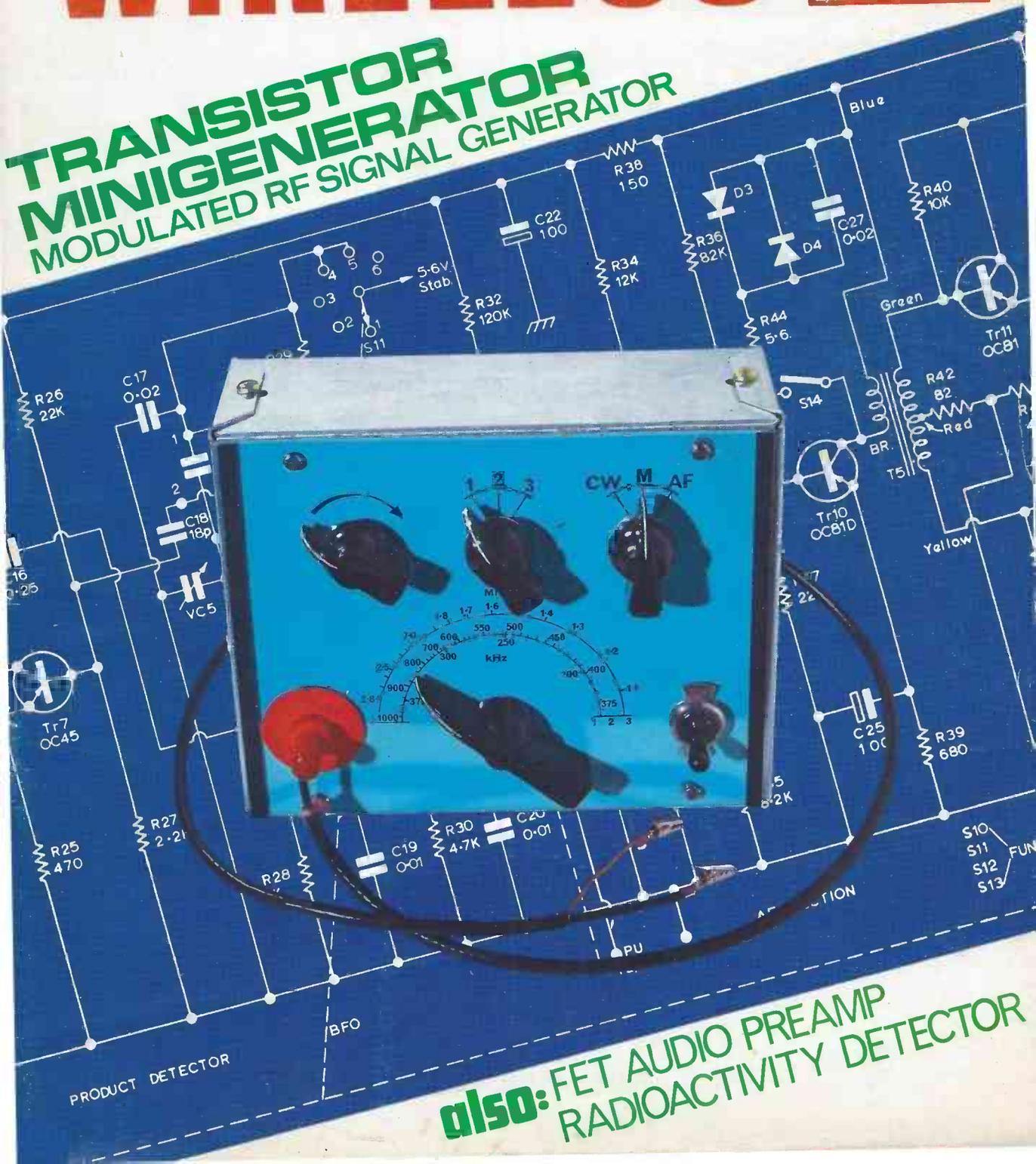


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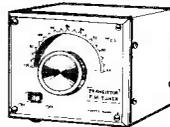
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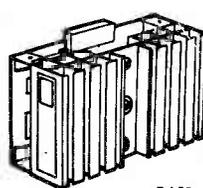
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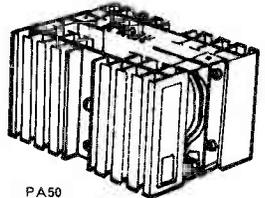


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PA50  
(50 watts RMS)

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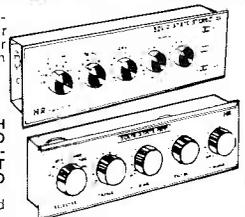
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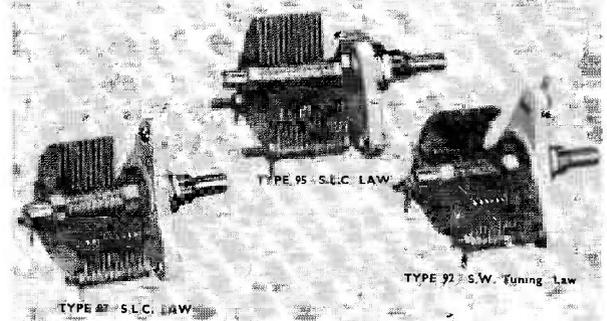
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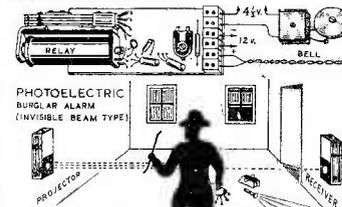
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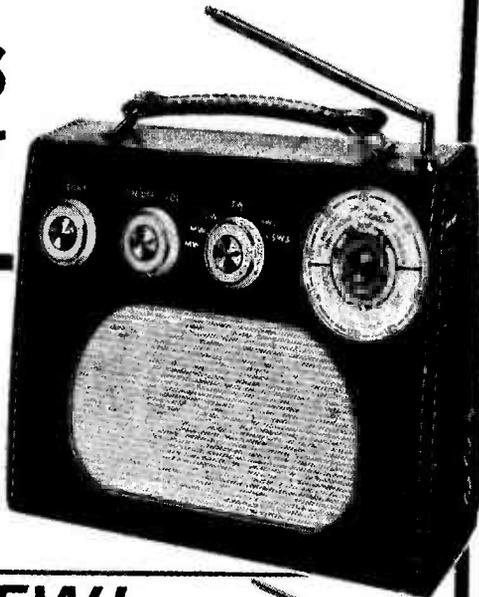
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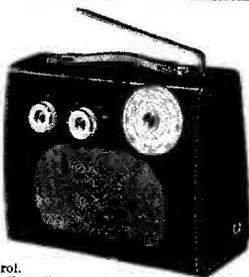
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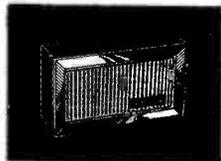
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Total building costs

**44'6**

P. & P.  
3/6

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Total building costs

**47'6**

P. & P.  
3/9

## roamer six

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INPUT SENSITIVITY: Suitable for medium or high output crystal cartridges and tuners. Cross-talk better than 30dB at 1Kc/s.

CONTROLS: 4-position selector switch (2 pos. mono and 2 pos. stereo) dual ganged volume control.

STONE CONTROL: Treble lift and cut. Separate on/off switch. A preset balance control.

*Duetto*

Integrated Transistor Stereo Amplifier

£9-10

plus 7/6d. p. & p.



The above 5 items can be purchased together for £29.10 + £1.10.0 p. & p.

## The Classic

£9 plus 7/6 p. & p.

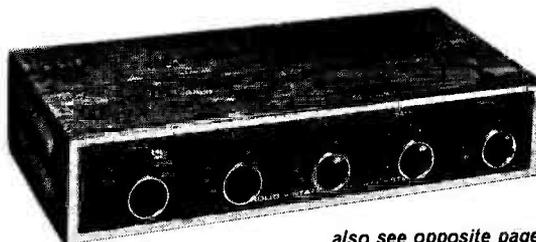
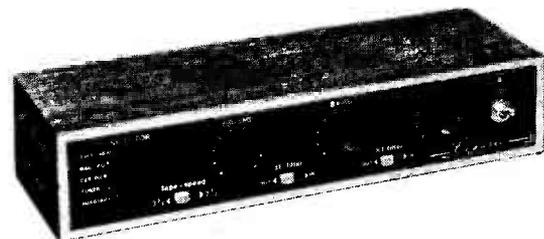
Controls: Selector switch Tape speed equalisation switch (3 1/2 and 7 1/2 i.p.s.). Volume. Treble. Bass. 2 position scratch filter and 2 position rumble filter.

Specification: Sensitivities for 10 watt output at 1KHz into 3 ohms. Tape head: 3mV (at 3 1/2 i.p.s.). Mag. P.U.: 2mV. Cer. P.U.: 80 mV. Tuner: 100mV. Aux.: 100mV. Tape/Rec. output: Equalisation for each Input is correct to within ±2dB (R.I.A.A.) from 20Hz to 20KHz. Tone control range: Bass ±13dB at 60Hz. Treble ±14dB at 15KHz. Total distortion: (for 10 watt output) <1.5%. Signal noise: <—60dB. A.C. mains 200-250v. Built and tested. Size 12 1/2 in. long, 4 1/2 in. deep, 2 1/2 in. high. Teak finished case.

## The Viscount

£14.5 plus 7/6 p. & p.

Integrated High Fidelity Transistor Stereo Amplifier. Specification—Output: 10 watts per channel into 3 to 4 ohms speakers (20 watts monaural). Input: 6 position rotary selector switch (3 pos. mono and 3 pos. stereo), P.U., Tuner, Tape and Tape Rec. out. Sensitivities: All inputs 100mV into 1-8M ohm. Frequency Response: 40Hz-20KHz ±2dB. Tone Controls: Separate bass and treble controls; treble, 13dB lift and cut (at 15KHz); Bass, 15dB lift and 25dB cut (at 60Hz). Volume Controls: Separate for each channel. A.C. Mains Input: 200-240V. 50-60Hz. Size, 12 1/2" x 6" x 2 1/2" in teak finished case. Built and tested. VISCOUNT MARK II for use with magnetic pick-ups specification as above. Fully equalised for magnetic pick-ups. Suitable for cartridges with minimum output of 4mV/cm/sec. at 1kc. Input impedance 47k. £15.15 plus 7/6 p. & p.



also see opposite page



## SPECIAL OFFER!

Complete stereo system comprising BALFOUR 4-speed autoplayer with stereo head, 2 Duo speaker systems, size 12 in. x 6 1/2 in. x 5 1/2 in. Plinth (less cover) and the DUETTO stereo amplifier. All above items

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## NEW COMPLETE HI-FI STEREO SYSTEM - £41

comprising SP 25 Garrard Mk II with diamond cartridge, or 2025 TC, Viscount Mk I amplifier, two type 2 speakers, plinth and cover

£41 plus £2-10-0 p. & p.



### The ELEGANT SEVEN Mk. III (350mW Output)

7 transistor fully tunable M.W.-L.W. superhet portable. Set of parts. Complete with all components, including ready etched and drilled printed circuit board—back printed for foolproof construction.  
MAINS POWER PACK KIT: 9/6 extra.

Circuit 2/6  
FREE WITH PARTS.

Price £4.9.6 plus 7/6 P. & P.

### The DORSET (600mW Output)

7-transistor fully tunable M.W.-L.W. superhet portable—with baby alarm facility. Set of parts. The latest modified and pre-alignment techniques makes this simple to build. Sizes: 12 x 8 x 3in.

Price £5.5.0 plus 7/6 P. & P.

MAINS POWER PACK KIT: 9/6 extra



Circuit 2/6  
FREE WITH PARTS.



### EXTRACTOR FAN

A.C. mains 230/250v. complete with pull switch. Size: 6 x 6 x 4in.

Price 27/6 plus 7/6 P. & P.

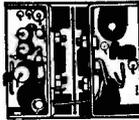
### X101 10W SOLID-STATE HI-FI AMP WITH INTEGRAL PRE-AMP

Specifications: Power Output (into 3 ohms speaker) 10 watts. Sensitivity (for rated output): 1mV into 3K ohms (0.33 microamp). 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. DC. at 800mA (6-24V. may be used).

Price 69/6 plus 2/6 P. & P.

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

Power Supplies for the X101: P101 M (for mono) 35/- plus 4/6 p. & p. P101 S (for stereo) 42/6 plus 4/6 p. & p.



### CAR TRANSISTOR IGNITION SYSTEM

by famous manufacturer

For 6 volt or 12 volt positive earth systems. Comprising: special high voltage working hermetically sealed silicon transistor mounted in finned heat-sink, high output ignition coil, ballast resistor and hardware (screws, washers, etc.).

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### 50 WATT AMPLIFIER

A.C. Mains 200-250V



Price £28.10

plus 20/- p. & p.  
3 & 4 300mV at 1m. Suitable for most high output instruments (gram, tuner, organ, etc.). Input sensitivity relative to 10w output. TONE CONTROLS ARE COMMON TO ALL INPUTS. Bass Boost +12dB at 60Hz. Bass Cut -13dB at 60 Hz. Treble Boost +11dB at 15 KHz. Treble Cut -12dB at 15 KHz. With bass and treble controls central -3dB points are 30 Hz and 20 KHz. POWER OUTPUT: For speech and music 50 watts rms. 100 watts peak. For sustained music 45 watts rms. 90 watts peak. For sine wave 38.5 watts rms. Nearly 80 watts peak. Total distortion at rated output 3.2% at 1KHz. Total distortion at 20 watts 0.15% at 1KHz. Output to match into 8 or 15 ohms speaker system. NEGATIVE FEEDBACK 20dB at 1KHz. SIGNAL TO NOISE RATIO 60dB. MAINS VOLTAGES adjustable from 200-250V. A.C. 50-60 Hz. A protective fuse is located at the rear of unit. Output impedance 3, 8 and 15 ohms.

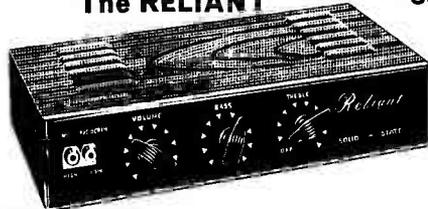
### B.S.R. TD-2 TAPE DECK

Takes 5 1/2in. spools, fitted with B.S.R. 1/2 Track Heads. Size 13 1/2in. long by 8 1/2in. wide.

Price £8.19.6 plus 7/6 P. & P.

### The RELIANT

SOLID STATE  
GENERAL  
PURPOSE  
AMPLIFIER



#### SPECIFICATIONS

Output—10 watts  
Inputs—1. -xial mic 10mV Tone Controls—Treble control range ±12dB at 10 KHz.  
2. -gram/radio 250mV

Bass control range ±13dB at 100Hz

Frequency Response—(with tone controls central) Minus 3dB points at 20Hz and 40KHz. 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 1/2" x 4 1/2" x 2 1/2". 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 from gram and mike. Built and tested.

#### RELIANT Mk. I

As above less teak case  
£5.15 plus 7/6 P. & P.

#### RELIANT Mk. II

In teak finished case.  
£6.16 plus 7/6 P. & P.

### RECORD PLAYER SNIP

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

ONLY £5.19.6 plus 7/6 P. & P.



A.C. Mains 240V



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Size 3 1/2 x 2 1/4 x 1 1/4in. Meter size 2 1/4 x 1 1/4in. Sensitivity 1,000 O.P.V. on both A.C. and D.C. volts 0-15, 0-150, 0-1,000 D.C. current 0-150mA Resistance 0-100KΩ Complete with test prods, battery and full instructions.

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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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Incorporating GEC Choke size 8 1/2 x 1 1/2 x 1 1/2in. 2 bi-pin holders starter and starter-holder. P. & P. 5/6. 11/6

Similar to above: 80W. Fluorescent Light Kit incorporating GEC choke size 1 1/2 x 1 1/2 x 1 1/2in. 2 bi-pin holders, start and starter holder. P. & P. 6/6. 17/6

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A complete Loud Speaker system on one frame, combining three matched ceramic magnet speakers with a low loss crossover 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 1/2 x 8 1/2 x 4 1/2in. By famous manufacturer.

List price £7 OUR PRICE 74/6 plus 5/- P. & P.

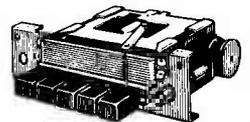
Similar speaker to the above without tweeters in 3 and 15 ohms 44/6 plus 5/- P. & P.

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Push Button Tuning Heart

This PRESTOLOK 5 station Push-Button Tuner Heart with Manual Over-ride is an ideal basis for a quality AM car radio. Size 6 1/2 x 4 1/2 x 2 1/2".

As illustrated but without knobs.  
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B96	5	2N3136 PNP Sil. Trans. TO-18. HFE 100-300 I.C. 600mA. 200MHz.	10/-
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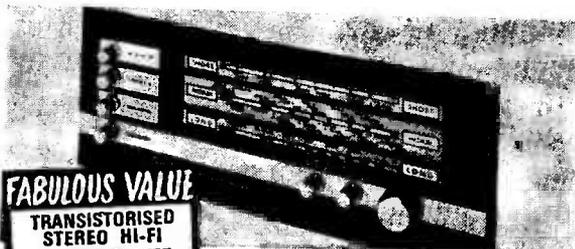
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ARMSTRONG 521	£52 0 0	£42 19 6
DULCI 207	£25 0 0	£17 0 0
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PHILIPS RH 590	£49 0 0	£37 12 6
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PHILIPS RH 690	£39 0 0	£33 2 6
QUAD Stereo FM	£51 0 0	£41 19 6
ROGERS Ravensbourne Tuner with Decoder	£61 17 9	£52 12 6
SINCLAIR 2000	£26 14 6	£19 4 6
TRUVOX FM 200/IC with decoder	£60 11 10	£39 19 6

	Rec. Retail Price	Comet Price
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ARENA T900 with MPX	£303 9 0	£258 0 0
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ARMSTRONG 526	£98 15 6	£79 19 6
ARMSTRONG 127	£43 19 6	£37 19 6
(Teak Case for 127)	£3 17 0	£3 19 0
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PHILIPS RH781	£74 19 6	£63 14 6
PHILIPS RH790	£125 0 0	£106 4 6
PHILIPS RH 691	£53 0 0	£37 0 0
TANDBERG System	£75 18 0	£59 19 6
TELETON F.2000	£51 0 0	£37 19 0
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	Rec. Retail Price	Comet Price
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TELETON CMS.400	£126 0 0	£99 0 0
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	Rec. Retail Price	Comet Price
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ARENA HT 7	£19 19 0	£17 0 0
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ARENA HT 20	£32 11 0	£26 19 6
ARENA HT 28	£75 15 0	£65 19 6
B & W DM3	£63 0 0	£53 6 0
B & W P2H	£94 10 0	£81 5 0
B & W DM1	£32 0 0	£23 19 6
CELESTION Ditton 10	£21 3 2	£17 5 0
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	Rec. Retail Price	Comet Price
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Denton	£18 0 0	£13 19 6
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Malton	£29 10 0	£23 19 6
Dovedale 3	£39 10 0	£29 19 6
Rosedale	£55 0 0	£43 19 6
UNIT 3 Speaker Kit	£10 19 6	£8 19 6

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GARRARD SL. 95B	£45 9 1	£37 19 6
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GARRARD SL. 72B	£30 2 0	£24 19 6
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GOLDRING GL. 75	£36 8 2	£27 19 6
GOLDRING 75P	£46 18 8	£38 0 0
GOODMANS 3025	£37 14 9	£32 19 6
<b>GOLDRING COVERS for 69P and 75P</b>		
THORENS TD. 125	£4 4 3	£3 6 0
THORENS 125 AB	£75 17 8	£59 19 6
THORENS 125 AB	£120 3 11	£99 19 6
THORENS TD 150	£29 9 1	£24 19 6
THORENS TD 150B	£33 13 0	£26 19 6
THORENS 150A MK II	£43 12 7	£32 19 6
THORENS 150AB MK II	£47 8 7	£40 19 6
THORENS TD 126/II	£46 15 10	£39 19 6

Bases, plinths and covers stocked.

## HI-FI STEREO TAPE DECKS AND TAPE RECORDERS

	Rec. Retail Price	Comet Price
AKAI 150D	£130 2 4	£109 0 0
AKAI X-360	£230 0 0	£200 0 0
AKAI X-360 D deck	£290 0 0	£243 0 0
AKAI 1710	£109 0 0	£89 19 6
AKAI 1800	£158 0 0	£133 0 0
AKAI 1800SD	£199 0 0	£167 0 0
AKAI 4000 D deck	£37 10 0	£31 19 6
TRUVOX PD 120 deck	£114 15 3	£79 0 0
MARCONI 4218 Stereo tape Recorder	£89 11 2	£69 19 6
MARCONI 4238 4-track tape Recorder	£58 11 0	£49 19 6
TRUVOX R52 & R54 3-speed 2-track	£77 5 1	£52 2 0

Tandberg also available

	Rec. Retail Price	Comet Price
<b>PICKUP ARMS</b>		
GOLDRING Lenco L75	£12 6 6	£10 19 6
GOLDRING Lenco G65	£7 13 6	£6 19 6
SME 3000 with S2 shell	£31 6 3	£24 19 6
SME 3012 with S2 shell	£33 7 3	£26 19 6

	Rec. Retail Price	Comet Price
<b>CHASSIS</b>		
Goodmans Axiote 8	£7 2 1	£5 13 6
Goodmans Twinxlatte 8	£8 0 7	£6 14 0
Goodmans Axiom 10	£8 0 0	£6 14 0
Goodmans Axiom 201	£12 10 0	£9 7 6
Goodmans Axiom 301	£17 16 0	£13 6 6
Goodmans Axiom 51	£11 6 0	£8 9 6
Goodmans Axiom 61	£16 7 0	£12 5 6
Goodmans Axiom 81	£27 12 0	£20 14 9
Goodmans Axiom 91	£31 5 0	£23 9 6
Goodmans Axiom 91/100	£34 17 0	£26 2 0
Goodmans ARU 180	£37 17 8	£28 19 6
Goodmans ARU 280	£37 17 8	£28 19 6
Goodmans ARU 480	£5 8 5	£4 1 3
Goodmans ARU 172	£37 17 8	£28 19 6
Goodmans Trebox 100	£7 9 0	£5 11 6
Goodmans Trebox 5K/20KL	£8 8 0	£6 8 0
Goodmans Mixax	£34 4 0	£26 2 0
Goodmans Attenuator	£3 1 4	£2 6 0
Goodmans Crossover Networks XO/950/5000	£8 8 7	£6 6 0
Goodmans Crossover Networks XO/950	£6 7 9	£4 15 9
Goodmans Crossover Networks XO/5000	£2 6 0	£1 14 6
Wharfedale 8" Bronze/RS/DD	£4 8 0	£3 13 6
Wharfedale Super 8/RS/DD	£7 12 0	£6 6 0
Wharfedale Super 10/RS/DD	£12 14 0	£10 19 6
Wharfedale VMT 1 Matching Transformer	16 9	13 6

	Rec. Retail Price	Comet Price
<b>CARTRIDGES</b>		
Goldring G65 Pick-up Arm	£7 16 1	£6 4 6
Goldring L75 Transcription Arm	£12 10 10	£10 0 0
Goldring 800 Cartridge	£13 0 0	£10 7 6
Goldring 800H	£10 13 9	£8 19 6
Goldring 800E	£18 17 1	£15 0 0
Goldring 800 Super E	£26 0 1	£20 15 0
Goldring CS90 Stereo Ceramic Cartridge	£5 4 0	£4 3 0
Goldring CS91/E	£7 16 1	£6 4 6
Ortofon SL 15E	£29 12 11	£23 12 11
Ortofon 2X 15K	£7 0 0	£5 5 4
Shure M3DM	£7 8 3	£6 6 3
Shure N3D	£5 11 2	£4 6 8
Shure M31E	£12 19 5	£10 6 0
Shure N31E	£9 5 3	£7 6 6
Shure M32E	£12 0 11	£9 12 0
Shure N32E	£8 6 9	£6 13 0
Shure M32-3	£11 2 4	£8 17 6
Shure N32-3	£6 9 8	£5 3 6
Shure M44-5	£11 2 4	£8 17 6
Shure N44-5	£7 8 3	£6 6 0
Shure M44-7	£10 3 10	£8 5 0
Shure N44-7	£6 9 8	£5 3 6
Shure M44-C	£10 3 10	£8 5 0
Shure N44-C	£6 9 8	£5 3 6
Shure M44E	£14 16 6	£11 16 6
Shure N44E	£10 3 10	£8 5 0
Shure M55E	£16 13 6	£14 13 6
Shure N55E	£11 2 4	£8 17 6
Shure M75G	£17 12 1	£14 0 0
Shure N75G	£9 5 3	£6 17 6
Shure M75-6	£16 13 6	£13 6 0
Shure N75-6	£8 6 9	£6 13 0
Shure M75EJ	£24 1 9	£19 4 6
Shure N75EJ	£11 2 4	£8 17 6
Shure M75EJ-95G	£27 15 11	£22 3 0
Shure N75E	£12 19 5	£10 6 0
Shure V15-11	£40 15 3	£32 19 6
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Shure V15-11-7	£38 18 3	£31 0 0
Shure VN7	£14 16 6	£11 16 6

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# R.S.C. SENSATIONAL HIGH FIDELITY STEREO 'PACKAGE' OFFERS

- \* Super 30 Amplifier (30 watt) in veneered housing
- \* Goldring Transcription Turntable on Plinth
- \* Shure or Goldring Magnetic Pick-up Cartridge
- \* Pair of Stanway II Loudspeaker Units

Special total price. Four fully wired units ready to "plug-in". Carr. 30/-  
**86 Gns.**  
 TERMS AVAILABLE ALL PACKAGE OFFERS

Matching as recommended for optimum performance. Send for coloured brochure showing other money-saving offers.

Package prices apply providing all individual units are purchased from any branch within 3 months. See leaflet.

- \* Super 30 amplifier (30 watt) in veneered housing
- \* Garrard SP25 Mk II Turntable on Plinth
- \* Goldring CS90 Ceramic P.U. Cartridge with diamond stylus
- \* Pair Stanway II Speaker Units

Four fully wired units ready to "plug-in". Special total price **76 Gns.** Carr. 30/-  
 \* TA12 Amplifier (13 watt) in veneered housing  
 \* Garrard SP25 Mk II 4 sp. player unit on plinth  
 \* Goldring CS90 Ceramic P.U. Cartridge **53 Gns**  
 \* Pair of Dorchester Loudspeaker Units  
 Special total price Carr. 25/-  
 Or Dep. £10.0.3 and 9 mthly. payments **£5.15.5** (Total 59 gns.). Transparent plastic cover 3 gns. extra.

## AUDIOTRINE HIGH FIDELITY LOUSPEAKERS



Heavy construction. Latest high efficiency ceramic magnets. Treated Cone surround. "D" indicates Tweeter Cone providing extended frequency range up to 15,000 c.p.s. Impedance 3 or 15 ohms. Please state choice. Except Max. performance. \*  
 Prices include carriage.  
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 HF811D 8" 10W 4 gns. HF126 12" 15W £5.5.0  
 HF102D 10" 10W 65/- HF126D 12" 15W £5.15.0

EXTREMELY ATTRACTIVE PLINTHS finished in Teak or Afrormosia veneer. Trans. plastic cover.

## RECORD PLAYING UNITS

Money saving units. Mounted on Plinth. Supplied with transparent plastic cover Ready to plug into Amplifier or Tape recorder.  
**RP2C** Garrard SP25 Mk II (with heavy turntable) fitted Goldring CS90 high compliance ceramic Stereo/Mono cartridge with diamond stylus. **23 Gns.**  
**RP5C** Garrard 2025 Auto Unit fitted Garrard GCS 23 Stereo Cartridge with diamond tip. Plinth & Cover as RP2C. inc. carr. **15 Gns.**  
 Other types available with Magnetic cartridges and with alternative design plinths. Limited Number of CLEARANCE LINES in leading makes of Hi-Fi equip. at Branches only

As above but with Garrard 3000 Autochanger (fitted Sonotone 9 TA Cartridge) in lieu of SP25 or Dep. £9 and 9 monthly payments. **£5.4.9** (Total £56.2.9). Transp. plastic cover 3 gns. extra inc. carr. Carr. 25/- **47 1/2 Gns.**

## R.S.C. TA12 MKII 13 WATT STEREO AMPLIFIER

FULLY TRANSISTORISED. SOLID STATE CONSTRUCTION HIGH FIDELITY OUTPUT OF 6.5 WATTS PER CHANNEL. Designed for optimum performance with any crystal or ceramic Gram P.U. cartridge, Radio tuner, Tape recorder, 'Mike' etc. \* 3 separate switched input sockets on each channel  
 \* Separate Bass and Treble controls  
 \* Slide Switch for mono use  
 \* Speaker Output 3.5 ohms or 200-250V A.C. mains  
 \* Frequency Response 30-20,000 c.p.s.—2dB \* Harmonic Distortion 0.3% at 1000 c.p.s. Hum and Noise—70dB \* Sensitivities (1) 300mV (2) 50mV (3) 100mV (4) 2mV. Output rating I.H.F.M. \* Handsome brushed silver finish Facia and Knobs. Complete kit of parts with full wiring diagrams & instructions. Factory built with 12 mthly payments **13 1/2 Gns.**  
 Dep. £5.10.6 and 9 monthly payments **£2.1.7** (Total £24.4.9).



## HIGH FIDELITY LOUSPEAKER UNITS

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

**DORCHESTER** Size 16 x 11 x 9 in. Appr. Range 45-15,000 c.p.s. Rating 8-10 watts. Fitted High Flux 13x8 in. Dual cone spkr. Imp. 3 or 15 ohms. Carr. 7/6

**STANWAY II** Size 20x10x19 in. approx. Rating 10 watts. Inc. Fane 13x8 in. speaker with highly flexible cone surround, long throw voice coil and 11,000 line magnet. High flux tweeter. Handsome Scandinavian design cabinet. Range 35-20,000 c.p.s. Imp. 15 ohms. Gives smooth realistic sound output. **16 Gns.**

## R.S.C. TA6 6 Watt HIGH FIDELITY SOLID STATE AMPLIFIER



200-250V. A.C. mains operated. Frequency Response 30-20,000 c.p.s.—2dB. Harmonic Distortion 0.3% at 1,000 c.p.s. Separate Bass and Treble

'lift' and 'cut' controls. 3 input sockets for Mike, Gram, Radio or Tape. Input selector switch. Output for 3-15 ohm spkrs. Max. sensitivity 5mV. Output rating I.H.F.M. Fully enclosed enamelled case, 9 1/2 x 2 1/2 x 5 1/2 in. Attractive brushed silver finish facia plate 10 1/2 x 3 1/2 in. and matching knobs. Complete kit of parts with full wiring diagrams and instructions. **7 Gns.** Carr. 7/6  
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for Record Playing units, cut for Garrard 1025, 2025, 3000, AT60, SP25 etc. Inc. Carr. **6 Gns.**  
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## THE 'YORK' HIGH FIDELITY 3 SPEAKER SYSTEM

\* Moderate size, only 25 x 14 x 10 in. Complete Kit **20 Gns.**  
 \* Response 30-20,000 c.p.s. Impedance 15 ohms  
 \* Performance comparable with units costing considerably more. Consists of (1) 12 in. 15 watt Bass unit with cast chassis. Roll rubber cone surround for ultra low resonance, and ceramic magnet. (2) 3-way quarter section series cross-over system. (3) 8 x 5 in. high flux middle range 'speaker. (4) High efficiency tweeter. (5) Appropriate quantity acoustic damping material. (6) Teak veneered cabinet. (7) Circuit and full instructions. Terms: Dep. £5.10.6 and 9 monthly payments 39/- (Total £23.1.0). DEMONSTRATIONS AT ALL BRANCHES

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\* High-sensitivity. \* 200-250V. A.C. Mains operation. \* Sharp A.M. Rejection. \* Drift-free reception. \* Output ample for any amplifier (approx. 500 m.v.). \* Output for feeding Stereo Multiplexer. \* Tuner head using silicon Planar Transistors. \* Designed for standard 80 ohm co-axial input. Visually matching our Super 15 and 30 amplifiers and of the same high standard of performance and reliability. Printed circuitry. A quality product at considerably less than the cost of comparable units. Factory built 18 gns. Or in Teak finished cabinet as illustrated 21 gns. Terms: Deposit £6.1.0 and 9 monthly payments. 2 gns. Total £24.19.0. Stereo version, 23 gns. All prices include carriage.

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 Approx. as Super 30 but single channel. Complete kit with full constructional details and point to point wiring diagrams. Carr. 12/6  
 or factory built 15t Gns. Carr. 12/6. Terms: Deposit 4 Gns. and 9 monthly payments 31/1 (Total £18.3.9) or in Teak or Afrormosia veneered housing. 19 Gns.

# R.S.C. SUPER 30 MKII HIGH FIDELITY STEREO AMPLIFIER

High Grade Components Specifications comparable with units costing considerably more.

TRANSISTORS 9 high quality types in each channel.

OUTPUT 10 Watts R.M.S. continuous into 15Ω (per channel). 15 Watts R.M.S. continuous into 3Ω.

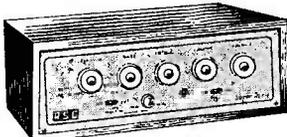
INPUT SENSITIVITIES Mag. P.U. 4 mV. Ceramic P.U. 35 mV. Tape Amp. 400 mV. Aux. 100 mV. Mic. 5 mV. Tape Head 2.5 mV.

FREQUENCY RESPONSE ± 2 dB. 10-20,000 c.p.s.

TREBLE CONTROL +17 dB to -14 dB at 10 Kc/s.

BASS CONTROL +17 dB to -15 dB at 50 c/s.

HUM LEVEL -80 dB.  
 HARMONIC DISTORTION 0.1% at 10 watts 1,000 c.p.s.



FACIA PLATE Attractive design in rigid Perspex. Spun silver finish matching control knobs as available.

## COMPLETE KIT OF PARTS Carr. 15/- 22 Gns.

Point to point wiring diagrams and detailed instructions. Eminently suitable for use with any make of Pick-up or Mic. (Ceramic or Magnetic, Moving Coil, Ribbon or Crystal) currently available. Superb sound output quality can be obtained by use with first-rate ancillary equipment. UNIT FACTORY BUILT 29 Gns. With 12 mths. guarantee. or Deposit £7.5.0 and 9 monthly payments 58/9 (Total £33.13.9) or in Teak or Afrormosia veneer housing 32 Gns. Carr. 15/-. Terms: Deposit £7.3.6 and 9 monthly payments of 66/- (Total £37.2.0). Send S.A.E. for leaflet.

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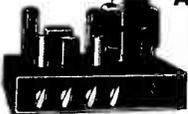
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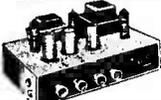
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Highly sensitive, Push-Pull high output with Pre-amp Tone Control Stages. Performance features of factory built units: Hum level — 70dB. Frequency response  $\pm 3\text{dB}$  30-20,000/c/s. Sectionally wound output transformer. All high grade components. Valves EF86, EF86, ECC81, 80T, 80T, C234. Separate Bass and Treble Controls. Sensitivity 36mV. Suitable for high impedance microphones. Crystal or Ceramic P.U.'s. Designed for Clubs, Schools, Theatres, Dance Halls or Outdoor Functions, etc. For use with Electronic Organ, Guitar, String Bass, etc. Gram, Radio or Tape, Reserve L.T. and H.T. for Radio Tuner. Two inputs with associated volume controls to that two separate inputs such as Gram and "Mike" can be mixed. 200-250v, 50c/s A.C. mains. For 3 and 15 ohm speakers. Complete kit of parts with point-to-point wiring diagrams and instructions. **15 Gns.** Carr. 1/26

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PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP. Two input sockets with mixing facilities High sensitivity, 5 valves. Independent Bass and treble controls. Frequency response  $\pm 3\text{dB}$  30-20,000 c/s. Hum level — 60dB. Sensitivity 40 millivolts. For Crystal or Ceramic P.U.s. High impedance "mikes".

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### 30 WATT HI-FI AMPLIFIER

FOR GUITAR, VOCAL OR INSTRUMENTAL GROUP. A 2 or 4 input, 2 vol. control HI-FI unit with Separate Bass and Treble controls. B.V.A. valves. Peak output rating. Strong Resine covered cabinet with handles. Attractive black/gold perspex fascia. Neon indicator. For 200-250v, A.C. mains. For 3 or 15 ohm speakers. Send S.A.E. for leaflet. Deposit 8 gns. and 9 monthly payments of 39/8 (Total 22 gns.) **19 Gns.** 12/6



### FANE ULTRA HIGH POWER LOUSPEAKERS

All power ratings are R.M.S. continuous. 2 years' guarantee. High Flux ceramic magnets. Heavy cast chassis. All prices carr. free

<b>'POP' 100</b> 18" 100 Watt 14,500 gauss 8/15Ω	<b>'POP' 60</b> 15" 60 Watt 14,000 gauss 15Ω	<b>'POP' 50</b> 12" 50 Watt 14,000 gauss 15Ω	<b>'POP' 30C</b> 12" 25 Watt Dual cone 15Ω
<b>21 GNS.</b>	<b>12 GNS.</b>	<b>10 GNS.</b>	<b>£5-19-9</b> Carr. free

### FANE LOUSPEAKERS

12" 25 Watt Dual cone 15Ω **£5-19-9** Carr. free

F.A.L. P.A. AMPLIFIERS PHASE 29 GNS. PHASE 50 100 59 GNS. S.A.E. for leaflets.

