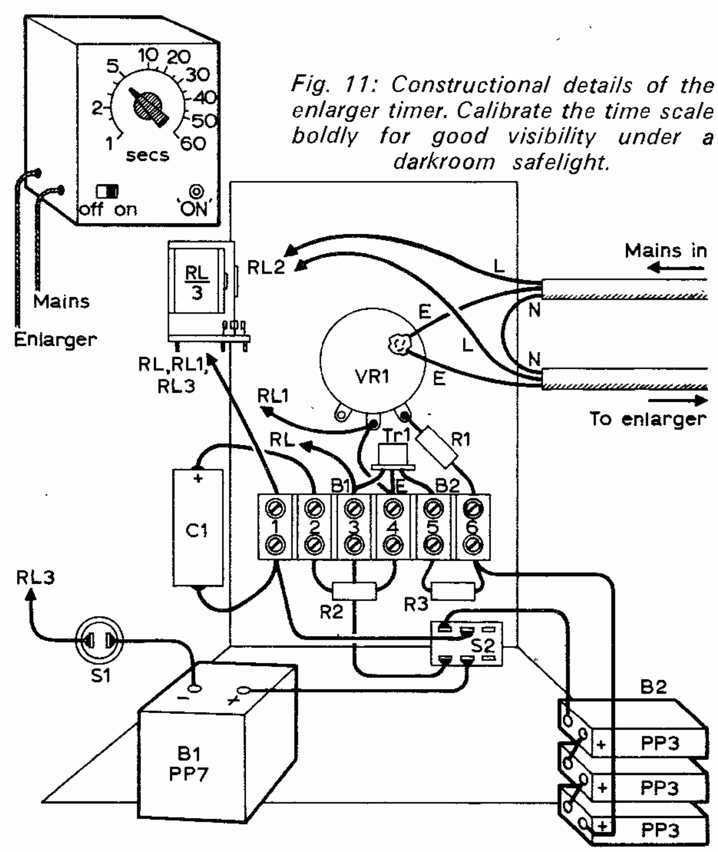


Fig. 11: Constructional details of the enlarger timer. Calibrate the time scale boldly for good visibility under a darkroom safelight.

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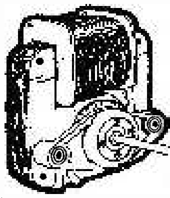

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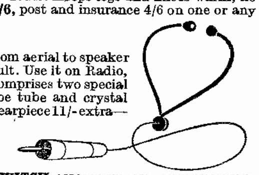

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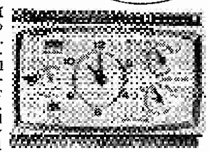

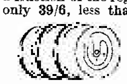

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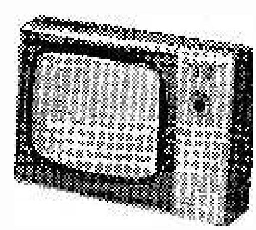

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exactly due to component tolerances. If a precise range of 1 second to 1 minute is required it may best be obtained by trying different components for R1, VR1 and C1. (Adjust R1 to vary the minimum period.) Doing this, one will discover the very wide tolerance allowed between electrolytic capacitors and the extreme non-conformity of potentiometer tracks! However, once calibrated the circuit will give very accurately reproducible timed periods.

A fairly high current is required to hold the relay closed and this is why a separate battery is used for this. 9V should be sufficient to operate the relay. If not a 12V battery can be used. When S2 is "off" the timer is out of action. The enlarger will remain on indefinitely when S1 is held pressed.

For safety reasons it is best to build the timer in an earthed metal cabinet, as darkrooms are likely to be humid. A further push-button switch S3 ("off") may be incorporated to interrupt a timed period if desired (see Fig. 10).

★ components list (ENLARGER TIMER)

R1	10kΩ ¼W
R2	22Ω ¼W
R3	680Ω ¼W
VR1	500kΩ log. pot.
C1	50μF 30V or above electrolytic
B1	9V PP7
B2	27V 3 x PP3
RL	12V 100Ω miniature relay with 3p.d.t. contacts
S1	Press-to-open switch
S2	D.P.S.T. on/off switch
S3	Press-to-close switch (if required)
Tr1	2N2646 or equivalent

Metal cabinet, terminal block, large pointer knob, wire, etc.

Colour Timer

A more complex photographic timer built for amateur colour print work (Paterson Pavelle process) will be described briefly. The complete circuit without constructional details is shown in Fig. 12. The timer is designed to do the following: (1) Switch on the enlarger for three separately set times (successive exposures through red, green and blue filters). (2) Give an audible signal at the end of three different preset periods of 3, 1 and 2 minutes (developer, stop and bleach-fix bath times).

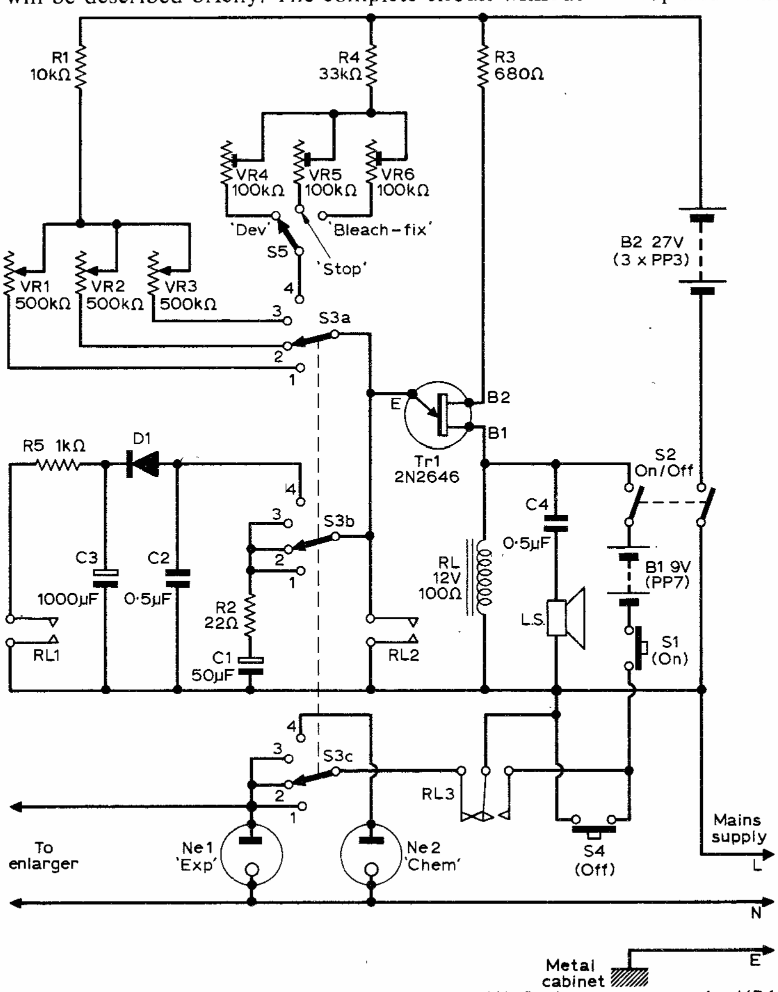

Fig. 12: Colour photographic timer. S3 settings: (1) Red exposure, set by VR1; (2) green exposure, set by VR2; (3) blue, exposure, set by VR3; (4) audible chemical bath time warning, three different preset periods set by S5.

