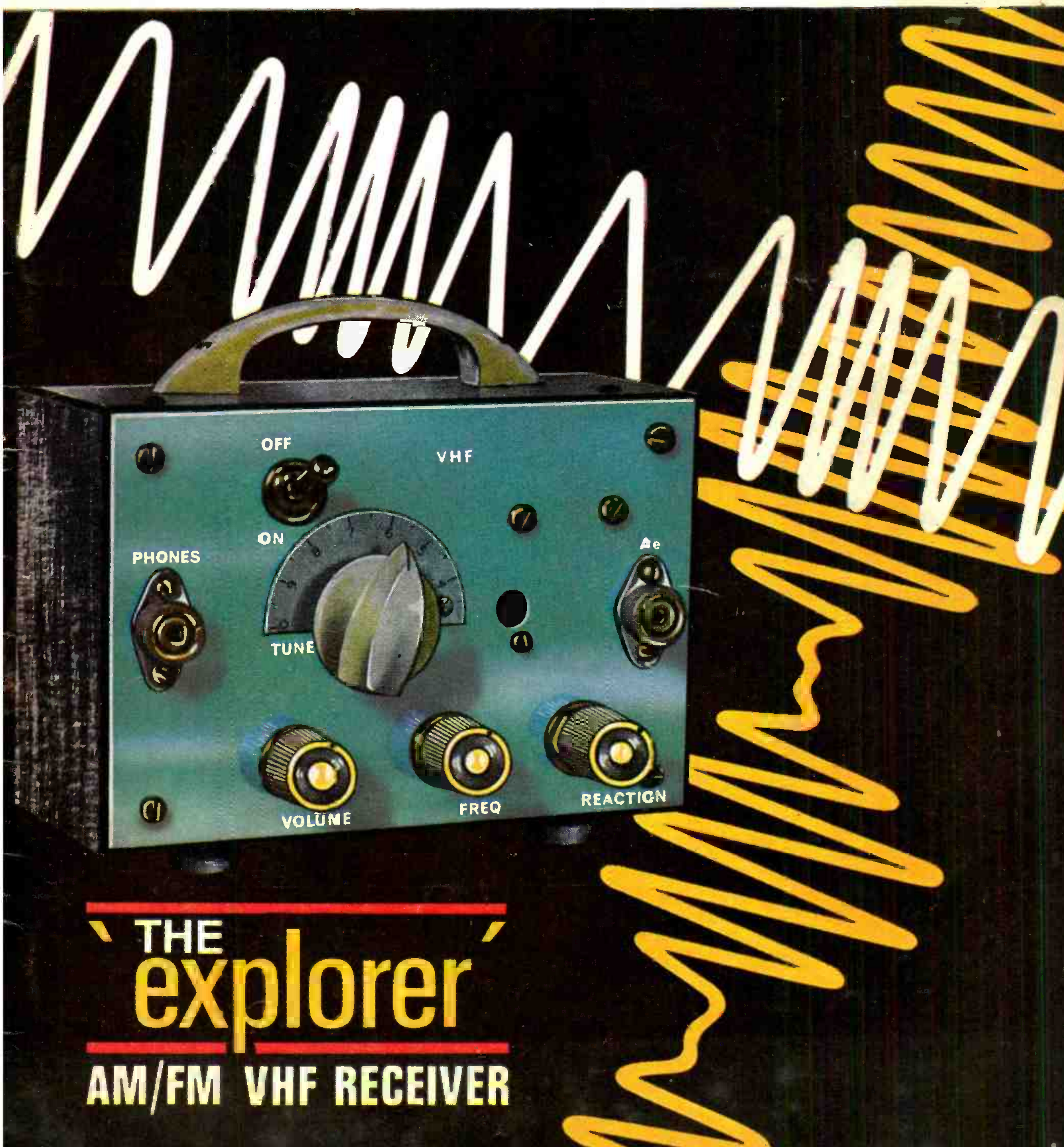
PRACTICAL WIRELESS

JANUARY 1967

2'6



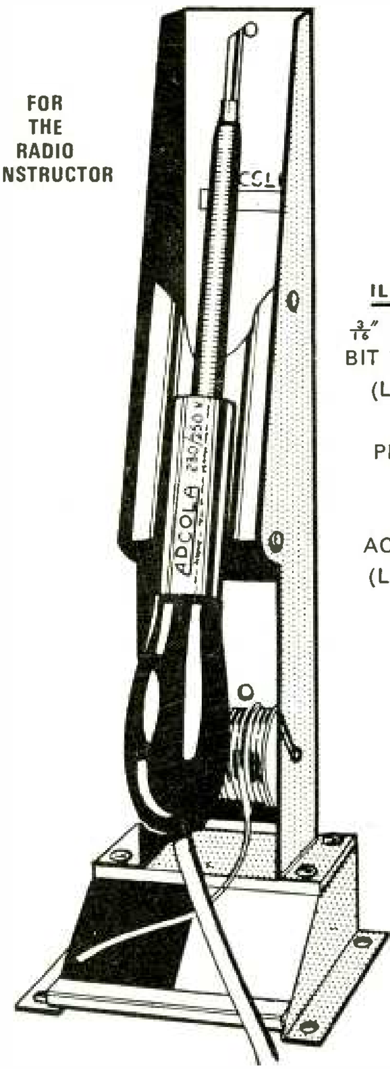
'THE explorer'