### R.S.C. COLUMN SPEAKERS

Covered in two-tone Resine/Vynair, ideal for vocalists and Public Address. 15 ohm matching. C57 15 watts inc. five 7 x 4in. speakers  $\pounds 7.19.11$ . TYPE C485 25/30 WATTS. Fitted four Rin. high flux 8 watt speakers. Overall size approx 42 x 10 x 5in. **16 Gns.** Carr. 10/-

Or deposit 67/- and 9 monthly payments 34/9 (Total  $\pounds 18.19.9$ ). TYPE C4125, 50 WATTS. Fitted four 12in. 11,000 line 15 watt speakers. Overall size 56 x 14 x 9in. approx. **15 Gns.** Carr. 15/-

Or Deposit  $\pounds 5.17.6$  and 9 monthly payments of 54/6 (Total  $\pounds 30.7.0$ ).



### R.S.C. MAINS TRANSFORMERS

FULLY GUARANTEED. Interleaved and Impregnated. Primaries 200-250v, 50c/s. Screened MIDGET CLAMPED TYPE 24" x 24" x 24in.

250-0-250v, 6.3v, 2a.	17/11
250-0-250v, 60mA, 6.3v, 2a.	18/11

FULLY SHROUDED UPRIGHT MOUNTING

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300-0-300v, 100mA, 6.3v, 4a.	39/9
300-0-300v, 130mA, 6.3v, 4a.	47/11
350-0-350v, 100mA, 6.3v, 4a.	39/9
350-0-350v, 150mA, 6.3v, 4a.	47/9
425-0-425v, 200mA, 6.3v, 4a.	89/9
425-0-425v, 200mA, 6.3v, 4a.	93/9
450-0-450v, 250mA, 6.3v, 4a.	99/9

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250-0-250v, 100mA, 6.3v, 3.5a.	27/9
250-0-250v, 100mA, 6.3v, 2a.	28/9
350-0-350v, 80mA, 6.3v, 2a.	29/11
250-0-250v, 100mA, 6.3v, 4a.	39/9
300-0-300v, 100mA, 6.3v, 4a.	39/9
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Suitable for Mullard 510 Amplifier

350-0-350v, 100mA, 6.3v, 4a.	39/9
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FILAMENT OR TRANSISTOR POWER PACK Types

6.3v, 1.5a, 8/9; 6.3v, 2a, 9/9; 6.3v, 3a, 13/9; 6.3v, 6a, 22/9; 12v, 1v, 9/11; 12v, 3a, or 24v, 1.5a, 23/9; 0.9-18v, 1.1a, 19/11; 0.12-2.5-4.2v, 2a, 31/9	
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CHARGE TRANSFORMERS 0.9-15v, 1.1a, 18/9; 2.1a, 19/11; 3a, 21/11; 5a, 25/11; 6a, 29/9; 8a, 36/9

AUTO (Step UP/step DOWN) TRANSFORMERS 0-110/120v, 200-230-250v, 50-80 watts 19/9  
150 watts, 33/6; 250 watts 49/9; 500 watts 105/-

OUTPUT TRANSFORMERS

Standard Pentode 1000 Ω or 7,000 Ω to 3 Ω	8/9
Push-Pull 8 watts EL84 to 3 Ω or 15 Ω	14/9
Push-Pull 10 watts 6V6 ECL86 to 3, 5, 8 or 15 Ω	24/9
Push-Pull EL84 to 3 or 15 Ω 10-12 watts	23/9
Push-Pull Ultra Linear for Mullard 510, etc.	39/9
Push-Pull 15-18 watts, sectionally wound 6L6, KT66, etc., for 3 or 15 Ω	35/9
Push-Pull 20 watt high quality sectionally wound EL84, 6L6, KT66 etc. to 3 or 15 Ω	59/9

SMOOTHING CHOKES - 150mA, 7-10H, 250 Ω 12/9; 100mA, 10H, 200 Ω 10/9; 80mA, 10H, 350 Ω 8/9; 60mA, 10H, 400 Ω 4/11.

SELENIUM RECTIFIERS F.W. (Bridged) All 6/12v, D.C. output. Max. A.C. input 18v. 1a, 4/3, 2a, 6/11, 3a, 9/9, 4a, 12/9, 6a, 15/9.

### HIGH QUALITY LOUSPEAKERS

In Teak or Afrmosia veneered Cabinets

L13 13" x 8" 10 Watt 10,000 lines	<b>£4-19-9</b>
3 or 15 ohms.	Carr. 7/6
L12 12" 20 Watt 10,000 lines	
15 ohms.	Carr. 8/9

**£8-19-9**

### R.S.C. BASS-REAGENT 50 WATT AMPLIFIER

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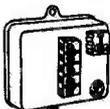
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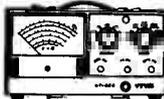
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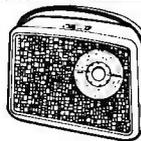


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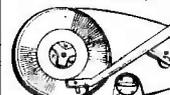
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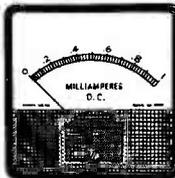
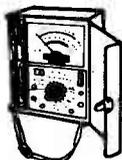


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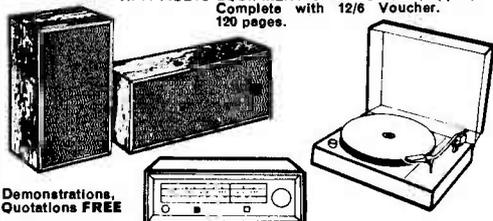
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Conds 10µf 150v tantalum 4 for 3/-. Paper conds tubular by Seimens 20µf 400v 6/-, 16µf 400v 5/-, 4µf 800v 5/-, H.V. conds. 1µf 1.6Kv 3/6, .05µf 2.5Kv 3/6, Plug & Sk 28-way with cover 4/6, Swts 2p 6w min 3/-. Toggle 2p c/o 3 for 5/-. Inst 2p 22w 2b with knob 7/6, Ledex coil 1K 3p 11w 3b 11/6, Meters 1 to 5 mA edgewise scale 0 to 2000yds 10 div 20/-, 500 µA scale 0 to 2 2A OSD 20/-, Control panel with 6x1 meg, 8x100K & 1K min type 15/6, Min panel fuse holders take 4in fuses 3 for 5/-. Pot Cores type LA.66 wound 3/6 ea, Yax Swts 6p 11w 6b with 27 1% resistors 12.6, 4p 12w 4b with 29 x 1%

# Lasky's

## SCOOP Garrard 3000

**CUSTOM UNIT** BY FAMOUS BRITISH MANUFACTURER

A deluxe custom styled and built record player unit made by world famous British manufacturer. The unit incorporates the renowned Garrard 3000 four speed autochanger with lightweight tubular pick-up arm FITTED WITH SONOTONE STA STEREO CARTRIDGE with diamond stylus. The beautifully made plinth is finished in richly figured teak veneer with tinted perspex panels in the lid and with attractive charcoal grey "mirror" insert panel on front. All metal trim parts are satin chrome. Blackleather grain underside. The lid allows the player to operate fully automatically when closed and has snap action "stay" when raised. Mains socket and 5 pin DIN audio output socket are at rear. Overall size 15 1/4 x 7 1/4 x 14 in.

**LASKY'S SPECIAL PRICE £16.15.0** Post 15/-

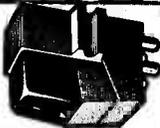


## AUDIO-TECHNICA

## Garrard

### SPECIAL OFFER

**AT-35X** Stereo magnetic cartridge with elliptical diamond stylus. Frequency response 20-25 kHz  $\pm$  2 dB. Channel separation 30 dB. Output 5mV. List Price £24.4.3.



**LASKY'S PRICE £17.10.0** Post Free

Also available AT-35 stereo magnetic cartridges with either 0.5 or 0.7 mil diamond stylus assemblies. List Price £18.10.0. Lasky's Price £13.10.0. Post Free.

**AT-33** Stereo magnetic cart.—frequency response 20-20 kHz with 0.7 mil diamond stylus. Output 5mV. List £10.14.3.

**LASKY'S PRICE £7.19.6**

## ADC 40 PRECISION PICK-UP ARM

The ADC 40 Mk II is a complete low inertia arm with side thrust compensator and anti-drag lead out arrangement. Single thrust ball bearings used at four points. Accurately machined walnut non-resonant arm. Adjustable counterweight. Plug-in head shell accommodates nearly all cartridges. Easy installations. Built-in arm rest. Arm length 10 1/2 in. overall. Pivot to stylus tip 9 in. Rear overhang 1 1/2 in.



List Price £19.1.6

**OUR PRICE £8.19.6** Post 3/6

## INTERNATIONAL

MAGNETIC RECORDING TAPE FROM THE U.S.A. AT LASKY'S RECORD LOW PRICES

3in. Message tape, 150ft. ....	2 6	5 1/2 in. Long play, 1200ft. Mylar ...	15 0
3in. Message tape, 225ft. ....	3 0	5 1/2 in. Triple play, 2400ft. ....	35 0
3in. Message tape, 300ft. ....	7 0	7in. Standard play, 1200ft. ....	12 6
3 1/4 in. Triple play, 600ft. Mylar ...	10 0	7in. Acetate ..... ..	12 6
5in. Double play, 1200ft. Mylar ...	15 0	7in. Standard play, 1200ft. ....	12 6
5in. Long play, 900ft. Acetate ...	10 0	7in. Mylar ..... ..	12 6
5in. Standard play 600ft. ....	8 6	7in. Long play, 1800ft. Mylar ...	15 0
5 1/2 in. Double play 1800ft. Mylar ...	22 6	7in. Double play, 2400ft. Mylar ...	25 0
5 1/2 in. Long play 1200ft. Acetate ...	15 0	7in. Long play 1800ft. Acetate ...	15 0
5 1/2 in. Standard play 900ft. Acetate ...	12 6	7in. Triple play 3600ft. Mylar ...	50 0

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

## USA MADE CASSETTES

AT LASKY'S BUDGET PRICES

C80 7 1/2 each post 1/-	38/- post 2/-	65/- post 3/-
C90 12 1/2 each post 1/-	57/- post 2/-	115/- post 3/-
C120 17 1/2 each post 1/-	88/- post 2/-	168/- post 3/-

## metro sound

CASSETTE HEAD CLEANER

This ingenious device enables the delicate recording heads and drive system of your Cassette Recorder to be cleaned without damage. Just slip in the cassette like any other cassette and run through once. Only takes moments to remove all dirt and oxide deposits.

**LASKY'S PRICE 10/8** POST 1/- EACH

## SP.25 Mk II



THE U.K.'s MOST POPULAR

### HI-FI TURNTABLE

4-speed single record playing deck features include heavy precision-built turntable, pick-up arm bias compensation, calibrated stylus-force adjustment, cueing device. After play, the arm automatically rises, returns to rest and switches off motor. Finish: dark green polychromatic and silver.



**LASKY'S PRICE £11.19.6**

SP. 25 Mk.11 with A.D.76K Stereo Magnetic Cartridge £15.0.0.

### OTHER GARRARD UNITS FROM STOCK AT LASKY'S EXCLUSIVE PRICES.

AUTOCHANGERS	3000 complete with 9TAHC stereo cartridge .....	£3 10 0
SL72B .....	SL95B .....	£3 10 0
SL72B .....	1025 with stereo cartridge .....	£3 10 0
AT80 Mk II .....	SL95B .....	£40 0 0
2025TC with stereo cartridge .....	SL75B .....	£32 0 0

**SINGLE PLAYERS**  
AP 75, £15.19.6 AP75 with AD76K mag. cart., £21.19.6. 401 Transcription Unit, £29.9.0

### BASES AND COVERS FOR GARRARD UNITS

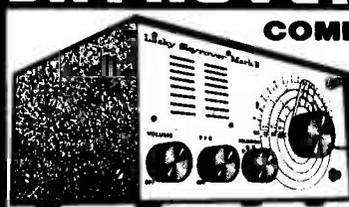
Type WB1 and WB3 for models AT80 Mk II, 2025TC, 3000, SL65B 1025, SP25 Mk II Price £3.12.6. WB5 £5.12.6. Type WB4 for models SL72B, SL75B, SL95B Price £3.12.6. Perspex covers: SPC1 for WB1, £3.14.1. SPC4 for WB4 and WB5 (allows unit to be played with the cover in place)—price £4.5.6.

### PACKAGE DEALS

AP75 complete with AD76K Stereo magnetic cartridge, teak plinth and perspex cover	<b>£30.0.0</b>	Post 10/-
SP25 Mk II complete with AD76K cartridge, teak plinth and perspex cover	<b>£19.0.0</b>	Post 7/6
1025 complete with J2185 stereo ceramic cart., teak plinth and perspex cover	<b>£11.19.6</b>	Post 7/6

Post on Garrard units: 6/- extra—except AP75, SL75B, SL95B and 401 7/6 extra Post on bases and covers 5/- extra.

## SKYROVER mkII



### COMMUNICATION RECEIVER

A short wave receiver, exclusive to Lasky's, at a real economy price. Four valve line up using one each 6BE6, 6BA6, 6AV6 and 6AR5 valves gives highly sensitive reception and powerful gain. Switch selected SW frequency range cover: 1.5 to 30 MHz in three separate band-spread ranges and full AM medium wave band

cover in one range 550-1,600KHz. Reduction drive tuning with hair line cursor. Controls include volume on/off BFO. Band selector. Power-on indicator lamp. External antenna connections and mains fuse at rear. Internal speaker plus standard 5mm jack socket for phones on front. For 220/240V a.c. mains operation. Strong metal cabinet finished in grey crackle with anodised silver front panel. Size 9 1/2 x 5 1/2 x 5 1/2 in. Complete with mains lead and full instructions.

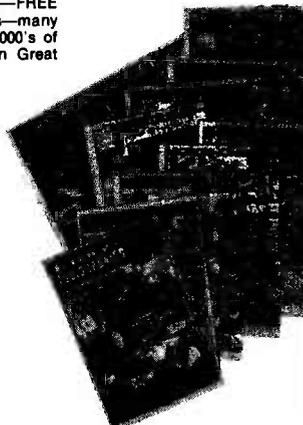
### THE IDEAL BEGINNERS RECEIVER

**LASKY'S PRICE £13.13.0**

Post 5/-

# Audio Tronics 70

The 1970 edition of Lasky's famous Audio-Tronics catalogue is now available—FREE on request. The 28 tabloid pages—many in full colour—are packed with 1000's of items from the largest stocks in Great Britain of everything for the Radio and Hi-Fi enthusiast. Electronics Hobbyist, Serviceman and Communications Ham. Over half the pages are devoted exclusively to every aspect of Hi-Fi (including Lasky's budget Stereo Systems and Package deals). Tape recording and audio accessories PLUS Lasky's amazing money saving vouchers worth over £25. All goods are available by Mail Order—bringing the benefits of shopping at Lasky's to you in the comfort of your home.



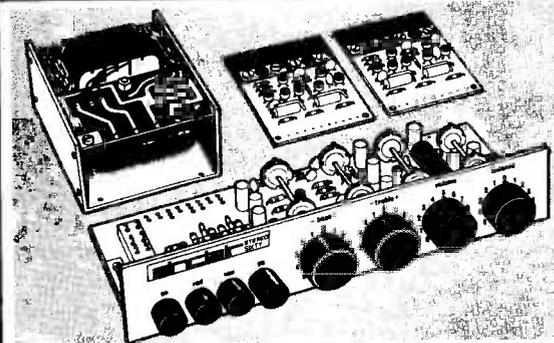
**SEND TODAY**

Your name, address and 2/- for postage only and inclusion of your name on our regular mailing list.

**DON'T MISS THIS MONTH'S**

**VOUCHER WORTH 30/- !**

## sinclair Project 60



Project 60 is a range of modules which connect together to form a complete stereo amplifier. The modules are: 1. Z-30 high gain power amp. 2. Stereo-60 pre-amp, control unit. 3. The PZ-5 unswitched and PZ-6 stabilised power supplies. A complete system comprises two Z-30's, one Stereo-60 and a PZ-5 or PZ-6.

### STEREO 60 SPECIFICATION

Input sensitivities: Radio up to 3mV. Magnetic Pick-up 3mV: correct to R.I.A.A. curve  $\pm 1\text{dB}$ ; 20 to 25,000Hz. Ceramic Pick-up up to 3mV. Auxiliary up to 3mV. Output: 1 volt. Signal to noise better than 70dB. Front panel: brushed aluminium with black knobs and controls. Size:  $8\frac{1}{2} \times 1\frac{1}{2} \times 4\text{in}$

**£9.19.6** post 3/6

### Z-30 SPECIFICATION

Power output: 15 w. R.M.S. into 8 ohms using a 35 volt supply. Frequency response: 30 to 300,000Hz  $\pm 1\text{dB}$ . Distortion: 0.02%. Signal to noise: better than 70dB. Input sensitivity: 250mV into 100 K ohms. Loudspeaker imp. 3 to 15 ohms. Power requirements: from 8 to 35V DC (The Z30 will operate from batteries if required) - Size:  $3\frac{1}{2} \times 2\frac{1}{4} \times 1\frac{1}{2}\text{in}$ .

**89/6** post 3/6

30V unswitched - sufficient to drive two Z-30's and a Stereo 60 for domestic applications.

**PZ5** 35V stabilised - ideal for driving two Z-30's and a Stereo 60 for low efficiency speakers.

**99/6** Post: 2/6

**PZ6** 35V stabilised - ideal for driving two Z-30's and a Stereo 60 for low efficiency speakers.

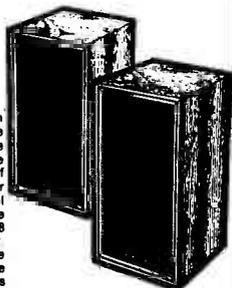
**£7.19.6** Post 2/6

**PACKAGE PRICE** For Stereo 60, two Z-30 and one PZ-5 **£21.10.0** Post 10/-

# EXCLUSIVE

## FOSTER "Criterion" MkII

### HIGH FIDELITY 2 SPEAKER TWO WAY BOOKSHELF SPEAKER SYSTEM



Another high quality sub-miniature booksheft system from Foster. The "Criterion" MkII is a sealed infinite baffle type enclosure using 5 1/2 in. bass/mid-range woofer with rolled cloth edge and a 2 1/2 in. HF cone type tweeter. The compact cabinet is constructed of 1/2 in. laminate with handsome oiled walnut veneer finish and black woven acoustic gauze-front panel with satin chrome edge insert. SPEC: Frequency range 90-20,000Hz. Power Handling 10 watts. Impedance 8 ohms. HF crossover. Screw Tag connections at rear. Size 12 1/2 x 7 3/4 x 6 1/4 in. The performance of the "Criterion" is superior to many larger and more expensive units and at Lasky's exclusive price offers absolutely unbeatable value.

LASKY'S PRICE **£9.10.0** or **£17.10.0** Post 1-7/6 2 for 2-10/-

## SONICS AS-57

### ELEGANT BUDGET PRICED BOOKSHELF SPEAKER SYSTEMS

The AS-57 is a real space saver. This fine booksheft high-fidelity speaker system will provide good quality sound anywhere in your home at remarkably low cost. Designed for use where space is at a premium, the AS-57 system is ideal for the small apartment or isolated listening area. The special high efficiency 5x7 in. full range speaker has a frequency range of 70-18,000 Hz with a peak handling capacity of 10 watts. Imp. 8 ohms. Finish: oiled walnut. Size: 5 1/4 x 15 1/4 x 8 1/4 in. (May be used upright or longways).

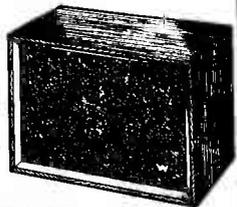
LASKY'S PRICE **£15** per PAIR Post 10/-

# SPECIAL OFFER

## THIS MONTH ONLY SUPERB—WHARFEDALE

### DENTON

A compact system sold in matched pairs for a perfectly balanced stereo system. Each Denton contains an 8 in. bass unit with 3 in. H.F. pressure unit, coupled by a Wharfedale cross-over network. Rated input 15 watts maximum. Frequency response 65-17,000Hz. Impedance 4/8 ohms. Cabinet 9 1/4 x 14 x 8 3/4 in. These most attractive units are available in oiled teak and are small enough to blend in with most surroundings.



LIST PRICE NORMALLY £36 PAIR

**OUR PRICE £33 PAIR** Post 15/-

## MIDLAND 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 1605 Kc/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 16 in. chrome telescopic antenna, size only 4 x 2 1/2 x 2 1/2 in. (inc. knobs). Complete with battery and full instructions.



**LASKY'S PRICE 72/6** Post 2/6

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207 EDGWARE ROAD, LONDON, W.2

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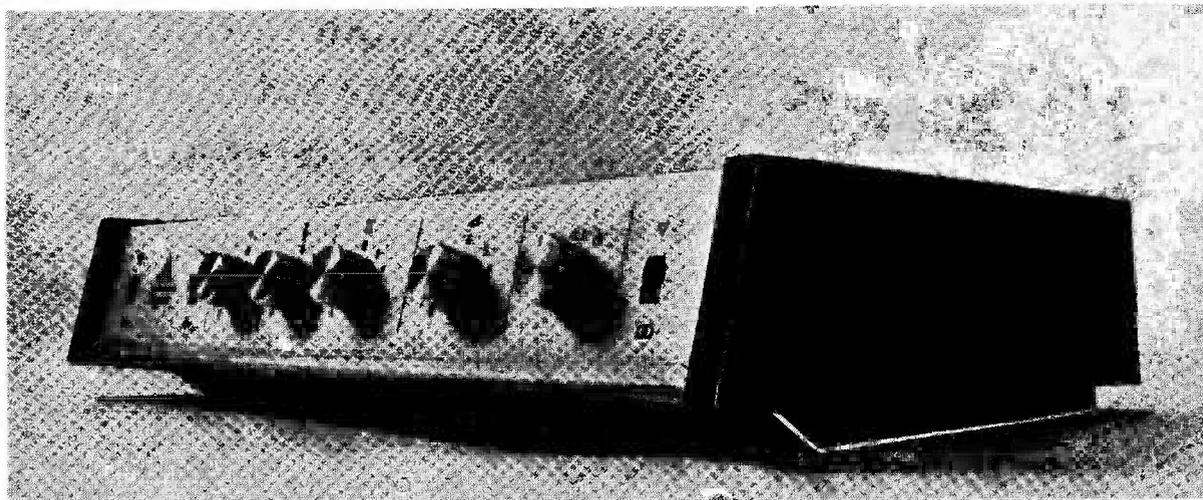
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Tel.: 01-790 4821



# peak sound englefield



developed out of the highly successful PW. 12+12 and now in complete kit form to save you still more

The Peak Sound Englefield is a system offering great flexibility whilst providing cost-performance ratios which have never been bettered in high fidelity. Here top-flight circuitry is housed in a cabinet of elegantly original styling which is both beautiful and completely practical front and back. Now we carry design standards further by offering a 12+12 watt version completely in kit form. The resultant specification surpasses that even of the original PW.12+12 which again was based on Peak Sound design. In this Englefield kit, printed circuit boards are supplied for you to mount the components on. Standards of input sensitivity and overload factor on all channels as well as filter performance are all improved. By giving you the satisfaction of building the Englefield this way, you save considerably and finish with a completely professionally styled instrument. Go to your dealer and start building now, or send direct for delivery by return in case of difficulty.

### and this is the Peak Sound Specification Guarantee

Peak Sound guarantee that their equipment meets all specifications as published by them and that these are written in the same terms as used in equipment reviews appearing in this and other leading British hi-fi journals. Audio output powers are quoted at continuous sine wave power in terms of Root Mean Square values (R.M.S.) into stated loads at stated frequencies.

### The specification that tells you everything (See guarantee)

Using two Peak Sound PA. 12-15's, driven simultaneously at 1 KHz from 240-V. mains supply.  
 Output per channel: 11 watts into 15Ω; 14 watts into 8Ω.  
 Frequency bandwidth: 10Hz to 45 KHz for 1dB at 1 watt.  
 Total Harmonic Distortion at 1 KHz at 10 watt into 15Ω—0.1%.  
 Input sensitivities: Mag. PU.3.5 mV. R.I.A.A. equalized into 68KΩ; Tape, 100mV linear into 100KΩ; Radio, 100mV linear into 100KΩ.  
 Overload factor: 29dB on all input channels.  
 Signal/noise ratio: —65dB on all inputs.  
 Vol. control at max.  
 Controls: Volume, Treble, Bass, Low-pass Filter, Mono/Stereo: On/off; Balance.  
 Complete kit of parts including cabinet assembly, knobs, transistors, well-prepared instructions and wire to length, colour coded and stripped at ends as well as built-in mains power supply. (Post free in U.K.)

£33.2.0

Englefield assembly as above, but in easy-to-put-together modules. (Post free in U.K.)

£38.9.0

Peak Sound ES.10-15 BAXANDALL LOUD-SPEAKER. Fantastic performance and value. Ideal with your Englefield. Cabinet 18"x12"x10" natural teak finish. Ready built—18½ gns. Parts available separately for building yourself with appreciable saving. Leaflet on request.

## peak sound

PEAK SOUND (HARROW) LTD., SAINT JUDES ROAD, ENGLEFIELD GREEN, EGHAM, SURREY. Egham 5316

To Peak Sound, Saint Judes Road, Englefield Green, Egham, Surrey  
 Details of Englefield systems, please and.....  
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 Write your stockist's name and address in margin below and cut out with coupon if necessary

**CAR LIGHT FLASHERS**



Heavy duty light flasher employs a condenser discharge principle operating on electro mechanical relay. (As inset). Housed in strong plastic case. Flashing rate between 60-120 per minute. 12V DC operation. Maximum load 6 amps. Size 2-11/16in. dia. x 4in. Supplied brand new at a fraction of original cost. 6/6 each P. 2/6. (\$ for 17/6 P. F. 4/6).

**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. Attractive 7/6. Or brand new with accessories. £7.19.8. Carr. 7/6.

**CLASS D WAVEMETERS NO. 2**

Crystal controlled. 1.2-19 Mc/s. Mains or 12V. D.C. operation. Complete with calibration charts. Excellent condition. £12.10.0. Carr. 30/-.

**R209 MK II**

**COMMUNICATION RECEIVER**  
11 valve high grade communication receiver suitable for tropical use. 1-20 Mc/s on 4 bands. AM/CW/FM operation. Incorporates precision vernier driver, B.F.O., aerial trimmer, internal speaker and 15v. D.C. internal power supply. Supplied in excellent condition fully tested and checked £15.0.0. Carr. 20/-

**TYPE 13A DOUBLE BEAM OSCILLOSCOPES**

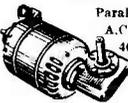


An excellent general purpose D/B oscilloscope. T.B. 3 K/s. Bandwidth 5-6 Mc/s. Sensitivity 38mV/C.M. Operating voltage 0/110/200/250V. A.C. Supplied in excellent working condition. £22.10.0. Or complete with all accessories, probe, leads, lid, etc. £25. Carriage 30/-.



**MARCONI T/44/TF956 AP Absorption Wattmeter**  
1 μwatt to 6 watts. £20. Carr. 10/-.

**GEARED MAINS MOTORS**



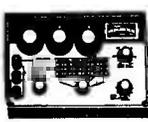
Paralux type 8D19 230/250V. A.C. Reversible. .30 r.p.m. 40 lb./ins. Complete with capacitor. Excellent condition. 99/6. Carr. 10/-.

**TO-3 PORTABLE OSCILLOSCOPE**



3in. tube. Y amp. Sensitivity 0.1v p-p/C.M. Bandwidth 1.5 cps-15 MHz. Input imp. 2 meg Ω 25pF. X amp. sensitivity 0.9v p-p/C.M. Bandwidth 1.5 cps-800KHz. Input imp. 2 meg Ω 20pF. Time base. 5 ranges 10 cps-300 KHz. Synchronization. Internal/external. Illuminated scale 140 x 216 x 330 mm. Weight 15 1/2 lb. 220/240V. A.C. Supplied brand new with handbook. £37.18.8 Carr. 10/-.

**TRANSORISED L.C.R. A.C. MEASURING BRIDGE**



A new portable bridge offering excellent range and accuracy at low cost. Ranges: R. 10-11.1 meg Ω 6 Ranges ±1%. L. 11.1 HENRY'S 6 Ranges -2%. C. 10pF ±1110mF. 1:1/1000-1:11100. 6 Ranges ±1%. Bridge voltage at 1,000 cps. Operated from 6 volts. 100μA. Meter indication. Attractive 2 tone metal case. Size 7 1/2 x 5 1/2 in. £20. P. & P. 5/-.

**UNR-30 4-BAND COMMUNICATION RECEIVER**

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



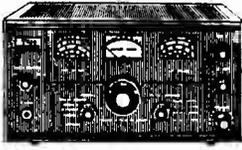
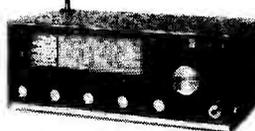
**TRIO JR-310 New Amateur Band 10-80 Metre Receiver in stock. £77.10.0.**



**LAFAYETTE SOLID STATE HA800 RECEIVER**  
5 BAND AM/OW/SSB AMATEUR AND SHORT WAVE 150 Kc/s-400 Kc/s and 550 Kc/s-30 Mc/s B.F.T front end & 2 mechanical filters. Heterodyne dial. Product detector. Variable BFO. Noise limiter. 8 meter. 24in Bandspread. 230V. A.C./18V. D.C. neg. earth operation. RF gain control. Size 15in. x 9 1/2in. x 8 1/2in. Weight 18 lb. EXCEPTIONAL VALUE. \$45. Carr. 10/-, S.A.E. for full details.

**UR-1A SOLID STATE COMMUNICATION RECEIVER**

4 bands covering 550 Kc/s-30 Mc/s continuous. Special features are use of FET transistors. 5 meter. built in speaker and telescopic aerial. variable BFO for SSB reception. noise limiter. bandspread control. sensitivity control. Output for low impedance headphones. Operation 220/240 volt A.C. or 12 volt D.C. Size 12 1/2in x 4 1/2in x 7in. Excellent value. ONLY £24 carr. 7/6.



**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. 8 meter. Sep. bandspread dial. IF 455 Kc/s. Audio output 1.5 W. Variable RF and AF gain controls. 115/200V. A.C. Mains. Beautifully designed. Size: 7 x 15 x 10in. With instruction manual and service data. £42. carriage paid. **TRIO COMMUNICATION TYPE HEADPHONES.** Normally £5.19.6. OUR PRICE £3.15.0 if purchased with above receiver.

**TRIO JR. 500SE 10-80 Metre Receiver £69.10.0**

**TRIO TS 510 AMATEUR TRANS-CEIVER with speaker and mains P.S.U. £218. IN STOCK!**



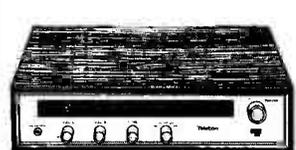
**RCA COMMUNICATIONS RECEIVERS AR88D**  
Latest release by ministry BRAND NEW in original cases. 110-250V. A.C. operation. Frequency in 6 Bands. 555 Kc/s-32 Mc/s continuous. Output impedance 2-600 ohms. Incorporating crystal filter, noise limiter, variable BFO, variable selectivity, etc. Price £27.10.0. Carr. £2.

**LAFAYETTE PF-60 SOLID STATE VHF FM RECEIVER**

A completely new transistorised receiver covering 152-174 Mc/s. Fully tunable 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. 75 Ω aerial input. Headphone jack. Operation 230V. A.C./12V. D.C. Neg. earth. £27.10.0. Carr. 10/-.



**TELETON CR-10T AM/FM STEREO TUNER AMPLIFIER**



A new model from Telenon. 31 solid state devices. 4+4 watt output. Inputs for ceramic/crystal cartridge. Frequency range AM 540-1600KHz FM 88-108MHz. Automatic FM Stereo reception. Stereo Indicator. Controls: Tuning, function selector, Tone and R & L volume controls. AFC switch. Stereo headphone socket. Size 13 1/2 x 3 1/2 x 9 1/2 approx. PRICE £34.0.0. Carr. 7/6.

**CLEAR PLASTIC PANEL METERS**

First grade quality Moving Coil panel meters. Type MR 38P. 1 1/2in. square fronts.

500-0-500μA	£27/6	50mA	£27/6	150V. D.C.	£27/6
1mA	£27/6	100mA	£27/6	300V. D.C.	£27/6
1-0-1mA	£27/6	100mA	£27/6	500V. D.C.	£27/6
2mA	£27/6	200mA	£27/6	750V. D.C.	£27/6
5mA	£27/6	300mA	£27/6	15V. A.C.	£27/6
10mA	£27/6	500mA	£27/6	150V. A.C.	£27/6
50-0-50μA	£27/6	750mA	£27/6	3V. D.C.	£27/6
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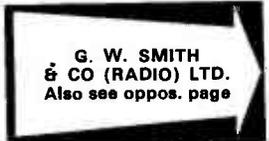
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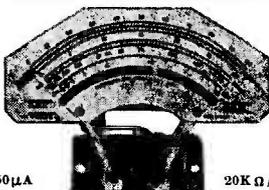
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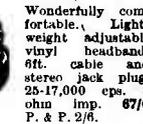
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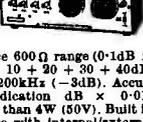
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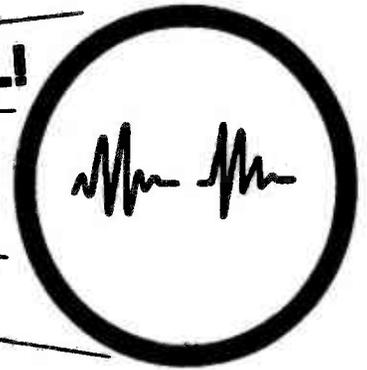
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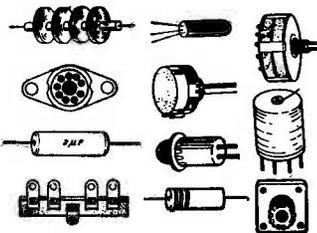


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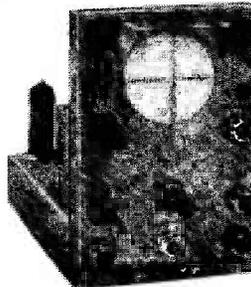
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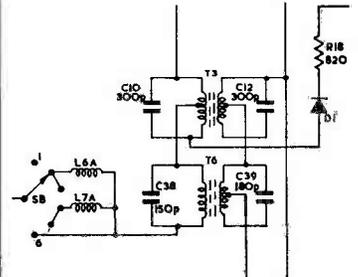
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# PRACTICAL WIRELESS

VOL 45 NO 12

Issue 758

APRIL 1970

## TOPIC OF THE MONTH

### Behind the times

**W**HAT on earth are the BBC and the Government up to? Having decided to open twenty local radio stations by the Autumn and twenty more within the next few years, and having found accommodation for them in Band II, the Minister of Posts and Telecommunications decides that these stations will also operate partly on m.w.

A government decision in the face of BBC opposition? Certainly not, for Ian Trethowen, managing director of BBC Radio, "warmly welcomes" the Minister's decision. The justification for using m.w. channels is said to be the shortage of suitable car radios and lack of v.h.f. portables. This is largely nonsense, although our set makers have been somewhat tardy in producing v.h.f. car radios.

But who can blame them for this, when the BBC still clings pathetically to a.m. For if the BBC is not seen to be convinced that v.h.f.-f.m. radio is the medium of today then how can set makers and the general public be swayed?

The BBC has been bold enough to set a target for the phasing out of 405-line v.h.f. television and this, of course, has given the industry and the public clear guide lines. What we need is a similar declaration on the future of sound broadcasting. As it is, the grandiose BBC plan of "Broadcasting in the Seventies" could be construed as meaning the *Eighteen Seventies!* Not to labour the point, our sound broadcasting is twenty years or so behind the times. Whereas, after the war, Europe and the USA in particular, put their faith in v.h.f.-f.m. we have largely dragged our heels, seemingly reluctant to take the final decisive plunge.

The local stations will use a.m. only during daylight, so that the best those without v.h.f. receivers will have is half a service. This is futile and half baked! So much so, that one can be excused for suspecting ulterior motives. And the only one we can think of at the moment is that the BBC and/or the Government have agreed to establish squatters rights on the two m.w. channels to thwart pirate and/or commercial stations from setting up house.

Whatever the case, the decision to use m.w. part of the time is a negative one and not in the interests of the development of sound broadcasting in this country.

W. N. STEVENS—*Editor.*

**MAY ISSUE WILL BE PUBLISHED ON APRIL 3**

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# NEWS... NEWS... NEWS...

## Brema figures

Colour television deliveries to the Trade continued to rise during November (when three channel colour broadcasts officially began) according to the Economic and Statistical Division of the British Radio Equipment Manufacturers' Association. 28,000 colour sets were delivered, bringing the total for the period January-November to 129,000 sets.