The operation with S3 in positions 1, 2 and 3 (red, green and blue) is clearly the same as the timer already described. VR1, VR2 and VR3 determine the red, green and blue exposures respectively. At the start and finish of each period a click is heard from the internal speaker.

For the three chemical bath times S3 is set to position 4 ("chem") and the appropriate preset period set by S5. To start the period (when the colour print is first immersed in the bath) S1 is pressed as before. The relay opens and the "chem" neon indicator lights (but not the enlarger). C3 is slowly charged through R4 and VR4, VR5 or VR6, and D1. After a minute or more the unijunction emitter reaches the firing potential. The unijunction fires and C2 is discharged. C3 is prevented from discharging by the diode D1. As the charge in C2 is insufficient to energise the relay, the circuit now oscillates as a relaxation oscillator with C2 as the capacitive timing element. A warning buzz is heard from the loudspeaker.

S4 ("off") is pressed to return the timer to normal (relay energised). S4 can also be used to interrupt a timing period. Relay contacts RL1 and RL2 discharge the timing capacitors between timing periods; R5 protects RL1 against excessive discharge current from C3.

It is important to note that the battery negative line is connected to the live side of the mains. For safety the circuit must be wired inside an *earthed* metal cabinet to which no other connection is made. In this respect the author made a mistake which might be instructive; the 27V supply is provided by three PP3 batteries which are metal cased. These were taped to the inside of the earthed metal cabinet without a second thought. When the instrument was first plugged in, fuses blew! Mains voltage had occurred across the internal case insulation of the PP3 batteries, which had been unable to withstand it. The remedy, of course, was to insulate the batteries from the cabinet. But there is a more important lesson to be drawn. Had the cabinet not been earthed it would have become dangerously "live" without blowing fuses. ■

★ components list

R1	10kΩ $\frac{1}{4}$W
R2	22Ω $\frac{1}{4}$W
R3	680Ω $\frac{1}{4}$W
R4	33kΩ $\frac{1}{4}$W
R5	1kΩ $\frac{1}{4}$W
VR1-VR3	500kΩ log. pots
VR4-VR6	100kΩ skeleton presets
C1	50μF 30V electrolytic
C2	0·5μF paper
C3	1000μF 30V electrolytic
C4	0·5μF paper
D1	Germanium diode
B1	9V PP7
B2	27V 3 x PP3
Ne1, Ne2	Mains neon indicators
LS	Small 3-15Ω speaker
RL	12V 100Ω miniature relay with 3p.d.t. contacts
Tr1	2N2646 or equivalent
S1	Press-to-open switch
S2	D.P.S.T. on/off switch
S3	Rotary 3p.4t. switch
S4	Press-to-close switch
S5	Rotary s.p.3t. switch
Metal cabinet, three pointer knobs, etc.	

PYRAMID SYSTEM — *continued from page 592*

inside the bottom portion, and rests on strips. Hinges, a catch, and carrying handles can then be screwed on.

Motor and Pickup

Leads from the motor and switch are fitted with battery clips, this circuit being separate from other connections as shown in Fig. 5. The motor is started by lifting the arm and moving it outwards. When the record is played movement of the pickup automaticaly operates the on/off switch, stopping the motor.

A screened lead descends through the pick-up arm mounting, and this is brought to a tagstrip, which anchors the impedance compensating resistor, and external lead. The external lead has a plug to match the amplifier input socket.

With a low impedance pick-up, the resistor is reduced in value, or omitted. The value shown is for the usual type of popular crystal pickup. Lowering the value increases volume, but pickup matching deteriorates. The amplifier tone control is adjusted for most satisfactory results. TO BE CONTINUED

NEXT MONTH IN P.W.

THE SOLID STATE

To mark the 21st anniversary of the advent of the transistor, this article provides a simple account of exactly how semiconductor devices work, from the simplest diodes to the more complex components coming into use at the present time.

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Almost all other tuners use the Foster-Seeley discriminator or the ratio detector. The System 2000 tuner uses a pulse counting discriminator. This is free from drift and possesses a lower level of distortion than any other system. Inter-station noise suppression, mains tuning and stereo indicators together with a sensitivity for full limiting of an incredible 3 microvolts are all incorporated. An additional attractive feature is provision for plug-in remote and switched tuning units (available separately). The amplifier and loudspeaker are equally outstanding and well worth comparing for yourself. Ask your dealer for a demonstration or write or ring us for a leaflet.

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Plug-in stereo decoder gns

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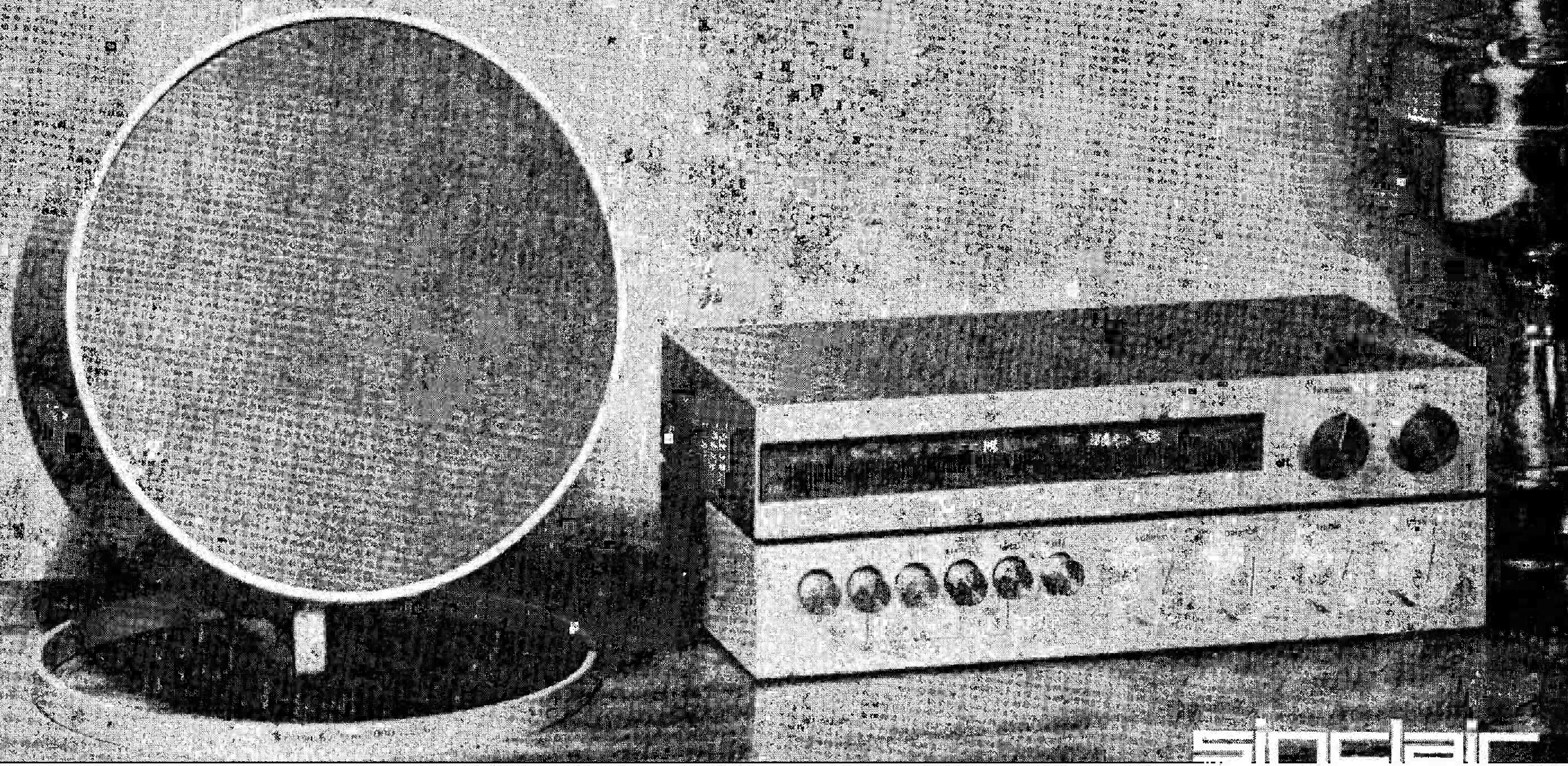