AM/FM VHF RECEIVER

ADCOLA
PRODUCTS LIMITED
(Regd Trade Mark)

SOLDERING EQUIPMENT

FOR THE RADIO CONSTRUCTOR



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$\frac{3}{16}$" DETACHABLE BIT INSTRUMENT (List No. 64) IN PROTECTIVE SHIELD WITH ACCESSORIES (List No. 700)

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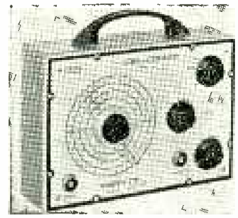

WIDE RANGE TRANSISTORISED SIGNAL GENERATOR MODEL 27

- ★ Range 150Kc/s-350Mc/s
- ★ Direct Calibration
- ★ Mod. or Unmod. output
- ★ Accuracy better than 2%

£10.18.9.

ALSO AVAILABLE

Audio Generator 63	..	£17.3.9
Inductance Bridge 66	..	£18.8.9
Power Supply Unit 61	..	£6.16.6

WIDE RANGE TRANSISTORISED C.R. BRIDGE—Model 62

6 Ranges: 1Ω to 100MΩ
1pF to 100μF

- ★ **Visual null indicator**
- ★ **Power factor check**
- ★ **Electrolytic leakage test**
- ★ **Battery operated**

£9. 8. 9.

All prices include battery, post and packing

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NOMBREX LTD INSTRUMENTS DIVISION
Estuary House, Camperdown Ter., Exmouth, Devon

For quick, easy faultless soldering

ERSIN Multicore 5 CORE SOLDER

Easy to use and economical. Containing 5 cores of non-corrosive flux, instantly cleaning heavily oxidised surfaces. No extra flux required. Ersin Multicore Savbit Alloy reduces wear of copper soldering iron bits.

SIZE 5 HANDY SOLDER DISPENSER
Contains 12 ft. of coil 18 s.w.g. Ersin Multicore Savbit Alloy. Quick and easy to use.
2/6 each

NEW SIZE 15
21 ft coil of 60/40 Alloy. 22 s.w.g. in a dispenser. Ideal for small components, transistors, diodes, etc.
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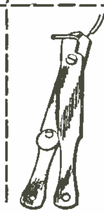
SIZE 12
Ideal for home constructors. Contains 102 ft. of 18 s.w.g. Ersin Multicore Savbit Alloy on a plastic reel. 15/- each (Also available in other sizes)



BIB MODEL 3 WIRE STRIPPER AND CUTTER
Strips insulation without nicking the wire, cuts wire and splits plastic twin flex.
4/- each

From Electrical or Hardware shops. If unobtainable write to:
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HI-FI AMPLIFIERS — TUNERS — RECORD PLAYERS

20+20 STEREO AMP. AA-22U


GARRARD PLAYER AT-60

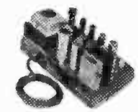

TRANSISTOR MIXER. MODEL TM-1. A must for the tape enthusiast. Four channels. Battery operated. Similar styling to Model AA-22U Amplifier. Kit **£11.16.6.** Assembled **£16.17.6**

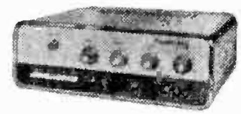
20+20W TRANSISTOR STEREO AMPLIFIER. Model AA-22U. Outstanding performance and appearance. 5 stereo inputs each channel, 20 transistor, 10 diode circuit. Kit **£39.10.0** Assembled **£57.10.0** (Cabinet **£2.5.0** extra).

GARRARD AUTO/RECORD PLAYER. Model AT-60, less cartridge **£14.12.10.** With Decca Deram pick-up **£19.7.4** incl. P.T.

Many other Garrard models available, ask for Lists.

HI-FI MONO AMPLIFIER. Model MA-5. A general purpose 5W Amplifier, with inputs for Gram., Radio. Modern functional appearance. Kit **£11.9.6** Assembled **£15.15.0**

10W POWER AMP. MA-12


9+9W STEREO AMP. S-99


HI-FI MONO AMPLIFIER. Model MA-12. 10W output, wide freq. range, low distortion. Use with control units. Models UMC-1 (Mono) or USC-1 (Stereo). Kit **£12.18.0** Assembled **£16.18.0**

3+3W STEREO AMPLIFIER. Model S-33. An easy-to-build, low cost unit. 2 inputs per channel. Kit **£13.7.6** Assembled **£18.18.0**

DE LUXE STEREO AMPLIFIER. Model S-33H. De luxe version of the S-33 with two-tone grey perspex panel, and high sensitivity necessary to accept the Decca Deram pick-up. Kit **£15.17.6** Assembled **£21.7.6**

HI-FI STEREO AMPLIFIER. Model S-99. 9+9W output. Ganged controls. Stereo/Mono gram, radio and tape inputs. Push-button selection. Printed circuit construction. Kit **£28.9.6** Assembled **£38.9.6**

POWER SUPPLY UNIT. Model MGP-1. Input 100/120V, 200/250V, 40-60 c/s. Output 6·3V, 2·5A A.C. 200, 250, 270V, 120mA max. D.C. Kit **£5.12.6** Assembled **£7.2.6**

Heathkit DAYSTROM

Make the most of your leisure time..