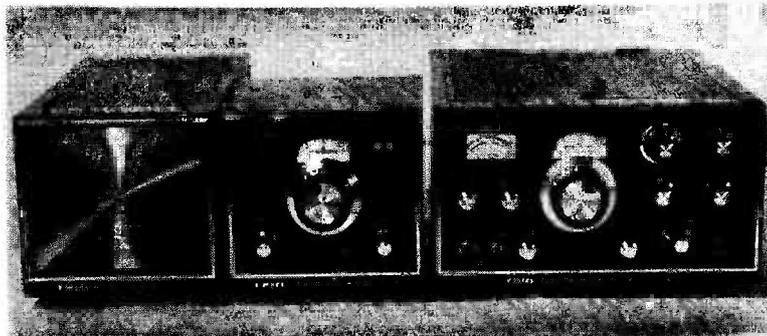
On the other hand, for the sixth month running deliveries of monochrome sets fell below the comparable month for 1968—165,000 monochrome sets were delivered in November, 9% below November 1968 (181,000).

The slight recovery in deliveries of radiograms has continued and for the third month in a row deliveries for the month have improved on the same month for 1968—deliveries in November were 25,000 as against 24,000 in November 1968.

No end to the fall in deliveries of radios (67,000) and car radios (20,000) was experienced in November; for the period January to November the figures continue to be 28% and 15% respectively below 1968.

These estimates are net figures of deliveries by manufacturers to the home market on firm and other accounts including those to specialist rental and relay companies.

## A trio from Trio



At the November 1969 R.S.G.B. Exhibition, Trio (B. H. Morris & Co. (Radio) Ltd.) introduced a new transceiver—the TS510 together with a companion v.f.o. and power supply/speaker unit.

The TS-510 Transceiver, on the right of the picture, employs a high-frequency crystal filter and covers all Ham bands from 3.5 to 29.7MHz. Both Rx and Tx sections employ the dual conversion configuration. The receiver is a dual-conversion superhet in which the r.f. and local oscillator are independently tuned. A selectivity switch is provided for s.s.b. and c.w. modes and the a.g.c. circuit features signal strength meter indication independent of r.f. gain adjustment. Type of emission is s.s.b. (A3J), c.w. (A1). Rated input: 160W at 3.5-21 MHz, 120W at 28MHz. The transceiver uses 14 valves, 2 f.e.t.s, 13 transistors and 29 diodes. Dimensions: 13 x 7 x 13½ in.

Stability is assured in the v.f.o. type 5D through the use of two f.e.t.s plus two other transistors. This unit is equipped with the same precision double-gear drive as the TS-510 transceiver which tunes a 25kHz range in one rev. Crystal controlled operation permits spot channel communication and built-in RIT circuit permits slight shifting of receive/transmit frequencies when desired. Frequency range on 80m is 3.5-4.1 MHz; 40m 7.0-7.6MHz; 20m 14.0-14.6MHz; 15m 21.0-21.6MHz; 10m (A) 28.0-28.6MHz; 10m (B) 28.5-29.1MHz; 10m (C) 29.1-29.7MHz.

The PS 510 power supply speaker unit measures 7½ x 9 x 12 in. approx. Further details may be obtained from B. H. Morris & Co. (Radio), 84-88 Nelson Street, London, E.1, or your nearest amateur radio equipment stockist.



The new President, Dr. Saxton

## The present and past

Dr. J. A. Saxton, DSc., PhD, CEng, FIEE, FInstP was installed as the 36th President of the Radio Society of Great Britain on January 16th.

Dr. Saxton, before, during and after the last war, was working on propagation studies and research in radio meteorology. He was appointed Deputy Director of the Radio Research Station in 1960 and in 1964 to 1966, he held the post of Deputy Director of the U.K. Scientific Mission and scientific counsellor at the British Embassy, Washington, U.S.A. Upon returning to the U.K., Dr. Saxton was appointed Director of the Radio & Space Research Station.



Immediate Past President, J.W. Swinnerton.

# NEWS... NEWS... NEWS...

## Oh to be in Finland

Christmas in Helsinki, Finland, was made a little livelier in 1969 due to the medium of TV. Finnish people were shocked when a pornographic film was shown over the air. Apparently the film was meant to be a closed-circuit test picture but it was put out on the air because a technician did not pull the right switch!

## Bromsgrove move

The Bromsgrove & District Amateur Radio Club, G3VGG, (Club Spot February) now meet at the Royal Oak pub, Catshill, Bromsgrove. Meetings are held the second Friday of the month at 8 p.m.

## Mobile radio systems

A conference on "Mobile Radio-communication Systems" is to be held from June 30th to July 2nd. The conference which is being organised by the Society of Electronic and Radio Technicians will be held at Brunel University, Uxbridge.

The conference will deal principally with vehicular and personal mobile systems. The increase of this field of communication, makes the subject of very wide interest not only to those already operating such systems but also to those contemplating such a step. The conference will cover all aspects of mobile radio-communication including propagation problems, system planning and design, statutory requirements and manufacturer and user experience.

This will primarily be a non-residential conference although hostel accommodation has been reserved for those delegates who are unable to travel to and from Uxbridge each day. The registration fee including lunch and refreshments each will be £7 7s. 0d. for members of the Society and £10 10s. 0d. to non-members.

Further information and registration forms may be obtained from: *The Conference Secretary, Society of Electronic and Radio Technicians, Faraday House, 8-10 Charing Cross Road, London, W.C.2.*

## Lasky's Hi-fi centre



Europe's biggest Hi-Fi and audio centre was officially opened in London recently. The Chairman of the company which operates the 5,000 sq. ft. store, Mr. Harry Lasky told over 150 electronics company guests from all over the world, "Our customers will have the choice of more than 10,000 items of equipment—that is the biggest selection outside the USA."

The centre in Tottenham Court Road, W.1. contains a demonstration studio where customers, with the aid of a custom-built comparator, can instantly compare the latest Hi-Fi installations exactly as they will sound in their own homes. Experts staff the new centre and they will plan a 'customised' system to suit the home and pocket of the prospective customer.

Mr. Lasky said, "Our new centre is designed to cater for the absolute beginner as well as the enthusiast with thousands of pounds to spend and it is an important landmark in the continuous process of introducing Hi-Fi to an ever-widening circle of the public."

The address of the new centre is: 42-45 Tottenham Court Road, London, W.1. Another Hi-Fi audio centre is at 118 Edgware Road, London, W.2. and the seven-branch group headquarters is 3-15 Cavell Street, London, E.1.

The photograph shows the Lasky demonstration studio which enables customers to make a balanced comparison of equipment.

## Motorola semiconductor data book

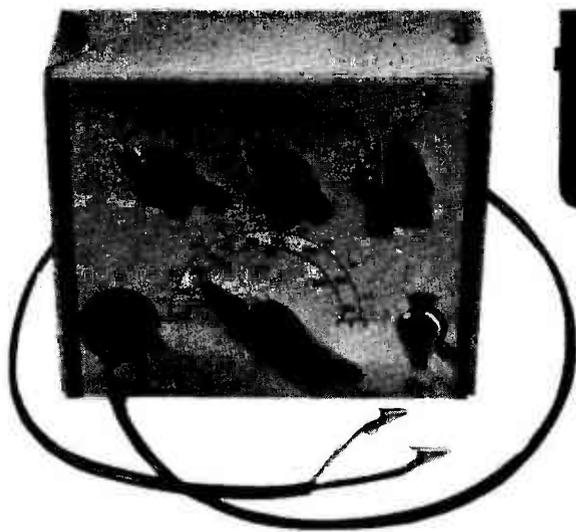
Motorola have just announced the availability in the U.K. of the fourth edition of 'The Semiconductor Data Book'. The price is £3 (plus 6s. postage) and it is available through the Modern Book Co., 19 Praed Street, London, W.2.

This latest edition has been enlarged (it now includes 2,160 pages) and the format has been redesigned to make it easier to retrieve data. Instead of a number of product categories, dis-

crete device specifications are presented in alphanumeric sequence in three major sections, namely: '1N' numbered devices, '2N' and '3N' numbered devices, and devices with Motorola house numbers. Also included is a 50-page section of selection guides which enable application needs to be directly related to semiconductor device numbers. Furthermore, the Data Book lists all EIA registered 1N, 2N and 3N devices along with their short-form specifications.

In all, more than 12,700 types are listed together with details of their characteristics.

# transistor



**A** SIGNAL generator is extremely useful for trimming, aligning and testing receivers, and testing amplifiers. The transistor signal generator described here is of small size, and has three tuned ranges:

- (1) 190-375kHz (approx. 1600-800 metres).
- (2) 375-1000kHz (approx. 800-300 metres).
- (3) 1.1-2.8MHz (approx. 275-105 metres).

These frequencies are available as c.w., or modulated with an audio tone. In addition, the audio tone is available, for amplifier and audio circuit checks. The ranges cover 470kHz, 1.6MHz and similar intermediate frequencies, as well as medium and long waves, while harmonics can be used for higher frequencies.

## Circuit Details

Figure 1 is the circuit, Tr1 being the audio oscillator, with feedback from primary to secondary of the transformer T1. Tr2/Tr3 are in the r.f. oscillator circuit, tuned by VC1. S3/S4 is a 2-pole switch, selecting coils L1, L2 or L3, for the required band.

S1/S2 is a further 2-pole switch. When S1 is at "C.W." the base of Tr1 is shorted to the positive line, cutting off Tr1. Tr2/Tr3 then provide an unmodulated r.f. signal, via C7, S2, and R9. With S1/S2 in the "Mod" position, Tr1 oscillates at audio frequency, and modulates Tr2/Tr3 due to the a.f. impedance of C2/R10. This gives an audible r.f. signal. With S1/S2 at "A.F." Tr2 base is shorted and moved positive, while a.f. from C4 is taken by S2 to R9. In all cases VR1 is an attenuator, and C8 gives d.c. isolation of external circuits.

Each kind of output signal—c.w., modulated, or a.f.—has its own particular uses, described later.

The coils L1, L2 and L3 are of fixed inductance, and manufactured to a high degree of accuracy. So provided VC1 is the capacitor listed, band coverage and calibration can be expected to agree well with that given. If wished, individual calibration can be made in the way described.

## Panel and Case

The completed generator is  $5 \times 6 \times 2$  in. and the case is made from "universal chassis" members. The box has a  $5 \times 6$  in. front, and sides  $5 \times 2$  in., top and bottom being  $6 \times 2$  in.

Sides, top and bottom are flanged, so they can be fitted later. This allows all construction and wiring to be done with the front and bottom only fitted together as in Fig. 2. Holes should be punched in

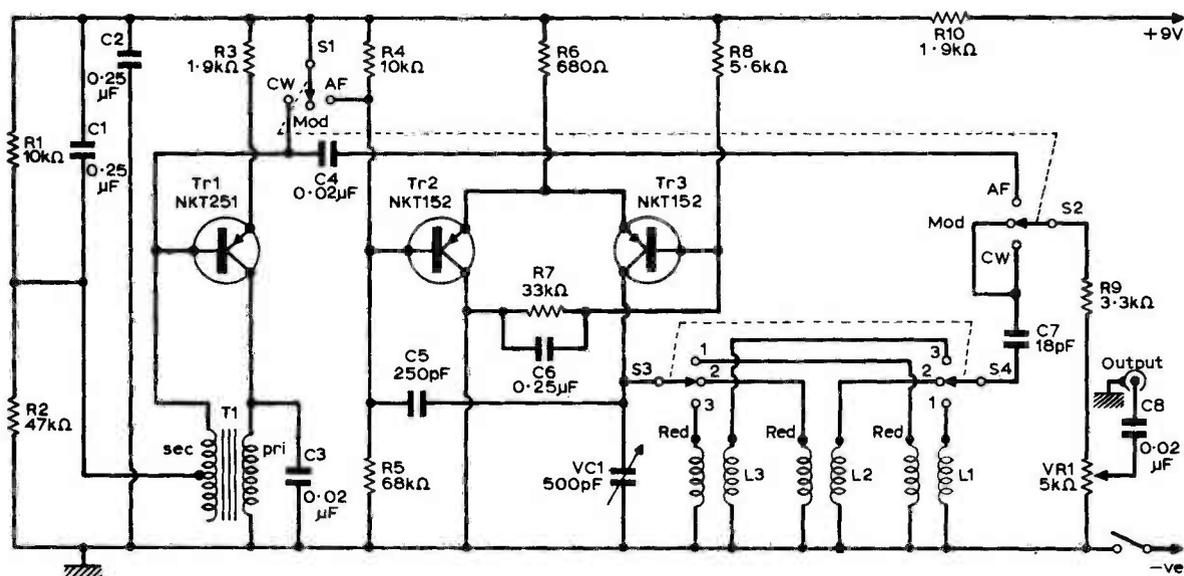


Fig. 1: Complete circuit of minigenerator

# mini generator

R. F. GRAHAM

the front for VC1, the switches, output socket, and VR1. VC1 is bolted to the bottom runner, which is then fixed to the panel. A countersunk bolt with extra nuts is passed through the panel and a hole in the top corner of the frame of VC1, the tag MC being locked here.

L1, L2 and L3 are held with countersunk bolts, through the panel and base into the mounting strips. The socket for C8 provides an output insulated from the metal.

The items in Fig. 2 are wired as shown, with sleeving on all leads. Note that the circuit has a negative earth (metal box), not positive as in much transistor equipment.

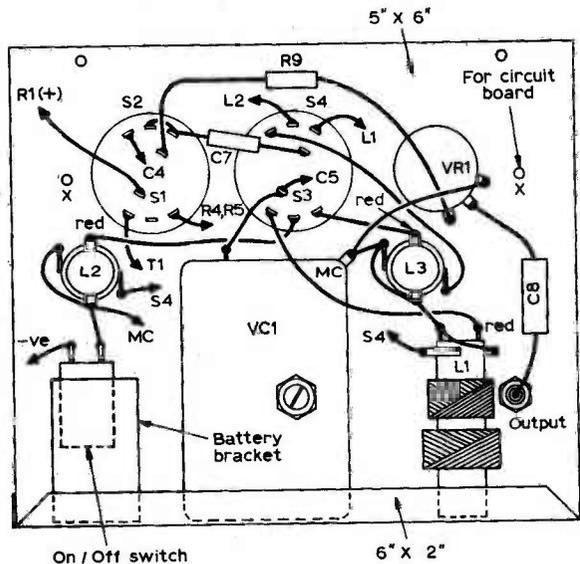
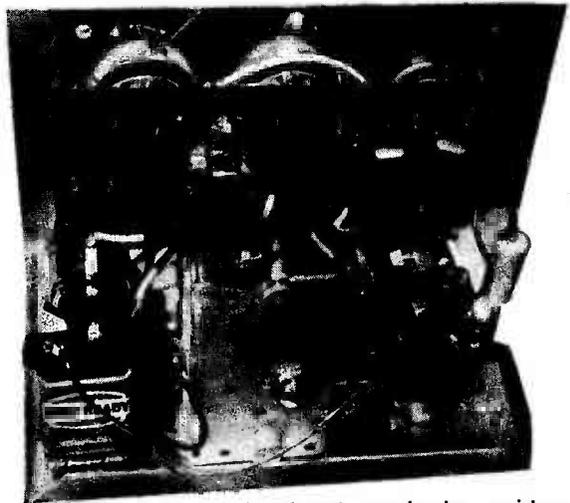


Fig. 2: Major component layout and wiring

The other components are assembled on a paxolin panel  $5 \times 1\frac{1}{2}$  in., as in Fig. 3. The holes X-X of the circuit board match holes X-X in the metal panel, Fig. 2. Countersunk bolts pass through the panel, and are locked here. Extra nuts are put on the bolts, and the finished circuit board can then be put into place, and held with further nuts, resting behind VR1 and the rotary switches.

The transformer is a driver type for OC81D/2xOC81, and if a different transformer is fitted, it may be necessary to reverse connections to one winding, to obtain audio oscillation.

Wiring of the circuit board should be quite straightforward. Take thin red flex from R10, for the battery positive connection. Leave flying leads from the points shown, for S1, S2, etc.



The circuit board is placed nearly in position, and the leads cut and soldered to S1, S2 and S3. The MC or negative connection is to the tag at VC1, and metal cabinet. The board can then be pushed right on the bolts, and held with nuts, leaving a little space between it and the tags of the switches.

## Case

The generator can be tested before finishing the case, by setting the switch to "Mod" and swinging VC1 on Range 2, when an audio tone should be heard in a nearby receiver on medium waves.

Elastic holds a PP3 9V battery to a bracket behind the on/off switch. Current drain is about 2-3mA at "Mod" with about  $4\frac{1}{2}$ V working voltage due to drop in R10. The back is held in position with self-tapping screws.

## Calibration

By fitting the specified coils and tuning capacitor VC1, coverage about as listed can be expected. The pointer knob is fully clockwise with VC1 closed, so goes a little beyond the mark at the other end of the scales.

## CALIBRATION POINTS

Range 1	°	Range 2	°	Range 3	°
180 kHz	179	375 kHz	169	1.1 MHz	166
200 "	147	400 "	149½	1.2 "	143½
250 "	95	450 "	123	1.3 "	127
300 "	58	500 "	99	1.4 "	112
350 "	27½	550 "	82	1.5 "	98
375 "	14½	600 "	68	1.6 "	87
		700 "	56½	1.7 "	76½
		800 "	42	1.8 "	67½
		900 "	24	2.0 "	51
		1000 "	3	2.5 "	30
				2.8 "	13

The frequency markings are copied on the card, before finally adding the perspex, and knobs. If the scales are to be individually calibrated, first put frequency markings directly against the pointer position, then add the perspex later.

For individual calibration of the scales, one of several methods can be used, according to the equipment available. The brief details following should be helpful.

**With Signal Generator.** If a calibrated generator can be borrowed, tune it to various frequencies, tune in the signal with a receiver, and adjust the Mini-generator tuning to the same frequency and mark its scale.

**With Calibrated Receiver.** If an accurately calibrated receiver is to hand, set this at various frequencies, tune the Minigenerator to the same frequencies, and mark its scales. This is the easiest and most accurate method when harmonic pips from a 100kHz crystal marker are available to give exact receiver tuning throughout.

**With Uncalibrated (or poorly calibrated) Receiver.** Tune in the BBC on 200kHz. Tune Minigenerator to same frequency, and mark 200kHz. Leave Mini-generator tuning untouched, and tune receiver to harmonic heard on 400kHz. Leave receiver tuning untouched, tune Minigenerator to 400kHz, and mark its scale. Repeat the procedure each time for 600kHz, 800kHz, 1,000kHz, etc., up to 1,400kHz for a MW receiver, and up to 2,800kHz (2.8MHz) for an all-wave receiver.

**Use of Harmonics.** Tune the receiver to a known high frequency, such as MSF, or 2,000kHz derived from the 200kHz BBC transmission as mentioned. Leave the receiver tuning, and tune the Mini-generator progressively towards lower frequencies. Harmonics will then be heard when a multiple falls on 2,000kHz (or other chosen frequency). As example, on 1,000kHz (x2), 500kHz (x4), 400kHz (x5), and so on. This allows calibration over 400-500kHz, for intermediate frequencies.

## ★ components list

### Resistors:

R1	10k $\Omega$	R6	680 $\Omega$
R2	47k $\Omega$	R7	33k $\Omega$
R3	1.9k $\Omega$	R8	5.6k $\Omega$
R4	10k $\Omega$	R9	3.3k $\Omega$
R5	68k $\Omega$	R10	1.9k $\Omega$

All resistors 10%  $\frac{1}{2}$  watt  
VR1 5k  $\Omega$  linear pot.

### Capacitors:

C1	0.25 $\mu$ F 150V
C2	0.25 $\mu$ F 150V
C3	0.02 $\mu$ F 150V
C4	0.02 $\mu$ F 150V
C5	250pF silver mica
C6	0.25 $\mu$ F 150V
C7	18pF silver mica
C8	0.02 $\mu$ F 350V

VC1 Jackson 500pF variable, Home Radio Cat. No. VC5.

### Semiconductors:

Tr1	NKT251
Tr2	NKT152
Tr3	NKT152

### Miscellaneous:

L1, L2, L3. C083A, C083G, C083F, Home Radio;  
5 x 6 x 2in. Universal chassis CU13, Home Radio;  
Two 2-pole 3-way rotary switches; On/off toggle switch; T1 Type RS.T/T6, Home Radio; KN9 type knob; PK4 insulated socket; PK3 plug; BTS33 perforated eyelet board, Home Radio; PP3 battery; sleeving; bolts; etc.

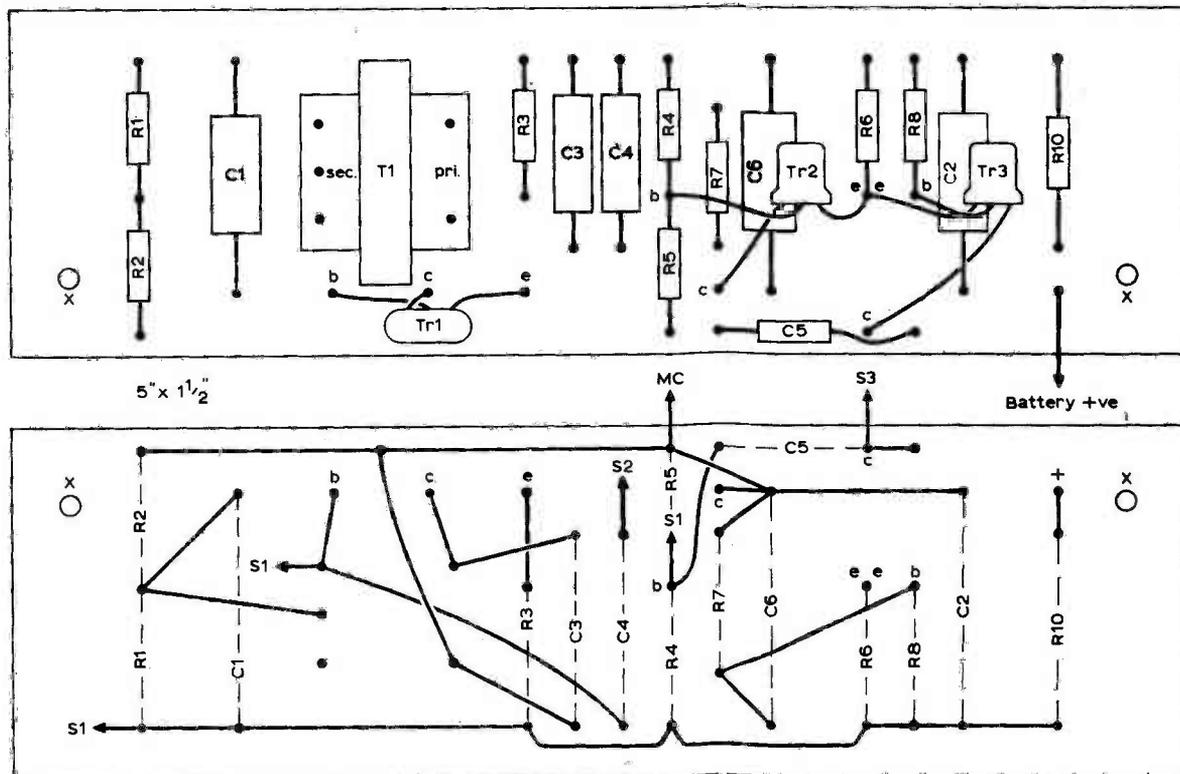


Fig. 3: Circuit board component layout and wiring

## Generator Output

The c.w. output resembles that of a transmitter during a silent interval in programmes. It will heterodyne with another c.w. signal (as from a crystal marker) or can be heard with a receiver having a b.f.o. It operates a tuning meter or indicator. It is used for critical alignment.

The modulated output has an audio tone accompanying the r.f., so can be tuned in with any receiver, and heard with the loudspeaker.

The a.f. output is used for audio circuit tests only, by injecting a.f. into various amplifier points, working backwards from the loudspeaker. When signals cease, the last coupling circuit or stage introduced is the one at fault.

## To Align I.F.T.'s

Set the generator to the wanted intermediate frequency. Should the i.f.t.'s be badly out of alignment, work backwards from the detector, dealing with them in turn. Then inject at the mixer base or signal grid, and check all i.f.t. cores. With all such work, keep signal strength well down. Output can be checked with a meter in one battery lead, with push-pull transistor receivers, or with an a.f. meter, or by watching the a.v.c. voltage.

## Checking Band Coverage

To adjust a receiver band coverage, set oscillator trimmers at the h.f. end of each band, and coil inductance at the l.f. band ends. In this way each band can be adjusted to have the wanted frequency range.

## R.F. Alignment

To adjust aerial or r.f. circuits for best results, deal with each band separately, in the manner described for the receiver. This usually requires that trimmers are set for best results near the h.f. end of a band, and coil inductances are adjusted near the l.f. end of each band.

## Coupling

Coupling from the signal generator to a receiver should always be very loose. With portables, a short lead can be plugged into the generator output socket, and placed near the receiver or its ferrite aerial. For other receivers, connect a short lead to the aerial socket, and place this near the generator output lead, or lightly twist the insulated wires together.

## Use of Harmonics

There are two main uses for the harmonic outputs of the signal generator. Such outputs are on multiples of the frequency to which the generator is tuned. For example, if the generator is tuned to 1MHz, a signal will be heard on 1MHz, 2MHz, 3MHz, 4MHz, and other multiples, the limit depending on receiver sensitivity. If the generator were tuned to 1MHz, a home-built receiver could thus be tuned from 1MHz upwards, and its scales marked to indicate 2MHz, 3MHz, etc. In this particular case, the 0.5MHz points could be found as harmonics of 0.5MHz, or 500kHz, if wanted.

Harmonics also allow exact calibration of small frequency bands. As example, if the generator is tuned to 200kHz, harmonics will appear on multiples of this. Those on 1,800kHz and 2,000kHz would set the limits of the 1.8-2.0MHz amateur band.

With a completely uncalibrated receiver, harmonics may if needed be identified by using the generator on two frequencies. As example, if all 1MHz points are marked, but not known, 5MHz can be identified by tuning the generator to 2.5MHz, as the 2nd harmonic falls on 5MHz. Or 6MHz could be identified from 2MHz on the generator (3rd harmonic), which would also give 4MHz as 2nd harmonic. When one frequency has been identified in a receiver tuning range, the remaining 1MHz points can be counted up and down from this.

## Audio Circuits

These are tested by injecting a.f. With some equipment, an earth return is required, from equipment chassis to generator case. The earth terminal allows this.

Tests should not be made on a.c./d.c. equipment having a live chassis.

Where little or no amplification is available, the full generator output will be wanted. But when tests bring into circuit one or more amplifier stages, output must be reduced with the generator potentiometer VR1, to avoid overloading the output or other stages in the receiver or amplifier. ■

# **PRACTICAL TELEVISION** *in the APRIL issue*

## **STROBE-TRIGGER TIMEBASE UNIT**

For detailed design work and TV experimentation strobe-trigger operation of the oscilloscope is necessary. This unit has been designed for use with the PTV Videoscope MV3. An output is available from the master multivibrator so that the unit can be used as a general-purpose squarewave signal generator.

## **REGULAR LONG-DISTANCE RECEPTION**

There are many areas where satisfactory signals can be obtained from more than one ITA or BBC transmitter, giving a worthwhile increase in the programmes available. The conditions necessary for reliable long-distance reception are examined, with an account of how to decide on its practicability in a given area.

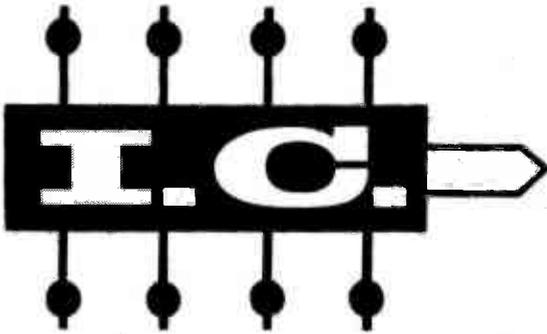
## **EHT MULTIPLIERS**

EHT multipliers of the simple ladder variety have been in use for some time now in monochrome receivers. A slightly different configuration provides considerable advantages in colour receivers. A full account is given of these advantages and the basic operation of this type of circuit.

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# OF THE MONTH

L.A.J. IRELAND

Number 6

## The Sanken SI-1020A/50A Audio Amplifiers

**J**APANESE electronic firms have always been quick to follow on the heels of their American and European counterparts and the same trend is becoming evident in the world of microcircuits. Lately the Sanken Electric Co. of Tokyo has introduced two rather advanced hybrid i.c.'s one of which can give an audio output power in excess of 50 watts. A very attractive feature of the units is that they comprise virtually the complete amplifier, the only external components required being a power supply, loudspeaker of  $8\Omega$  impedance and coupling capacitor. They provide therefore an ideal beginners project in electronics since with so few components involved, success is virtually guaranteed and a first-class hi-fi amplifier obtained.

A look at Fig. 1 shows that the amplifier itself is fairly orthodox and straight forward in design. The common emitter input stage Tr1, provides a typical input impedance of  $70k\Omega$  and degeneration from the output can be applied across its emitter resistor via pin 3 of the i.c. The signal is then r.c. coupled to Tr2 which acts as a driver for the complementary pair Tr3 and Tr4 and these in turn are direct coupled to the power output stage. Provision is made for the inclusion of a ripple filtering circuit in the 1020A version which is not included in the 1020A.

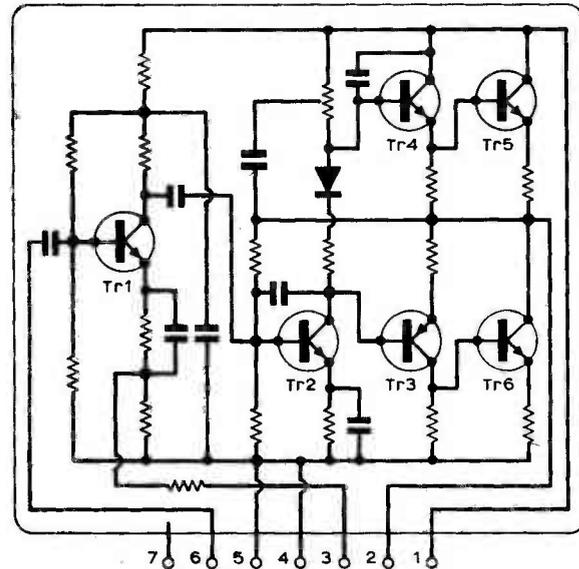


Fig. 1: Circuit of the SI-1020A

Characteristic	Symbol	SI-1020A	SI-1050A
Supply Voltage	$V_{cc}$	48V	62V
Maximum Continuous Output Power (distortion < 0.5%)	$P_o$ max (rms)	25W	50W
Voltage Gain	$G_v$	30dB typ.	30dB typ.
Frequency Range (output 1W)		20Hz—100kHz	20Hz—100kHz
Input Impedance	$Z_{in}$	$70k\Omega$ typ.	$70k\Omega$ typ.
Output Impedance	$Z_{out}$	$0.2\Omega$ typ.	$0.2\Omega$ typ.
S/N Ratio		90dB typ.	90dB typ.
Idling Current		30mA typ.	30mA typ.

CONDITION :  $25^\circ\text{C}$  ambient, 1kHz,  $R_L=8\Omega$

Electrical characteristics of the two amplifiers

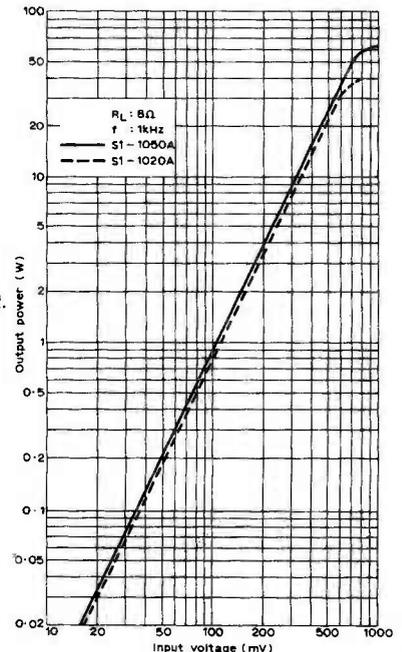


Fig. 2: Graph showing required signal input for a given power output.

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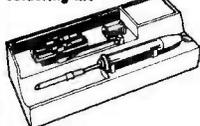


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OB2 4/6	6F1 8/9	12AD6 7/6	90C3 34/1	EA76 13/1	EL84 4/9	PCC189 10/6	UBF80 5/9	W107 7/1	BA116 5/1	OA70 3/1
OZ4 6/6	6F6G 4/1	12AE6 7/6	90CV 33/6	EABC80 6/1	EL85 7/6	PCC805 13/9	UBF89 6/9	W729 10/1	BA129 2/6	OA73 3/1
IA3 4/6	6F6M 12/6	12AT6 7/6	90CV 33/6	EAC91 3/1	EL86 8/3	PCC806 13/6	UBR21 10/1	X24 16/6	BA130 2/1	OA79 1/9
1A5 7/3	6F12 3/3	12AT7 3/9	90C19 16/6	EAF42 8/9	EL95 5/3	UBC92 5/6	UC29 5/6	X61 5/9	BA131 2/1	OA81 1/9
1A6 7/3	6F13 3/6	12A16 4/9	130C2 5/9	EB34 3/1	EM80 7/1	PCF82 6/3	UC84 8/1	X61 5/9	BCY12 1/6	OA85 1/6
1C1 5/6	6F15 10/1	12A17 4/6	301 20/1	EB41 4/6	EM81 7/6	PCF84 8/1	UC85 4/6	X63 5/6	BCY33 5/1	OA86 4/1
1C2 9/1	6F18 7/6	12A18 5/6	302 16/6	EB91 2/3	EM84 6/6	PCF86 9/1	UCF80 8/3	X64 12/6	BCY34 4/6	OA90 2/6
1C3 7/1	6F23 13/3	12A17 8/1	303 15/1	EB41 4/6	EM85 11/1	PCF87 16/1	UCH21 9/1	X65 5/1	BCY38 5/1	OA91 1/9
1C5 4/9	6F24 11/9	12AX7 4/6	305 16/6	EBC81 5/6	EM87 7/6	PCF800 13/1	UCH42 13/1	X66 7/6	BCY39 4/6	OA95 1/9
1D5 6/9	6F25 13/1	12AY7 9/9	306 13/1	EBC90 4/1	EY51 7/6	PCF801 7/1	UCH81 6/6	X101 30/6	BCZ11 3/6	OA200 1/1
1D6 9/6	6F26 5/3	12BA6 6/1	807 11/9	EBC91 5/6	EY81 7/1	PCF802 9/1	UCR82 7/1	X109 26/1	BCI07 4/1	OA202 2/1
1FD1 6/6	6F28 14/1	12BE6 5/9	956 2/1	EFB80 6/9	EY83 8/3	PCF805 11/6	UCL83 10/1	X119 6/6	BCI08 3/6	OA210 1/6
1FD9 4/3	6F29 6/6	12BH7 6/1	1821 10/6	EFB83 2/1	EY84 7/6	PCF806 11/6	UFL8 10/1	X719 5/9	BCI13 5/1	OA211 13/6
1G6 6/1	6F30 6/1	12E1 17/1	5763 10/1	EFB89 6/3	EY86 6/6	PCF808 12/6	UJ46 12/6	Z749 13/3	BCI15 3/1	OA2200 12/1
1H5GT 7/1	6F32 3/1	12J5GT 2/6	6060 5/6	EBL21 11/1	EY87 6/6	PCF82 7/6	UF80 6/9	Z777 3/3	BCI16 5/1	OA2201 10/6
1L4 2/6	6H6GT 1/9	12J7GT 6/6	7193 10/6	EC33 12/6	EY88 7/6	PCF83 9/1	UF85 6/9	Z152 4/6	BCI18 4/6	OA2202 9/1
1LDS 5/1	6J5G 3/9	12K5 10/1	7475 4/1	EC54 6/1	EY91 3/1	PCF84 7/6	UF86 9/1	Z219 16/1	BD119 9/1	OA2203 9/6
1LNS 8/1	6J5GT 4/6	12K7GT 5/9	A1834 20/1	EC70 4/9	EZ35 5/1	PCF85 9/1	UF89 6/9	Z719 4/6	BFY50 4/1	OA2204 9/1
1N5GT 7/9	6J6 3/1	12O7GT 7/6	A2134 10/1	EC86 12/6	EZ40 7/6	PCF86 8/6	UL41 10/6	Z729 6/3	BFY51 4/1	OA2205 9/1
1U4 7/1	6T7G 4/9	12S4GT 6/9	A3042 15/1	EC88 12/6	EZ80 6/6	PCF88 11/6	UL46 12/6	Z759 4/5	BFY52 4/1	OA2206 9/1
1F10 5/9	6T7GT 6/6	12S7 3/1	AC2PEN/	EC92 4/6	EZ80 6/6	PCF88 11/6	UL84 6/6	Z759 4/5	BFY54 3/1	OA2207 10/6
1P11 5/9	6K7G 2/1	12S7 3/1	DD 19/6	EC93 15/6	EZ81 4/9	PCF801 15/1	UM80 6/6	Z759 4/5	BFY59 5/1	OA2210 7/1
1R5 5/6	6K7GT 4/6	12SH7 3/1	AC2PEN/	EC93 31/6	EZ90 4/3	PEN45 7/1	URIC 10/6	Z759 4/5	BFY63 4/1	OA2211 7/1
1S4 4/9	6L1 19/6	12S7 4/6	DD 19/6	EC93 31/6	EW4 12/6	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2212 16/6
1S5 4/3	6L6GT 7/9	12S7 4/6	AC6PEN 4/9	EC94 29/6	FC4 12/6	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2213 16/6
1T4 2/9	6L7 12/6	12S7GT 7/6	AC/PEN (5)	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2214 16/6
1U2 4/3	6L8 12/6	12S7GT 7/6	AC/PEN (7)	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2215 16/6
2A7 12/6	6L18 6/1	14S7 15/1	AC/PEN (7)	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2216 16/6
2D13C 7/1	6L19 19/1	18 12/6	AC/PEN (7)	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2217 16/6
2D21 5/6	6LD12 6/1	19A05 4/9	AC/TH10/	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2218 16/6
2X2 4/9	6LD20 9/6	19H1 40/1	AC/TP 19/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2219 16/6
3A4 3/6	6N7GT 6/6	20D1 13/1	AC/TP2 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2220 16/6
3A5 10/1	6P1 12/1	20D4 20/5	AC/TP2 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2221 16/6
3B3 5/1	6P5 4/1	20S2 14/1	AC/TP2 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2222 16/6
3D6 3/6	6P25 12/1	20L1 13/1	AZ1 8/1	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2223 16/6
3Q4 6/6	6P26 12/1	20P1 17/6	AZ31 9/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2224 16/6
3Q5GT 6/1	6P28 25/1	20P3 18/1	AZ41 7/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2225 16/6
3S4 5/9	6P12 6/1	20P4 18/6	B36 6/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2226 16/6
3V4 5/9	6Q7G 6/1	20P5 18/6	B39 6/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2227 16/6
4D1 3/9	6Q1T 8/6	25L6GT 5/6	B79 5/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2228 16/6
5R4G 5/9	6R7G 7/6	25S2 14/1	B729 12/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2229 16/6
5U4G 5/6	6R7 11/1	25Y5G 8/6	BL6 10/1	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2230 16/6
5V4G 7/6	6SA7GT 7/1	25Z4G 6/1	CL33 18/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2231 16/6
5Y3GT 5/6	6SA7 7/1	25Z5 7/1	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2232 16/6
5Z3 8/1	6S7GT 6/6	25Z6G 8/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2233 16/6
630L2 12/6	6S7 6/1	30C1 6/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2234 16/6
630L3 12/6	6S17 3/3	30C15 12/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2235 16/6
6AC3 3/1	6SK7GT 4/6	30C18 7/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2236 16/6
6AG5 3/6	6SN7GT 4/6	30F5 16/1	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2237 16/6
6AJ5 8/6	6SQ7GT 7/6	30F11 15/1	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2238 16/6
6A18 5/9	6S57 3/1	30F11.2 16/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2239 16/6
6AK5 5/6	6G4GT 12/1	30F11.3 16/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2240 16/6
6AK6 6/6	6V6G 3/6	30F11.4 16/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2241 16/6
6AK8 4/1	6X4 4/3	30L1 6/1	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2242 16/6
6AL5 2/3	6X3GT 5/1	30L1.5 13/9	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2243 16/6
6AM6 3/6	6Y6G 8/1	30L1.7 15/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2244 16/6
6AQ5 5/6	6Y7G 12/6	30P4 12/1	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2245 16/6
6AR6 20/1	6Z1 12/6	30P4MR 17/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2246 16/6
6AT6 4/1	7AN7 6/3	30P12 13/9	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2247 16/6
6AU6 5/1	7B6 10/9	30P18 6/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2248 16/6
6AV6 5/6	7B7 7/1	30P19 12/1	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2249 16/6
6B8G 2/6	7C6 6/1	30P11.5 12/1	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2250 16/6
6B6A 4/6	7D6 15/1	30P11.5 15/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2251 16/6
6B6E 4/9	7E1 7/6	30P11.6 15/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2252 16/6
6B6G 2/6	7H7 12/1	30P11.5 15/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2253 16/6
6B6H 7/6	7Y7 5/1	35A3 9/1	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2254 16/6
6B6J 8/6	7V4 6/6	35A5 15/1	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2255 16/6
6BQ5 4/9	7Z4 4/6	35D5 12/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2256 16/6
6BQ7A 7/1	8B76 7/1	35L6GT 8/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2257 16/6
6BR4 6/6	9D7 4/6	35L6GT 8/6	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2258 16/6
6BR8 8/1	10C1 12/6	35Z3 10/1	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2259 16/6
6B8T 16/6	10C2 10/1	35Z4GT 4/9	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2260 16/6
6B8V 12/9	10C4 6/6	35Z5GT 6/1	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2261 16/6
6B9W 11/1	10D1 8/1	42 5/1	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2262 16/6
6B9X 4/6	10D2 14/7	43 10/1	CV6 10/6	EC94 9/6	GZ30 7/1	PEN45 7/1	URIC 10/6	Z759 4/5	BFY73 7/6	OA2263 16/6
6BZ6 6/1										

A diagram of the complete amplifier together with a suitable power supply is given in Fig. 3. The 1A fuse (2A in the case of the 1050A model) in series with the power supply provides adequate protection in the event of a short-circuit of the loudspeaker terminals. The units themselves are capable of withstanding a short-circuit of the output terminals for 5 seconds under all operating conditions and so the fuse will blow before any damage is done. The metal housing in which the amplifier is mounted provides sufficient heat dissipation and in addition it can be directly bolted to the chassis or case without the need for insulating washers as it is electrically insulated from the i.c. itself. The 1020A measures approx. 3.15in. x 1.8in. and the 1050A 3.9in. x 1.6in. approx. overall.