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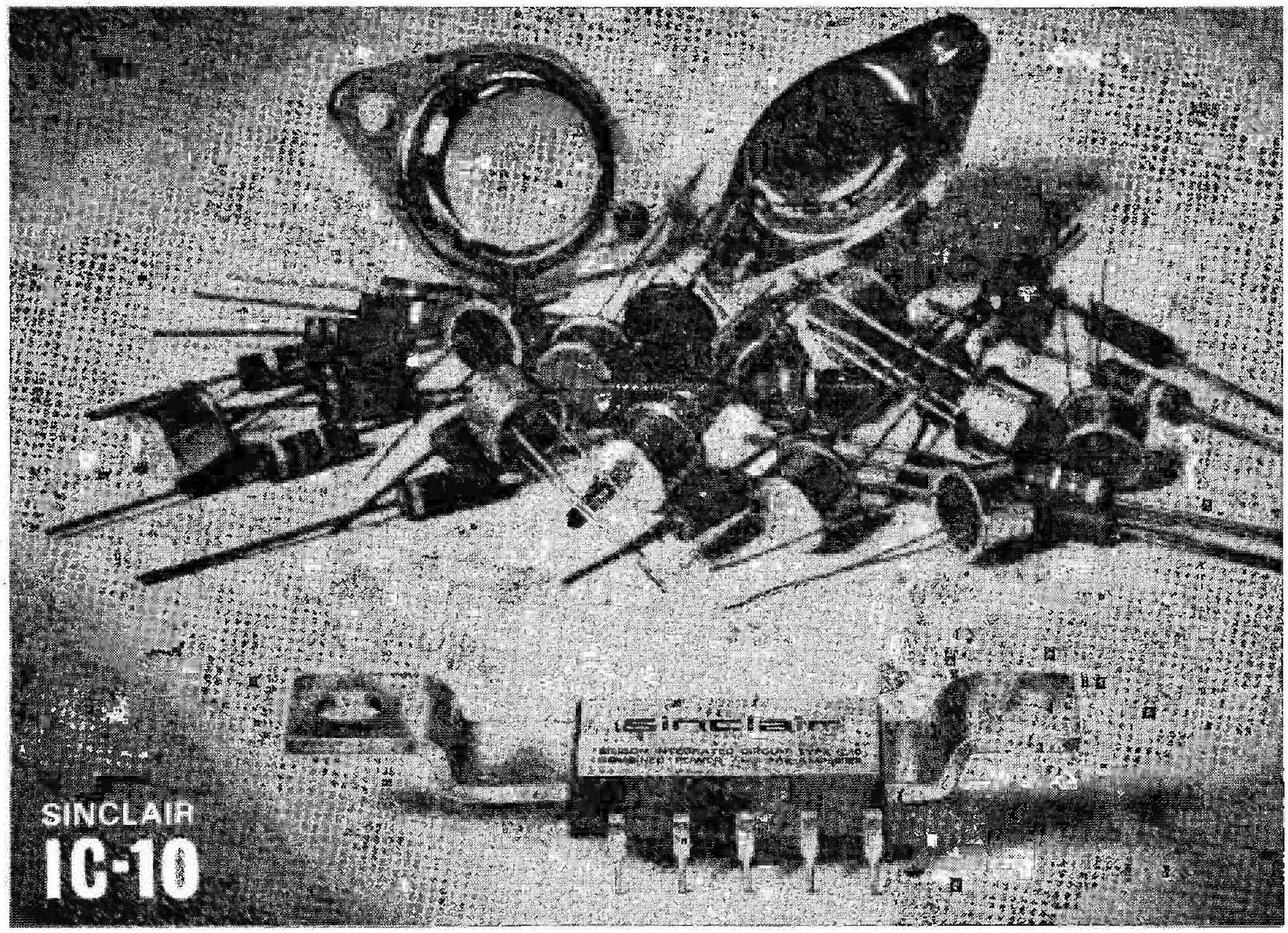


the world's most advanced high-fidelity amplifier

The Sinclair IC-10 is the World's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself, which has an output power of 10 Watts, is a chip of silicon only a twentieth of an inch square by one hundredth of an inch thick. This tiny chip contains 13 transistors (including two power types), 2 diodes, 1 zenor diode and 18 resistors, all of which are formed simultaneously in the silicon by a series of diffusions. The chip is encapsulated in a solid plastic package which holds the metal heat sink and connecting pins.

Monolithic I.C's. were originally developed for use in computer and space applications where their extraordinary toughness and reliability were even more important than their minute size. These same advantages make them ideal for linear applications such as audio amplifiers, but hitherto they have been confined to low power applications. The IC-10 thus represents a very exciting advance. Not only is it far more rugged and reliable than any previous amplifier, it also has considerable performance advantages. The most important are complete freedom from thermal runaway due to the close thermal coupling between the output transistors and the bias diodes and very low level of distortion.

The IC-10 is primarily intended as a full performance high fidelity power and pre-amplifier, for which application it only requires the addition of the usual tone and volume controls and a battery or mains power supply. However, the IC-10 is so designed that it may be used simply in many other applications including car radios, electronic organs, servo amplifiers (it is d.c. coupled throughout) etc.