Hear the BBC Stereo FM Programmes

on the TRANSISTOR STEREO FM TUNER

Elegantly designed to match the Stereo Amplifier, AA-22U

Many special features including:—

★ Pre-assembled and aligned RF tuning unit.
★ 4 stage IF amplifier, Automatic freq. control.
★ Printed circuit board, 14 transistor circuit.

Available in two units, sold separately, can be built for a **TOTAL PRICE KIT (STEREO) £24.18.0** incl. P.T.
Kit (MONO) **£20.19.0** incl. P.T. can be converted to stereo with adaptor, optional extra. Cabinet, optional extra **£2.5.0.** Send for details.

TRANSISTOR RADIOS

Oxford

"OXFORD" LUXURY PORTABLE Model UXR-2. Specially designed for use as a domestic or personal portable receiver. Many features, including solid leather case. Kit **£14.18.0** incl. P.T.

UXR-1

TRANSISTOR PORTABLE. Model UXR-1. Pre-aligned I.F. transformers, printed circuit. Covers L.W. and M.W. Has 7″ x 4″ loudspeaker. Real hide case. Kit **£12.11.0** incl. P.T.

JUNIOR EXPERIMENTAL WORKSHOP Model EW-1. More than a toy! Will make over 20 exciting electronic devices, incl.: Radios, Burglar Alarms, etc. 72 page Manual. The ideal present! Kit **£7.13.6** incl. P.T.

HIGH PERFORMANCE CAR RADIO, CR-1. Superb LW/MW entertainment, wherever you drive. For 12v pos. or neg. earth systems. Tastefully styled to match any car colour scheme. Many special features. Send for details. Kit (less speaker) **£12.17.0.,** L/S **£1.4.5** extra. Prices incl. P.T.

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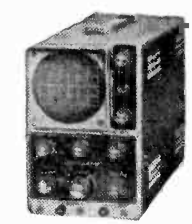
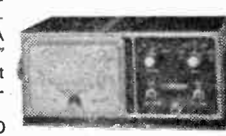
3″ LOW-PRICED SERVICE OSCILLOSCOPE. Model OS-2. Compact size 5″ x $7\frac{3}{8}$″ x 12″ deep. Wt. only $9\frac{3}{4}$lb. "Y" bandwidth 2 c/s-3 Mc/s, ±3dB Sensitivity 100mV/cm. T/B 20 c/s-200 kc/s in four ranges, fitted mu-metal CRT Shield. Modern functional styling. Kit **£23.18.0** Assembled **£31.18.0**



OS-2

5″ GEN.-PURPOSE OSCILLOSCOPE. Model 10-12U. An outstanding model with professional specification and styling. "Y" bandwidth 3 c/s-4·5 Mc/s ±3dB. T/B 10 c/s-500 kc/s. Kit **£35.17.6** Assembled **£45.15.0**

DE LUXE LARGE-SCALE VALVE VOLTMETER. Model IM-13U. Circuit and specification based on the well-known model V-7A but with many worth-while refinements. 6″ Ernest Turner meter. Unique gimbal bracket allows operation of instrument in many positions. Modern styling. Kit **£18.18.0** Assembled **£26.18.0**



VVM, IM-13U

AUDIO SIGNAL GENERATOR. Model AG-9U. 10 c/s to 100 kc/s, switch selected. Distortion less than 0·1%, 10V sine wave output metered in volts and dB's. Kit **£23.15.0** Assembled **£31.15.0**

V-7A

VALVE VOLTMETER. Model V-7A. 7 voltage ranges d.c. volts to 1,500. A.C. to 1,500 r.m.s. and 4,000 peak to peak. Resistance 0·1 Ω to 1,000M Ω with internal battery. D.C. input resistance 11MΩ. dB measurement, has centre-zero scale. Complete with test prods, leads and standardising battery. Kit **£13.18.6** Assembled **£19.18.6**

RF-1U

MULTIMETER. Model MM-1U. Ranges 0–1·5V to 1,500V a.c. and d.c.; 150μA to 15A d.c.; 0·2Ω to 20MΩ $4\frac{1}{2}$″ 50μA meter. Kit **£12.18.0** Assembled **£18.11.6**

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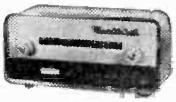
SINE/SQUARE GENERATOR. Model 1G-82U. Freq. range 20 c/s–1 Mc/s in 5 bands less than 0·5% sine wave dist. less than 0·15μ sec. sq. wave rise time. Kit **£25.15.0** Assembled **£37.15.0**

IG-82U

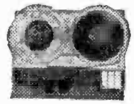
TRANSISTOR POWER SUPPLY. Model IP-20U. Up to 50V, 1·5A output. Ideal for Laboratory use. Compact size. Kit **£35.8.0** Assembled **£47.8.0**

Prices and specifications subject to change without notice

TAPE AMPLIFIERS — TAPE DECKS — CONTROL UNITS



FM TUNER FM-4U

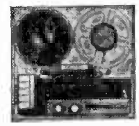


STUDIO-MATIC DECK

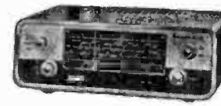
HI-FI FM TUNER. Model FM-4U. Available in two units. R.F. tuning unit (£2.15.0 incl. P.T.) with I.F. output of 10·7 Mc/s and I.F. amplifier unit, with power supply and valves (£13.13.0). For free standing or cabinet mounting. Total Kit **£16.8.0**
(Multiplex adaptor available, as extra).