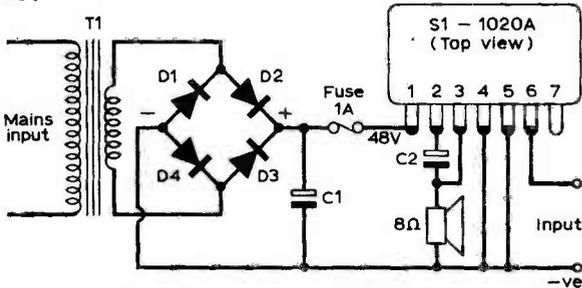


Fig. 3: Circuit of suitable power supply

Two very attractive features of the units are their frequency response, 20Hz. to 30kHz., and harmonic distortion of less than 0.5% at the full output power levels and with a signal to noise ratio of greater than 90dB. they should fill the requirements of the most discerning hi-fi enthusiast. One slight disadvantage however, especially if the units are to be put to mobile use is the rather high operating voltage required but even here idling current has been reduced to a mere 30mA which ensures economical battery operation.

## ★ components list

### Capacitors :

- C1 4000 $\mu$ F 60V (70V for 1050A)
- C2 2000 $\mu$ F 30V (40V for 1050A)

### Miscellaneous :

- D1-4 60V 1A (70V 2A for 1050A)  
(Henry's Radio Type RS32AF)
- T1 Transformer (Henry's Radio Type MT104AT)
- IC Type SI-1020A or SI-1050A  
(Photain Controls Ltd., Randalls Road, Leatherhead, Surrey)

The signal input levels required for various power outputs can be derived from Fig. 2.

At the present state of the art, these are the most powerful i.c.'s available and provide the obvious answer to anyone requiring a rugged and miniature audio power amplifier.

**NEXT MONTH:** The RCA 3052 i.c., comprising four separate amplifiers, will be reviewed. It is ideal for use ahead of the SI-1020A or SI-1050A amplifier reviewed above. ■

# THE MW COLUMN

CONDITIONS on the band this winter have been the best for several years. Especially noticeable were the number of Far East stations logged in the afternoons—China on 940, 1000, 1230 and 1290kHz, Taiwan on 750 and 1200. Ryukyu islands on 1178 and 1360, South Korea on 1190. Calcutta 1130kHz was a regular for several weeks. Near East stations logged were Bagdad 760, Teheran 895 and 1325, Kabul 1280, Kuwait 1345 and at night the Indians—Rajkot 1070 and Jabalpur 1180. North American DX was almost unbroken all winter. The writer started the year with a fine logging of *KOMO Seattle* on 1000kHz from 0740 to 0800 Hrs GMT on the 2nd January. Earlier the same morning *WVOV Huntsville Alabama* on the same frequency was heard doing an equipment test at 0630. Other DX includes *CBF Montreal* 690kHz, a Newfoundland relay station on 740, *WJR Detroit* 760, *WWL New Orleans* on 870, *CBM Montreal* 940, *WCFL Chicago* 1000, *CFRB* 1010 in Toronto, *KMOX St. Louis* on 1120, *WBT Charlotte North Carolina* 1110, *WOAI* 1200 in *San Antonio Texas*. Some of the best North American DX occurs in the spring and autumn. Stations that have been logged in this country are *KOMO* 1000kHz in *Seattle*, *KING* 1090 also in *Seattle*, *KNX* 1070 *Los Angeles*, *KEX* 1190 *Portland Oregon*, *KFBK* 1530 in *Sacramento, California*.

The Caribbean area is often heard well at this time of year. After midnight, look for *CMGN* 720kHz *Radio Rebelde* in *Colon, Cuba*, *St. Vincent* in the *Windward Islands* on 705, *Port Maria, Jamaica*, on 750 with the call *JBC*, *ZFY Radio Demerara, Georgetown, Guyana*, 760, *ZBVI Roadtown, Tortola, British Virgin Islands* on 780, *PJB Trans World Radio Bonaire Netherlands Antilles* on 800 (an easy one), *4VEC 'La Voix Evangelique'* 830kHz *Cap Haitien, Haiti* in French and English, *Radio Belize, British Honduras* on 834, *Radio Caribbean* 840 *Castries, St. Lucia* in English and French, *Radio Antilles* 930 in *Montserrat, Leeward Islands* in French and English, *TIFC 'The Lighthouse of the Caribbean'* 1075kHz in Spanish and English, *WBMJ* 1190kHz in *San Juan Puerto Rico* with pop music and English announcements, *PJD2 'The Gospel Voice of the Eastern Caribbean'* 1295kHz in *St. Martin, Netherlands Antilles* in Dutch and English. A new station is *Radio Anguilla* on 1505kHz with a power of 500 watts.

The new 1000kW station at *Beida, Libya*, is now on the air on 1124kHz and has been heard in North America. Another powerful North African is *Azilal Morocco* on 209kHz on the Long Waves. This station is the only African on this band and it can be heard in Spanish, French and English as well as in Arabic. The Spanish station audible at sunset on 1140 is *ECS11 Radio Centro Madrid* which has moved from 1394kHz. Another member of the same network is *ECS13, La Voz de Ciudad Real*, currently on 1145kHz.

CHARLES MOLLOY

# practically wireless commentary by HENRY

Just playing  
about!

I DO not know Mr. Matthews. And he knows Henry only by the odd effusions he occasionally picks up in this column. Odd, it would seem, is hardly a strong enough term. My informant is Mrs. Matthews, whose bus-top confidences to Mrs. Henry sparked off the idea for this month's contribution.

You see, Mr. Matthews is one of our unsung electronic heroes—a radio enthusiast, an avid constructor, a lonely wielder of the soldering iron who does not believe in flaunting his merits abroad. In the privacy of his own two-up, two-downer, he struggles with the intricacies of transistor testers, knocks up a record player for his younger daughter, modifies the family radio set and will one day provide his doted-on grandson with a personal communications receiver.

Henry would never have heard of him if it were not for his distressing tendency to drop hot solder on the tufted living-room carpet. One can almost hear the whoops of commiseration as the two ladies swapped horror stories.

*'It's just the same in our house! Once he gets his nose into that book, and spreads his wires all over the floor, there's no stopping him.'*

That book, as you will have guessed, is *Practical Wireless*, which, if the ladies get the emancipation they are militating for

and rule our lives in deadly earnest, will soon join the Fahrenheit 451 list of banned, subversive literature. And what will Henry do then, poor thing?

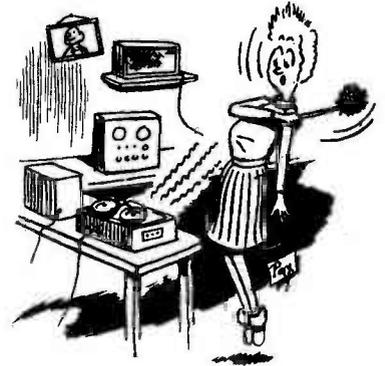
Well, I'll tell you what he may do. He may join Mr. Matthews and others of like bent in the formation of a radio-dabblers underground movement. One of the basic rules is that members shall have suffered at least a single eviction from what they thought was going to be a snug den, to a draughty corner of the potting shed or equivalent.

The ladies, bless them, just do not understand. Poor Mr. Matthews, I am told, has suffered the final indignity of having his precious equipment jocularly dismissed as 'toys'. He is 'permitted' to play at set hours, in carefully circumscribed places, so long as he does not make too much noise. That he still manages to derive a great deal of fun from his hobby is as much a tribute to his sense of humour and tolerance as to the well-known attraction of the electron. A few spots of solder on the Cyril Lord are a small price to pay for such peace of mind that our hobby can give—and, after all, flourishing pliers and tin-snips does not drag us away from the family hearth. That is surely a plus-point, madam?

Reading this, Mr. Matthews will realise I am joking—having mastered the initial shock of my intrusion into his privacy. Indeed, I would not have known about him at all—though he, apparently, has the advantage of me—were it not for his wife's very obvious pride in her lord and master's prowess.

The fact that a chap can string two wires together and make an invisible power give voice smacks something of witchcraft and we all know how superstitious the hausfrau can be.

Mrs. Henry, for example, has little regard for my prowess as a



*"Programmed to yell 'don't touch me!'"*

gardener. She prefers to remember the time I uprooted a corner of dormant 'busy-lizzie' in the belief I was ridding the world of convolvulus rather than the bird-activated pea-protector that very nearly was successful. Only the switching time of an OC71 was the best we could do in those days...

But the communications corner of my den still scares her. In this last refuge, from which I am still winkled when the approach of visitors demands I turn it back into the spare bedroom, I can at least be sure of some isolation. I believe my advantage stems from the time Joe and I were experimenting with an intriguing—and probably quite illegal—voice-operated CQ switch, and Mrs. H. was interrupted in the middle of a private tidying-up session by the clicking of relays and a disembodied Joe asking: 'Hallo there, are we together?'

It would not be much trouble for Mr. Matthews and me to collaborate in the design of a series of proximity switches that could activate a solenoid-switched tape recorder programmed to yell 'Don't touch me!' loud and clear. Now that would be a toy worth having. Even better than that electronic shoehorn (bootstrapped circuit, of course) that young Bob has promised to make me.



*"My informant is Mrs. Matthews"*

# DISCOSOUND

## NEW DISCOSOUND PRE-4



**DISCOSOUND** announce a new range of high quality modular pre-amps, and main amplifiers which offer a wide range of facilities to suit all types of applications.

**Model Pre-4.** This is a four channel fully mixable pre-amp, with separate treble, bass and master volume controls, and is completely self powered. All four inputs are by standard jack socket on the front panel with the addition of inputs 3 and 4 being duplicated on the back panel, with two paralleled outputs also featured for versatility in use.

**Specification:**

Inputs.	Vol. 1. 10 mv at 50k Ohms	} Other Impedances can be made to special order.
	Vol. 2. 10 mv at 50k Ohms	
	Vol. 3. 50 mv at 500k Ohms	
	Vol. 4. 50 mv at 500k Ohms	

Frequency Response: 30—20,000 HZ  $\pm$  3db.

Signal/Noise Ratio: -65db.

Bass: continuously variable 20db. at 100 HZ.

Treble: continuously variable 20db. at 10 KHZ.

Output: variable up to 1 volt RMS at 25k Ohms.

Size: front panel 12 $\frac{1}{2}$  x 5 $\frac{1}{4}$  cut out required 11 $\frac{1}{2}$  x 4 $\frac{1}{4}$ .

Completely built and tested.

**PRICE £18.0.0 inc. P. & P.**

## NEW DISCOSOUND 70 MAIN AMPLIFIER

This is a 70 watts RMS (8 Ohms) High Fidelity power Amplifier which utilises all silicon transistors of modular construction and features, full automatic overload protection against short or open circuits. The High output is ideally suited for discotheques, groups, clubs, etc., or anywhere where reliability and quality are required. This unit is the companion model for use with our control pre-amp Discosound PRE-4, or can be used with any other high quality pre-amp control unit.

**Specification:**

Power Output: 70 watts RMS into 8 Ohms.

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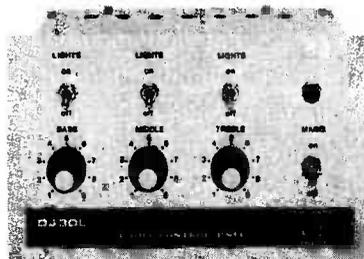
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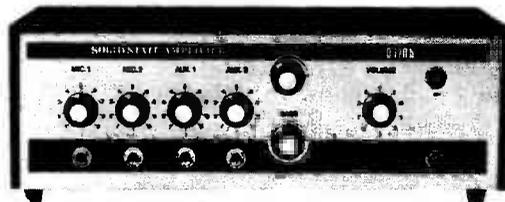


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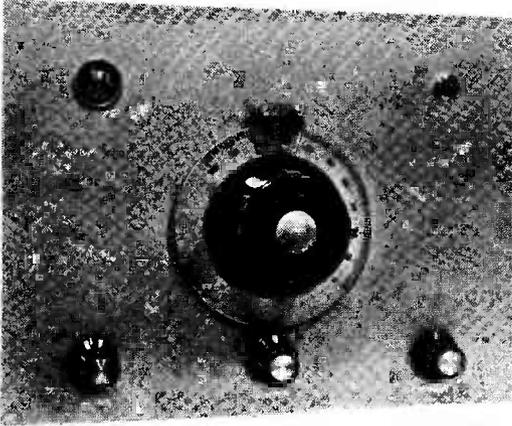
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# RADIO CONSTRUCTOR

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# SHORT WAVES

## MONTHLY NEWS FOR DX LISTENERS

This month I have enough DX News and logs to fill several pages so I will start with:—

**Peter Giles** of Wolverhampton has a Heathkit RG-1 and a 70 foot end-fed aerial which enabled him to send in the following log:—

11855 *S. Arabia* in English from 0430 to 0530  
 11970 *R. Lebanon* in English from 0230 to 0300  
 15105 *WIBS* in English (weak signal), 1945 to 2130  
 17705 *Havana*, Cuba in English from 2010 to 2138  
 17920 *UAR* in English from 1315 to 1430.

**N. G. Pope** of Chesterfield also heard the Saudi Arabian station in English on 11855 but at the earlier time of 1716-1730.

Mr. Pope also mentions that the *Voice of Denmark* will continue to broadcast in Danish in accordance with the following schedule:—

On 15165 at 0730-0815, 0945-0950, 1130-1155, 1200-1245, 1330-1345, 1400-1445, 1730-1815, 1830-1915 and 2100-2145 also on 9520 from 0100-0145.

The station will only answer letters and reports which are written in Danish.

**Mr. T. R. Gibbs** of Swindon sent me his log which included: *Radio Portugal* on 17895 and 21495 at 1350-1415; *Radio Australia* on 9570 at 2100-2130 and *All India Radio* on 7215, 11775 and 15435 at 2200-2230.

**Michael R. Preston** of London, NW11 used his HMV Domestic and 12 metre wire to send in one of the best logs this month:—

9540 *R. Lubumbashi*, Katanga, Congo in French at 2200  
 9605 *Athens* at 1832  
 11925 *Tashkent* at 1400.

Michael also mentions that *Radio Finland* now uses 11755 instead of 11805 in all transmissions including English from 1800-1830 which is also on 9550 and 15185. Another news item from Michael says that *Radio New Zealand* plans to increase its power from 7.5 to 20kW.

**Robert Hanstock** of Sheffield sent me the English schedule of *Radio Belgrade* which reads:—

1530-1600 on 9620, 11735 and 15240; 1830-1900 on 6100 and 2000-2030 on 7200 and 9620.

Another good log came from **Mr. R. Ellis** of Stroud with his Hammarlund receiver and 49 metre 'V' dipole:—

7250 *Vilnius, Lithuania* from 2230 to 2300  
 11855 *S. Arabia*, good signal from 1830 to 1900  
 15150 *Radio Kuwait*, 55455 from 1600-1615  
 15180 *ETLF* in English sign on at 1600  
 15255 *HCJB*, Ecuador, 54343 from 1900 to 1915  
 17750 *Karachi*, Pakistan, 44344 from 1500 to 1511  
 17850 *Bucharest*, Rumania, 44233 from 1315 to 1330.

**Kevin Goulding** of Bath informs me that the

Times in GMT • Frequencies in kHz

## THE BROADCAST BANDS

Malcolm Connah

World Radio-TV Handbook Co. Ltd. (see December 1969 issue) has changed its address to: Søjlilveje 44, 2650 Hvidovre, Denmark.

### Africa

**Sierra Leone:** The latest schedule from Radio Sierra Leone indicates that all transmissions are on the frequency of 3316 (10kW) and the hours of broadcasting are: 0600-0930, 1245-1330 and 1545-2300 Monday to Friday; 0600-1000 and 1200-2330 on Saturday and 0600-2230 on Sunday.

**South Africa:** Radio RSA continues to broadcast in English to the U.K. from 1756 to 1850 on 15250 and 21480 but has dropped the frequency of 17795.

### Asia

**Nepal:** Radio Nepal signs on at 0120 on 7105 and 11970 and also at 1220 on 7165 and 11970, the power used is 5 or 100kW.

**Mongolia:** According to a new programme schedule from Radio Ulan Bator the station now broadcasts in English from 1220 to 1250 on 15445 and 17785 and also from 2200 to 2230 on 9540 and 11860.

**Qatar:** Radio Qatar is now using the new frequencies of 5150, 6135, 9550, 9770 and 11710. This should make reception easier as the station used to be on the very crowded channel of 9570 only.

**South Vietnam:** Radio Vietnam in Hue broadcasts in Vietnamese on 9667 until sign off at 1500, this station is not listed in the World Radio-TV handbook.

### Oceania

**Australia:** Radio Australia has a new broadcast in English for the Pacific area on 15140 from 0900 to 1400. The station is also testing the frequency of 11920 between 2000 and 2055.

**Gilbert and Ellice Islands:** Radio Tarawa can be heard on 4912.5 and the following schedule is given:—

English and Vernaculars from 1845 to 2000 Monday to Saturday and in English from 0700 (0630 on Sunday) to 0745 daily.

**New Zealand:** Radio New Zealand has been picked up in England between 0700 and 0845 with fair strength on 11780.

**Tahiti:** Radio Tahiti, Papeete has been heard around 0600 on 11825 with strong interference from several adjacent stations.

Many thanks to all of you who sent in your logs for the benefit of the other readers, I hope that you will continue to do so and will be joined by many other contributors.

73 and good DX until the next time.

# THE AMATEUR BANDS

David Gibson, G3JDG

IT has been one of those months on the amateur bands. Such a mixture of logs and contradictions that it's difficult to decide just what is what.

One s.w.l. claims that the l.f. bands have been very good and appeared to be getting better towards the end of the month. Another tells harrowing tales of evenings spent listening to long slices of noise, and at times even the arrival of a solitary European station was enough to cause a minor celebration.

The same tale has been repeated at the other end of the spectrum. Some have described ten metres as an r.f. cemetery while others have praised its service in the interests of amateur radio. Perhaps some of us have listened at the wrong times.

At the home QTH, the l.f. bands, forty metres and below, have appeared reasonable. Hoards of W stations have been heard s.s.b.-ing to each other and a number of EUs have been logged both calling and working Oceania, although it must be confessed that VK stations and the like could not be received and so don't count.

In the v.h.f. region we scooped an all-time record—two logs received. One exponent of these frequencies threatens to listen on seventy centimetres. Any one doing anything with lasers yet?

P. Knisely (Surrey) informs of two more stations now active from Anguilla, VP2EQ and VP2EM. Owls may care to QRX on twenty and fifteen from midnight on most nights.

John Morris, G3ABG, sends details of the Worked All Britain award. Interesting to note that there are certificates for s.w.l.s. Interested enthusiasts, and sheepskin hunters, should drop John a line at 24 Walhouse Street, Cannock, Staffs.

P. Flatman (Suffolk), NCX100 plus PR30 pre-selector, admits to plundering 80. The swag includes: CN8HD, EA6BG, OHØNC (Aaland Is.), VE1IE, VO1FG, W2HBW, 4X4GV, all s.s.b.

Pearls of wisdom from Pat Johnson regarding the where and when on 80. For W/VE/VO, any time after 2300 up until 0800. Best DX frequencies are 3-790 and 3-80MHz. Pat advises to QRX for LA5KG or ON4UN and listen to their QSOs. He also reckons that the best EU DXers seem to favour a half-wave vertical with ground radials. So if you can plant a 130 odd feet of vertical in your back yard, you're in business. Pat used an Eagle RX60, PR30, a.t.u. and 35ft end fed running N/S, or a 70ft wire running N/E-S/W for s.s.b. sigs from: CN8MN, EA5JK, HK3WO, K1KTH, K2ADY, K3UZE, K4JY, LX1GP, OA8V, OJØMR (Market Reef, between Aaland Is. and Sweden), OY2Z, TA3RF, UW9AF, VE1BU, VE3AYS, VO1CC, VS6DO, W1CF, W3AGM, W4OKL, W9WIB, WB2LWH/VP9, YV4UA, 4S7PB.

J. Jackson (Leeds), TCS13, a.t.u. plus "wire in the loft" detected 80 metre s.s.b. from: CN8MN, CR4BC, HK3WO, KV4FZ, OJØMR, TA3RF, UW9AF, VE1AUC, VE2MY, VE3HJ, VO1CV, VP2VI, WA1AIM/P/VO2, W1FZ, W2PV, W4AQW, W5IOU, YV4UA. He also logged YT3OV, a special Yugoslavian station.

Stephen Champion (Herts) has an R1155 with a 60ft end fed. He claims that 80 is packed with EUs but that the DX is there for the patient. Stephen's

best were HK3WO and VK3MV.

Tom Maxwell (Lanarkshire) CR7OA and 18ft end fed had a long, lingering lugfull on fifteen and twenty. Rewards include: CN8MN, CR6IS, CT2AK, EA3JE, IT1TTH, KV4FZ, LX1BA, OK4PI/MM, PY4AS, PY8OL, TF2WLM, TI2JCC, UB9KAG, UNIKAM, VE3GKH, VO9JJ, VP2AA, VR6GX, YV4WT, ZB2BV, ZP5CF, ZS6AJS, 3V8AL, 6Y5GB, 8R1U, 9K2CM, all on 20 s.s.b.

David Robbins (Warwick), CR7OA, 60ft of mains cable "looped vertically up to 20ft." (The Electricity Board shall hear of this!) The following procession passed through the hoop on 15 s.s.b.: CN8HD, CN8HL, CR4BB, CT2AT, HC1MG, IS1LIO, JX3DH, KP4RK, KV4FZ, OJØMR, PY4AKR, TF2WKL, TF3HS, TU2BB, VP2AA, W6-QI, YDK, YWQ, ZFN, FDR, HGU, ZB2BY, ZL3JC, ZS6BRK, 4X4AX, 4X4FC, 4Z4HG, 9H1BL, 9Q5SN, 9X5SP.

N. Richardson (Bucks) CR7OA, PR30, 30ft end fed at 18ft, queries RA3BCF claiming to be in Moscow. His best on ten metres s.s.b. were: CR6LX, KV4AD, UV3DN and ZS6HR.

John Moore (Leicester) is eavesdropping on two metres. A home brew (good lad) G3BKQ f.e.t. convertor into a CR100/2 tuning 24-9-26-9MHz is fed with a 6-element Yagi indoors. (What happens when you want to have a bath, OM?) Signals bearing the a.m. label received from: G3GJY, G3JXN, G3PYG/A (near Sheffield), G8CB, G8BPO, G8BRT/P (near Sheffield), G8BYW/P (Derbyshire). Two independent squeaks of s.s.b. heard from G3OCH and G6NB.

"Tell Glyn Richards he isn't the only 2 metre fan in G.B.," says L. Coombes who lives in Cwmbran. (I don't know either, it's certainly not near St. Albans.) Listening on an Interceptor 1880 raised: G3YRN, G8AFA, G8DCK, GW3IJE, GW5NF, GW8CCA. The antenna is an inverted L about 75ft long.

Quite an active month for contest enthusiasts. March 7-8th BERU contest; 7-8th ARRL phone contest; 21-22nd ARRL c.w. contest; April 5th 80 metre QRP contest.

A special one on March 28-19th April is the IARC propagation research contest, which is a phone only one. Don't forget that it's nearly mobile rally time. The first in my diary is the North Midlands Rally on 19th April. Listen for a talk-in station at all these rallies on topband. For the c.w. types, National Field Day this year will be on the 6-7th of June. Just time to get a bit of practice in on the key. ■

## BINDERS AND INDEX

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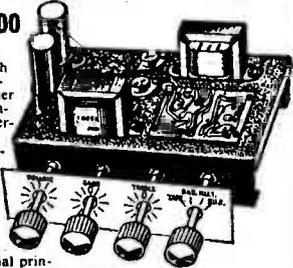
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Output power measured at 10Kc-2 watts RMS into 3 ohms. 5.8 watts RMS into 15 ohm. Overall frequency response 30 c/s-18 Kc/s. Continuously variable tone controls: Bass, +8db to -12db at 100c/s. Treble, +10db to -10db at 10Kc/s. The HSL.700 has been designed for true high fidelity reproduction from Radio Tuner, Gramophone deck and Tape Recorder preamp. Supplied ready built and tested, complete with knobs, attractive anodised aluminium front escutcheon panel, long spindles (can be cut to suit your housing requirements) full circuit diagram and operating instructions.

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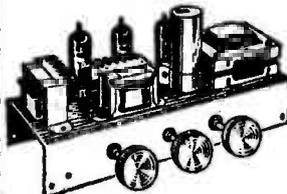
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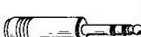
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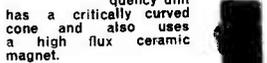
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# FET'S AND THEIR USES

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## PART 2

LAST MONTH THE PARAMETERS OF F.E.T.'S WERE DISCUSSED TOGETHER WITH A TESTER SUITABLE FOR DETERMINING THESE. THE SECOND PART DESCRIBES A NUMBER OF CIRCUITS USING F.E.T.'S.

### F.E.T. CASCADE WITH TRANSISTOR AS A PRE-AMP FOR CRYSTAL OR CERAMIC PICK-UP

A very useful combination that presents a high input impedance and low output impedance suitable for other transistor stages and provides gain is shown in Fig. 7.

The output transistor is set at a collector current of 0.5mA if the output is at plus 8V and  $R_1 + R_2$  is 16k $\Omega$ . As it is a feedback amplifier, putting in a signal of 0.1V means that for the circuit to be satisfied, 0.1V must be fed back to the source from  $R_2$ . If 0.1V occurs across  $R_2$ , then the current change must be  $0.1/R_2$ , and to the voltage across  $R_1 + R_2$  must be  $0.1/R_2 \times (R_1 + R_2)$ ; so this voltage, which is the output voltage, will be  $\frac{R_1 + R_2}{R_2}$  times the input voltage,

or in the other words the gain is  $\frac{R_1 + R_2}{R_2}$  . . . . . (11)

$$\text{Gain} = \frac{15 + 0.68}{0.68} = 20$$

Taking a typical MPF103 with a  $V_p$  of 3V at a bias of 2.5V,  $I_D$  will be about 100 $\mu$ A.  $I_{DSS}$  will be about 3mA. Thus from (3)

$$g_m = \frac{2 \times 3}{3} \left( 1 - \frac{2.5}{3} \right) = 0.34 \text{mA/V}$$

The output impedance will be much lower than in Fig. 6 because the  $g_m$  is multiplied by the transistor gain, say times 50.

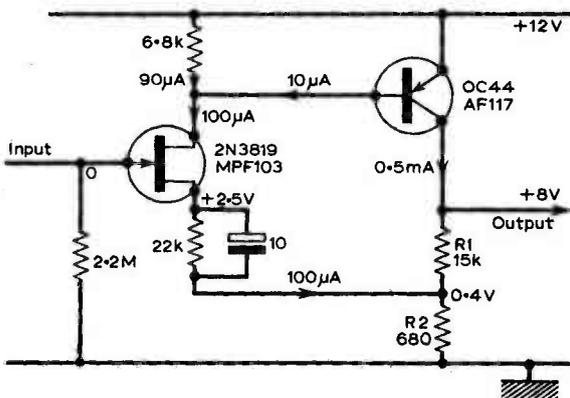


Fig. 7: A high input impedance/low output impedance preamplifier.

$$R_{out} = \frac{15000}{1 + (15 \times 0.34 \times 50)} = \frac{15000}{250} = 60\Omega$$

And input impedance is of course 2.2M $\Omega$ .

At 0.5mA  $I_C$  for the output transistor plus the 0.1mA through the f.e.t. only 0.4V is produced across the 680 $\Omega$  resistor, so the rest of the f.e.t. bias of 2.5V must be made up by a source resistor in the f.e.t. This is 2.1V at 100 $\mu$ A i.e.. approximately 22k $\Omega$  which must be by-passed by a capacitor to prevent negative feedback. The 100 $\mu$ A drain current must not be allowed to go into the transistor base, which with a gain of 50 will only need about 10 $\mu$ A. This gives a value of drain resistor equal to 6.8k $\Omega$  but this may need adjustment to set the output voltage at approximately 8V.

### Hi-Fi- TONE CONTROL

Figure 8 shows a Hi-Fi tone control circuit which gives up to  $\pm 15$ dB of bass and treble control. It is a big improvement over ordinary circuits because most of the capacitors are a tenth of the normal value, these being the most bulky items and so a much smaller unit is possible.

Once again an N-channel f.e.t. is used, source bias is chosen to set the f.e.t. at a low value of  $I_D$  to allow a high drain resistor for good gain. At present N-channel f.e.t.'s are the most common and cheapest. For instance, taking a Newmarket type NKT0213 with a typical  $V_p$  of 1V and  $I_{DSS}$  of 0.4mA, if we bias it at 100 $\mu$ A from equation (2)

$$V_{gs} = 1.0 \left( 1 - \sqrt{\frac{0.1}{0.4}} \right) = 0.5V$$

$$\therefore R_{source} = \frac{V_{GS}}{I_D} = \frac{0.5}{0.1} \approx 4.7k\Omega$$

If the supply voltage is 12V and we let the drain voltage be 3V then  $R_L = \frac{9}{0.1} \approx 82k\Omega$

Then from (3)

$$g_m = \frac{2 \times 0.4}{1} \left( 1 - \frac{0.5}{1} \right) = 0.4 \text{mA/V}$$

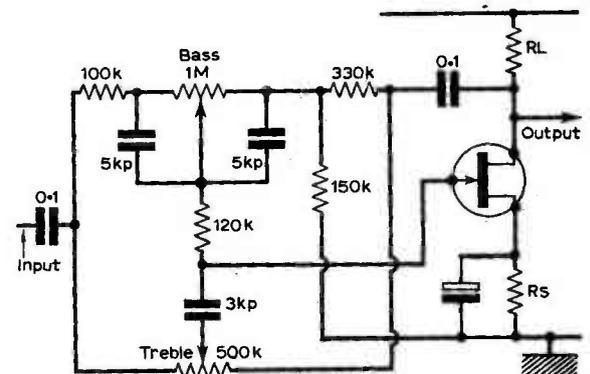


Fig. 8: A hi-fi tone control—see text.

So gain from (7) =  $0.4 \times 82 = 33$

This figure of 33 is the inherent gain of the stage but the feedback tone controls reduce this to a low level at middle frequencies and the gain is used to give the treble and bass boost.

## F.E.T. VOLTMETER

If f.e.t.'s are used to drive a meter, then a voltmeter with a very high input impedance will result.

For instance, Fig. 9 shows a voltmeter with  $20M\Omega$  input impedance on all ranges, using a  $100\mu A$  meter. In this circuit the tester should be used to get two f.e.t.'s matched so that, at the drain current used, the gate bias is within 10 per cent.

Using a 9V battery and a potential divider which sets the gate of the right hand f.e.t. at +3V with respect to the negative terminal of the battery, is the starting point of design.

If 1mA is chosen as a useful operating current, then measuring  $V_{GS}$  on typical Motorola MPF103's will give a bias of about 1V. Thus the sources should sit at about +4V. With the zero set pot. at its mid-position of  $2.5k\Omega$ , then to make 1mA flow the fixed source resistor must be  $1.5k\Omega$ .

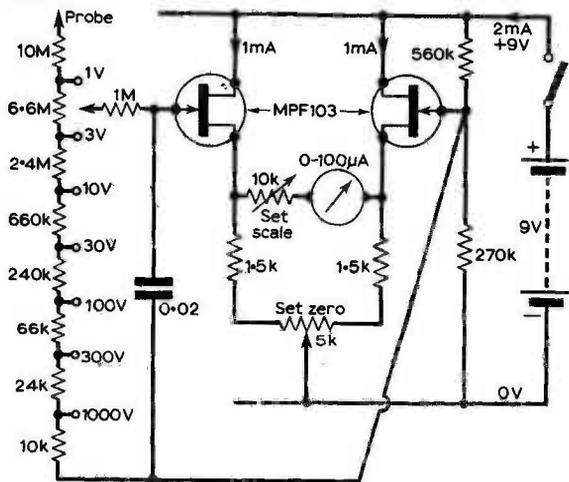


Fig. 9: F.E.T. voltmeter circuit.

These sums shown here are to enable the constructor to redesign the circuit should he not have f.e.t.'s of similar ratings.

Setting-up procedure consists of adjusting the set pot. for zero meter reading with the scale pot. set at zero resistance.

Then apply a known test voltage on the correct range and adjust the scale pot. to correct meter reading; this is a pre-set adjustment and should not require changing again.