The photographic masks required for producing monolithic I.C's. are expensive but once made, the circuits can be produced with complete uniformity and at very low cost. So we are able to sell the IC-10 at a price far below that of the components for a conventional amplifier of comparable power. At the same time, we give a 5 year unconditional guarantee on each IC-10 knowing that every unit will work as perfectly as the original and do so for a lifetime.

sinclair

SINCLAIR RADIONICS LTD, 22 Newmarket Rd. Cambridge. Tel: OCA3-52731

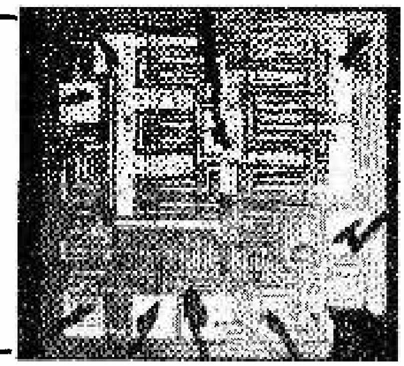
10 WATT MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER

■ Specifications

Power Output	10 Watts peak, 5 Watts R.M.S. continuous.
Frequency response	5 Hz to 100 KHz$\pm$1dB.
Total harmonic distortion	Less than 1% at full output.
Load impedance	3 to 15 ohms.
Power gain	110dB (100,000,000,000 times) total.
Supply voltage	8 to 18 volts.
Size	1 x 0.4 x 0.2 inches.
Sensitivity	5 mV.
Input impedance	Adjustable externally up to 2.5 M ohms for above sensitivity.

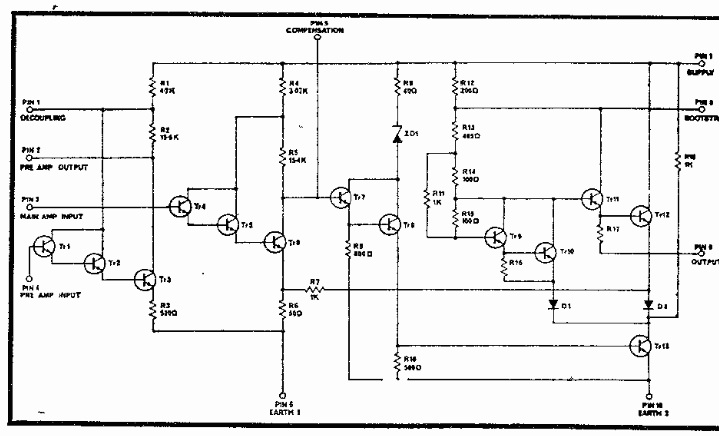
■

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.



■ Construction

The monolithic I.C. chip is bonded onto a gold plated area on the heat sink bar which runs through the package. Wires are then welded between the I.C. and the tops of the pins which are also gold plated in this region. Finally the complete assembly is encapsulated in solid plastic which completely protects the circuit. The final device is so rugged that it can be dropped thirty feet on to concrete without any effect on performance. The circuit will also work perfectly at all temperatures from well below zero to above the boiling point of water.

■ Applications

Each IC-10 is sold with a very comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity uses. These include public address, loud-hailers, use in cars, inter-com., stabilised power supplies, electronic organs, oscillators, volt meters, tape recorders, solar cell amplifier, radio receivers.
The transistors in the IC-10 have cut off frequencies greater than 500 MHz so the pre-amp section can be used as an R.F. or I.F. amplifier making it possible to build complete radio receivers without any additional transistors.

SINCLAIR IC-10

The complete IC-10 with the manual and 5 year guarantee costs just

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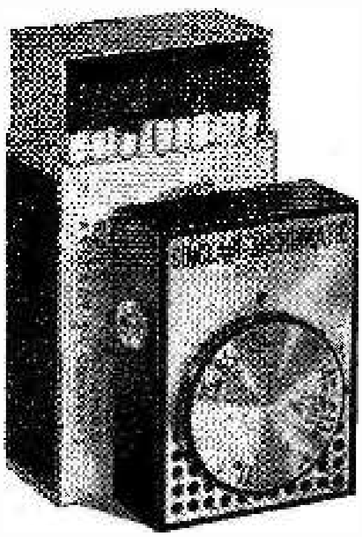
SINCLAIR Q.14

low-priced high fidelity speaker

- Handles up to 14 watts
- 60-16,000 Hz
- 8 ohms impedance
- Ideal for IC-10 or Z.12

It costs a quarter of what you would expect to pay for a good stereo speaker system when you choose Q.14s. This is the result of research and experimentation in materials and careful design to make the Q.14 an instrument so outstandingly good that experts, reviewers and the public alike are unanimous in their praise for it. The Q.14 measuring only $9\frac{3}{4}$" square on its face by $4\frac{3}{4}$" deep. Its unusual contours permit it to be positioned where no ordinary speaker could be used to advantage. Black matt finish with aluminium bar trim keep this speaker pleasantly in conformity with modern design trends.

£7.19.6



SINCLAIR MICROMATIC

the smallest radio set in the world

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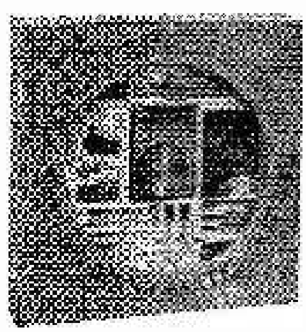
- Tunes over medium waves
- Plays anywhere



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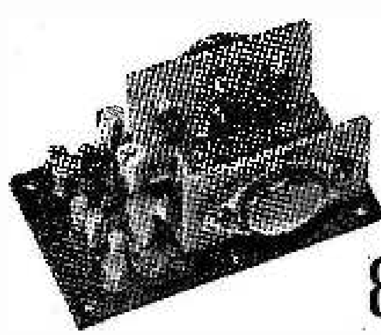
SINCLAIR Z.12

INTEGRATED 12 WATT HI-FI AMP AND PRE-AMP

- Size 3"x$1\frac{3}{4}$"x$1\frac{1}{4}$"
- Suitable for car battery operation
- For all high quality audio applications



89/6

15 to 50,000 Hz1 ± dB, using ultralinear Class B output. Input sensitivity —2mV into 2kΩ OUTPUT–12 WATTS R.M.S. CONTINUOUS SINE WAVE (24 w. PEAK), 15 WATTS MUSIC POWER (30 w. PEAK). Suitable for 3-15Ω loudspeakers. Two 3Ω speakers may be used in parallel. **READY BUILT, TESTED AND GUARANTEED.**