HI-FI AM/FM TUNER. Model AFM-1. Available in two units which, for your convenience, are sold separately. Tuning heart (AFM-T1—£4.13.6 incl. P.T.) and I.F. amplifier (AFM-A1—£22.11.6). Printed circuit board, 8 valves. Covers L.W., M.W., S.W., and F.M. Built-in power supply. Total Kit **£27.5.0**
(Multiplex adaptor available, as extra).

STUDIOMATIC "363" TAPE DECK. The finest buy in its price range. Operating speed: $1\frac{7}{8}$", $3\frac{3}{4}$" and $7\frac{1}{2}$" p.s. Two tracks. "wow" and "flutter" not greater than 0·15% at $7\frac{1}{2}$" p.s. **£13.10.0**
With TA-1M Tape Pre-amplifier kit **£31.5.6**



TRUVOX DECK



AM/FM TUNER

TRUVOX D-93 TAPE DECKS. High quality stereo/mono tape decks.
D93/2, $\frac{1}{4}$ track, £36.15.0 D93/4, $\frac{1}{2}$ track, £36.15.0

TAPE RECORDING/PLAYBACK AMPLIFIER.

Mono Model TA-1M	Kit **£19.18.0**	Assembled **£28.18.0**
Stereo Model TA-1S	Kit **£25.10.0**	Assembled **£35.18.0**

HI-FI CABINETS. A wide range available for example:—
Malvern Kit **18.1.0** incl. P.T.

MONO CONTROL UNIT. Model UMC-1. Designed to work with the MA-12 or similar amplifier requiring 0·25V or less for full output. 5 inputs. Baxandall type controls. Kit **£9.2.6** Assembled **£14.2.6**

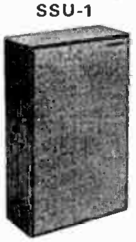
STEREO CONTROL UNIT. Model USC-1. Push-button selection accurately matched ganged controls to ±1dB. Rumble and variable low pass filters. Printed circuit boards. Kit **£19.19.0** Assembled **£27.5.0**

Enjoy building a Heathkit model

Heathkit DAYSTROM

SPEAKER SYSTEMS

SSU-1



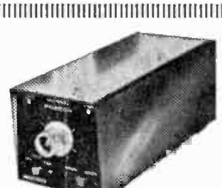
Berkeley

HI-FI SPEAKER SYSTEM. Model SSU-1. Ducted-port bass reflex cabinet "in the white". Two speakers. Vertical horizontal models with legs, Kit **£12.12.0**, without legs, Kit **£11.17.6** incl. P.T.

The **BERKELEY SLIM-LINE SPEAKER SYSTEM,** fully finished walnut veneered cabinet for faster construction. Special 12" bass unit and 4" mid/high frequency unit. Range 30-17,000 c/s. Size 26" x 17" only $7\frac{3}{8}$" deep. Modern attractive styling. Excellent value.
Kit **£19.10.0** Assembled **£24.0.0**

COTSWOLD SPEAKER SYSTEMS. Outstanding performance for price.
MFS: Size 36" x $16\frac{1}{2}$" x 14" deep.
Kit **£25.12.0** Assembled **£33.17.0**
STANDARD: Size 26" x 23" x $14\frac{1}{2}$" deep.
Kit **£25.12.0** Assembled **£33.17.0**

MULTIPLEX DECODER SD-1



SD-1

For receiving Stereo FM. Convert your existing FM Mono receiver to stereo with this low cost, self powered unit. Fully transistorised.
Kit **£8.10.0** Assembled **£12.5.0**
Styled to match British Heathkit models.

SEND FOR THE LATEST FREE CATALOGUE

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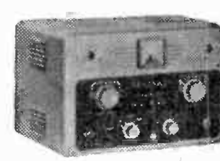
"AMATEUR" EQUIPMENT

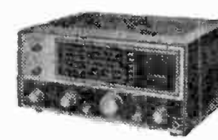


DX-40U

80-10m TRANSMITTER, DX-40U. Power inputs 75W. C.W., 60W peak CC phone. Output 40W to aerial. Provision for VFO.
Kit **£29.19.0** Assembled **£41.8.0**

SSB ADAPTOR, SB-10U
Kit **£39.5.0** Assembled **£54.18.0**

AMATEUR BANDS RECEIVER Model RA-1. To cover all the Amateur Bands from 160-10 metres. Many special features, including: half-lattice crystal filter; 8 valves; signal strength "S" meter; tuned R.F. Amp. stage.
Kit **£39.6.6** Assembled **£52.10.0**



RA-1

160-10M TRANSMITTER. Model DX-100U. Careful design has achieved high performance and stability. Completely self-contained.
Kit **£81.10.0** Assembled **£106.15.0**