This meter drifts very little with temperature, time or battery voltage down to about 6V, due to the long tailed pair circuit configuration.

In passing it should be mentioned that due to the high impedances involved, pick-up can be troublesome and it is suggested that a metal box be used for construction and a screened lead for the probe.

## SENSITIVE F.E.T. MILLIVOLTMETER

If the constructor does not wish to use a sensitive  $100\mu A$  meter or requires greater sensitivity, then the addition of two transistors as amplifiers will allow the use of a 1mA meter with a sensitivity of 30mV f.s.d.

Figure 10 shows such a circuit with an input impedance fixed only by the input attenuator, which can be as high as  $50M\Omega$ .

The circuit will be recognised as a doubling up of Fig. 7 with some extra complications.

The meter used is made up to  $100\Omega$  resistance, which means that 100mV is required to give f.s.d. The  $2.7k\Omega$  and  $1.5k\Omega$  resistors give a gain of 2.8 times but the shunt of  $18k\Omega$  and the gain set pot. means this can be increased and set accurately to times 3.3 so the input signal required for f.s.d. is only 30mV.

This sensitivity can be reduced to read any higher voltage in a similar manner to the earlier circuit. But in order to reduce the effects of amplifier drift, it is recommended that the first set of range switching to say 1V, is carried out by inserting series resistors in the meter circuits. The test meter runs from three 9V batteries and consumes about 6.5mA. The f.e.t.'s can be selected on the meter for matched  $V_{GS}$  at an  $I_D$  of 1mA. The lower f.e.t. is used as a constant current source for the amplifier. If the voltage on the drain of an f.e.t. is varied, then the current through it will not vary by more than a few per cent, as long as the voltage is greater than  $V_p$ . In this case the tester is used to select an f.e.t. with an  $I_{DSS}$  equal to 6mA and it is put in the circuit with  $V_{GS} = 0$ , or simply gate and source strapped together, so now variations of battery voltage will not change the current fed to the amplifier. Should it prove difficult to get an f.e.t. with the correct  $I_{DSS}$ , then select one with greater than 6mA and insert a source resistor as calculated from Fig. 5a to give an  $I_D$  of 6mA.

The transistors should be silicon types but are not critical as regards frequency response.

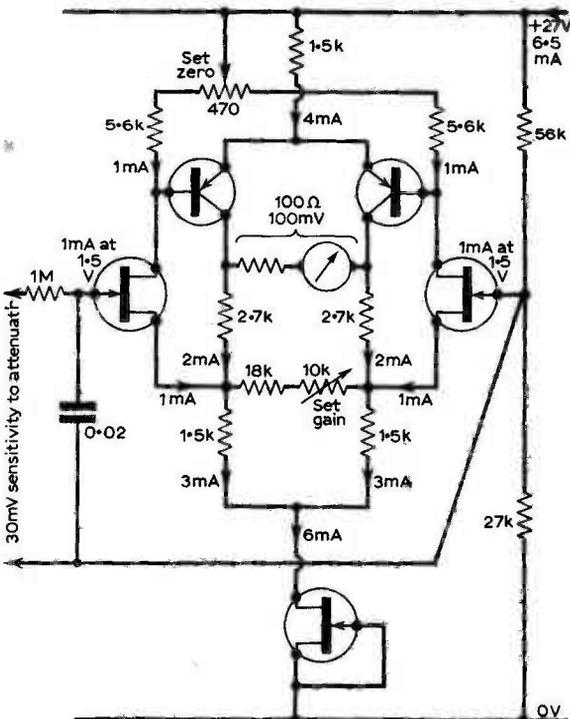


Fig. 10: Circuit for a sensitive f.e.t. voltmeter.

## TAPE PRE-AMPLIFIER

In replaying tapes, the aim of the amplifier is to present a high impedance at least ten times the head reactance and if possible, upon switching on, not

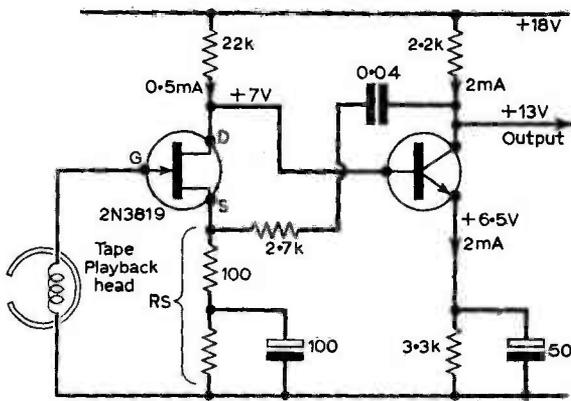


Fig. 11: Tape preamplifier equalised for 3½ i.p.s. The transistor should be shown as a 2N2926.

introduce any capacitor charging currents or d.c. into the head circuit, because these will cause noise to be impressed on the tape.

Most normal transistor circuits inevitably do cause charging currents to flow, however they can be made high impedance enough with some trouble; but an f.e.t. pre-amplifier gets around all these troubles. The tape head can be fed directly into the gate, and so no capacitors are involved; also the high input impedance is unquestioned.

Figure 11 shows a circuit with 120μS equalisation for normal 3½in. recorded tapes.

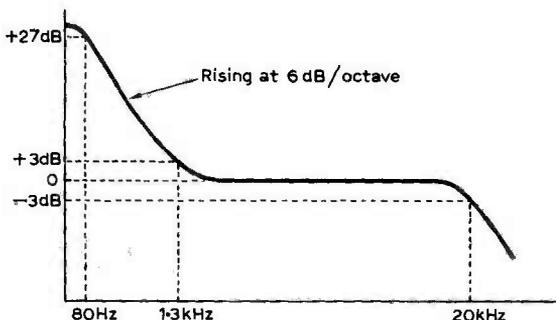


Fig. 12: The equalisation curve used in Fig. 11.

The f.e.t. is run at an  $I_D$  of 0.5mA and  $R_S$  is calculated from the tester measured characteristics as in Fig. 5a. The 2.7kΩ and 100Ω resistors give a medium to high frequency gain of 27 times, while the capacitor in series with the 2.7kΩ gives the low frequency rising characteristic as needed for tape replay, as shown in Fig. 12.

The time constant should be 120μS for normal 3½in. tapes, so with the 2.7kΩ resistor

$$CR = 120 \times 10^{-6}$$

$$\therefore C = \frac{120}{2.7 \times 10^3} \mu F \approx 0.04 \mu F$$

The rest of the voltages and currents as calculated are all shown on the circuit diagram.

## MAGNETIC PICK-UP PRE-AMPLIFIER

Shown in Fig. 13 is a pre-amp for a high fidelity magnetic pick-up cartridge.

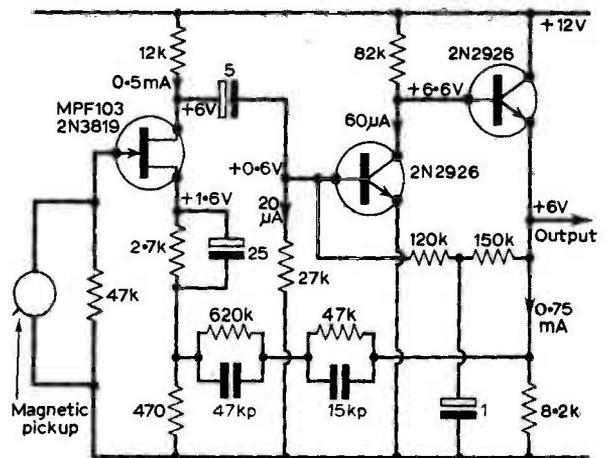


Fig. 13: Preamplifier for a hi-fi magnetic pick-up cartridge.

Here the f.e.t. is used to present a very high input impedance and then a resistor is put across the input to match the pick-up in use. Otherwise with a normal transistor circuit one would have to design a high input impedance, say 100kΩ circuit and then put a resistor in parallel to bring it down to the correct value; this would be all right if the input impedance could be relied upon to stay constant over the audio band and also be constant from unit to unit despite transistor variations; however the f.e.t. overcomes all these problems.

The f.e.t. is biased at 0.5mA as previously discussed, followed by a grounded emitter stage to give some more gain, and an emitter follower to provide low output impedance and to drive the equalisation components which feed back into the source to give the correct play characteristics. The transistor pair are coupled together in a d.c. feedback configuration with the a.c. signal removed by the 1μF capacitor.

The circuit gives a gain of 100 at 1kHz with an output swing of about 2V r.m.s., enough to fully drive any normal power amplifier, response is within ±1dB of the RIAA characteristic from 20Hz to 20kHz. Output impedance is less than 1kΩ.

Design voltages and currents are shown on the circuit diagram.

The previous notes should now have given a good idea of how to use f.e.t.'s to their best advantage, but we finish now with the warning that they are, especially m.o.s.f.e.t.'s, rather fragile as regards stray voltages in handling, and it is recommended that plug-in sockets be used whenever possible and leave the f.e.t.'s out of circuit whenever soldering.

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# AN ELECTRIC THERMOMETER

THE temperature of a piece of intrinsic semiconductor material determines the number of electrons and 'holes' (spaces left in the structure by departed electrons) available for electric conduction. Therefore the resistance of the material depends on temperature. A thermistor is a component consisting simply of two leads joined by a piece of suitable semiconductor material. The instrument to be described measures the temperature-dependent resistance of a thermistor designed specifically for thermometer use and displays the corresponding temperature on a meter. The electric thermometer possesses several features which make it more versatile than the ordinary mercury- or alcohol-in-glass types, viz:

(i) The temperature-sensitive thermistor is connected to the measuring instrument by ordinary twin flex and may be almost any distance from it. This makes the thermometer suitable for many remote temperature sensing applications.

(ii) A meter scale is generally easier to read than the engravings on a glass thermometer.

(iii) The piece of semiconductor material in the specified thermistor is roughly the size of a pinhead. This means that the thermistor has a small heat capacity and can follow a rapidly changing temperature, and that temperature readings can be taken without delay.

(iv) The thermistor is small enough for insertion in many otherwise inaccessible places, although it is rather fragile.

## THERMISTOR

The thermistor specified is a Mullard Varite VA3705 which has a miniature glass bead construction. For general use it can be mounted in a holder made from a hexagonal shape ballpoint pen ('BIC') case (Fig. 1.). The pen cap is used to protect the fragile 'business end' of the thermistor when not in use. Twin flex is connected to the thermistor leads as shown using plastic sleeving to insulate them. This must be done carefully as the leads are fragile. Individual thermistors vary somewhat, but average values of resistance for the VA3705 are:  $6.8\text{k}\Omega$  at  $25^\circ\text{C}$ . ( $77^\circ\text{F}$ .),  $700\Omega$  at  $90^\circ\text{C}$ . ( $194^\circ\text{F}$ .) i.e: resistance decreases with increasing temperature.

## CIRCUIT

The circuit of the thermometer is shown in Fig. 2. B1 and B2 are two small dry cells connected in series to give about 3 volts. Current passes through current limiting resistor R1 and through zener diode D. The zener diode operates in its reverse breakdown condition so that the voltage drop across it is virtually constant (2.4 volts). This ensures the voltage supply to the thermistor is constant in spite of battery wear. The current passing through the thermistor is

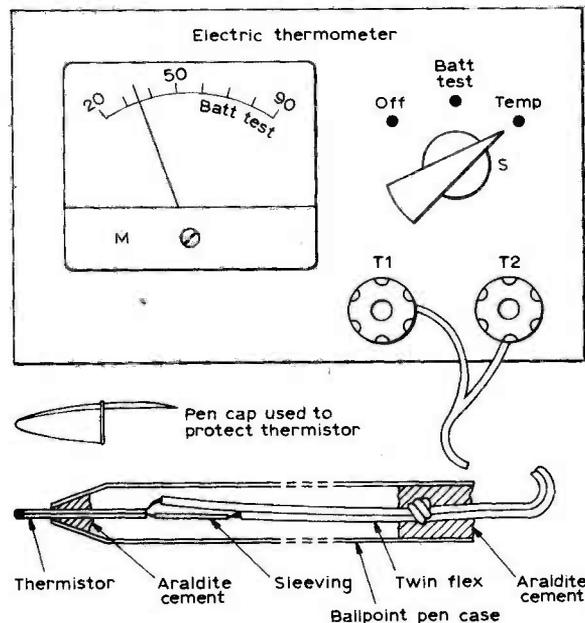


Fig. 1: (top) panel layout (bottom) probe construction

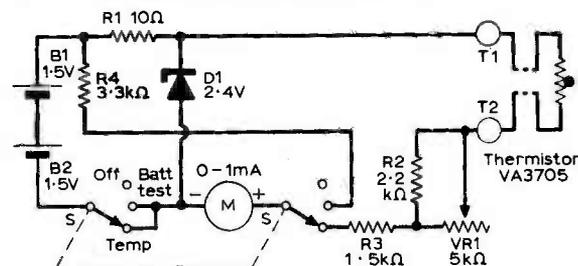


Fig. 2: Circuit of thermometer

measured by meter M which can be directly calibrated in temperature. VR1 is part of the current limiting resistance in series with the thermistor and is preset to give full scale meter deflection (1mA) at 90°C. (194°F.). When S is in the BATT TEST position, the battery voltages under load can be checked on the meter. The dissipation constant of the VA3705 is about 1mW/°C which means that the heating effect of the current passed through it will not introduce an inaccuracy greater than ±1°C.

## CONSTRUCTION

The instrument can be constructed in any convenient cabinet and the few components wired direct. The front panel carries rotary switch S, insulated terminals T1 and T2 and 1mA moving coil meter M, which can be any cheap surplus meter, as large as possible for easy reading. VR1 is mounted inside the cabinet as it only has to be set once; it can be any type of potentiometer, a salvaged volume control from a defunct transistor radio will suffice. The author made a simple holder for the two U12 cells (B1 and B2) from a matchbox, a scrap of metal and two drawing pins (Figs. 3a, 3b).

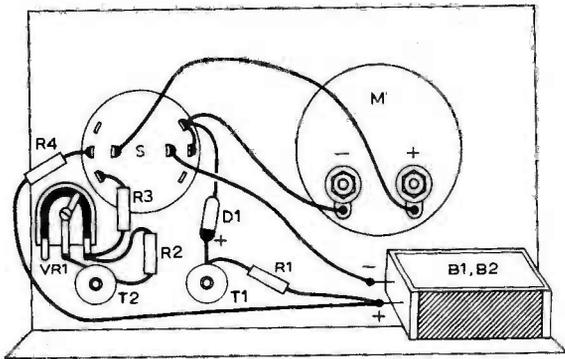


Fig. 3a: Panel wiring

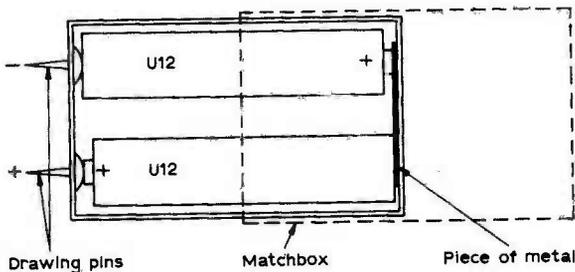


Fig. 3b.: Battery holder

## CALIBRATION

The instrument is easily calibrated using an ordinary mercury thermometer. With VR1 set to maximum resistance, connect the probe to T1 and T2 and place it in water heated to exactly 90°C. (194°F.) as measured with the mercury thermometer. Adjust VR1 for 1mA deflection and use a dab of glue or wax to fix it in this position. Now place the probe in water, cooled to exactly 20°C. (68°F.) and note the meter reading. Now plot these two readings

on a graph (Fig. 4). As the temperature coefficient of the thermistor is linear between these two limits, the two plots have only to be joined by a straight line to provide a complete calibration graph. If a clinical thermometer is available it can be used to provide a third calibration point at 36.7°C. (98°F.).

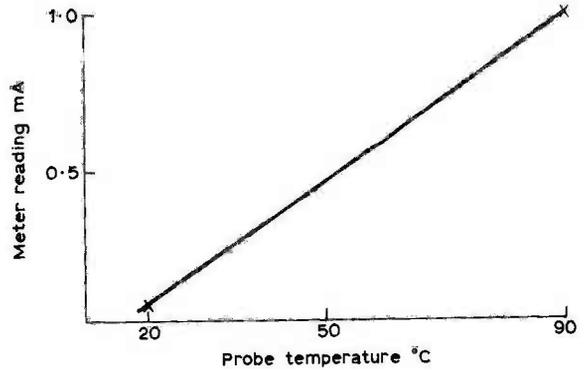


Fig. 4: Construction of graph

## ★ components list

### Resistors:

- R1 10 Ω ½W 10%
- R2 2.2k Ω ½W 10%
- R3 1.5k Ω ½W 10%
- R4 3.3k Ω ½W 10%

D 2.4V 1W zener diode

M 1mA f.s.d. moving coil meter

VR1 5k Ω pre-set pot.

S Two-pole three-way rotary switch

B1, B2 Ever Ready U12 cells

Thermistor Mullard VA3705

The graph can be used to calibrate the meter scale directly, if desired. Open the meter unit carefully and away from dust to avoid damage to the movement. A piece of paper suitably calibrated in degrees centigrade and/or fahrenheit is then slipped under the needle and glued in place. Mark the scale with a green area above 0.80mA. When the needle fails to reach this area on BATT TEST, the batteries should be replaced. If the thermistor is damaged and has to be replaced, the temperature calibration must be repeated.

## USE

The instrument is now complete and will continue to give accurate measurements provided the thermistor temperature does not pass outside the range 20°C. (68°F.) to 90°C. (194°F.). The author's original use for the instrument was measuring transistor heat sink temperatures. Merely touching the probe tip to the heat sink was found to give fairly accurate readings. Overall accuracy of the instrument is better than ±1.5°C. if a good thermometer is used for calibration. The procedures for converting degrees fahrenheit to centigrade and the reverse are as follows: To convert degrees F. to degrees C., subtract 32 from the F. value, multiply by 5 and divide by 9; to convert degrees C. to degrees F., multiply by 9, divide by 5, and then add 32 to the result. Degrees Kelvin or Absolute are degrees centigrade plus 273 degrees. ■

# REPAIRING TRANSISTOR RADIOS

V. CAPEL

## PART 2

**I**N the last part we saw that speed is essential in repairing the cheaper transistor radios if an economic job is to be done. Whatever short cuts may suggest themselves in diagnosis and repair should be used even though these may not always be considered to be good practice with more conventional jobs.

Distortion and no-signal faults were dealt with, but now we will consider the symptom of low sensitivity. Almost any stage could give rise to this, but rarely the output stage as faults here generally produce distortion as well. Before getting too involved though, as with other faults, always check the battery first. Although more usually producing distortion, many modern circuits allow the battery voltage to fall to quite low levels before distortion sets in, but sensitivity is bound to suffer.

A quick check can be made by detuning the set and turning up the volume full. A fairly strong background hiss would suggest that the audio circuits were in order and that the trouble probably lay in an early stage, the mixer or the first i.f. A too silent background would indicate that the fault was in the latter stages.

The most usual causes of low sensitivity are mechanical damage, faulty transistors or mis-alignment. Of the first, a broken ferrite rod is perhaps the most frequent example. A visual examination will soon reveal this. When replacing, make sure that the diameter is the same as well as the length.

In cases where the ferrite rod has broken free from its mounting not only can the fine connecting wires be broken away from the print as described in the previous issue, but the coils themselves can sustain damage. The long-wave coil, being layer wound often suffers with other sharp components digging in and penetrating several layers. This may cause a complete open-circuit or a short-circuit of several turns. This short can be reflected into the medium wave windings and cause low sensitivity on both bands.

Faulty transistors can be diagnosed by voltage readings and shunting a replacement across the suspect as described before. Some idea as to the operation of the i.f. stages can be obtained by detuning each i.f. transformer in turn. There should be a sharp tuning peak in each case with the possible exception of the last one which may be damped by the detector. If it is possible to rotate the core with very little drop in volume, then the associated stage would appear to be faulty. Sometimes a stage may be completely inoperative yet low-volume results can still be obtained due to stray coupling from a preceding stage. Thus the signal 'jumps' the offending stage. Where a good peak is obtained, there is unlikely to be a fault in that part of the circuit. Restore each coil to its correct tuning point before dealing with the next.

Coming back to the ferrite rod aerial again, the

aerial coils may simply be loose on the rod and therefore out of their optimum position. Aligning and sealing will bring back the sensitivity to normal.

Mis-alignment can come about in many ways. Portable radios are obviously subject to more shock and stress than others, hence there is plenty of opportunity for coils to become loose and slip as well as coil cores to turn. If the few quick checks we have outlined here fail to come up with the answer, try re-aligning. Not only may an alignment cure the trouble, but if a circuit fault exists, aligning will often reveal it, as something does not tune up which should do.

Conventional alignment procedure calls for the use of signal generator and output meter, but the simple circuits we are dealing with here do not require these. As we have seen, speed is all important and it is quite possible to do an alignment in just a few minutes without wasting time setting up an array of equipment, by using broadcast signals and the ear. Results are little inferior to those obtained when doing it 'properly', if at all.

## ALIGNMENT

As with more conventional methods, the first step is to align the i.f.'s. A broadcast transmission should be chosen that is weak in order to avoid a.g.c. action, but it should be steady. One of the more distant BBC Home services will usually serve the purpose. Volume should be turned down to a fairly low level as the ear is more sensitive to volume changes at lower levels.

It can be assumed that the i.f. coils are already near the correct i.f. frequency, or perhaps all except one that has been affected by a fault condition which is now cleared. If it is suspected that all or most of the coils are some way out, as would be the case if the receiver had been tampered with, then a signal generator would have to be used to align to the correct i.f. frequency.

Normally though, the broadcast signal can be used. So starting with the last i.f., the cores are tuned for maximum volume. With a weak station there will be a background hiss due to the local oscillator, and as this is steady, it is often easier to listen to this for making the adjustments rather than the programme content which of course will be varying.

In most cases all i.f. coils will be peaked, but there are some that are stagger tuned. These are usually in the better type of receiver, and stagger tuning is rarely if ever found in the types we are discussing. If stagger tuned coils are peaked, then instability will most likely result. The adjustments should be repeated, especially if it was found that one coil was some way out of tune.

Now we come to the oscillator. Circuits differ widely at this point, but with the simpler portable, differences are not so great as to affect alignment much. Most circuits employ a single oscillator coil

### QUICK ALIGNMENT SEQUENCE FOR RADIOS WITHOUT L.W. OSCILLATOR TRIMMER

Tune to:	Adjust:
Weak m.w. station	3rd i.f. transformer for max. volume 2nd i.f. transformer for max. volume 1st i.f. transformer for max. volume then repeat procedure.
Radio 2, 1,500m. Radio 3, 464m. BBC West, 206m. or Radio 1, 247.	Oscillator coil for compromise dial setting Oscillator gang trimmer for correct dial setting then repeat procedure
Weak l.w. station	L.W. aerial coil for max. volume
Radio 3, 464m. or nearby weak station BBC West 206m. or nearby weak station	M.W. aerial coil for max. volume Aerial gang trimmer for max. volume then repeat procedure

### QUICK ALIGNMENT SEQUENCE FOR RADIOS WITH L.W. OSCILLATOR TRIMMER

Tune to:	Adjust:
Weak m.w. station	3rd i.f. transformer for max. volume 2nd i.f. transformer for max. volume 1st i.f. transformer for max. volume then repeat procedure
Radio 3, 464m. BBC West, 206m. or Radio 1, 247m.	Oscillator coil for correct dial setting Oscillator gang trimmer for correct dial setting then repeat both procedures
BBC 2, 1,500m.	L.W. Oscillator trimmer for correct dial setting
Weak l.w. station	L.W. aerial coil for max. volume
BBC 3, 464m. or nearby weak station BBC West, 206m. or nearby weak station	M.W. aerial coil for max. volume Aerial gang trimmer for max. volume then repeat procedure

for both wavebands. As it stands, it works the medium waveband, and for the long waveband an additional capacitor is switched in. In some cases a trimmer is switched in as well, and the alignment procedure depends on whether this trimmer is present or not.

The first thing to do then, is to look for a trimmer apart from the two appearing on the gang tuning capacitor. Sets having a bandspread medium waveband in addition to the normal medium wave, will have extra trimmers in which case they will have to be identified. This can be done by giving each a slight turn back and forth and seeing which band is affected. Oscillator trimmers tune sharply whereas aerial trimmers are flat.

Going back to the straightforward two-waveband job, if the separate long wave trimmer is present, we start with the medium wave. Tune in a station at the low frequency end of the scale (gang at maximum capacitance), the Third programme on 464 metres is suitable. Adjust the oscillator coil core to bring the station to the correct point on the scale. Now tune to the other end of the band and tune in

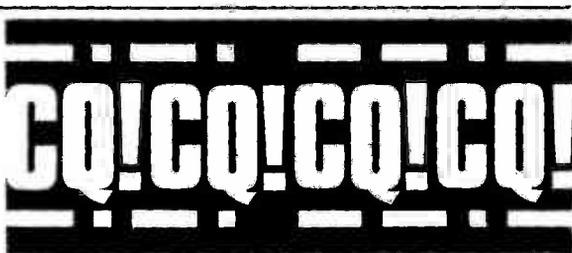
a suitable station, the West Home Service on 206 metres or Radio One on 247 metres. Adjust the oscillator trimmer on the gang for correct scale calibration. Repeat both adjustments if necessary.

Switching now to the long wave, tune in the Light programme on 1500 metres and adjust the long wave trimmer.

If there is no long wave trimmer, we start on the long wave. Tune in the Light programme and adjust the oscillator coil core to give correct scale reading. Then we switch to the medium wave and check that the Third programme or other station at the l.f. end comes in the right place. If it does not, the coil is adjusted to give a compromise between the two. With this type of set, scale markings are not very precise purposely. Next the h.f. end of the medium wave is aligned using the West programme or Radio One with the oscillator gang trimmer as in the previous case. A check will then have to be made on both l.f. end of medium wave and long wave and a re-adjustment made if needed. In practice, it will be found that the gang trimmer has very little effect on the long waveband.

Finally, the aerial circuits are lined up. Weak stations are best for this, if the ones used for oscillator alignment are weak they can be used, but if not, others nearby should be found. On the long wave, all that is required is to slide the long wave aerial coil (the largest, most likely layer wound) along the ferrite rod for maximum volume. The medium wave is aligned with the medium wave aerial coil at the l.f. end, then the aerial trimmer on the gang capacitor is used to line up the h.f. end. It is useful to remember that with both oscillator and aerial circuits, induction is used to tune the l.f. and capacitance to tune the h.f. end of a waveband.

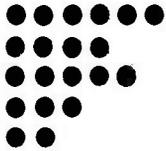
All that is needed now is to seal the coils on the rod by melting wax over them and so complete an economical repair. ■



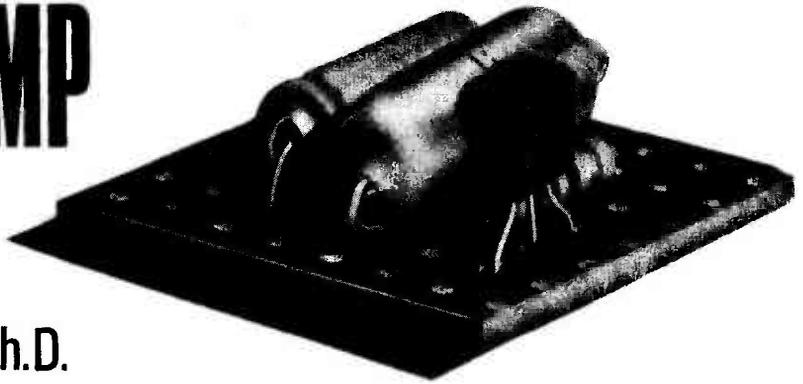
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# F.E.T. PREAMP



W.T. MORRIS B.Sc., Ph.D.



THE matching of ceramic and crystal pickups to transistorised amplifiers often presents a problem to the constructor. The outputs of these transducers, in common with those of crystal microphones, most valve pre-amplifiers and valve f.m. tuners, must be fed into amplifiers with input impedances of  $1M\Omega$  or higher in order to achieve good bass response and a low background noise level. This requirement is easily met with valved amplifiers, but not with most transistorised designs, which have input impedances of a few kilohms only. Remedies such as inserting a high resistance in series with the amplifier input are generally unsatisfactory, since most of the signal is lost, especially the treble frequencies, and the signal to noise ratio is usually very poor.

The achievement of high input resistances with "ordinary" bipolar transistors, even silicon types, demands a fairly complex circuit (see Fig. 1), and even then noise levels can be high, particularly if "cheap" transistors of doubtful origin are used.

Field Effect Transistors (f.e.t.'s) offer an ideal solution to this problem. They have an extremely high input impedance and a very low noise level when driven from a high impedance source such as a ceramic or crystal cartridge. Also, their cost is now low enough to make them a most attractive proposition for the Hi-Fi enthusiast and experimenter. Figure 2 shows a simple circuit using an N-channel f.e.t. Note that this requires a positive voltage supply, like an n-p-n transistor. The input impedance is over  $2M\Omega$ , as recommended by the manufacturers of such cartridges as the "Deram" 9TAHC, CS90 etc. The performance of the circuit is excellent.

The high frequency response extends into the radio-frequency range. (A roll-off at ultrasonic frequencies above 20KHz can be arranged if required simply by adding a resistor R1 of  $330k\Omega$  to  $1M\Omega$  as close as possible to the pre-amp. input). Distortion is very low, rising to one per cent only at signal levels of 1.5V to 2V r.m.s. Noise is so low as to be virtually unmeasurable: this feature alone makes the slight extra cost of f.e.t.'s seem worthwhile!

The output voltage of the pre-amp. is typically nine-tenths of the input, i.e. there is a ten per cent loss of voltage. However, it is *current* gain that we require here, and this is of the order of 1,000 times. In conjunction with the f.e.t. pre-amp., the 300mV maximum output of a typical valve f.m. tuner would appear as about 250mV into the load of  $2k\Omega$  provided by the input of a transistor power amplifier. In other words, the *current* output of the tuner,  $0.3/2 \times 10^6$  amps., i.e.  $0.15\mu A$ , is amplified by the

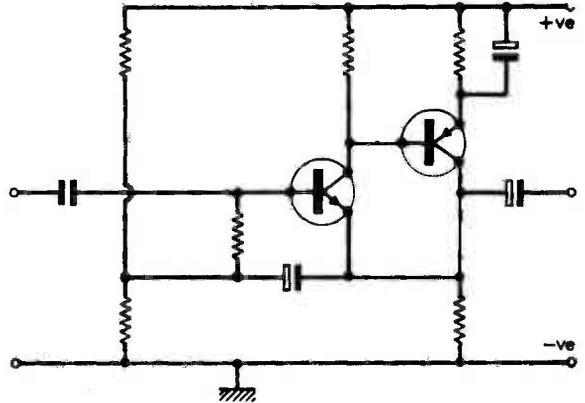


Fig. 1: The circuit configuration necessary for achieving a high impedance using bipolar transistors.

f.e.t. pre-amp. to a current of  $0.25/2 \times 10^8$  amps., i.e.  $0.125mA$ , a current gain of 800 times! Without the aid of the f.e.t. pre-amp., the f.m. tuner could supply only a few millivolts to the power amplifier; bass frequencies would be lost, and there would probably be a high level of background noise.

## CONSTRUCTION

The pre-amp. is readily accommodated on a piece of 0.15in. matrix "Veroboard", 8 holes (about  $1\frac{1}{2}$ ins.) square. Figure 3 gives a convenient layout. Connect the resistors first, then the capacitors, and lastly, the f.e.t. Do not shorten the leads of the transistor, and observe the usual precaution of gripping them with pointed-nosed pliers or crocodile clip while soldering. to avoid overheating the transistor. All connec-

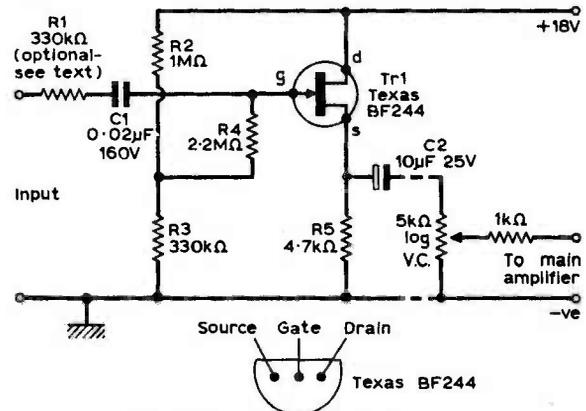


Fig. 2: The circuit of the f.e.t. preamp.

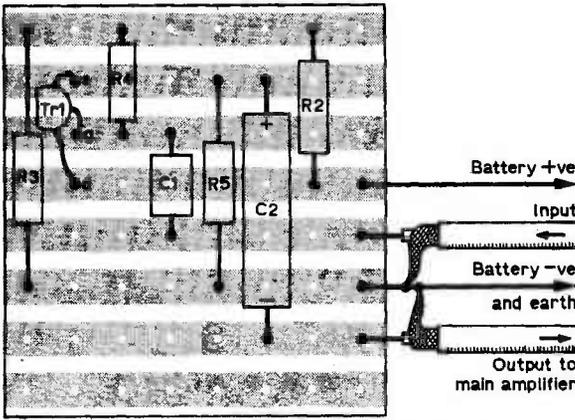


Fig. 3: The component layout on Veroboard.

tions to the pre-amp. can be made using the spare row of holes at the edge of the board remote from the f.e.t., again, of course, completing the job quickly to avoid overheating the components. Note that if an f.e.t. different from the one suggested is tried in the circuit, the base connections may not be in the same order as given in Fig. 2, the correct connections for the particular type must of course be known with certainty if an expensive mistake is to be avoided!

The values of the capacitors are not critical. Any value between  $0.01\mu\text{F}$  and  $0.1\mu\text{F}$  will do for C1: miniature polyester types with voltage ratings of 100V to 400V are especially suitable. C2 should not be less than  $8\mu\text{F}$  to avoid any loss of bass: on the other hand there is nothing to be gained by using values above  $25\mu\text{F}$  for audio signals. A voltage rating of 25V is adequate for C2.

## POWER SUPPLY

A negative-earth power supply of 18V to 24V at 1 to 2mA is required. The exact value of the current drain will depend on the particular f.e.t., but the circuit is designed to compensate to a large extent for transistor variations. Two 9V batteries connected in series can be used, and large types such as the PP9 will have a very long life even when supplying current to a pair of pre-amps. in a stereo set-up. If a mains power pack is used, it must be very well smoothed, and decoupling capacitors of  $1,000\mu\text{F}$  are recommended if the main amplifier's power supply is used. (Before attempting to use the main amplifier's power pack, check that it is of the correct polarity, i.e. it *must* be positive, with the negative line earthed.)

## CONNECTION AND MOUNTING

Input and output connections should be made with screened microphone lead, the input lead being kept short to avoid hum pick-up. The pre-amp. fits

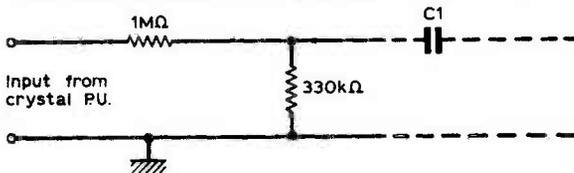
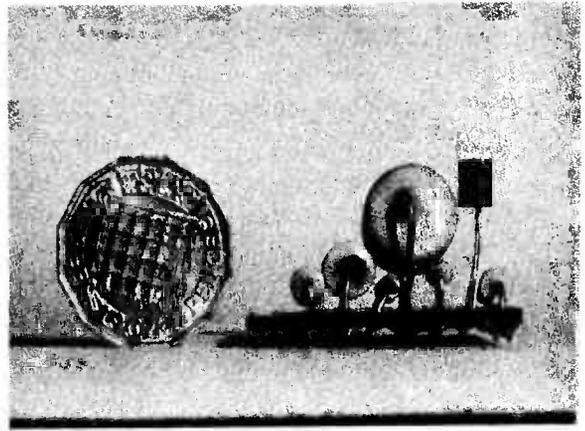


Fig. 4: The circuit of the attenuator necessary when high output cartridges are used. The actual value of the unmarked resistor will depend upon the attenuation required.



When built on a small piece of Veroboard the complete unit is very small.

neatly into a matchbox, and an ideal mounting position is near the tag-strip under a record-player deck. The output lead can be up to 20ft. long, and likewise there is no restriction on the length of the battery leads. If hum is troublesome, it can usually be cured by wrapping the matchbox in aluminium cooking foil, and earthing the foil.

The circuit given in Fig. 2 will handle signals of at least 1.5V r.m.s., and will therefore accept the outputs of low and medium-output cartridges. Some crystal cartridges, however, give more than 250mV per cm per sec recorded velocity (i.e. maximum outputs of more than 2.5V r.m.s. are possible). In such cases, an attenuator should be fitted as shown in Fig. 4. This will be necessary only if the output of the cartridge is quoted as being 200mV/cm/sec or more. The use of a volume control, a 1 or  $2\text{M}\Omega$  log. potentiometer, across the input is also possible: if this is done the pre-amp. must be positioned as close to the volume control as possible to minimise loss of treble frequencies. It is normally preferable to place the volume control across the output of the pre-amp., i.e. across the input of the power amplifier, a 5 or  $10\text{k}\Omega$  log. potentiometer being suitable.