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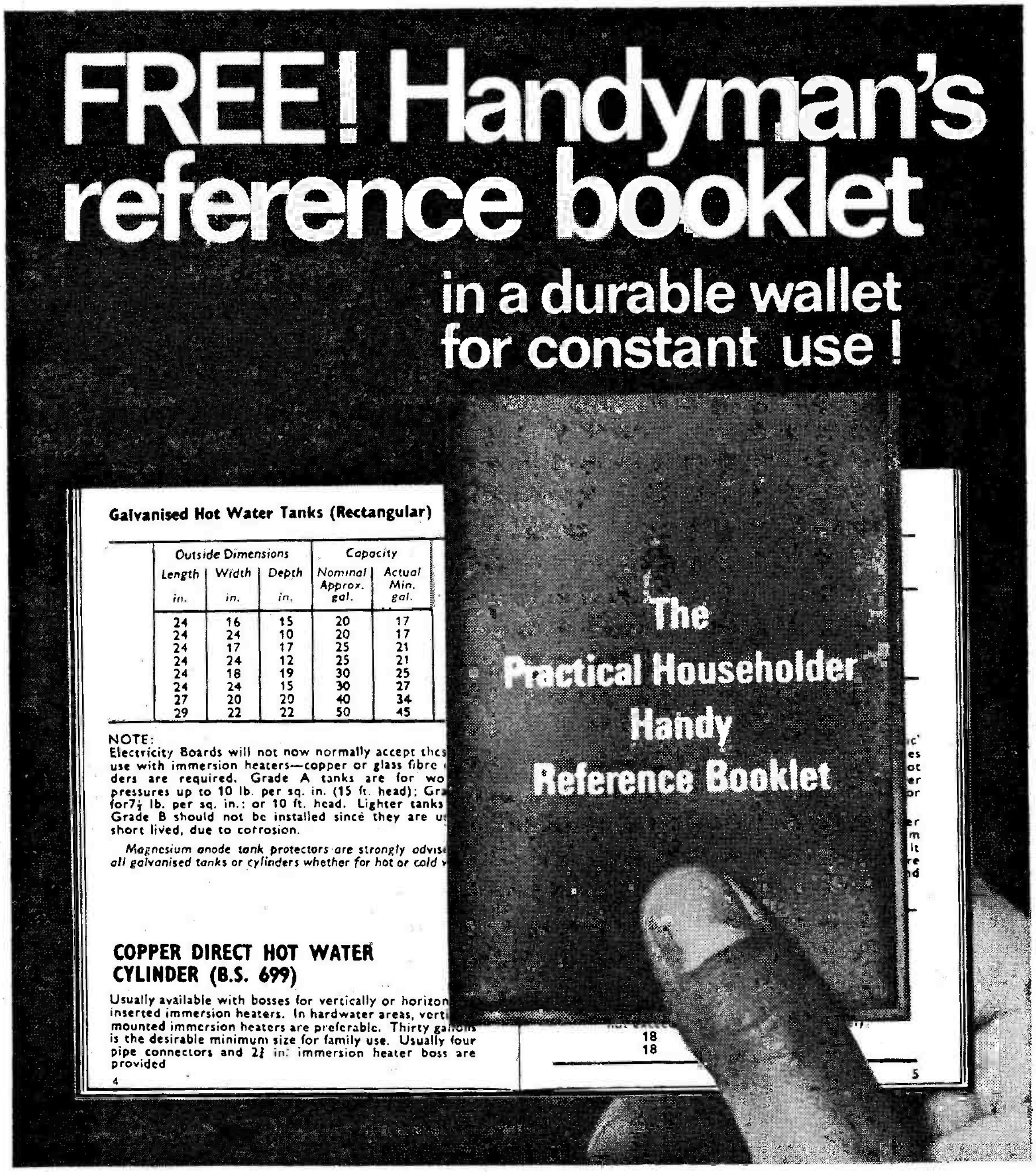
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UCC85	6/6
UCF80	8/3
UCH21	9/-
UCH42	9/3
UCH81	6/6
UCL82	7/-
UCL83	9/3
UF41	9/6
UF42	9/-
UF80	6/9
UF85	6/9
UF86	9/-
UF89	6/3
UL41	9/6
UL46	12/6
UL84	6/6
UM80	5/-
UR1C	10/6
UU5	7/-
UU8	14/-
UU12	4/6
UY1N	9/-
UY21	9/6
UY41	6/9
UY85	5/6
U10	9/-
U12/14	7/6
U16	15/-
U17	5/-
U18/20	10/-
U19	34/6
U22	7/9
U25	13/-
U26	11/9
U31	6/-
U33	29/6
U35	16/6
U37	34/11
U45	15/6
U50	5/6
U52	4/9
U76	4/9
U78	3/6
U107	18/3
U191	12/6
U251	16/-
U281	8/-
U282	8/-
U301	11/-
U329	16/-
U403	6/6
U404	7/6
U801	17/6
U4020	6/9
VP4B	10/6
VP13C	7/-
VP23	2/6
VR75	24/-
VR105	5/-
VR150	5/-
VT61A	7/-
VT501	3/-
VU111	7/3
VU120	12/-
VU120A	12/-
VU133	7/-
W42	10/6
W61M	24/6
W63	10/6
W76	5/9
W77	2/6
W81M	6/-
W101	26/2
W107	7/-
W729	10/-
X24	16/6
X41	10/-
X61	5/9
X63	5/6
X64	12/6
X65	5/-
X66	7/6
X76M	7/6
X81M	29/1
X101	29/1
X109	26/-
Y63	5/-
Y65	5/-
Z63	4/9
Z77	3/3
Z329	11/9
Z729	6/-
Z759	23/-
Transistors and diodes	
2G225	10/6
2N404	6/-
2N2297	4/6
2N2369A	4/3
2N3121	50/-
2N3866	20/-
AA120	3/-
AA129	3/-
AAZ13	3/6
AC107	3/-
AC113	5/-
AC114	8/-
AC126	2/-
AC127	2/-
AC128	2/-
AC154	5/-
AC155	6/6
AC156	4/-
AC157	5/-
AC165	5/-
AC166	5/-
AC167	12/-
AC168	7/6
AC169	6/6
AC176	11/-
AC177	5/6
ACY17	3/-
ACY18	3/8
ACY19	3/9
ACY20	3/6
ACY21	3/9
ACY22	3/6
ACY28	4/-
AD140	8/-
AD149	8/-
AF114	4/-
AF115	3/-
AF116	3/-
AF117	2/9
AF119	3/-
AF124	6/6
AF125	36-
AF126	5/3
AF127	3/6
AF139	11/-
AF178	10/-
AF179	13/6
AF180	9/6
AF181	14/-
AFZ12	5/-
ASY27	8/6
ASY28	6/6
ASY29	10/-
BA115	2/8
BA116	9/-
BA129	2/6
BA130	2/-
BCY10	5/-
BCY12	5/-
BCY33	5/-
BCY34	4/6
BCY38	5/-
BCY39	4/6
BCZ11	3/6
BC107	4/-
BC108	3/6
BC109	4/3
BC113	5/-
BC115	3/-
BC116	5/-
BC118	4/6
BD119	9/-
BFY50	4/-
BFY51	4/-
BFY52	4/6
BF154	5/-
BF159	5/-
BF163	4/-
BF167	2/6
BF173	2/6
BF180	12/-
BF185	8/-
BTX34/400	40/-
BY100	3/6
BY101	11/6
BY105	10/6
BY114	6/6
BY126	6/6
BY234	4/-
BY236	4/-
BY238	4/-
BYY23	20/-
BYZ10	5/-
BYZ11	5/-
BYZ12	5/-
BYZ13	5/-
BYZ15	35/-
CG12E	4/-
CG64H	4/-
GD3	6/6
GD4	6/6
GD5	5/6
GD6	5/6
GD8	4/-
GD9	4/-
GD10	4/-
GD11	4/-
GD12	4/-
GD14	10/-
GD15	8/-
GD16	4/-
GET102	4/-
GET103	4/-
GET105	18/-
GET113	4/-
GET115	17/-
GET116	6/6
GET119	4/-
GET573	7/6
GET587	8/6
GET872	10/-
GET873	3/-
GET882	10/-
GET887	4/6
GET889	4/6
GET890	4/6
GET896	4/6
GET897	4/6
GEX13	3/6
GEX35	4/6
GEX36	10/-
GEX45	7/-
GEX66	15/-
GT3	5/-
M1	2/10
M3	2/10
OA5	5/6
OA9	2/6
OA10	6/6
OA47	2/-
OA70	3/-
OA73	3/-
OA79	1/9
OA81	1/9
OA85	1/6
OA86	4/-
OA90	2/6
OA91	1/9
OA182	2/-
OA200	1/-
OA202	2/-
OA210	9/6
OA211	13/6
OAZ200	12/-
OAZ201	10/6
OAZ202	9/-
OAZ203	9/6
OAZ204	9/-
OAZ205	9/-
OAZ206	9/-
OAZ207	10/6
OAZ210	7/-
OAZ213	7/-
OAZ224	16/6
OC19	25/-
OC22	5/-
OC23	5/-
OC24	5/-
OC25	5/-
OC26	5/-
OC28	5/-
OC29	16/6
OC30	5/-
OC35	5/-
OC36	7/6
OC38	11/6
OC41	10/-
OC42	6/9
OC43	12/6
OC44	2/-
OC44PM	8/3
OC45	1/9
OC45M	8/-
OC46	3/-
OC65	22/6
OC70	2/3
OC71	2/-
OC72	2/-
OC73	16/-
OC74	2/6
OC75	2/-
OC76	2/6
OC77	2/6
OC78	3/-
OC78D	3/-
OC79	3/-
OC81	2/-
OC81D	2/-
OC81M	5/-
OC81Z	5/6
per pair	
OC82	2/3
OC82D	2/3
OC83	2/-
OC84	3/-
OC123	4/6
OC139	12/-
OC140	19/-
OC169	3/6
OC170	2/6
OC171	3/4
OC172	4/-
OC200	4/4
OC202	4/6
OC203	4/6
OC204	5/6
OC205	7/6
OC812	8/-
OCP71	27/6
ORP12	15/-
SX1/6	3/6
TS2	12/6
TS3	15/-
V10/15A	12/-
MAT100	7/9
MAT101	8/6
MAT120	7/9
MAT121	8/6
ZE12V7	1/9