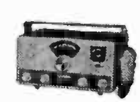
COMMUNICATIONS TYPE RECEIVER. Model RG-1. A high performance, low cost receiver for the discriminating listener. Frequency coverage: 600 kc/s–1·5 Mc/s and 1·7 Mc/s–32 Mc/s.
Kit **£39.16.0** Assembled **£53.0.0**

HM-11U

REFLECTED POWER METER and SWR BRIDGE. Model HM-11U. Indicates reliably but inexpensively, whether the RF power output of your TX is being transferred efficiently to radiating antenna. Kit **£8.10.0** Assembled **£10.15.0**

OUTSTANDING "AMATEUR" EQUIPMENT
A wide range of American Amateur SSB equipments is now available in the U.K. Why not send for full details of range, for example:

FILTER TYPE SSB TRANSCEIVERS
Models for 80, 40 or 20 metre bands.
Model HW-12 (80M) **£67.10.0** Kit.
Model HW-22 (40M) } **£66.0.0 each kit.**
Model HW-32 (20M) } price inc. duty, etc.



80M Transceiver HW-12

Without obligation please send me (Tick here)
FREE BRITISH HEATHKIT CATALOGUE .... ☐
FULL DETAILS OF MODEL(S) .... ☐
(*Please write in BLOCK CAPITALS*)
NAME ....
ADDRESS ....
.... **DEPT. P.W.1**

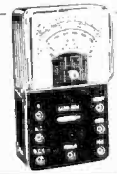
BSR MONARCH UA16 with FULL-FI HEAD

4-speed, plays 10 records, 12in. 10in. or 7in. at 16, 33, 45 or 78 r.p.m. Internixes 7in., 10in. and 12in. records of the same speed. Has manual play position: colour, brown. Dimensions: 12½ x 10¾in. Space required above base board 4¾in. below baseboard 2¾in. Fitted with Full-Fi-turn-over crystal head. P. & P. 9/-.

£4.19.6

Complete Amplifier Kit comprising E.C.L. 82 Mains transformer, metal rectifier, volume control, smoothing condenser, metal chassis, speaker, etc.
To the purchasers of the above changer only **19/6** plus 3/- P. & P.

POCKET MULTI-METER



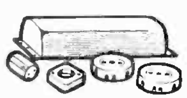
Size 3⅞ x 2¼ x 1⅜in. Meter size 2⅛ x 1⅜in. Sensitivity 1000 O.P.V. on both A.C. and D.C. volts. 0·15, 0·150 0·1000. D.C. current 0·150mA. Resistance 0·100kΩ. Complete with test prods, battery and full instructions, **42/6**. P. & P. 3/6. **FREE GIFT** for limited period only. 30 watt Electric Soldering Iron value **15/-** to every purchaser of the Pocket Multi-Meter.

"MAYFAIR" 5-Transistor TAPE RECORDER

Capstan-driven, battery operated 7½ and 3¾ i.p.s. Precision made. Push-button controls. High quality 2¾in. speaker. Push-pull circuit. Output 400mW. Frequency response: 200-7,000 kc/s. Fast rewind. Up to 1 hour twin track playing time. Automatic erasing for re-recording. Dimensions: 8in. x 11in. x 3¾in. Weighs only 7lb. Takes 5in. spools.

£11.11.0 plus 9/-. P. & P.

40W FLUORESCENT LIGHT KIT



Incorporating **GEC** Choke size 8¼in. x 1¾in. x 1¾in., 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 11¾in. x 1¾in. x 1¾in. 2 bi-pin holders, starter and starter holder. P. & P. 6/6 **17/6**

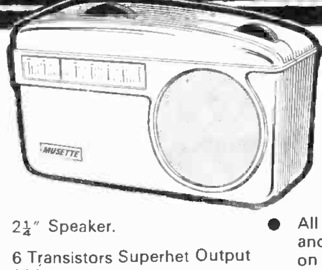
Twin 40W Choke instant start for 2 x 2ft. tubes **17/6**. P. & P. 5/6.

THE MOTORIST'S REV COUNTER

FULLY TRANSISTORISED

Suits 4 or 6 cyl. engines. Would cost at least £8 to buy. Kit contains moving coil movement and all parts including transistors, a circuit diagram and full instructions. Maximum reading 8,000 r.p.m. Send P.O. for **22/-**, which includes 2/6 postage.

MUSETTE 6 TRANSISTOR SUPERHET PORTABLE RADIO



39/6

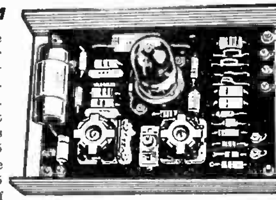
P. & P. 3/6.
Circuit diagram 2/6.
Free with parts.

INCLUDING CARRYING STRAP

- 2¼" Speaker.
- 6 Transistors Superhet Output 200mW.
- Plastic Cabinet in red, size 4¾" x 3" x 1⅜" and gold speaker louvre.
- Horizontal Tuning Scale.
- Ferrite Rod Internal Aerial.
- IF 470 kc.
- All components, Ferrite Rod and Tuning Assembly mount on printed board.
- Operated from PP3 Battery.
- Full comprehensive instructions and point-to-point wiring diagram.
- Printed Circuit Board.
- Tunable over medium and long waveband. Car aerial and ear piece socket.