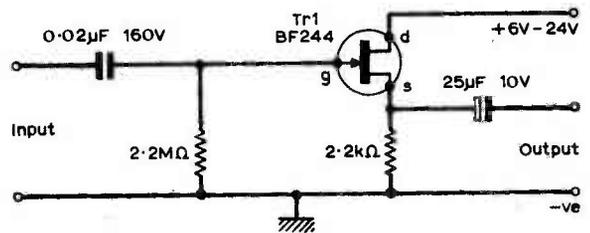


Fig. 5: An even simpler circuit for an f.e.t. preamp.

## A SIMPLER CIRCUIT

The even simpler circuit of Fig. 5 can be used with lower supply voltages, down to 6V if required. However, the current drain varies widely according to the particular f.e.t. sample, and if the current is found to be less than 0.7mA, the attenuator of Fig. 4 will be necessary even with low-output cartridges (50-80mV/cm/sec), though not with f.m. tuners and crystal microphones. The circuit of Fig. 5 is therefore ideal for use with these latter sources, and has the advantage of being insensitive to quite large amounts of ripple on the power supply.

SUMS

plus

CIRCUITS

equals

UNDERSTANDING

# PART 1

LESLIE MOORE

**B**UILDING electronic circuitry can be an extremely interesting and worthwhile past time. The functions of many of these circuits can be explained in simple terms, provided a basic knowledge of component operation has been attained. More complex circuits, however, cannot be described so precisely and an alternative exact method must be found.

Mathematics can provide a means of describing a circuit function, can be used to determine exactly how a circuit will operate under all conditions and must be used in design techniques, again, assuming an understanding of component operation with, of course, the availability of relevant component data.

The aim of this series is to introduce the reader to several basic mathematical theorems and explain the applications of these theorems to electronic circuitry.

## Algebraic Manipulation

One of our aims should be to be able to predict the operation of a circuit given any necessary manufacturer's design data for the components used. A simple example of the use of algebraic manipulation is in the determination of the gain of a thermionic triode amplifier stage, of which a circuit diagram and an equivalent circuit are shown in Fig. 1.1. The equivalent circuit considers the operation of the amplifier under signal conditions. Internal resistances of the h.t. power supply are assumed negligible compared with other resistances in the circuit, hence the effective signal output voltage is developed across  $R_L$ . The value  $r_a$ , or "anode resistance" is the effective resistance of the valve under given bias conditions, and  $\mu$ , or "amplification factor," is the ratio by which the valve will amplify a signal applied to the grid.

Quantities  $r_a$  and  $\mu$  are supplied in manufacturer's data, but they can be measured. Voltage gain of the amplifier,  $A$ , is defined as output voltage,  $V_o$ , divided by input voltage,  $V_g$ , or:-

$$A = \frac{V_o}{V_g}$$

The valve is represented by a voltage generator in the equivalent circuit, producing a voltage of  $\mu V_g$ . Therefore the amplifier output voltage will only be a fraction of  $\mu V_g$ . Considering Kirchoff's law (explained in detail later) which states that the sum of potentials in a circuit is zero, then :

$$-V_a - V_o + \mu V_g = 0$$

$$\text{or } \mu V_g = V_a + V_o \dots \dots \dots (1)$$

This equation is obtained from: the equivalent circuit because of the potential directions (indicated by arrows). A simple rule is :

Follow current direction in the circuit. For all those potential arrows opposing current flow, subtract; for all those in the same direction as the current, add.

From Ohm's Law

$$V_a = i_a r_a \dots \dots \dots (2)$$

$$\text{and } V_o = i_a R_L \dots \dots \dots (3)$$

substitute equations (2) and (3) in equation (1) gives  $\mu V_g = i_a r_a + i_a R_L$

Because both  $r_a$  and  $R_L$  are multiplied by  $i_a$ , this equation may be re-written as

$$\mu V_g = i_a (r_a + R_L) \dots \dots \dots (4)$$

Now, we wish to determine a relationship between  $V_o$  and  $V_g$ .

Equation (3) states that  $V_o = i_a R_L$  and equation (4) states that  $\mu V_g = i_a (r_a + R_L)$ .

To obtain a relationship for  $V_g$  alone, we divide both sides of equation (4) by  $\mu$  to give

$$V_g = \frac{i_a (r_a + R_L)}{\mu} \dots \dots \dots (5)$$

By dividing equation (3) by (5) the required result:

$$\frac{V_o}{V_g} = \frac{i_a R_L \mu}{i_a (r_a + R_L)}$$

or, because the effect of  $i_a$  cancels:-

$$\frac{V_o}{V_g} = \frac{\mu R_L}{r_a + R_L} = A \text{ (Voltage gain of the amplifier)}$$

From the above example it can be seen that algebraic manipulation can be broken down into three parts which are:

- (1) Developing an equivalent circuit to represent a circuit under its working conditions.
- (2) Deriving equations from the equivalent circuit.
- (3) Manipulating the derived quantities into the required form.

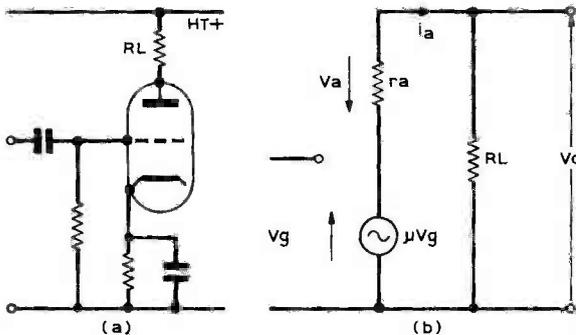


Fig. 1.1 (a) Typical amplifier circuit.  
(b) Equivalent circuit.

Firstly, a familiarity with electronic components and their principles of operation is an important factor. Numerous text books give many standard equivalent circuits, but a good understanding of how these are obtained will prove to be an asset.

Secondly, the derivation of equations from an equivalent circuit requires a knowledge of the more common network theorems, a précis of which is given here:

(1) OHM'S LAW:

The voltage  $V$ , developed across a resistance  $R$ , is directly proportional to the current  $I$ , flowing through that resistance. (see Fig. 1.2).

(2) KIRCHOFF'S LAWS, of which there are two:

(A) The sum of the currents flowing into a junction must equal the currents flowing away from it. (see Fig. 1.3 (a) ).

(B) As before, the total sum of potentials in a circuit is zero. (see Fig. 1.3 (b) ).

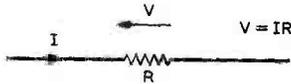


Fig. 1.2: Ohm's Law.

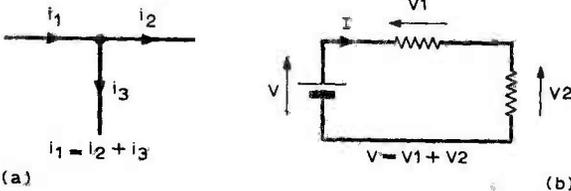


Fig. 1.3: (a) Kirchhoff's Law A.  
(b) Kirchhoff's Law B.

(3) METHOD OF MESH CURRENTS:

Derived from Kirchoff's Laws but, in fact, can provide a simpler solution to complex problems.

(4) THEVENIN'S THEOREM:

This is used for determining the current flowing in a branch of a network and is applied in the following manner:

- Make a break in the branch in question.
- Determine the voltage which would appear across the break.
- Reduce all sources of e.m.f.'s. (or voltages) to zero and replace them by their internal resistances.
- Determine the impedance looking into the break.
- Divide the result of (b) by the result of (d) to give branch current.

An example of the use of Thévenin's Theorem is given in Fig. 1.4.

Example:

Determine the current  $i_2$  shown in Fig. 1.4(a)

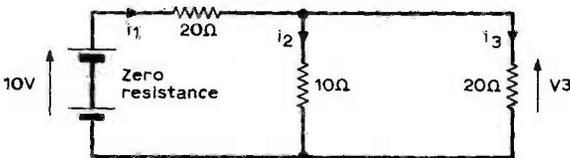


Fig. 1.4: (a) Current  $i_2$  unknown.

Step (a)

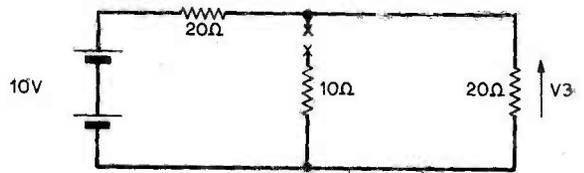


Fig. 1.4: (b) Make a break in the branch.

Step (b) There is now no current in the 10Ω resistor so the voltage looking into the break is equal to  $V_3$

$$V_3 = \frac{20}{20+20} \times 10 \text{ Volts} = 5 \text{ volts.}$$

Step (c)

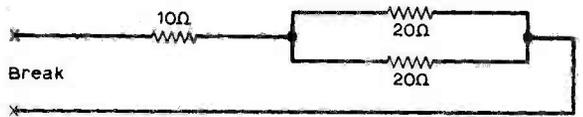


Fig. 1.4: (c) Determine the resistance looking into the break, voltages reduced to zero.

Step (d)

$$\text{Resistance} = 10\Omega + \frac{20 \times 20}{20+20} = 20\Omega$$

Step (e)

$$i_2 = \frac{5}{20} = \frac{1}{4} \text{ Ampere (250mA)}$$

(5) NORTON'S THEOREM

This is similar to Thévenin's Theorem but uses equivalent constant current generators.

Such a list could be used to include many more complex theorems, however, if those mentioned were understood completely they would provide a good background to enable the formation of mathematical equations from circuitry.

Thirdly, the manipulation of equations obtained. This may be broken down into three logical steps:—

- What is the problem, or what is to be found?
- Which pieces of information are required to solve the problem?
- How should the equations be manipulated to give this information?

To demonstrate them consider the further example of a transistor amplifier stage using the standard hybrid parameter equivalent circuit as shown in Fig. (1.5).

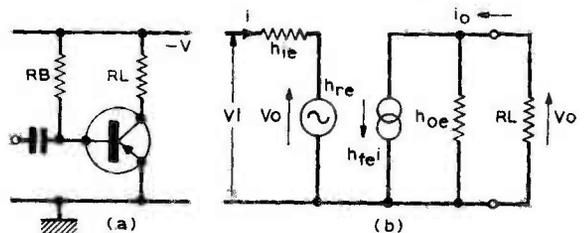


Fig. 1.5 (a) Typical amplifier circuit.  
(b) Equivalent circuit neglecting biasing resistor.

From the equivalent circuit which employs voltage and current generators to represent the inherent characteristics of the transistor, the following equations may be derived.

$$V_i = ih_{ie} + h_{re} V_o \dots\dots\dots(1)$$

$$V_o = -i_o R_L \text{ (due to current direction)} \dots\dots(2)$$

$$i_o = ih_{fe} + V_o h_{oe} \dots\dots\dots(3)$$

Note that the units of  $h_{oe}$  are those for conductance or the inverse of resistance.

Suppose we wish to know the input resistance of the circuit (i.e. at a frequency where capacitive components have negligible reactance to the signal). From Ohm's Law, the input resistance to the circuit is given by the relation:

$$r_i = \frac{V_i}{i}$$

Equation (1) gives an equation containing both  $V_i$  and  $i$ , but  $V_o$  is also present. Therefore we must substitute other quantities to give a relation between input resistance and other circuit constants: From equation (2) we have

$$V_o = -i_o R_L$$

and from equation (3)

$$i_o = h_{fe} i + V_o h_{oe}$$

Substituting for  $i_o$  in (2) gives

$$\begin{aligned} V_o &= -R_L (h_{fe} i + V_o h_{oe}) \\ \therefore V_o (1 - R_L h_{oe}) &= -R_L h_{fe} i \\ \therefore V_o &= \frac{-R_L h_{fe} i}{(1 + R_L h_{oe})} \dots\dots\dots(4) \end{aligned}$$

Substituting equation (4) in equation (1) gives

$$\begin{aligned} V_i &= ih_{ie} - \frac{R_L h_{fe} h_{re} i}{1 + R_L h_{oe}} \\ \therefore V_i &= i \left( h_{ie} - \frac{R_L h_{fe} h_{re}}{1 + R_L h_{oe}} \right) \quad (1) \\ \text{or } \frac{V_i}{i} &= r_i = h_{ie} - \frac{R_L h_{fe} h_{re}}{1 + R_L h_{oe}} \end{aligned}$$

Thus giving the relationship required.

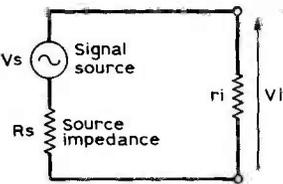


Fig. 1.6: Determination of true input voltage,

Fig. 1.6 shows the importance of being able to determine an amplifier input resistance. All signal sources will have an output impedance which can be represented as a series impedance with the source. The actual amplifier input voltage  $V_i$ , will then be only a fraction of the signal source voltage  $V$ .

Then the amplifier input voltage will be given by:

$$V_i = \frac{r_i}{R_s + r_i} V$$

The usefulness of algebraic manipulation applied to circuits does not end here. It is hoped, however, that these examples have served as a good introduction and that further articles will help give a complete picture of how mathematics can become another tool of the enthusiast.

**TO BE CONTINUED**

# AUDIO LIMITER

**R. F. GRAHAM**

FOR short wave reception and personal listening, headphones are frequently used. The output stage of communications type and other receivers will provide enormously more volume than required, so that almost continuous manipulation of the audio gain control is required. Even then, while tuning or listening, bursts of interference, or powerful transmissions, can be very uncomfortable when searching for weaker signals.

This discomfort, and the need for much adjustment of the receiver volume control, can be eliminated by the audio limiter circuit in Fig. 1. Audio is taken from the usual phone outlet of the receiver.

The series resistor R1 limits power reaching the diodes with very strong signals. The diodes conduct to clip positive and negative audio peaks, the residual amplitude depending largely on the diode resistors R2 and R3. The potentiometer VR1 allows a suitable signal level to be taken off for the phones.

The components may be wired on a small panel, or in a box, with twin leads and a jack plug to provide the audio input from the receiver. The phone jack plug is inserted in a socket on the limiter.

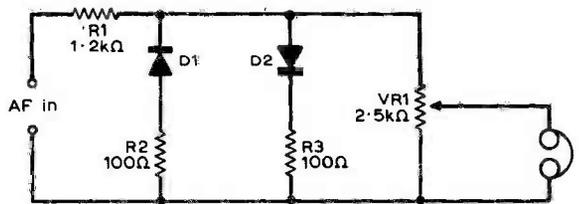


Fig. 1: Limiter for high impedance headphones.

Tune in a signal, adjust the receiver volume control until distortion commences, and turn it back somewhat from this point. VR1 is then adjusted for the required headphone volume. It will then be found that headphone volume does not increase if the receiver gain control is advanced, though there is a deterioration in audio quality due to the clipping action. For most signals the receiver volume control can be left in a suitable middle position, giving enough volume with weak transmissions, without serious loss of quality on strong transmissions. The circuit also limits some types of static and similar interference.

Values in Fig. 1 were for high impedance phones. Values could easily be modified if necessary. D1 and D2 were GD9 or OA91 diodes. Others are suitable.

Where output is taken from an extension circuit attached to the secondary of a speaker transformer, and the speaker is out of use, a 10Ω or similar 1-watt resistor may be connected across the a.f. input points, this provides some loading to reduce a.f. peak voltages in the transformer primary. ■

# LETTERS

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

## Space signals

I cannot agree with Mr. R. Hall, Cornwall that we shall not receive signals from other planets. We can, and do receive signals from the planet Jupiter.

Unintelligible signals, but signals nevertheless, which can be picked up on any domestic receiver, which covers the 21 to 14 metres band.

Electrical or magnetic storms in the atmosphere of Jupiter are thought to be the cause of the signals received.

Other rich sources are the Crab Nebula, and the galaxy Andromeda.

The simplest form of radio telescope could be a television set with directional aerial, steerable and used when the local stations are off the air.

For those who would like to take up this absorbing branch of radio, there are excellent text books in your local libraries, giving constructional details of receivers which are quite easy to construct and operate, together with details of galaxies to search, frequencies, etc.

Who knows, some day or night, we may receive the kind of signals, from many light years away, to reawaken us to revise our whole concept of life as we know it.—E. Furlong (*Cheshire*).

## Points of view

After reading the letter in your December issue from Mr. E. W. Baigent on the "old days," I became rather dissatisfied with putting "supplied components into holes in a printed circuit board." It seems that construction today is a rather automatic process—I wonder how many of your readers would ever dream of modifying any of your circuits other than by changing slightly the odd capacitance or resistance value. It seems that individuality is a thing of the past—I am no exception to this.

I find it rather harder to agree with his other points, however. One of the greatest and most constantly overlooked needs in electronics is that of standardisation, ("Practically Wireless" No.

63, December issue). In the case of "c.p.s.," what would that mean to a Frenchman or a German? Once established, the use of a name tends to become international and readily understandable to many more people.

As for the new colour coding, this is another example of international standardisation. The colours now coming into use are of necessity a compromise. Though the use of red for live would have been very desirable from our point of view, quite a large number of Continental firms had until recently been using red for earth! In any case, brown is not very far removed from red, and if we remember that on mains wires, the only two-tone wire is the earth, it takes very little adjustment to adapt ourselves to the new system.

The case for the Hertz is very debatable, I agree, but the new wiring takes into account people's lives, no mean commodity, in this country and abroad; we should be glad to have at last an acceptable compromise, and think before we shout.—A. L. McLeish (*Durham*).

## What, no chips?

Much has been written on the subject of Integrated Circuits (Chips) and I would like to add my own comments.

Having purchased one with the intention of making a record player amplifier, I was amazed at the difficulty of setting it up. One is obliged to experiment with component values and to add this and that to prevent instability. Really, it is reminiscent of tinkering with a regenerative receiver to make it operate correctly!

The small physical size of these chips seems to me to be of no advantage as they need quite a few added external components including large electrolytic capacitors.

Cost-wise too, there is no advantage. For the cost of constructing a 5W mono amplifier using a "chip," I am able to build the P.W. Double 12 in mono which gives 12W (both powers in r.m.s.). I refer to constructing the respective chassis without cabinet

trimmings etc. If the integrated circuit amplifier goes wrong, I have to purchase a new chip but if my P.W. Double 12 packs in, I pay, at the most, a few shillings for a new component.

I do not think "chips" pose any threat to our fascinating hobby and to those constructors like myself, who like to build equipment from scratch.—Frank Casson (*Teesside*).

## No Denial!

Re Mr. R. Hall's letter in the January issue, I well remember that towards the end of the active career of Marconi, the newspapers reported that when he was cruising on his yacht 'Electra' in the Mediterranean, some mysterious long wave signals were being received by him. The reports were really quite reserved. Their general tone was: 'where do the peculiar wireless signals received by Marconi, come from?' A few went further and mentioned the possibility of Mars!

Though Marconi did not actually claim they *did* come from Mars, he in no way said they did not! "He would investigate further."—A. Trowbridge (*Middlesex*).

## PRACTICAL WIRELESS QUERY SERVICE

Before using the query service it is important to read the following notes:

The PW Query Service is designed primarily to answer queries on articles published in the magazine and to deal with problems which cannot easily be solved by reference to standard text books. In order to prevent unnecessary disappointment, prospective users of the service should note that:

(a) We cannot undertake to design equipment or to supply wiring diagrams or circuits, to individual requirements.

(b) We cannot undertake to supply detailed information for converting war surplus equipment, or to supply circuitry.

(c) It is usually impossible to supply information on imported domestic equipment owing to the lack of details available.

(d) We regret we are unable to answer technical queries over the telephone.

(e) It helps us if queries are clear and concise.

(f) We cannot guarantee to answer any query not accompanied by the current query coupon and a stamped addressed envelope.

# MEDIUM WAVE DXING

CHARLES MOLLOY

**I**NTEREST has been growing recently in the medium waves. DXers who look for something different, something more exacting or who are simply curious to sample local broadcasting from other parts of the world are turning to the 'broadcast band'. The medium waves do offer a real challenge. In Europe the main problem is interference: several hundred stations broadcast on unauthorised frequencies or use excessive power. Many are on the air 24 hours a day, so the band is never quiet after dark. Directional aerials help to counteract the problem. Loop antennas, based on the frame aerial that was popular in the early days of radio are now standard equipment for the majority of MW DXers. The second problem is knowing the right time to listen. Most parts of the world, with the exception of Australasia, can be logged at some time of the year. The hobby is not seasonal and is not restricted to the winter months. All that is required for success is a path of darkness between transmitter and receiver and of course, favourable propagation conditions. Broadly speaking the best DX to be had in the UK will be trans-equatorial in summer and from the northern hemisphere in winter. The Far East is only heard in winter while stations in East and South Africa are usually only logged in summer. There is no lack of stations, in fact there are many more of them on the medium waves than on all of the Short Wave broadcast bands put together—over 5000 in the United States alone. Canada, United States, Caribbean, Central and South America, Africa, Near East, India, China and Japan, have all been logged on numerous occasions by DXers in this country.

## PROPAGATION

The medium waves are used almost exclusively for local broadcasting, propagation being by ground wave. During the daytime the sky wave is absent since high angle radiation is absorbed by the lowest part of the ionosphere—the 'D' layer. This layer disappears at sunset enabling refraction from higher regions to take place; even vertical radiation is returned. The sky wave interferes with the ground wave to produce severe fading in areas where the two are comparable in strength. As distance increases from a MW transmitter, an area is reached where selective fading and distortion occur after dark limiting the useful night-time range of the transmitter. The ground wave diminishes in strength as the distance from the transmitter increases and finally it disappears. Beyond this point after dark, only the sky wave can be received, we are now out of the normal service range of the transmitter and the signal is becoming DX.

Anti-fading aerials are used by large numbers of medium wave transmitters. This type of aerial, which is a vertical, puts out maximum signal at low angles to the horizon and minimum signal at high angles. The reduction in high angle radiation reduces the amount of sky wave into the service area, con-

sequently fading decreases and the night-time range is extended. Low angle radiation is of great interest to the DXer. It enters the ionosphere at a shallow angle and can travel up to 1500 miles in a single hop after reflection by the 'E' layer. Often it continues for thousands of miles in successive hops when propagation is favourable. Conditions on the medium waves are more variable than on the short waves, a factor which frequently causes disappointment to the newcomer. Persistence and patience are the qualities required of the MW DXer. If you do not hear North America at the first attempt then try again a few days later. If conditions are poor they are unlikely to remain so for long.

## AERIALS

No serious MW DXer would be without a loop (Fig. 1). This type of aerial is directional, maximum pick-up is along the plane of the windings, minimum pick-up is along a line at right angles to the windings. The depth of the null (degree of signal suppression) depends on the electrical balance of the windings so it is important that they should be symmetrical. The loop is very simple to use. Tune in a station on the receiver, peak it with the loop tuning control and rotate the loop for optimum reception. Frequently it is possible to null-out different stations on the same frequency e.g. on 1070kHz CBA in Canada can sometimes be heard free of interference if the null is pointing towards LR1 in Buenos Aires and similarly LR1 can be heard with CBA nulled-out. There are additional benefits to be had from a loop. Static is reduced, in early summer when much of it comes from thunderstorms to the south, it can be eliminated when listening to the west. Overloading and cross-modulation are reduced leading to the unlikely, but quite correct, claim that audio quality is sometimes better when using a loop. Direction finding can be a help to station identification. Turn the loop until the unidentified station disappears, when its direction will be along a line at right angles to the windings. The 40in. loop is a compromise between pick-up and convenience. A larger loop will have greater pick-up. Alternative sizes can be constructed using approx. 100ft. of plastic covered wire of about 22 s.w.g. for the main winding which should be wound to a whole number of turns. If the loop will not tune to the h.f. end of the band there are too many turns. If it will not tune to the l.f. end then add turns or increase the value of the tuning capacitor.

If anyone has space to erect a long wire aerial several wavelengths long he will find it is directional along the length of the wire and the pick-up will be far greater than that of a loop. DXers in New Zealand achieve remarkable results using long wires. Few of us in this country will have the space for this type of aerial and it is doubtful if one would be of value in the presence of strong QRM. No-one should be deterred from DXing on the medium waves through lack of an outside aerial. The

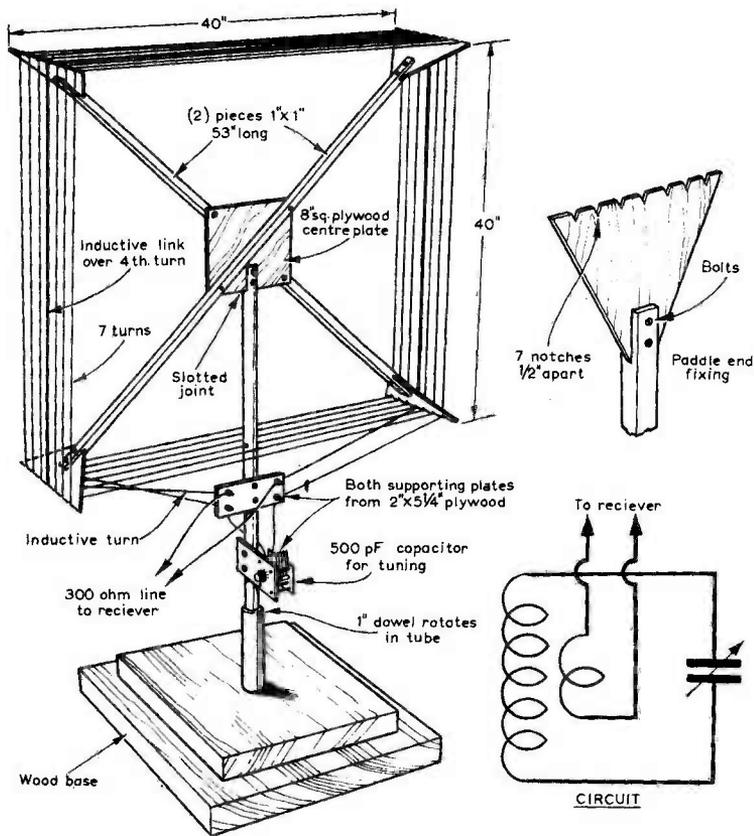


Fig. 1: The loop aerial.

ordinary TV aerial gives excellent results when used in conjunction with a good earth at the receiver. Connect the inner wire of the co-ax downlead to the aerial socket and earth the outer braiding. In some locations better results will be obtained by using the co-ax outer as the aerial.

## DXING

Winter is the time of year for Asiatic stations and there are three periods of the day when reception is possible. The first is in the afternoon from approx. 1500hrs to 1700hrs GMT. Stations heard recently include Taiwan on 750kHz; Bagdad (760); Teheran (895); Iran (985); Anwei, China (940); Peking (1000); Calcutta (1130) in English 1530 to 1600hrs; Philippines (1140); VOA, Okinawa (1178); Korea (1190); Kabul, Afghanistan (1280); China (1290); Teheran (1325); Kuwait (1345). The second period is in the evening from 2000hrs onwards:—Saudi Arabia (588); Jerusalem (677); Aleppo, Syria (746); Amman, Jordan (800); Beirut (836); Bagdad (908); Damascus (957); Diyakir, Turkey (1061); Haifa (1205). The last period is after midnight when stations in India are sometimes logged. The easiest is Rajkot 1070kHz but others have been heard on 910, 1020, 1060, and 1330.

North Americans can be heard throughout the year. In summer those along the east coast of Canada and the United States are audible for an hour before sunrise and are usually free of interference since the greater part of Europe is in daylight at this time. During the winter stations from this area appear regularly after 2300hrs GMT, the time when most Europeans sign-off for the night. If conditions are favourable the following should be heard between 2300hrs and midnight:—WOR (710) and

WINS (1010) in New York City; WHDH (850) Boston; CBH (860) Halifax, Nova Scotia; CJON (930) St John's, Newfoundland; CBA (1070) Moncton, New Brunswick; WBAL Baltimore on 1090. More stations appear as the night progresses but at 0300hrs when Eastern Europeans sign-on QRM starts to become troublesome. The following may be heard during this period—WNBC (660), WABC (770), WCBS (880), WHN (1050), and WNEW (1130) all in New York City; CHER (950) Sydney, N.S.; CHNS (960) Halifax; KDKA (1020) Pittsburg; WOWO (1190) Fort Wayne, Indiana; WKBW (1520) Buffalo N.Y.; WCKY (1530) Cincinnati Ohio.

South American stations are at their best in summer. From June to September (when it is winter in the southern hemisphere) during the two hours before sunrise, look for stations from the deep south and the east of the continent such as CX16 (850) *Radio Carve*, Montevideo Uruguay; PRF4 (940), PRE8 (980) and PRE3 (1180) *Radio Globo*, Rio de Janeiro; PRB9 (1000) *Radio Record* in Sao Paulo; CB106 (1060) *Radio Minería* in Santiago de Chile; OAX41 (1320)

*Radio Cronica* Peru. These are but a few of the stations that can be heard and sometimes they come roaring in, especially the Brazilians.

In winter, the Caribbean area and parts of South America are heard regularly after midnight including YVKS (750) *Radio Caracas* Venezuela; Jamaica also on 750 in English; Georgetown, Guyana (760); PJB (800) Bonaire; WKVM (810) in Spanish, and WBMJ (1190) in English of San Juan, Puerto Rico; *Radio Caribbean* (840) St. Lucia in French; *Radio Belize* (835) British Honduras; LR3 (950) *Radio Belgrano* and LR1 (1070) *Radio el Mundo*, both in Buenos Aires; HJHN (960) Barranquilla, Colombia; PJD2 (1295) St Maartin (in Dutch and English).

During the late evening in winter look for the following West Africans:—Tenerife, Canary Islands on 620 and 894; Monrovia, Liberia (629); *Radio Sahara* (656) in Spanish Sahara; Dakar (764) in Senegal; Luanda, Angola (1088); Conakry, Guinea (1403); Funchal, Madeira (1529). Conakry broadcasts in French and is often quite strong at 2300hrs. In summer, the following have been logged from East and South Africa between 0200 and 0400hrs:—Dar es Salaam, Tanzania (638); Lourenco Marques, Mozambique (917); Kitwe, Zambia (1070); Pretoria (1268); Johannesburg (1286).

Medium wave stations in Europe are spaced 9kHz apart while in other parts of the world, including North America, they are usually on 'channels' 10kHz apart. Co-incidence occurs every 90kHz, namely on 620, 710, 800, 890, 980, 1070, 1160, 1250, 1340, 1430, 1520 and exceptionally, 1570kHz. This set-up is significant; if a European DXer wants to listen to North America he will find it easier if he listens on those sections of the band

—continued on page 965

# radioactivity DETECTOR

L. McNamara



THE high voltage required to operate geiger tubes in portable equipment is usually obtained from h.t. batteries. This article describes a method for operating one of these tubes from a 7.5V battery and eliminates the need for rather large and cumbersome power supplies. The pulses produced by the radioactive particles are heard as "clicks" in the loudspeaker or, if the constructor so wishes, they can be fed into a scaler and counted in this way.

Referring to the circuit diagram, Fig. 1, it can be seen that basically the design consists of a static inverter followed by a voltage doubler circuit to give the high tension required to operate the tube. The inverter is an astable multivibrator with regeneration provided by R3 and R4. The primary of the transformer forms the load for Tr1 and Tr2 while resistors R1 and R2 ensure that the transistor leakage current is kept to a minimum.

For correct operation of the tube 400V is required. If the voltage is too low the tube will fail to trigger when a radioactive particle enters it. If on the other hand it is too high a continuous discharge will take place. To control this voltage a 100Ω pre-set resistor was inserted between one terminal of the battery and the inverter and this can be adjusted to give the correct operating voltage on the tube.

Whenever a radioactive particle enters the tube it ionises some of the gas particles. The negative ions produced in this way will move towards the anode while the positive ions move to the cathode. Some of these charged particles accelerated by the high voltage will collide with other gas molecules causing further ionisation and so a rapid discharge of the tube follows. This pulse is taken from across R5 and fed via C3 to the transistor amplifier. R6 acts as a buffer resistor to limit the current drawn from the geiger tube. If too much current were drawn then the voltage across C2 would drop below 400V with the result that if a number of particles

were to follow in quick succession some would fail to register.

The super alpha pair Tr3 and Tr4 further increase the input impedance of the amplifier and biasing resistors were found to be unnecessary as the input pulse was of a sufficiently high amplitude to bias the transistors on. In the absence of a pulse no current flows through Tr3 and Tr4. Consequently the voltage across R7 will be virtually zero and this ensures that Tr5 is biased off and so no current flows through the loudspeaker. When the tube is triggered the negative going pulse biases Tr3 and Tr4 on, and the current flowing through them causes a voltage drop across R7 which in turn biases Tr5 on and this gives rise to a 'click' in the loudspeaker.

Some constructors may find the pulse amplifier

## ★ components list

### Resistors:

R1	470 Ω	R5	2.2M Ω
R2	470 Ω	R6	330k Ω
R3	2.2k Ω	R7	4.7k Ω
R4	2.2k Ω	VR1	100 Ω preset

### Capacitors:

C1	0.1 μF 250V	C3	0.05 μF 250V
C2	8 μF 450V		

### Semiconductors:

Tr1	2N2926	Tr4	OC81
Tr2	2N2926	Tr5	2N2926
Tr3	OC81	D1, D2	BY100

### Miscellaneous:

Geiger tube type CV2247 (G5H)†; Loudspeaker 30 Ω to 80 Ω type; Transformer type MT98, primary 0-250V, secondary 9.0-9V†; copper laminate printed circuit board etc.

† Available from Henry's Radio Ltd.

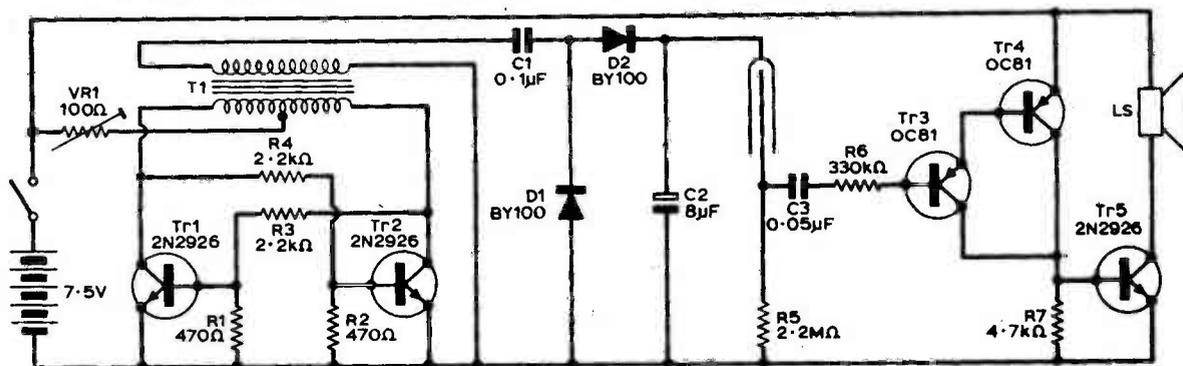


Fig. 1: Circuit of the radioactivity detector.

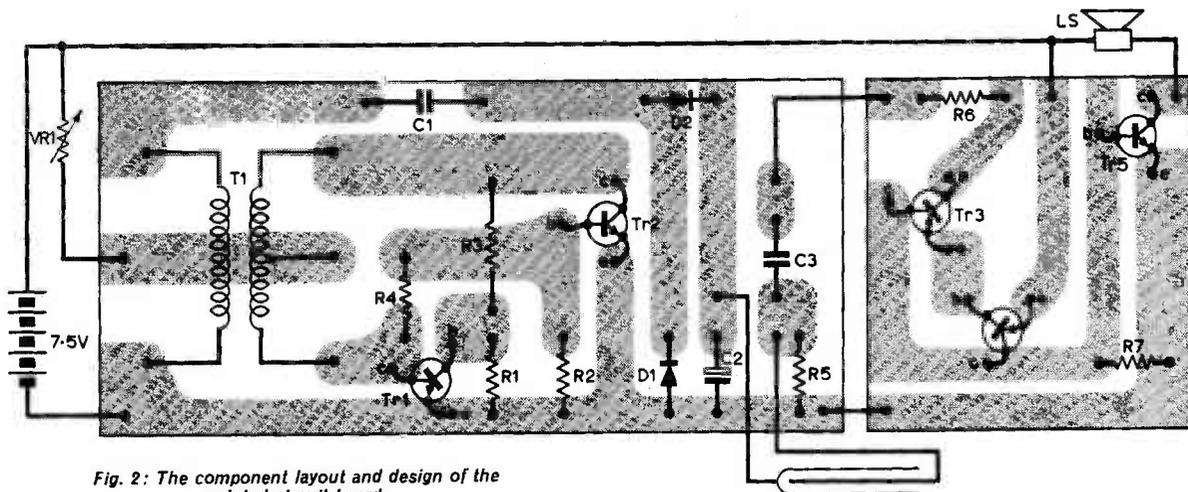


Fig. 2: The component layout and design of the printed circuit board.

unnecessary, especially if they may wish to operate the unit to drive a scaler or an earphone. Consequently the prototype was built on two separate printed circuit boards and Fig. 2 shows the layout pattern which should be painted on a copper laminate board and etched in a solution of ferric chloride.