MATCHED TRANSISTOR SETS 1—OC44 and 2—OC45 **8/6**; 1-OC81D and 2-OC81 **7/6**; 1—OC82D and 2—OC82 **8/6**; Set of three—OC83 (GET118/119) **8/6**; LP15 package (AC113, AC154 AC157, AA120) **10/6**; Postage 6d. per set.
S.T.C. 1 watt Zener diodes. 2·4v: 2·7v: 3·0v: 3·6v: 4·3v: 13v: 16v: 18v: 30v. All **3/6d.** each.

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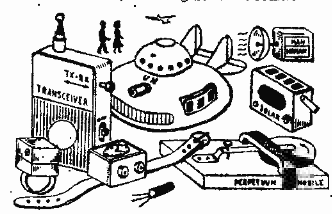

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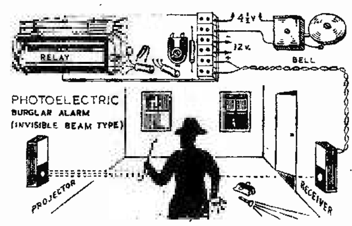
(1) Crystal Set with biased Detector. (2) Crystal Set with voltage-quadrupler detector. **(3) Crystal Set with Dynamic Loudspeaker. (4) Crystal Tuner with Audio** Amplifier. (5) Carrier Power Conversion Receiver. (6) Split-Load Neutralised Double Reflex. (7) Matchbox or Photocell Radio. (8) "TRI-FLEXON" Triple Reflex with **self-adjusting regeneration (Patent Pending). (9) Solar Battery Loudspeaker Radio.** The smallest 3 designs yet offered to the Home Constructor anywhere in the World. **3 Subminiature Radio Receivers based on the "Triflexon" circuit. Let us know** if you know of a smaller design published anywhere. **(10) Postage Stamp Radio.** Size only 1·62" × ·95" × ·25". (11) Wristwatch Radio 1·15" × ·80" × ·55". (12) **Ring Radio ·70" × ·70" × ·55". (13) Bacteria-powered Radio. Runs on sugar or** bread. (14) Radio Control Tone Receiver. (15) Transistor P/P Amplifier. (16) Intercom. (17) 1-valve Amplifier. (18) Reliable Burglar Alarm. (19) Light-Seeking Animal, **Guided Missile. (20) Perpetual Motion Machine. (21) Metal Detector. (22) Transistor** Tester. (23) Human Body Radiation Detector. (24) Man/Woman Discriminator. (25) Signal Injector. (26) Pocket Transceiver (Licence required). (27) Constant **Volume Intercom. (28) Remote Control of Models by Induction. (29) Inductive-Loop** Transmitter. (30) Pocket Triple Reflex Radio. (31) Wristwatch Transmitter/Wire-less **Microphone. (32) Wire-less Door Bell.** (33) Ultrasonic Switch/Alarm. (34) Stereo Preamplifier. (35) Quality Stereo Push-Pull Amplifier. (36) Light-Beam Telephone "Photophone". (37) Light-Beam Transmitter. (38) Silent TV Sound Adaptor. (39) **Ultrasonic Transmitter. (40) Thyristor Drill Speed Controller.**

PHOTOELECTRIC KIT

CONTENTS: 2 P.C. Chassis Boards, Chemicals, Etching Manual, Infra-Red Phototransistor, Latching Relay, 2 Transistors, Condensers, Resistors, Gain Control, Terminal Block, Elegant Case, Screws, etc. In fact everything you need to build a Steady-Light Photo-Switch/Counter/Burglar Alarm, etc. (Project No. 1) which can be modified for modulated-light operation.



PHOTOELECTRIC KIT

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INVISIBLE BEAM OPTICAL KIT

Everything needed (except plywood) for building: 1 Invisible-Beam Projector and **1 Photocell Receiver (as illustrated). Suitable for all Photoelectric Burglar Alarms,** Counters, Door Openers, etc.
CONTENTS: 2 lenses, 2 mirrors, 2 45-degree wooden blocks, Infra-red filter, projector lamp holder, building plans, performance data, etc. Price 19/6. Postage and Pack. 1/6 (UK). Commonwealth: Surface Mail 2/-; Air Mail 8/-.