MULTIPLEX DECODER

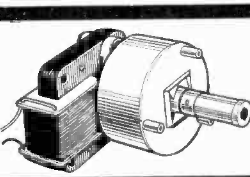
For receiving Stereo FM



Now is your chance to benefit in full from the new B.B.C. stero transmissions with our Multiplex Decoder. Design features: Highly efficient Mullard vinkor pot cores. Two semi-conductor diodes. Double purpose valve. Printed circuit type construction high input impedance. Specification: Cross talk minus 26 dB at 1 kc/s. Input requirements 0·5—1·5 RMS. Stability plus or minus 0·1%. Voltage requirements H.T. 190—250 volts. D.C. at 5 mA. heaters 6·3 volts. A.C. at 300 mA. Self powered unit shortly available, price to be announced. Size 5¼" x 3½" x 1". Fully built and tested.

Price **£4.4.0** P. & P. 3/-

Type E MOTOR



Small A.C. mains motor 230/250 volts complete with gearbox. **6 r.p.m.** Price **15/-** plus 4/-. P. & P.
Similar to above motor but without gearbox. Price 8/6 plus 3/-. P. & P.

FIRST QUALITY P.V.C. TAPE

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5¾in.	L.P.	1200ft.	11/6	5¾in.	T.P.	2400ft.	32/6
7in.	L.P.	1800ft.	18/6	7in.	T.P.	3600ft.	42/6
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P. & P. on each 1/6, 4 or more post free.

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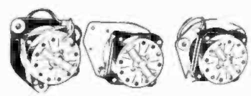

Set of three Tape Deck Motors 240V. A.C. Three motors **49/6**. P. & P. 6/-.

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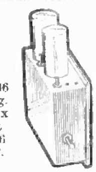

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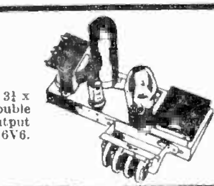

3-4 watt Amplifier built and tested. Chassis size 7 x 3½ x 1in. Separate bass, treble and volume control. Double wound mains transformer, metal rectifier and output transformer for 3 ohms speaker. Valves ECC81 and 6V6.
£2.0.0 plus 5/6 p. & p.
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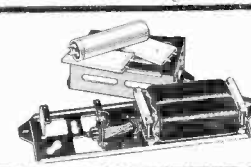

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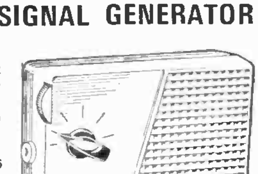

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6F11	**5/9**	L63	**5/9**		
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6X4	**3/6**	UU7	**9/6**		

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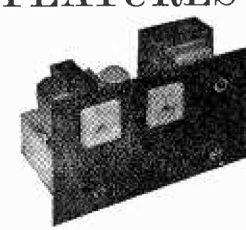

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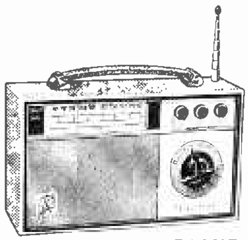

THE SKYROVER De Luxe

7 transistor plus 2 diode superhet, 6 waveband portable receiver covering the full Medium Waveband and Short Waveband 31–94M and also 4 separate switched band-spread ranges, 13M., 16M., 19M., and 25M., with Band Spread Tuning for accurate Station Selection. The coil pack and tuning heart is completely factory assembled, wired and tested. The remaining assembly can be completed in under three hours from our easy to follow, stage by stage instructions. Superhet, 470 Kc/s. All Mullard Transistors and Diode. Uses 4 U2 batteries. 5in. Ceramic Magnet P.M. Speaker. Easy to read Dial Scale, 500 MW Output. Telescopic Aerial and Ferrite Rod Aerial. Tone Circuit is incorporated, with separate Tone Control in addition to Volume Control. Tuning Control and Waveband Selector. In a wood cabinet, size 11½ x 6½ x 3in. covered with a washable material, with plastic trim and carrying handle. Car aerial socket fitted.

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This conversion is suitable for receivers that have already been constructed.

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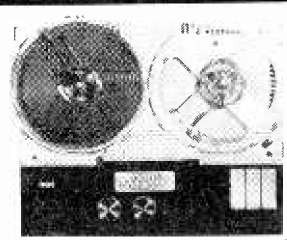
TAPE RECORDERS

MAGNAVOX 363 TAPE DECKS



The very latest 3 speed model—1⅞, 3¾, 7½ ips, available with either ½ track or ¼ track head. Features include: pause control; digital counter; fast forward and rewind; new 4 pole fully screened induction motor, interlocking keys. Size of top plate 13½ x 11in. x 5½in. deep below unit plate. For 200/250v. A.C. mains, 50 cps operation. New, unused and fully guaranteed.

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Now available from stock—for use with the Magnavox 363 Tape Deck.