When the unit is switched on for the first time a

meter should be inserted in the battery leads to monitor the current drawn. It should be in the region of 25mA. VR1 can then be adjusted to give the correct operating voltage. The background radiation with the type of tube specified should give a count of approximately 40 per minute but this will vary considerably depending upon the location. ■

## MEDIUM WAVE DXING

— continued from page 963

where the North American channels are clear of Europeans. For Example, CBA (1070) cannot usually be heard until Paris II signs-off at 2300hrs. On the other hand CJON, St John's Newfoundland on 930kHz can often be heard earlier in the evening since the nearest European frequencies (and QRM) are 926 and 935. Schedules of European stations are important. Many Europeans close down late on Saturday nights but have shorter broadcasting hours on a Sunday. Most, including the BBC, sign-on late on Sunday mornings and many sign-off early on Sunday evenings as well.

DX signals on the medium waves nearly always suffer from slow cyclic fading. The fast fluttery type of fading that can be counted in 'fades per minute' is seldom encountered by the MW DXer. If two stations are heard simultaneously on a channel, it will be found that their relative strengths are changing continually. If the DXer is patient (and lucky) he may hear each station in the clear for a short while during a fade of the other one.

## RECEIVERS

It is not necessary to own an expensive communications receiver to DX on the medium waves, especially if a loop is used. Both the R1155 and the PCR receiver are satisfactory. Good sensitivity and selectivity are desirable but freedom from overloading and cross-modulation are of paramount importance and in this respect oldish ex-service equipment excels. The AR88D and the CR100 are popular with MW DXers in this country. The writer uses a CR100 and a BC314, the latter being an i.f. version of the well known BC312. It covers 150kHz to 1500kHz in 4 bands and the i.f. is only 90kHz which gives good selectivity without a crystal filter. The MN26C is similar and more readily available but unfortunately does not have a tuning scale as it was designed for remote control.

Modern communications receivers perform well on

the medium waves but beware of double or triple conversion as some are prone to spurious on this band. It is not unknown for modern receivers to have their performance degraded on the MWs, probably to make them suitable for entertainment purposes. If in doubt examine the circuitry and look for damping resistors in the r.f. and mixer stages.

When tuning across the band, switch off the a.g.c. otherwise weak stations close to strong ones may be overlooked. In order to protect the ears use an audio limiter of the type connected between the receiver and headphones.

## REFERENCES

There are a number of specialist publications that provide news and information about the MWs. Broadcasting Stations of the World Part 2 published by the US Government Printing Office, Washington D.C. 20402, lists by frequency all broadcasting stations in the range 150kHz to 28MHz except for those in the USA. World Radio and TV Handbook, published annually in Denmark but available in bookshops in the UK, lists MW stations throughout the world as well as containing a mine of information of use to the general DXer. Medium Wave News, the club Magazine of the Medium Wave Circle appears eight times a year and contains recent loggings, station news and information on loops and receivers. Further information can be had from the editor, Ken Brownless, 7 The Avenue, Clifton, York YO3 6AS. For readers in the United States there are the International Radio Club of America, 5421 Clinton Court, Englewood, Colorado 80110 USA and the National Radio Club of America, PO Box 99, Cambridge Mass. 02138 USA. Both clubs specialise in the MWs.

Peak MW DX occurs in years when solar activity is low and since we are currently on a declining part of a sunspot cycle, further outlook is good. Several years of good and improving conditions lie ahead and will no doubt attract many newcomers to the oldest DX band, the medium waves. ■

# WHAT DO YOU KNOW ABOUT METER SHUNTS?

## PART 1

H.A. COLE, C. ENG., M. I. E. R. E.

IT is presumed that many readers could set about calculating separate shunt resistor values for a multi-range milliammeter but one wonders how many could do the same thing for a universal shunt? Where does one start? What value should be chosen for the shunt? And having selected a value, how does one then go about calculating the various sections of the shunt?

This article hopes to clear up these points and enable the reader to calculate both types of shunt.

### The basic ammeter

The great majority of indicating meters used in testmeters are of the moving coil type where a coil of very fine wire is wound over a drum-shaped former and suspended between the poles of a permanent magnet (the pole pieces are specially shaped to fit the contour of the drum). When current is passed through the coil a magnetic field is set up around it which interacts with that from the permanent magnet. The interaction is such that the drum carrying the coil is forced to rotate, hence the name 'moving coil' for this type of meter.

Two small coil springs, one at each end of the drum, provide a partial restraining force against the rotation and hold the drum stationary when the deflecting force produced by the interaction of magnetic fields exactly balances that of the two springs. The springs also serve to conduct the current into and out of the coil. A very thin lightweight pointer is attached to one end of the drum so that it rotates with it, and a graduated scale positioned behind the pointer enables the deflection to be measured.

The amount of coil current required for the pointer to reach full scale deflection (f.s.d.) depends, other factors being equal, upon the number of turns in the coil. A coil with many turns may, for example, require only  $25\mu\text{A}$  for f.s.d., whereas a coil consisting of much fewer turns may require  $10\text{mA}$  or more to produce the same deflection. Meters requiring very little current for f.s.d. are said to have a high sensitivity, whereas those requiring larger currents (about  $1\text{mA}$  or more) are considered to be low sensitivity types. High sensitivity meters e.g.,  $50\mu\text{A}$  f.s.d., have coil resistances of the order of  $1,000\text{--}2,000\Omega$ , whereas low sensitivity types e.g.,  $10\text{mA}$ , are of the order  $50\text{--}100\Omega$ . The difference is in the number of turns and the gauge of wire used in the construction of the moving coil; the thinner the wire and the greater the number of turns, the higher the resistance.

For multi-range testmeter applications of the moving coil meter, it is desirable to be able to use the same basic meter to measure a wide range of currents. To do this one must first select a meter which has an f.s.d. suitable to the smallest range of currents to be covered by the testmeter. For example, if the lowest range on the test-

meter is to be  $0\text{--}100\mu\text{A}$ , then one must use a meter whose f.s.d. is not greater than  $100\mu\text{A}$ . The next step is to provide means for bypassing that portion of the current to be measured which is in excess of the meter f.s.d. For example, for a  $100\mu\text{A}$  meter to indicate  $1\text{mA}$  ( $1,000\mu\text{A}$ ) full scale, it is necessary to by-pass  $900\mu\text{A}$ . By-passing current in this way is called shunting, and is achieved by connecting a resistor of appropriate value in parallel with the meter; such resistors are called *shunts*.

Shunting in practice can be achieved by either of two methods. In the first a separate shunt resistor is used for each current range to be covered by the meter, and the appropriate shunt selected by a switch. In the second method a single shunt resistor is permanently connected across the meter and tapped at intervals along its length so as to provide the required amount of shunting for the ranges to be covered; this form of shunt is known as a *universal shunt*.

### The separate shunt method

Assume a  $50\mu\text{A}$  moving coil meter (a very popular choice) which has a coil resistance of  $1,000\Omega$ , and that this meter is to be used in a testmeter having d.c. ranges of  $0\text{--}200\mu\text{A}$ ;  $0\text{--}1\text{mA}$ ;  $0\text{--}25\text{mA}$ ;  $0\text{--}100\text{mA}$  and  $0\text{--}500\text{mA}$ . For the first range it is necessary to provide a  $150\mu\text{A}$  shunt so that only  $50\mu\text{A}$  is allowed to flow in the meter (remember, ALWAYS ensure that not more than  $50\mu\text{A}$  is allowed to flow in the meter, no matter what range is to be covered.) The required arrangement is shown in Fig. 1. ( $R_s$  is the shunt resistor and  $R_m$  is the meter coil resistance). The total current ( $I_t$ ) applied through the input terminals of the testmeter divides so that  $50\mu\text{A}$  flows in the meter,  $I_m$ , and  $150\mu\text{A}$  flows in the shunt,  $I_s$ . Now to derive a simple but very useful formula which can be used to calculate the value of  $R_s$  for any values of  $I_t$ ,  $I_m$  and  $R_m$ .

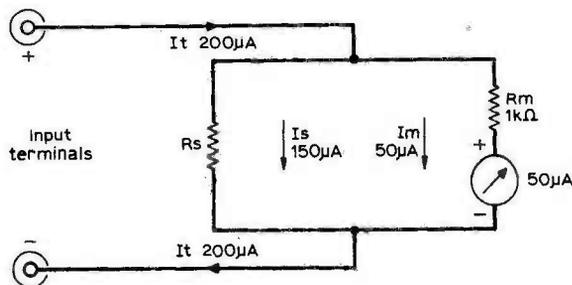


Fig. 1 Simple meter shunt

Referring to Fig. 1, since  $I_m$  flows through  $R_m$  then a voltage ( $V_m$ ) will be developed across  $R_m$  equal to  $I_m \times R_m$  i.e.,

$$V_m = I_m \cdot R_m \text{ (by Ohm's law) } \dots \dots \dots (i)$$

Now, since  $R_s$  is connected in parallel with  $R_m$ , then  $V_m$  must also appear across  $R_s$  and therefore the current in  $R_s = I_s = \frac{V_m}{R_s}$  or, by substituting for  $V_m$  from equation (i),  $I_s = \frac{I_m \cdot R_m}{R_s}$  Transposing for  $R_s$ :

$$R_s = \frac{I_m \cdot R_m}{I_s} \dots \dots \dots (ii)$$

Now, since  $I_s = I_t - I_m$ , one may substitute  $I_t - I_m$  for  $I_s$  so that the equation becomes;  $R_s = \frac{I_m \cdot R_m}{I_t - I_m}$

Now divide top and bottom of this equation by  $I_m$ :

$$R_s = \frac{\frac{I_m}{I_m} \times R_m}{\frac{I_t}{I_m} - \frac{I_m}{I_m}} = \frac{R_m}{\frac{I_t}{I_m} - 1}$$

Finally, since the ratio  $\frac{I_t}{I_m}$  is really the multiplying factor of the f.s.d. of our basic meter, call this factor 'N' and write the equation as:

$$R_s = \frac{R_m}{N - 1} \dots \dots \dots (iii)$$

Now to use this equation to calculate the value of  $R_s$  for the  $105\mu A$  shunt in Fig. 1 (some may prefer to use equation (ii), which is equally valid, by substituting  $I_m = 50\mu A$  and  $I_s = 150\mu A$ ).

Since  $N = \frac{200\mu A}{50\mu A} = 4$ , then  $R_s = \frac{1,000}{4 - 1} = 333\Omega$

Summarising, in order to use the  $50\mu A$  meter to indicate  $200\mu A$  at f.s.d. (range 1), one must provide a shunt resistor ( $R_{s1}$ ) of  $333\Omega$ .

Now consider the requirements of the second range ( $I_{mA}$ ), making use of equation (iii):

$$N = \frac{1mA}{50\mu A} = \frac{1,000\mu A}{50\mu A} = 20$$

$$R_{s2} = \frac{R_m}{N - 1} = \frac{1,000}{20 - 1} = 52.6$$

$$R_{s2} = 52.6\Omega$$

For range 3 (25mA),

$$N = \frac{25mA}{50\mu A} = \frac{25,000\mu A}{50\mu A} = 500$$

$$R_{s3} = \frac{1,000}{500 - 1} = \frac{1,000}{500} = 2 \text{ (ignoring 1 in the denominator because it is so small compared to 500).}$$

$$R_{s3} = 2\Omega$$

For range 4 (100mA),

$$N = \frac{100,000}{50} = 2,000 \text{ and } R_{s4} = \frac{1,000}{2,000} = 0.5$$

$$R_{s4} = 0.5\Omega$$

An important point should be noted at this stage, and that is the fact that since 100mA is 100 times 1mA, then 100 times as much shunt current is required for the 100mA range as was required for the 1mA range. Therefore, since current is inversely proportional to resistance ( $I = V/R$ ), then a 100mA shunt will be 100 times smaller in value than a 1mA shunt. Having already calculated  $R_{s2}$  for 1mA and found it to be  $52.6\Omega$  the value of  $R_{s4}$

for 100mA will be  $\frac{52.6}{100} = 0.526\Omega$  or, approximately

$0.5\Omega$ . This agrees well with the value obtained for  $R_{s4}$  using equation (iii).

Next calculate  $R_{s5}$  for range 5 (500mA) using equation (iii), or determine its value by observing that 500mA is 5 times greater than 100mA, and therefore  $R_{s5}$  (for 500mA) will be 1/5th of the value of  $R_{s4}$  (for 100mA),

i.e.,  $R_{s5}$  for 500mA =  $\frac{0.5}{5} = 0.1\Omega$ . Checking this answer by using equation (iii);  $N = \frac{500,000}{50} = 10,000$ ,

$$\text{therefore } R_s = \frac{1,000}{10,000} = 0.1\Omega.$$

$$R_{s5} = 0.1\Omega.$$

Fig. 2 shows a suitable arrangement for incorporating the shunts just calculated to provide the desired ranges on the testmeter.

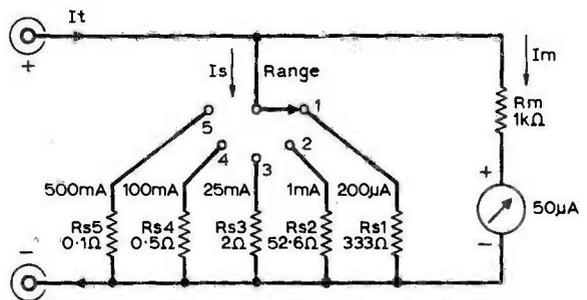


Fig. 2: Final circuit using separate shunts

The big disadvantage with this type of circuit is the contact resistance introduced by the switch. This may not be very important with a new good quality switch but after a period of use the contacts of most switches become dirty causing an increase in the resistance between the contacts, thus introducing measurement errors. The problem is not very important on the lower current ranges because the shunt resistors associated with these ranges are usually so large compared with the contact resistance that its effect may be ignored. On the high-current ranges, however, this is not the case and the contact resistance is comparable in value with that of the shunt (we have just shown that a shunt of only  $0.1\Omega$  is required for the measurement of 500mA).

The problem of contact resistance may be alleviated considerably by artificially increasing the resistance of the meter ( $R_m$ ). From equation (iii), the shunt resistance

is directly proportional to  $R_m$  ( $R_s = \frac{R_m}{N - 1}$ ), so if we

increase the value of  $R_m$  then the value of  $R_s$  can be increased in the same proportion. Achieving this will not only reduce the importance of contact resistance but it will also avoid the need for fractional ohmic values of shunt resistance (it is never a simple matter to produce, or obtain, resistor values of less than  $1\Omega$ ). To illustrate how this can be done, take the same  $50\mu A$ ,  $1,000\Omega$  meter, and deliberately increase its resistance tenfold i.e., make  $R_m = 10k\Omega$ ; by connecting a  $9k\Omega$  resistor in series with it. Now repeat the testmeter design procedure, using equation (iii), for the same current ranges of  $200\mu A$ ; 1mA; 25mA; 100mA and 500mA.

For range 1 (200 $\mu$ A).

$$N = 4, \text{ therefore } R_{s1} = \frac{10,000}{4-1} = 3,333\Omega.$$

$$R_{s1} = 3,330\Omega$$

For range 2 (1mA).

$$N = 20, \text{ therefore } R_{s2} = \frac{10,000}{20-1} = 526\Omega$$

$$R_{s2} = 526\Omega \text{ and so on.}$$

It will be noticed that the values of  $R_{s1}$  and  $R_{s2}$  are now ten times greater than what they were when  $R_m$  was 1,000 $\Omega$ . In other words, multiplying  $R_m$  tenfold has enabled us to multiply the shunt resistor values tenfold also. This means that  $R_{s5}$  for 500mA is now 1 $\Omega$  instead of 0.1 $\Omega$ , and this is a standard value which can be obtained without great difficulty. The same applies to the 100mA range;  $R_{s4}$  is now 5 $\Omega$  instead of 0.5 $\Omega$ , which again is readily obtainable. The values of  $R_{s1}$ — $R_{s5}$  are now large enough, except perhaps for the 500mA range, to make contact resistance of the switch negligible.

All this sounds very convenient, so what are the snags? The big snag is that the effective resistance of the testmeter i.e., the resistance which would be measured between the two input terminals, is now much larger than it previously was, and this resistance may introduce errors into measurements, particularly when measuring large currents derived from low voltages. To demonstrate this, consider the simple circuit shown in Fig. 3.

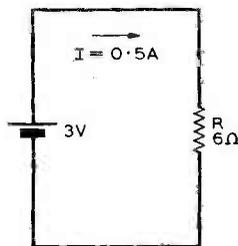


Fig. 3: Simple circuit.

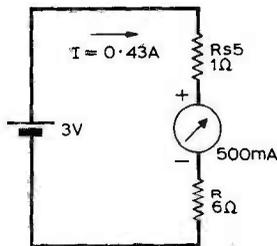


Fig. 4: Effect of adding meter

A 3V battery is connected across a 6 $\Omega$  resistor (this could be a torch bulb, for instance) causing a current of 500mA to flow ( $I = 3V/6\Omega$ ). Now connect the testmeter, switched to the 500mA range, in series with this circuit so as to measure the current flowing and we shall be adding a resistance of about 1 $\Omega$  to the circuit (this is the calculated value of  $R_{s5}$  for 500mA; we can neglect the value of  $R_m$  which is 10k $\Omega$  because it is so large compared with  $R_{s5}$ ). The circuit now appears as shown in Fig. 4 and the current ( $I$ ) now equals

$$\frac{3V}{R_{s5} + R} = \frac{3}{7} = 0.43A \text{ (430mA).}$$

This is the current which will be indicated on the meter, although it is known that the *true* circuit current without the meter in circuit is really 500mA. The presence of the meter has therefore introduced an error of

$$\frac{500-430}{500} \times 100\% = 14\%$$

and this is quite substantial!

Now consider what would happen using the testmeter fitted with the original value of  $R_{s5}$  for 500mA i.e., 0.1 $\Omega$ . The circuit current would now be

$$I = \frac{3V}{6\Omega + 0.1\Omega} \times 10^3 \text{mA} = 491 \text{mA.}$$

## NEXT MONTH IN

# PRACTICAL WIRELESS

### F.M. STEREO DECODER

With the ever increasing interest in the B.B.C.'s stereo broadcasts on the v.h.f. band, it is natural that the demand for stereo equipment is also on the increase. One of the most important items in the stereo set-up is the decoder. The author describes the construction of an inexpensive unit, which nevertheless has an excellent performance. A indicator lamp is included to indicate the presence of a stereo transmission. Full constructional details and wiring diagrams are included.

### AERIALS FOR MOBILES

With that long warm summer to look forward to the mobile enthusiast will be going over his gear to see how he can best improve it after the mediocre results of last season. But whatever the equipment in use it is not much good if the weakest link in the chain, the aerial system, is not up to scratch.

Fred Judd, G2BCX, a very experienced 'mobileer' describes various practical arrangements and methods to ensure that the aerial system is really tuned up 'on the nose'.

### A 3-BAND TRF-4 RECEIVER

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In addition the BBC's Radio 2 service on I.w. plus continuous extended m.w. coverage from 150 to 620m. Full constructional details in the April issue.

### PLUS THE REGULAR FEATURES AND OTHER CONSTRUCTIONAL ARTICLES.

May issue on sale April 3rd. 3/6

The measurement error is now

$$\frac{500-491}{500} \times 100\% = 1.8\%$$

this is still significant but much more acceptable.

The price to pay for high meter resistance is reduced measurement accuracy—especially on the high-current ranges. It is interesting to note here that the AVO model 7, which has a 1mA (effective) indicating meter, is much more suitable for measuring low-voltage high-currents than is the AVO model 8, which has a 50 $\mu$ A (effective) indicating meter. This is because the effective resistance of the model 7 is lower than that of the model 8, due to the lower resistor values used for the current shunts (the 1 amp shunt on the model 7 is about 0.14 $\Omega$ , whereas the equivalent shunt on the model 8 is about 0.5 $\Omega$ .)

TO BE CONTINUED

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PW4/70

# TAKE 20

JULIAN ANDERSON

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

**A**SSUMING that the reader has a multimeter, this month's project should cost no more than five shillings since it consists simply of a single transistor with no associated components "pepping up" the performance of the resistance range on a multimeter.

Lie detectors are not very accurate pieces of equipment but they do work in a vague sort of way using a very simple principle and they provide endless hours of fun. The principle of simple lie detectors is that the skin resistance of a person varies with changes of emotion. These changes can easily be measured and are surprisingly rapid especially when the emotion is fear.

Many readers will know that a reading of skin resistance can be obtained using the high resistance range on a multimeter simply by holding the probes, one in each hand. The actual resistance varies enormously—between about 20k $\Omega$  and 300k $\Omega$  but under most conditions the resistance is between 100k $\Omega$  and 250k $\Omega$ . Cheaper multimeters will certainly show a reading for this sort of resistance but it will almost certainly be at the extreme end of the scale and to observe changes of about 5 per cent is very hard.

It is however very easy to increase the sensitivity of the meter just by connecting a transistor's collector and emitter to the meter and taking the probes from the base and collector. The battery inside the meter (1.5V in most cases with additional 9V or 15V ones in the better types) provides the supply voltage and it will quickly be seen from Fig. 1 that a very high resistance in the base-collector circuit of the transistor brings about a greater current flow through the meter and thus effectively registers a lower resistance. Note that the positive connection to a meter is actually the negative connection to the battery and so the connections to the transistor are made in what appears to be the wrong way around.

A silicon n-p-n transistor should be used (so here the meter positive lead goes to the emitter) and a 2N2926, BC109 or BC169 or any similar type is ideal. These transistors have very low leakage and very high gain and will bring the meter reading to the centre portion of the scale.

The same circuit is also applicable for measuring very high resistances or checking insulation. Using the circuit shown most meters will give a decent reading for 20M $\Omega$ —something quite outside the scope of most meters. Your scale will of course bear no relationship to the resistance being measured but it is a relatively easy matter to plot points on a graph using known resistances for calibration.

The transistor itself should be mounted on solder tags fixed to a small panel of perspex or polythene. The resistance of wood or similar sorts of material

## No. 12 LIE DETECTOR

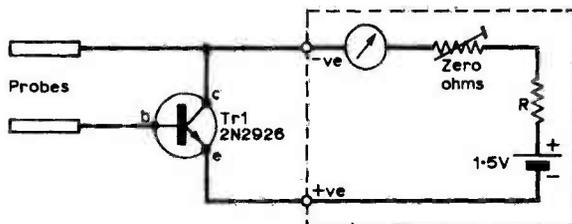


Fig. 1: The circuit of the lie detector. The components inside the dotted line are those within the multimeter itself.

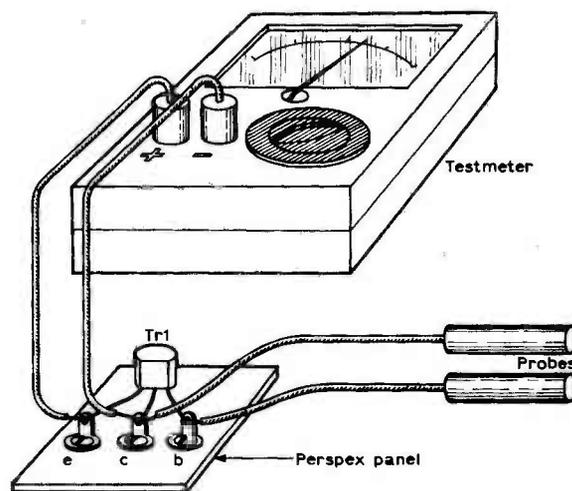


Fig. 2: The connections to the transistor.

will upset the readings. The hand held probes can be made from brass or copper rod and when used these should be firmly held.

The use of the lie detector can be very amusing and provide hours of fun at parties. There is an admirable solution to the inevitable sceptic who mocks the test—pour your drink over his hands! The surprise itself should be enough to produce the reaction but what he will probably not know is that the liquid will improve the probe contact and increase the reading. (Use water with a little salt in for this emergency measure—it looks quite like gin or vodka and after all you don't want to waste your drink do you!)

Next month's *Take 20* project is a two transistor radio. The circuit is designed specifically for miniaturisation by the constructor.

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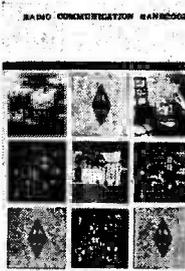


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Continued from last month

**F**IXING holes for the drive are located with the paper template included with it. The S-meter is fitted to the right, Fig. 4. Holes are punched to take the controls under the chassis, as in Fig. 5.

An aperture is cut in the chassis to take the flywheel and drive. Holes are positioned for aerial and earth sockets, etc., and under each section of the ganged capacitor. Each coil needs a  $\frac{1}{4}$  in. dia. hole and they will be placed as in Fig. 5.

The chassis flanges are fixed to the panel with chromed bolts, the bottom of the chassis being  $\frac{1}{8}$  in. higher than the bottom of the panel, to allow for the cabinet flange.

Leads are soldered to the bottom tags of the variable capacitor, and passed down through the holes mentioned. Capacitor and drive spindles are carefully lined up and joined with a flexible coupling. Spaces or extra nuts are needed under the capacitor, to raise it.

Space is left for a PP9 battery, Fig. 4. When the audio panel is completed, it is fitted a little clear of the chassis as in Fig. 4. This is done with two bolts with extra nuts. One bolt also provides the earth return connection from amplifier positive to chassis.

The i.f. and S-meter amplifier panel is secured with two small brackets, Fig. 4. This allows all cores and underneath wiring to be reached, with short connections where necessary. Positive is returned to the chassis at a bracket.

The small b.f.o. and produce detector panel is also fixed with two brackets, Fig. 4. The b.f.o. coil

core is reached from the underside, so it is necessary to have a short adjusting tool, or make one from a strip of paxolin or insulated rod.

## Bandswitch

This has a mechanism with moving stop, which is placed to give four positions. The three wafers are placed with their identification marks all the same way, and are threaded on the shaft. The screwed rods are then put in, with spacers allowing the wafers to come approximately as in Fig. 5.

Each wafer is three-pole four-way, and the switch cannot work if any is reversed, or has its rotating section wrongly placed on the shaft. If there is any doubt about its operation, this will be clarified by examining a wafer, and checking with a meter, with the switch in each of its four positions in turn. Also test the receiver with the three coils for one band only actually connected, with the switch in the appropriate position.

The front wafer is S1, S2 and S3. S3 is nearest the chassis, and wired to VC1 (and VC4). Tr1 base goes to S2 as in Fig. 5. The remaining section is S1, used for aerial.

The central wafer is S4, S5 and S6. Tr1 collector goes to S4, Tr2 emitter to S5, Fig. 5, and again the tag nearest the chassis has a short lead through to VC2.

The rear wafer is S7, S8 and S9, Tr2 emitter and collector going to S8 and S7, positioned as in Fig. 5, with a short lead from VC3 to the remaining section S9, near the chassis. This allows short leads where required.

## Coils, etc.

These are positioned as in Fig. 5, for short leads on the h.f. ranges, while keeping similar coils well separated. The wiring is largely duplicated from one band to the next, as follows:

**Blue (Aerial) Coils.** 1 and 9 joined on all, and to chassis. 7 joined on all, and to C1. C1 goes directly from S.W.1, pin 7, to chassis, Fig. 5. S1 tags, S2 tags and S3 tags are then wired in sequence to 8, 5 and 6, of S.W.1, S.W.2, S.W.3 and M.W. coils.

**Yellow (Mixer) Coils.** All tags 1 to chassis. Tags 8 joined and to C3. Tags 7 joined and to C5 at S.W.1, Fig. 5. S4, S5 and S6 then go to 9, 5 and 6. for each range, as before.

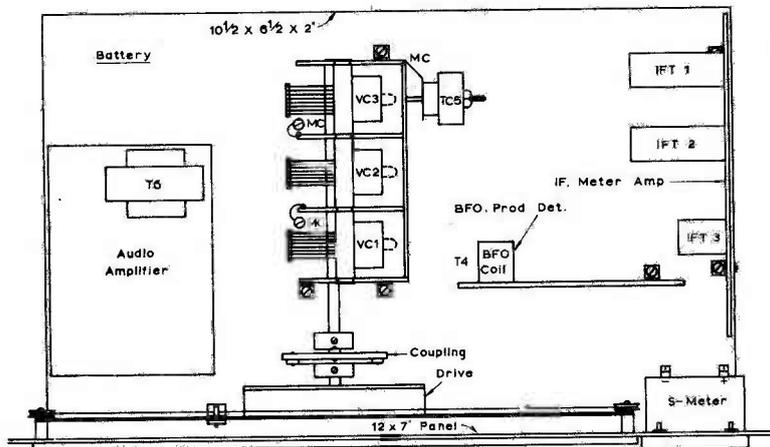


Fig. 4: Layout of main components on the top of the receiver chassis.

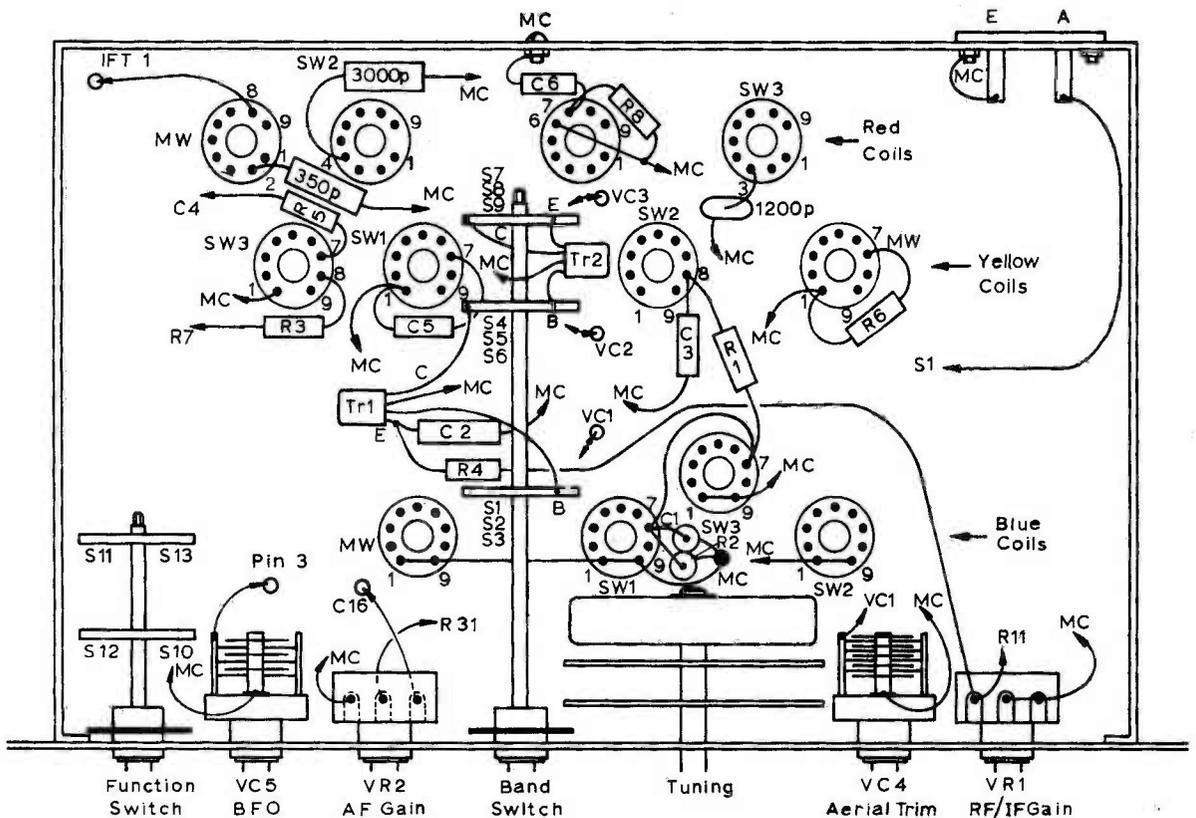


Fig. 5: Layout and part wiring of components on the chassis underside.

**Red (Oscillator) Coils.** Tags 8 joined, and to 2 on i.f.t.1. Tags 7 to C6 at S.W.1 (Fig. 5). S7, S8 and S9 to tags 9, 5 and 1. Padders as described, and in Fig. 5.

Chassis returns for S.W.1 and S.W.2, including those via capacitors C1, C5 and C6, *must* be very short and direct. For these ranges, 20 s.w.g. connections are suggested, with 26 s.w.g. for the lower frequency coils. Different colours of 1mm sleeving will help identify the leads.

Coils were placed to allow a screen between blue and yellow types, but this was found unnecessary. Shorting type wafers to earth all unused windings are not available in the three-pole type. Small absorption effects were found to arise at about 12, 17 and 24MHz. Since 12MHz is available on both S.W.1 and S.W.2, this may be neglected. The others would be cured by using shorting wafers. This would require more wafers, as they are only available in two-poles per wafer type. Alternatively, the offending coils could be placed in the cans supplied by the maker, for screening.

Tr1 and Tr2 are close to their connecting points, and with each the shield lead goes to the chassis. Actual wires are emitter, base, shield, collector, in line and with extra spacing for the collector lead.

Individual mixer coil trimmers are not shown in Fig. 5 for clarity. These are soldered directly from

pin 1 to pin 6 on each yellow coil, the plate adjacent to the adjusting screw-head going to 1 (chassis).

## Constructional Points

Amplifiers and product detector with b.f.o. are assembled on insulated eyelet board having holes at 0.2in. centres. Plain board could be drilled to suit.

Some 26 s.w.g. tinned copper or similar wire may be used throughout, with 1mm sleeving. It is helpful to identify external and other connections by colour, and to use red for chassis (positive) and black for

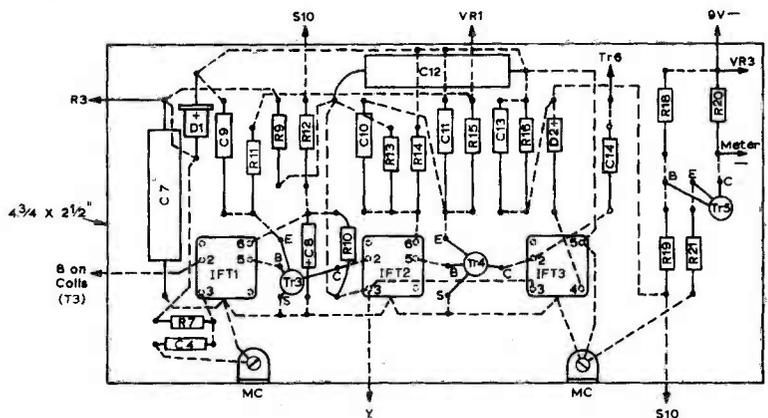


Fig. 6: I.F. amplifier and meter amplifier board.

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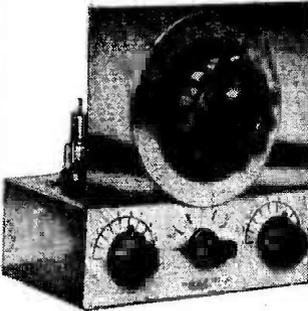
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negative circuits.

Short pieces of sleeving will also identify transistor leads when these are fitted. Black is suggested for base, yellow for emitter, and red for collector.

**I.F./Meter Amplifier.** This is the largest unit, shown in Fig. 6. It mounts vertically by two brackets used as chassis return. Figure 6 shows the "top" of the board, with i.f.t.s, resistors, etc. Wiring under the board is shown with broken lines.

It is convenient to fit the i.f.t.s first, with central holes to reach the cores later. All the cans are earthed. If each component and lead is marked with coloured pencil as fitted and soldered it will be easily clear what has been done, and nothing is likely to be omitted.

Later, leads are passed through the chassis to the function switch, 8 on oscillator coils, and other items as shown. A check should be made against Fig. 2 as required. R18 to R21, Tr5 and the meter may be omitted until later.

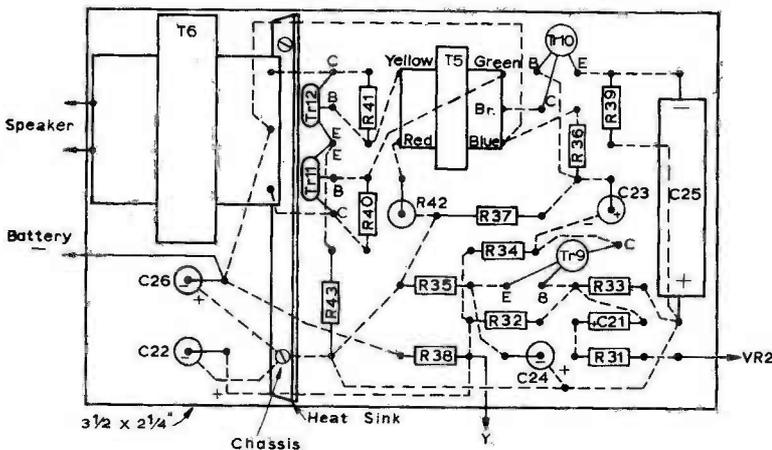


Fig. 7: The audio amplifier board.

**Audio Amplifier.** Figure 7 shows components and wiring. The heatsink is fixed with two 1/4 in. or similar bolts, and a tag under one nut serves as chassis return. Extra nuts are put on, and the finished board can then be clamped to the chassis, with a little clearance.

Tr11 and Tr12 occupy clips bolted to the heat-sink. The connections given for T5 are for the particular transformer listed, and if an alternative is fitted, the maker's data should be followed.

A black flexible lead with negative battery clip runs from C26. The lead Y supplies the i.f. amplifier. VR2 slider runs to R31.

The whole amplifier can be tested by taking an audio input to R31, with battery positive as earth return.

If the receiver is to be temporarily or permanently used for ordinary a.m. reception (speech, music) only, VR2 can be fed from diode D2 via a capacitor, as described.

**Product Detector and B.F.O.** Connections are shown in Fig. 8. The completed panel again mounts vertically on brackets, and is placed to allow quite short leads from C14 and VC5. A hole is necessary under the b.f.o. coil to reach its core.