JUNIOR PHOTOELECTRIC KIT

Versatile Invisible-beam, Relay-less, Steady-light Photo-Switch, Burglar Alarm, **Door Opener, Counter, etc., for the Experimenter.**
CONTENTS: Infra-Red Sensitive Phototransistor, 3 Transistors, Chassis, Plastic Case, Resistors, Screws, etc. Full Size Plans, Instructions, Data Sheet "10 Advanced Photoelectric Designs".
Price 19/6, Postage and Pack. 1/6 (UK). Commonwealth 2/-; Air Mail 4/-.

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CONTENTS: 2 Lenses, Infra-red Filter, Lampholder, Bracket, Plans, etc. Everything **(except plywood) to build 1 miniature invisible beam projector and photocell receiver** Price 10/6. Postage and Pack. 1/6 (UK). Commonwealth: Surface Mail 2/-; Air Mail 4/-

PHOTOELECTRIC PARKING LAMP SWITCH

Turns your light on at dusk, off at dawn, automatically. Never forgets. Protects your **car. Saves the Battery. Miniature construction.** Simply insert in the parking lamp lead. Price: **27/6.** Post & Packing (U.K.) 2/6 (12 volts only).

ELECTRONIC MAINS LAMP DIMMER

Varies lamp brightness from nothing to full 100 watt maximum. Ideal for **Parties, TV watching, Children's bedroom** etc. Just mount on the wall in place of on-off switch. Price: **59/6.** Post & Packing 2/6.

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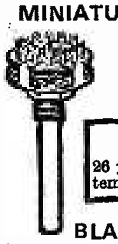
DRY JOINT TESTER

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.

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.

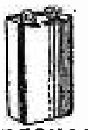
WATERPROOF HEATING ELEMENT
26 yards length 70W. Self-regulating temperature control. 10/- post free.

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. 3 heat model 7/6.

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 devices 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.

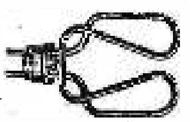


PP3 ELIMINATOR. Play your pocket radio from the mains! save £s. Complete component kit comprises 4 rectifiers—mains dropper resistances, smoothing condenser and instructions, only 6/6 plus 1/- post.

BECKASTAT

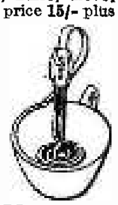
This is an instant thermostat, simply plug your appliance into it and its lead into wall plug. Adjustable setting for normal air temperatures. 13A loading. Will save its cost in a season 19/6. Post and ins. 2/9.

KETTLE ELEMENT



230/240V 1500 watt. Made by Best for kettles with 9/16 in. dia. hole including: Best, Besco, Chalfont, Davidson, Dimplex, Grafton, Hawkins, Jurymaid, Morroware, Monogram, Pifco, Revo, Towen, Swan. Normally 32/6. Our price 15/- plus 2/6 post.

QUICK CUPPA



Mini Immersion Heater, 350w. 200/240v. Boils full cup in about two minutes. Use any socket or lamp holder. Have at bedside for tea, baby's food, etc. 19/6, post and insurance 1/6. 12v. car model also available.

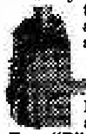
MAINS TRANSISTOR POWER PACK

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.

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.

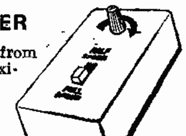


Type "D". We call this the Ice-stat as it cuts in and out at around freezing point, 2/3 amps. Has many uses one of which would be to keep the 10ft. pipes from freezing, if a length of our blanket wire (16 yds. 10/-) is wound round the pipes. 7/6. P. & P. 1/1.

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

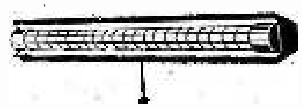
Type "F". Glass encased for controlling the temp. of liquid—particularly those in glass tanks, vats or sinks—thermostat is held (half submerged) by rubber sucker or wire clip—ideal for fish tanks—developers and chemical baths of all types. Adjustable over range 50° to 150°F. Price 18/-, plus 2/- post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

DRILL CONTROLLER



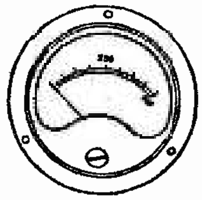
Electronically changes speed from approximately 10 revs. to maximum. Full power at all speeds by finger-tip control. Kit includes all parts, case, everything and full instructions. 19/6 plus 2/6 post and insurance. Or available made up 25/-, plus 2/6 post.

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.

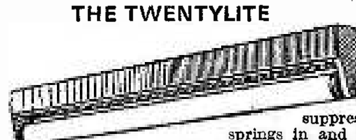
2½" MOVING COIL METER



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.

FLUORESCENT LIGHTING SNIP

THE TWENTYLITE



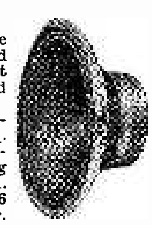
A Fluorescent lighting unit made by the famous Atlas company, with super silent polyester filled choke and radio suppressed starter. The tube springs in and out and the whole unit is beautifully made and finished white enamel. Amazingly economical. If left on all the time costs only one penny per day (uses ½ unit). Measures 2ft. long. Is ideal in Kitchen, Bedroom, Hallway, Porch, Loft, etc. Don't miss this amazing offer, 39/6 with tube. Assembled ready to install. Postage and Insurance 6/6 extra.

THIS MONTH'S SNIP

TIMED SWITCH

For keeping an electrical circuit closed for a time period of up to ten minutes. Made by a very famous company for switching washing machines, but equally suitable for any appliance lamp or heater up to 13 amp. Special snip price 9/6 post free if ordered with other lightweight items totalling £5, Otherwise add 2/9 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 5¼in. A £6 speaker offered for only £3.9.6 plus 7/6 p & p. Don't miss this offer.

BATTERY OPERATED TAPE DECK

With Capstan control. This unit is extremely well made and measures approx. 6 x 5 x 2in. deep. Has three piano key type controls for Record, Playback and Rewind. Motor is a special heavy duty type intended for operation off 4/5 volts. Supplied complete with 2 spools ready to install. Record, Replay head is the sensitive M4 type intended for use with transistor, amplifier. Price 89/6. Post and insurance 4/6.

BARGAIN OF THE YEAR

MICRO-SONIC

7 transistor Key chain Radio in very pretty case, size 2⅜ × 2⅛ × 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.

Spring coil leads as fitted to telephones, 4 core 2/6 each. 3 core 2/- each.
Indicator lamp. Panel mounting, consists of neon lamp in red plastic lens with resistor in leads for mains operation. 2/6 each. 24/- dozen.
Appliance switch double-pole 16A 230v rating spindle for pointer knob control, 3/6.
0005 tuning condenser for crystal or transistor radio, 24/- dozen.
16mm Zoom Lens for closed circuit TV camera, brand new, £75. (Half current price list.)
Baulkhead Aerial lead out two cone shaped porcelain insulators with OBA brass rod through centre fitted terminals 8/6.
12V Blower heavy duty motor with centrifugal blower coupled to one end, ideal for car heater, 12/6, plus 4/6 post.