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

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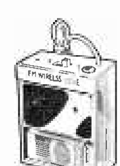

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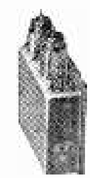

TRANSISTORISED UHF MINIATURE MODEL 1

Shielded metal case only 3¼ x 1½ x 3in. Fully tunable—complete with two AF139 transistors. LASKY'S PRICE **39/6**

TRANSISTORISED UHF MODEL 2

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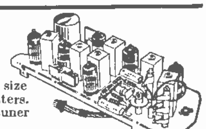

38 Mc/s. Contains a large number of components, IF transformers, resistors, capacitors etc., and the following valves: 2 x PCF80, 1 x EB91, EF80, EF183 and EF184. Overall size 11½ x 3½ x 4in. deep. Ideal for servicemen and experimenters. This IF amp. when used with the valve model UHF tuner (above) provides a suitable conversion for BBC2. No circuit available. LASKY'S PRICE **39/6** Post 2/6

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Free standing table cabinet, size 19½ x 9 x 5½in., finished in medium Mahogany. Scale marked 21 to 68 (UHF band). Designed to accept the above IF Amplifier with space for a Valve UHF Tuner.

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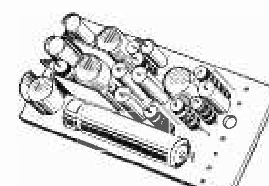
Special Package Offer: IF Amplifier, UHF Tuner with valves and Table Cabinet PACKAGE PRICE **89/6** Post 6/-

NEW—LASKY'S MINIATURE TRANSISTOR AMPLIFIER MODULES



Incorporating the very latest circuitry to provide high sensitivity and good quality in conjunction with extreme small size and compactness. High quality Newmarket transistors used throughout. All designed to operate on 9v. miniature battery.

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TYPE LRPC 1. 3 transistor. Input sens. 50mV, output 150mW, output imp. 40 Ω, 2 x 1 x ⅜in. .... PRICE **27/6**

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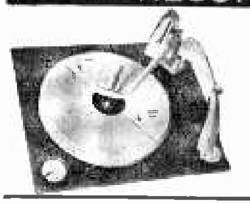

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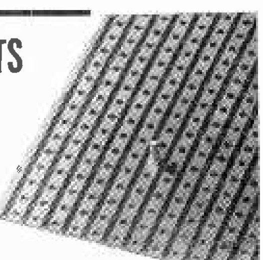
33 TOTTENHAM CT. RD., LONDON, W.1 Tel. MUS 2605
All the above branches open all day Saturday. Early closing Thursday.

42 TOTTENHAM CT. RD., LONDON, W.1 Tel. LAN 2573
152/3 FLEET STREET, LONDON, E.C.4 Tel. FLE 2833
Both open all day Thursday. Early closing Saturday.

Mail Orders and correspondence to 3-15 Cavell Street, Tower Hamlets, London, E.1. Tel.: STEpney Green 4821/2

LASKY'S FOR SPEEDY MAIL ORDER SERVICE

BUILD YOUR CIRCUITS on VEROBOARD



— the Universal Wiring Board —
obtainable from your local Retailer

If in difficulty write to:—

NORMAN ROSE (ELECTRICAL) LTD.
8 ST. CHAD'S PLACE, GRAYS INN ROAD, LONDON, W.C.1

2 Station System ideal for Home, Office, Sick room — endless uses. Operates on one 9 volt battery with a life of 4 to 6 months. Two fully transistorised sets — either one can speak or listen to the other even if switch is at "off" position. Size of both master and sub station 3 x 2 x 4in. Two tone strong plastic cases finished with silver trim. Complete with 66 ft. connecting cable and fitted jack-plugs, staples and fixing tape, battery and instructions. Postage, packing and transit insurance 3/-.

IDEAL FOR XMAS GIFTS LOW COST BABY ALARM/INTERCOM. RELAX AND SAVE YOUR LEGS OUR SPECIAL PRICE 54/6d.— BATTERY INCLUDED—usually 7 gns. Fitted in seconds ! ! Despatch by return.

VALVES

SAME DAY SERVICE
NEW! TESTED! GUARANTEED!

SETS 1R5, 1S5, 1T4, 3S4, 3V4, DAF91, DF91, DK91, DL92, DL94. Set of 4 for 16/-. DAF96, DF96, DK96, DL96, 4 for 24/6