The circuit provides a.m. detection when the b.f.o. is off, and the function switch breaks this circuit.

Tr6 and Tr7 run from the reduced voltage available from Y at the i.f. amplifier. The b.f.o. receives the regulated supply from the 5.6V Zener diode. When the completed panel is fixed in place, remove the temporary coupling capacitor used to give a.m. reception from D2, if previously fitted.

## IF Alignment

The intermediate frequency is 465kHz. If a signal generator is available, loosely couple it to the base of Tr2, and rotate all the cores for best results with a 465kHz input. A c.w. signal will operate the meter, so i.f.t. cores can be adjusted for best meter reading. Input should be kept well down.

With a modulated signal from the generator, adjustments can be for maximum audio output, with gain controls at maximum; or for maximum battery current, shown by a meter in one lead. Input must again be kept well down.

If no generator is available, a stable signal should be tuned in (such as a BBC transmission, with a very short aerial). The five cores are then carefully adjusted for best results.

A properly shaped core adjusting tool is best employed for the i.f.t.s. Final alignment should be with a weak signal. These cores are then left and need no further adjustment.

## BFO

With VC5 half closed, and the b.f.o. switched on, a strong heterodyne should be heard when the b.f.o. coil core is rotated with a tool. Ignore any weak whistles produced at other core settings, and place the core so that it is at the central or zero beat position. A whistle, which rises in pitch, will then be heard if VC5 is opened or closed. During these adjustments, a

steady carrier should be present, from a signal generator or transmission.

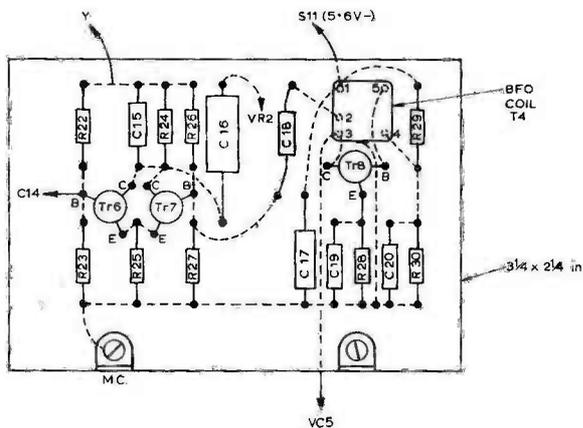


Fig. 8: Product detector and b.f.o. board.

## RF, Mixer and Osc

It is necessary to describe adjustments to only one range, as each range is dealt with separately.

TC5 is about two-thirds or so closed. Its setting primarily determines band limits at the high frequency end of the band. The red coil core is adjusted to obtain a suitable band limit at the low frequency end of the band.

The coils are normally packed with the brass screws set right in, so it is as well to unscrew them all so that roughly  $\frac{1}{2}$  in. of 6BA rod projects, to begin.

Set VC4 (aerial trimmer) about half closed, and rotate the cores of blue and yellow coils for best results, near the l.f. end of the band (ganged capacitor nearly fully closed). Tune to the h.f. end of the band, this time adjusting the yellow coil trimmer for best results.

Repeat these adjustments, as necessary, for suitable band coverage, and best performance. VC4 will not need continuous adjustment, when the blue cores are suitably placed, but this trimmer is helpful when changing aerials, or bringing up weak signals.

## Notes on Operating

The dial reads 0-500, to log particular s.w. transmissions, etc. s.w. reception, especially on the h.f. bands, varies greatly from hour to hour, daily, and has seasonal and other variations.

For normal reception, put the function switch to a.m. with a.v.c. When very strong transmissions overload early stages, VR1 must be turned back. VC4 is simply peaked for best results, and should never be fully open or fully closed.

In some cases manual control of r.f. gain only is required, and 3rd and 4th positions of the switch provide this, the latter with the b.f.o. on. In the 4th position, s.s.b. and c.w. do not control gain via the a.v.c. circuit. In the 5th position, these signals provide a.v.c. bias.

With the switch in the 5th position, c.w. and s.s.b. can be resolved over a considerable level of signal strengths. Rotating VC5 one way or the other, from the central or zero position, will resolve an s.s.b. signal, the direction of rotation depending on whether upper or lower sideband is being transmitted. With exceptionally strong or local signals, gain must be reduced with VR1.

With c.w., the b.f.o. acts as a pitch control, and may also be above or below the carrier frequency, as giving best results.

In all cases VR2 controls volume, and it is as well to keep current peaks down to 30-40mA or so, which should give ample output.

S14 can be closed during noisy static conditions, or when wearing headphones. The limiting is fairly heavy, to avoid blasting on phones.

VR3 should originally be set at about its middle position, with VR1 at maximum gain. With no aerial, and no signal tuned in, adjust VR3 for zero on the S-meter. If wished, VR3 can be made up from one or more resistors in series with a potentiometer of lower value, though using 5k $\Omega$  as shown is not too critical when adjusting zero.

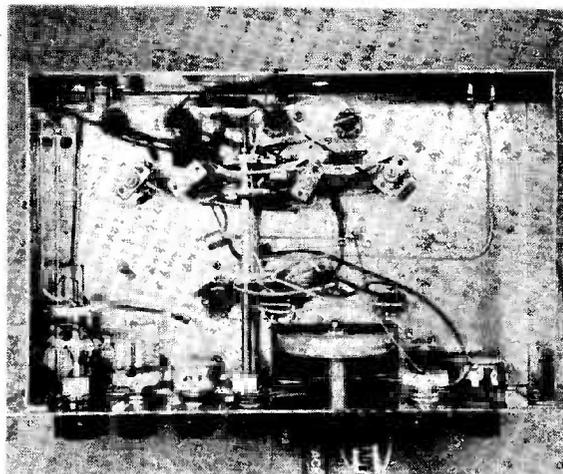
For very long distance reception, one of the numerous external short wave aerials of improved type may be used—a dipole, doublet, tuned end-fed wire, etc.

For general results, any end connected wire may be taken to the aerial socket. It will probably be

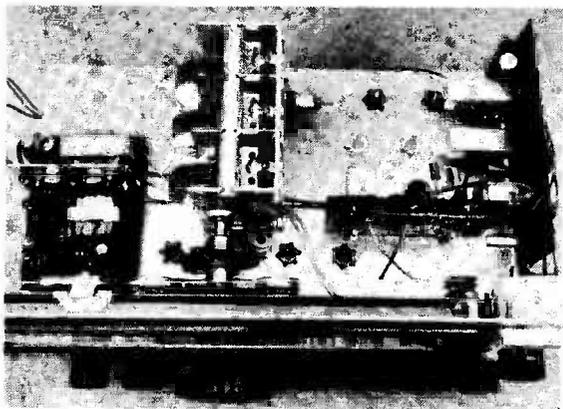
found that a long wire is best avoided for medium and low frequencies.

A telescopic 30in. or similar aerial, fixed to the case but insulated from it, will give very good results over medium and high frequencies, though naturally not with extremely remote stations. A flying lead from the aerial can be taken to the aerial socket, or directly to the fixed section of VC1.

With some frequencies and transmissions, adding an earth will bring about no significant improvement. With other signals (such as weak Top Band amateurs) adding an earth will increase volume very considerably.



Photographs show underside and above views of the complete receiver.



## Other Points

R38 and R9 are chosen to drop just over 3V with a current slightly in excess of 10mA. Since D1 maintains 5.6V, 3.4V must be dropped with a 9V supply. The fairly high resistor values are to help reduce current lost through D1.

Though the values shown should prove satisfactory with 10% resistors and some variation in the actual controlled voltage of D1, a stabilised supply may no longer be obtained, when the battery voltage falls even slightly. If so, R9 should be slightly reduced. Battery drain, with no signal, should be about 20-25mA, with VR1 at maximum. ■

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CC	1/8W	5%	4.7Ω-830KΩ	E24	2.5	2	1.75
C	1/4W	10%	4.7Ω-10MΩ	E12	2.5	2	1.75
C	1/2W	5%	4.7Ω-10MΩ	E24	3	2.5	2.25
MO	1/2W	2%	10Ω-1MΩ	E24	9	8	7
C	1W	10%	4.2Ω-10MΩ	E12	6	5	4.5
WW	1W	10% + 1/20Ω	0.22Ω-3.3Ω	E12	15d all quantities		
WW	3W	5%	12Ω-10KΩ	E12	15d all quantities		
WW	7W	5%	12Ω-10KΩ	E12	18d all quantities		

Codes : C = carbon film, high stability, low noise.  
MO = metal oxide, Electrofil TR5, ultra low noise.  
WW = wire wound, Plessey.

Values : E12 denotes series: 1, 1.2, 1.5, 1.8, 2.2, 2.7, 3.3, 3.9, 4.7, 5.6, 6.8, 8.2 and their decades.  
E24 denotes series: as E12 plus 1.1, 1.3, 1.6, 2, 2.4, 3, 3.6, 4.3, 5.1, 6.2, 7.5, 9.1 and their decades.  
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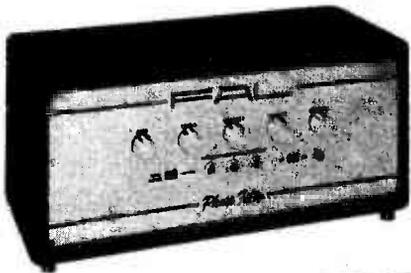
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# P.W. GUIDE TO COMPONENTS

PART 16

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

## INTEGRATED CIRCUITS

**A**N integrated circuit may be defined as a multi-element circuit module constructed and encapsulated in such a way that the individual elements cannot be isolated by normal bench techniques. They can be divided into various groupings categorised by the constructional methods employed in manufacture. Figure 1 illustrates diagrammatically the basic groupings.

The two basic categories of integrated circuits are thin film circuits—which contain no active semiconductor devices—and semiconductor circuits which contain active semiconductor components. Two methods of construction are used to produce semiconductor integrated circuits and these are known as monolithic and hybrid integrated circuits. Hybrid circuits consist of many discrete circuit elements, such as diode and transistor chips bonded to a header and interwired, whilst monolithic circuits consist of a single silicon die with both active and passive components diffused into the surface.

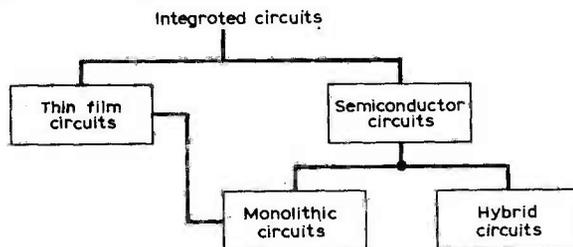


Fig. 1: Basic groupings of integrated circuits.

At present the great majority of integrated circuits available commercially are of monolithic construction, as this form is best suited to mass production techniques. Thin film and hybrid circuits are usually manufactured to suit a particular requirement and are more suitable for small production runs. For example, a manufacturer of, say, missiles would use hybrid or thin film circuits for special applications such as i.f. amplifiers, whilst for switching or logic functions standard monolithic logic circuits would be used. The i.f. amplifiers would be built to the manufacturer's requirements of performance, and in all probability could not be used by other manufacturers.

It follows therefore that the majority of integrated circuits available are of monolithic construction. However thin film techniques are used in monolithic construction for the formation of end connections, resistors and capacitors.

### Thin Film Circuits

Thin film circuits are manufactured by depositing layers of metals or metallic compounds on to the surface of a high resistivity substrate to form resistor combinations, capacitors or inductors. A typical thin film circuit is shown diagrammatically in Fig. 2. Three types of substrate are in common use: glass, ceramic and glazed ceramic. When compatible thin film circuits are deposited on monolithic silicon structures then the substrate is a layer of oxidised silicon.

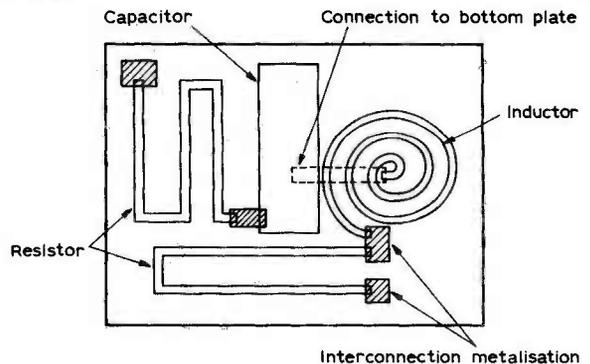


Fig. 2: Typical thin film circuit.

The required materials are deposited on to the substrate by a variety of methods of which the most common are vacuum evaporation, sputtering, gas plating and silk screening. Silk screen layers are deposited in the required pattern by the actual process whereas in all the other processes further work is required, patterning being achieved by a photographic (photoresist) and etching system.

Perhaps the most common deposition system is vacuum evaporation and this is used for gold, silver, aluminium and nichrome (NiCr). The pure metals are used for capacitor plates, inductor windings, and connections and interwiring—whilst nichrome forms the basis of most thin film resistors. Vacuum evaporation is achieved by the evacuation of a glass bell-shaped chamber and rapidly heating the material to be deposited by an electric current through a separate filament. The substrate is positioned near the material, which vaporises, and

collects part of the condensate as a thin film over its surface. Subsequent etching then produces the required pattern to give the desired characteristics.

Cathode sputtering is used to deposit tantalum to form resistors or oxidised to form capacitors. In this case deposition is due to bombardment of a tantalum cathode by high energy inert gas particles (often Argon). The substrate is placed at the anode of a highly evacuated jar and the released tantalum atoms are attracted by a high d.c. (or occasionally a.c.) potential difference between anode and cathode. The tantalum atoms impinge on the substrate and adhere, thus building a thin film on to the surface.

Gas plating is used for the production of films of silicone dioxide ( $\text{SiO}_2$ ), aluminium silicate ( $\text{Al}_2\text{O}_3\text{SiO}_2$ ) and aluminium oxide ( $\text{Al}_2\text{O}_3$ ), which are used as dielectric layers for capacitors. The chemical reactions are complex and depends upon either hydrogen reduction or thermal decomposition of compounds. The compound in vapour form is passed over the heated substance and decomposition or a chemical reaction takes place to leave the required dielectric layer.

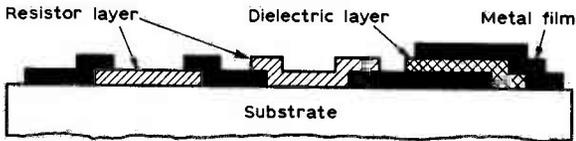


Fig. 3: Cross section of thin film circuit.

We have seen how resistors, capacitors and inductors may be formed and Fig. 3 shows a cross section through a typical thin film surface. Only passive components, however, can be produced by these techniques and although passive filters, attenuators etc. are often required system flexibility is limited. In order to combat these limitations transistor chips, which are manufactured separately, can be bonded to the surface of the film. Wire interconnections are used and hence extremely flexible circuits can be produced. A typical thin film r.f. amplifier is shown in Fig. 4.

Now ideally all-integrated circuits should display the same characteristics as equivalent discrete component circuits, but in practice, because of the close proximity of components, parasitic capacitive and inductive effects are present. These parasitic effects require careful consideration in the initial design.

Another problem resulting from the close proximity of components is leakage paths along the surface of the substrate. Substrates are specifically chosen to reduce surface leakage and these effects are further reduced by careful layout. One considerable advantage of thin film circuits lies in the close component tolerances and wide range of values which can be achieved.

## Hybrid Circuits

Hybrid semiconductor circuits are formed by bonding discrete components to a header and interwiring with wire. A typical hybrid circuit is shown in Fig. 5. The header forms part of a TO-5 size transistor case with 10 leads. The discrete transistor chips are usually normal production line transistors whilst the capacitors, resistors and inductors are specially produced to fulfill the circuit requirements.

Interwiring with gold wire is carried out by hand using special micromanipulators and microscopes. This form of fabrication results in an expensive component. However, the yield is high because each component is tested prior to assembly. Hybrid

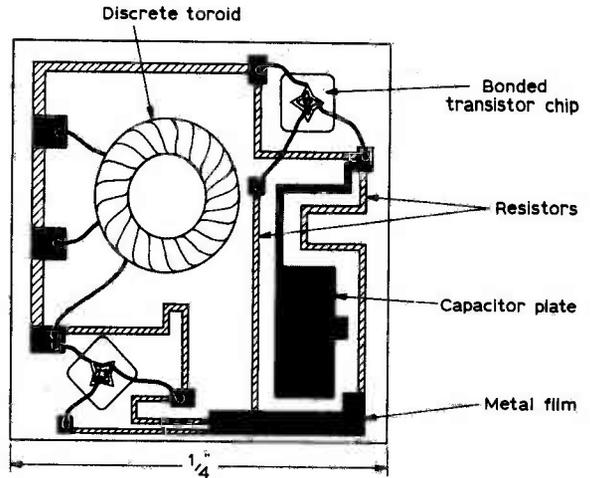


Fig. 4: Some of the components of a thin film r.f. amplifier.

circuits are therefore similar to conventional circuits except that fabrication is carried out in a micro-miniature assembly. Development is thus considerably simplified as breadboard models can be constructed and the layout tested without investing in costly processes. Because each component is manufactured separately the flexibility of the system is considerable, since every transistor can be chosen for individual characteristics and no component relies on the characteristics of other components. Thus hybrid construction is the costliest production system as a result of the non-automatic assembly techniques but requires considerably less development time to produce.

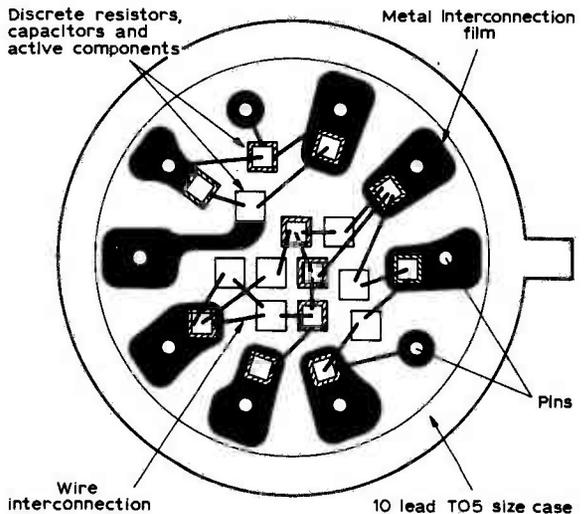


Fig. 5: Hybrid integrated circuit.

Hybrid circuits therefore are particularly suitable for small quantity requirements and production runs. Because of the flexibility, elaborate and close

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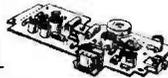


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2 poles	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
3 poles	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
4 poles	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
5 poles	6/6	6/6	6/6	6/6	6/6	6/6	6/6	6/6
6 poles	5/6	10/6	10/6	10/6	10/6	10/6	10/6	10/6
7 poles	6/6	10/6	10/6	10/6	10/6	10/6	10/6	10/6
8 poles	10/6	10/6	10/6	10/6	10/6	10/6	10/6	10/6
9 poles	10/6	10/6	10/6	10/6	10/6	10/6	10/6	10/6
10 poles	10/6	10/6	10/6	10/6	10/6	10/6	10/6	10/6
11 poles	10/6	10/6	10/6	10/6	10/6	10/6	10/6	10/6
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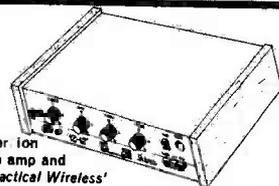
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tolerance circuits can be achieved. Hybrid construction is consequently rarely used for general purpose mass produced devices.

## Monolithic

The vast majority of integrated circuits available to the amateur are of monolithic construction as this construction is best employed for mass production. Initial design is difficult and costly whilst the actual manufacture is reasonably economic and hence economically priced units are possible only for large demand circuits.

The fabrication of most monolithic structures combines the planar epitaxial transistor process and thin film technology. Only thin film materials and processes which do not damage the basic structure or impurity concentrations, can be employed, and such films are known as compatible thin films. Let us now examine the steps involved in the fabrication of a circuit using both p-n-p and n-p-n transistors. Most other components are manufactured during one or more of these stages.

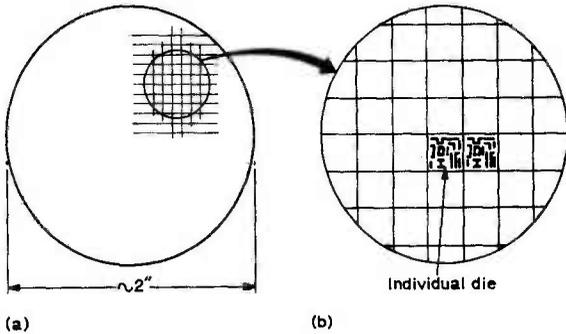


Fig. 6: Monolithic integrated circuit wafer. (a) wafer, (b) enlargement showing dice.

The starting point consists of a p- or n-type silicon wafer such as that illustrated in Fig. 6(a). Fig. 6(b) shows how ultimately the wafer will be subdivided to give individual dies. We will consider only one of the dies and it should be appreciated that in each process perhaps 10-20 wafers each with 100-200 individual integrated circuits are treated simultaneously. In consequence true mass production is carried out in processes which require laboratory standards of accuracy, measurement and cleanliness.

Initially a p-type impurity is diffused into the surface of the basic n-type slice to give the cross section shown in Fig. 8(a). At the end of the diffusion steam is passed over the wafer and forms a layer of silicon dioxide on the surface. The surface is coated with photoresist and the areas to be diffused next masked with an extremely accurate photographic mask. The photoresist is set by exposing the wafer to ultra-violet light and the silicon dioxide is then etched off where the diffusion is required, since diffusion does not penetrate the silicon dioxide layer. The resulting structure is shown in Fig. 8(b).

The second diffusion is known as the isolation diffusion since the areas which are to become components—in this case a p-n-p and an n-p-n transistor—are masked by silicon dioxide. The diffusion is of n-type impurity and is of such a depth as to penetrate through to the n-type substrate, thus forming islands of p-type in the basic n-type sub-

strate as illustrated by Fig. 8(c). At the end of this diffusion a layer of silicon dioxide is again formed to give the structure of Fig. 8(d). The collector of the p-n-p transistor has now been formed by the original p-type diffusion and is isolated from other components by the n-type substrate. This isolation is only effective providing the resultant p-n junction is reverse biased. In consequence an n-type substrate is always electrically connected to the most positive supply voltage and a p-type one to the most negative supply voltage.

In order to reduce the number of diffusions to a minimum it would now seem logical to diffuse the n-type base of the p-n-p transistor and the collector of the n-p-n transistor simultaneously. Unfortunately this is not possible as the impurity concentrations required differ considerably. The n-p-n collector is masked and etched to remove the silicon dioxide. Great care is taken in the alignment of the mask since the final characteristics depend on physical dimensions as well as impurity concentrations. Alignment is aided by instruments but final adjustments are carried out by eye. The n-type diffusion is carried out and a further silicon dioxide layer formed to give the structure shown in Fig. 8(e).

Further masking and diffusions produce the p-n-p transistor base shown in Fig. 8(f) and then by simultaneous p diffusions the p-n-p emitter and n-p-n base shown in Fig. 8(g). The final n diffusion completes the two-transistor structure shown in Fig. 8(h). The interconnecting to other components is carried out by a further mask and etch of the silicon dioxide and the formation of a thin film (often aluminium) interconnection pattern.

Figure 7 shows the schematic of the structure which has been fabricated. Clearly isolation can only be maintained if the isolation diodes  $D_i$  are reverse biased. Also it will be noted in Fig. 8(h) that the substrate and n-p-n transistor form a p-n-p-n structure (or thyristor) which would fire to the

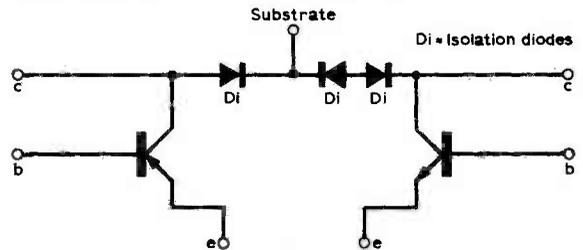


Fig. 7: Schematic of fabricated structure.

saturated condition unless reverse biased. In addition parasitic effects of leakage current, capacitance and inductance are present and these will be discussed later.

## Resistors

As far as possible resistors are formed of semiconductor material usually during the resistive base diffusion which results in medium resistivity semiconductor. Occasionally the low resistivity emitter diffusion is used for low value resistors. Fig. 9 illustrates the structure of such a resistor. Isolation is again achieved by reverse biased pn-junctions. Resistor values of from  $100\Omega$  to  $30k\Omega$  with tolerances of  $\pm 10\%$  can be achieved by this method.

Compatible thin film resistors are manufactured from nichrome, tin oxide, tantalum, aluminium,

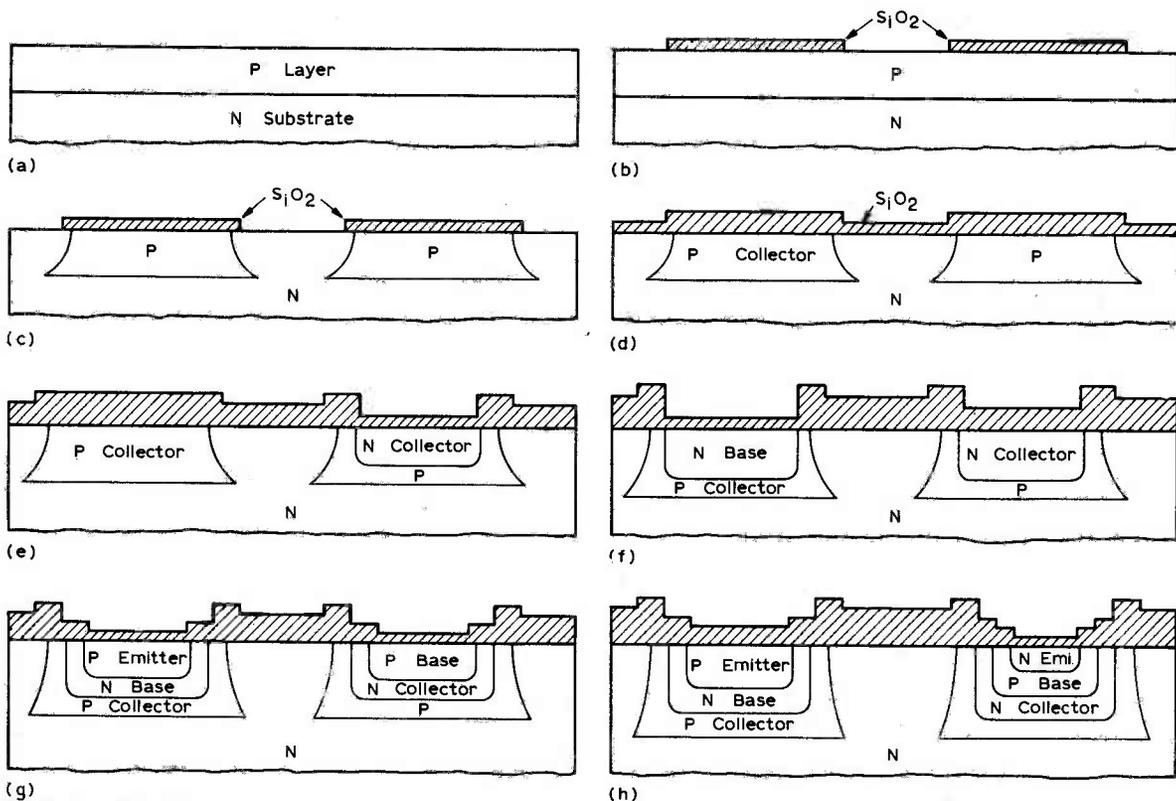


Fig. 8: (a) portion of starting wafer, (b) silicon dioxide masked for transistors, (c) isolation diffusion n type, (d) silicon dioxide grown after diffusion, (e) collector of n-p-n transistor formed, (f) base diffusion of p-n-p transistor, (g) simultaneous p type base and emitter diffusion (h) final n type emitter diffusion.

chromium and nickel. Values from  $20\Omega$  to  $3M\Omega$  can be achieved with tolerances of  $\pm 5\%$ . In all cases the power and voltage ratings are severely limited and are  $3mW$  per square mil maximum power and  $20V$  maximum voltage drop.

of  $2.5pF/mil$  and  $0.3$  to  $0.5pF/mil$  respectively. Tolerances generally are  $\pm 20\%$  and maximum voltage ratings of  $20-50V$ . Q factors vary from  $10-100$  and practical maximum capacitance values are  $1000pF$  or  $5000pF$  for tantalum oxide.

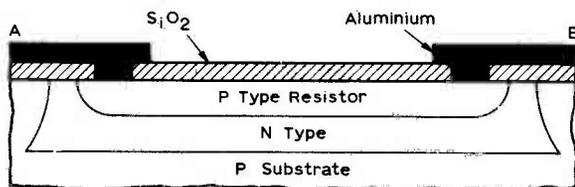


Fig. 9: Diffused resistor structure.

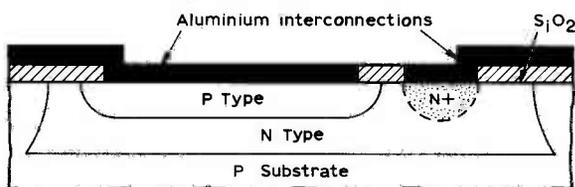


Fig. 10: Diffused capacitor structure.

## Capacitors

Wherever possible capacitors are fabricated from reverse biased diodes and such a structure is illustrated in Fig. 10. However as the isolation of such diodes is achieved by reverse biased junctions considerable parasitic capacitance is present. Where necessary silicon dioxide dielectric capacitors are fabricated to overcome this disadvantage. Silicon dioxide capacitors have the added advantages that they are non-polar and their capacitance is constant with bias voltage.

Thin film capacitors of tantalum oxide and aluminium are also used and give capacitance values

## Inductors

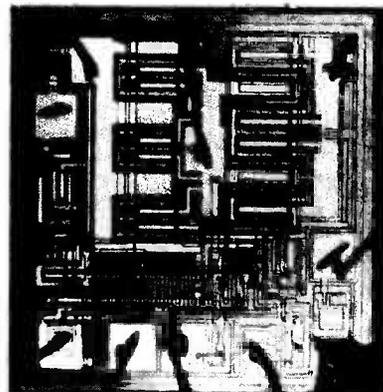
Inductors with practical values of inductance and Q are the most difficult components to produce. Despite the considerable research devoted to inductors it is true to say that their value as an integrated circuit component is severely limited. The maximum practical inductance is limited to  $4\mu H$  with Q factors of  $1-5$  in monolithic structures or  $30-50$  in thin film fabrications.

**TO BE CONTINUED**

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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 such components as tone and volume controls and a battery or mains power supply. However, it 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 as part of the process of producing monolithic I.C.s are expensive but once made, the circuits can be produced with complete uniformity and at very low cost. This enables us to cover every IC-10 with the Sinclair guarantee of reliability.

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Sensitivity	5mV.
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#### ■ CIRCUIT DESCRIPTION

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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. These include stabilised power supplies, oscillators, etc. The pre-amp section can be used as an R.F. or I.F. amplifier without any additional transistors.

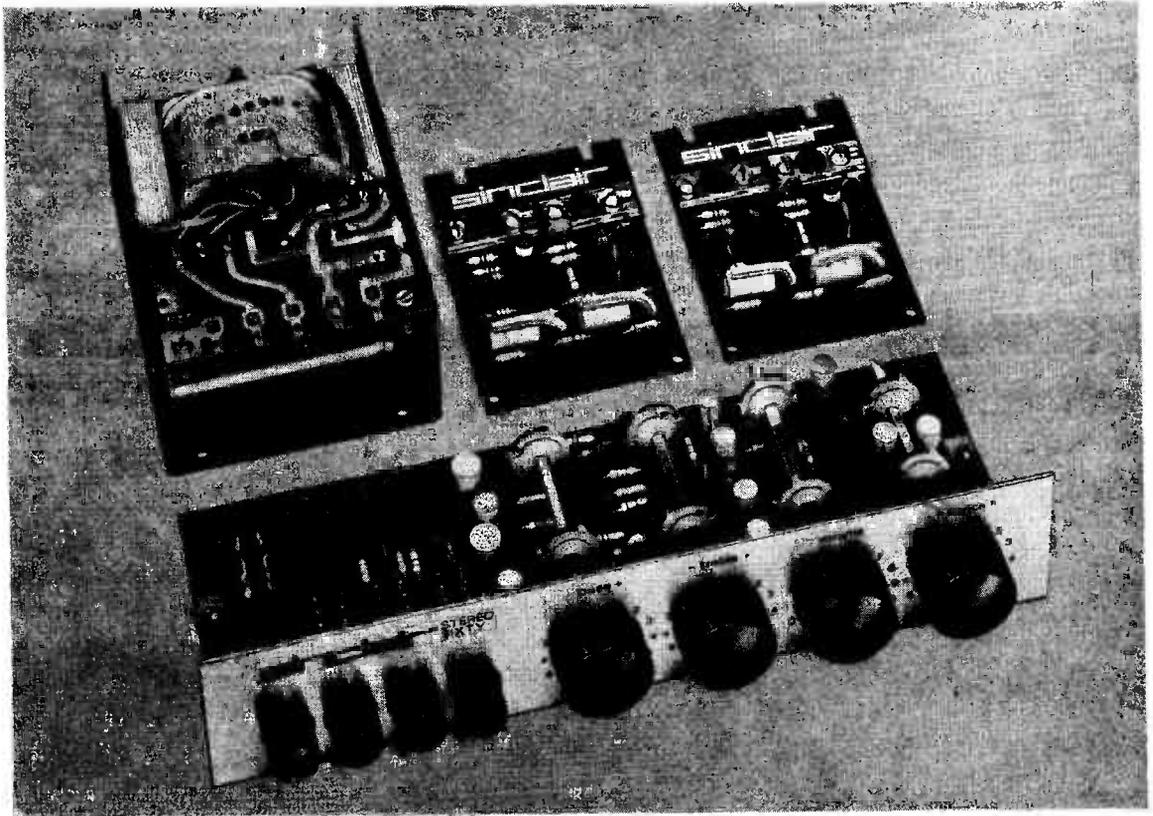
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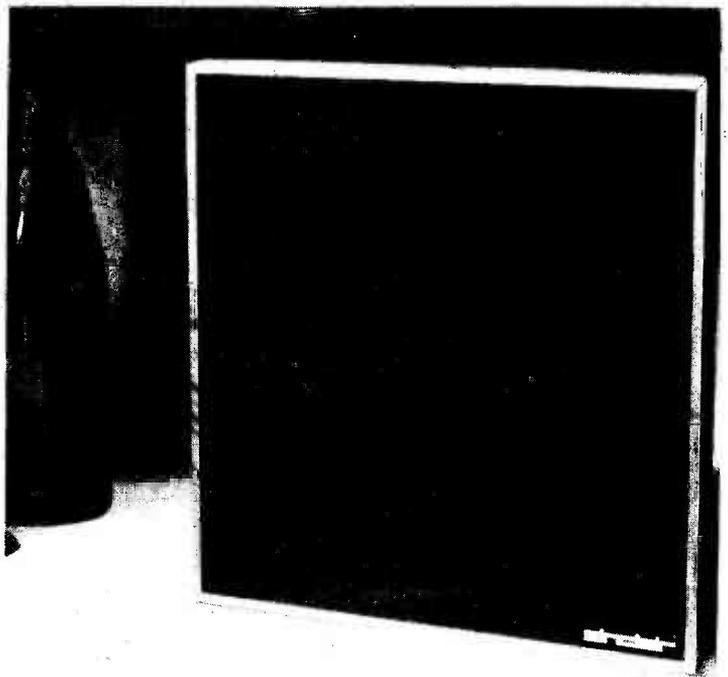
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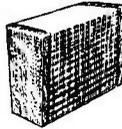
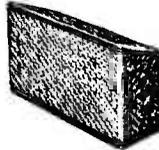


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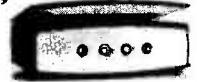
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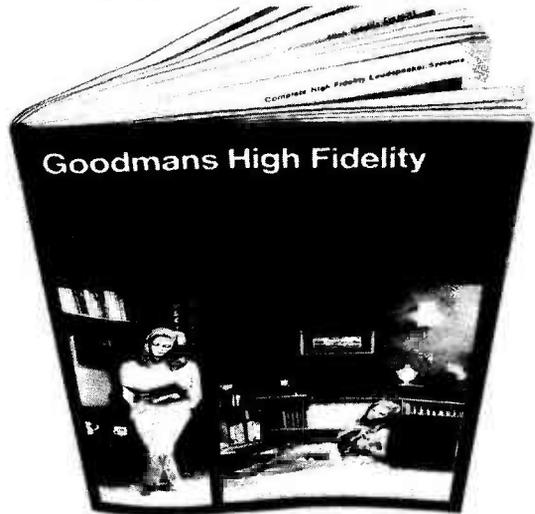
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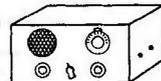
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8 1/2"	6 1/2"	1	1	6	6	1	11
10 1/2"	7 1/2"	1	8	6	15	6	18
12 1/2"	3 1/2"	1	1	6	6	1	11
12 1/2"	6 1/2"	1	8	0	14	0	17
12 1/2"	8 1/2"	1	16	0	3	0	2
14 1/2"	3 1/2"	1	5	0	1	11	6
14 1/2"	9 1/2"	2	3	0	2	15	9
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