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Double pole push to test switch. Spring return 10 amp. 250V. 2/9 each. 30/- doz.
A.E.I. FRACTIONAL H.P. MOTOR. 200/250v. 50/60 c.p.s. enclosed, continuous rating 1/40 h.p., ex. equipt. Perfect order 19/6 plus 4/6.

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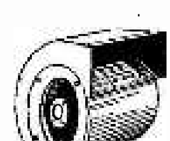
CENTRIFUGAL FAN



CENTRIFUGAL BLOWER or extractor by Torrington, very low noise but large capacity air flow, designed for central heating and air conditioning; ideal also for fume extraction over cooker, duct type outlet, 200-250 v. 50 C.P.S. motor. £3.19.6, post and insurance 7/6.

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(continued page 637)

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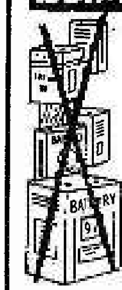

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8¼″	6⅞″		17	9	1	1	6	1	5	0
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12¼″	3⅞″		17	9	1	1	9	1	4	9
12¼″	5⅞″	1	2	3	1	7	0	1	10	6
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14¼″	3⅞″	1	0	6	1	5	0	1	7	3
14¼″	9⅞″	1	15	0	2	4	9	2	7	0
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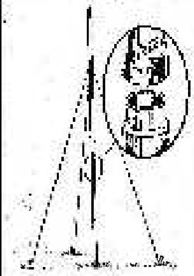

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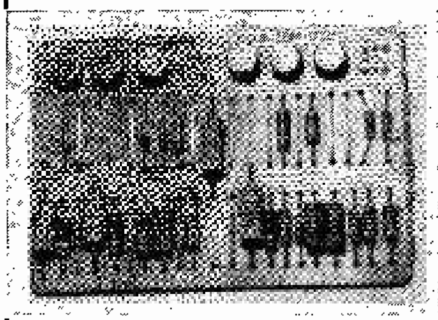

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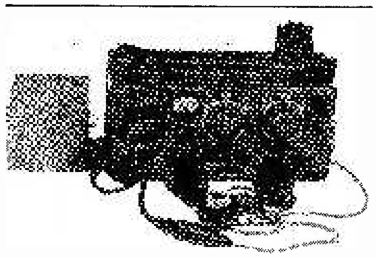

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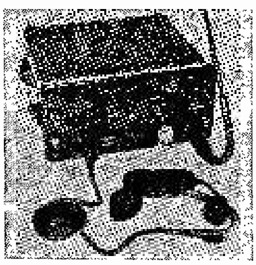

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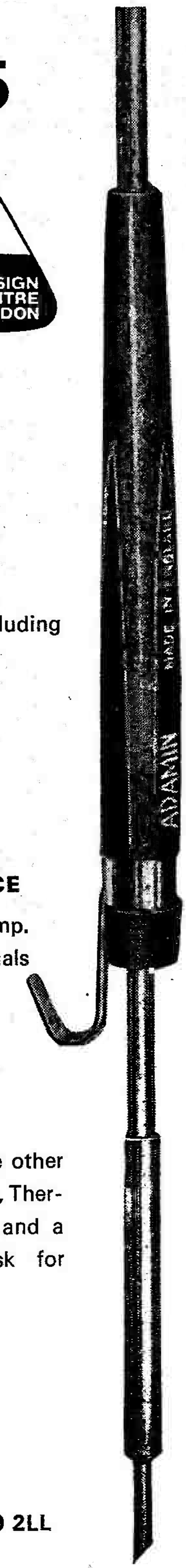

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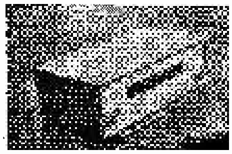

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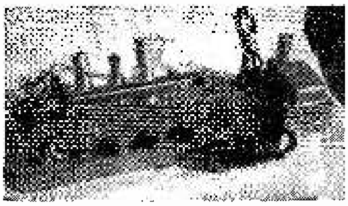

Chassis 12½ x 5¼ x 4½in. high. Front panel "gold" finish—12½ x 4¼in. 200–250 A.C. Record/Playback amp. switch Off/On-Tone; Vol./Mic.; Vol./Gram; Mic. Input; Gram. Input; Monitor; Speaker Socket Valves 6BR7; 12AX7; EM84; EL84; 6X4 Separate power pack, 2 Track **£8.19.6;** 4 Track **£10.4.6** (6/- post each). Rexine covered cabinet (tan) 15½ x 17 x 9½in. high with sloping front for amp; complete with two tweeter speakers, and special adapting brackets for Magnavox Deck **85/-** (8/- carr.) 3 speed Magnavox 4 track tape deck, Type 363. **£16.10.0**, carr. paid. 2 × 2 Stereo deck **£20.**

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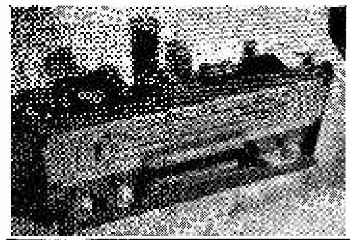

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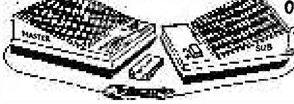

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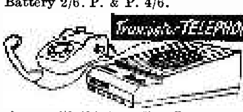

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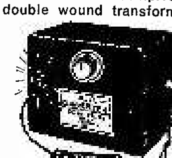

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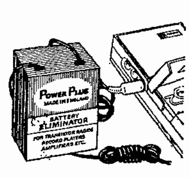

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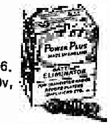

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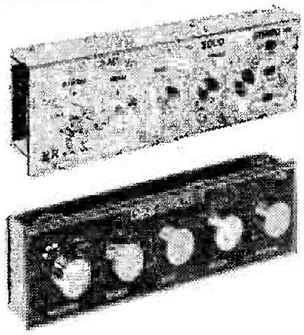

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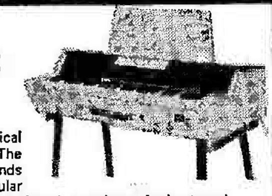

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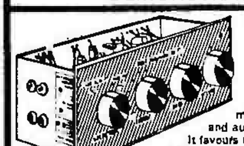

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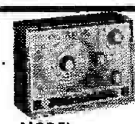

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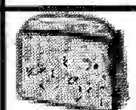

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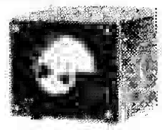

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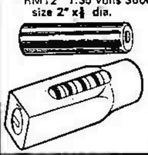

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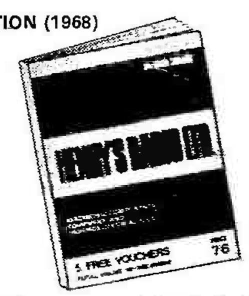

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