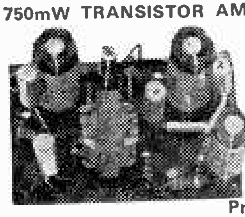
1A7GT	7/6	10C2	12/-	DF96	6/-	EF89	5/-	PEN36C	15/-	UCH42	8/9
1H5GT	7/3	10F1	9/9	DH76	3/6	EF91	3/6	PEN383	9/6	UCH81	6/-
1N5GT	7/9	10P13	8/6	DH77	4/-	EF92	2/3	PFL200	14/6	UCL82	7/-
1R5	4/9	12AT7	3/9	DH81	12/6	EF97	7/6	PL36	8/9	UCL83	8/9
1S4	4/9	12AU6	4/9	DK32	7/9	EF183	6/9	PL81	6/9	UF41	8/-
1S5	3/9	12AU7	4/9	DK91	4/9	EF184	6/-	PL82	6/6	UF89	5/9
1T4	2/9	12AX7	4/9	DK92	8/-	EL33	6/6	PL83	6/-	UL41	8/9
3A5	7/-	12K7GT	3/6	DK96	6/6	EL38	11/9	PL84	6/3	UL44	15/-
3Q4	5/6	12K8GT	8/6	DL33	6/9	EL41	8/6	PL500	14/-	UL84	5/9
3S4	4/9	12Q7GT	3/6	DL35	5/-	EL42	7/9	PL801	7/6	UY21	8/9
3V4	5/6	20F2	11/6	DL92	4/9	EL84	4/9	PX25	7/9	UY41	4/9
5U4G	4/6	20L1	14/-	DL94	5/6	EL90	4/9	PY31	6/6	UY85	4/9
5V4G	7/9	20P1	9/-	DL96	6/-	EL95	5/-	PY32	8/6	VP4B	11/-
5Y3GT	4/11	20P3	9/-	DY86	6/6	EM80	5/9	PY33	8/6	VP1321	21/-
5Z4G	6/9	20P4	13/6	DY87	6/6	EM81	7/3	PY80	5/3	W76	3/6
6/30L2	9/6	25U4GT	11/6	EABC80	6/-	EM84	5/9	PY81	5/3	W77	2/9
6AL5	2/3	30C15	10/6	EAF42	7/6	EM87	6/6	PY82	5/-	Z77	3/6
6AM6	3/6	30C17	11/6	EB41	4/-	EY51	6/3	PY83	5/9	**Transistors**	
6AQ5	4/9	30C18	8/-	EB91	2/3	EY86	6/-	PY88	7/3	AC107	13/6
6AT6	4/-	30F5	9/9	EBC33	6/-	EZ40	6/3	PY800	6/6	AC127	9/6
6BA6	4/6	30FL1	10/6	EBC41	7/9	EZ41	6/6	PY801	6/6	AD140	15/6
6BE6	4/3	30L15	11/-	EBF80	6/-	EZ80	3/9	R19	7/6	AF102	18/-
6BJ6	5/6	30L17	12/-	EBF89	5/9	EZ81	4/-	R20	12/9	AF115	6/9
6BW6	7/3	30P4	11/6	ECC81	3/9	GZ32	9/-	TH21C	9/6	AF116	6/9
6F1	7/9	30P12	9/9	ECC82	4/9	KT61	6/6	U25	9/-	AF117	5/-
6F13	3/6	30P19	11/6	ECC83	7/-	N18	5/6	U26	8/9	AF118	16/6
6F14	9/-	30PL1	11/9	ECC84	6/3	N78	14/9	U47	8/6	AF124	9/6
6F23	9/9	30PL13	11/9	ECC85	5/6	PC97	6/9	U49	9/6	AF125	9/-
6K7G	1/6	35L6GT	6/3	ECF80	7/6	PCC84	5/6	U52	4/6	AF126	8/6
6K8G	4/3	35W4	4/6	ECF82	6/9	PCC89	9/9	U78	3/6	AF127	8/6
6K8GT	7/6	35Z4GT	4/6	ECF86	9/-	PCC189	9/-	U191	10/6	OC22	17/6
6L18	7/6	85A2	5/9	ECH35	6/-	PCF86	6/6	U301	11/9	OC25	10/-
6Q7G	5/6	185BT	20/-	ECH42	9/-	PCF82	6/9	U801	16/3	OC26	6/9
6V6G	3/6	6063	12/6	ECH81	5/-	PCF86	8/3	UABC80	5/9	OC44	4/3
6V6GT	6/6	AZ31	8/9	ECH84	8/6	PCF800	10/6	UAF42	7/9	OC45	3/3
6X4	3/6	B36	4/6	ECL80	6/-	PCF801	9/6	UBC41	6/9	OC71	3/6
6X5GT	6/3	B729	10/-	ECL82	6/3	PCF805	8/-	UBF80	6/-	OC72	4/9
7B6	10/9	DAC32	7/3	ECL86	7/9	PCL82	6/9	UBF89	5/9	OC75	5/9
7B7	7/9	DAF91	3/9	EF39	3/9	PCL83	9/-	UBL21	9/-	OC81	3/6
7C5	8/9	DAF96	6/-	EF41	6/3	PCL84	7/6	UC92	5/6	OC81D	3/6
7C6	6/9	DCC90	7/-	EF80	4/9	PCL85	8/3	UCC85	6/6	OC82	5/9
7H7	5/-	DF33	7/9	EF85	5/-	PCL86	8/6	UCF80	8/3	OC82D	5/6
7Y4	5/-	DF91	2/9	EF86	6/3	PENA4	6/9	UCH21	9/3	OC170	7/6

READERS RADIO

85 TORQUAY GARDENS, REDBRIDGE, ILFORD, ESSEX. CRE 7441

Postage on 1 valve 9d. extra. On 2 valves or more, postage 6d. per valve extra. Any Parcel Insured against Damage in Transit 6d. extra.

750mW TRANSISTOR AMPLIFIER



4 transistors including two in push-pull input for crystal or magnetic microphone or pick-up—feed back loops—sensitivity 5 m/v.

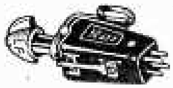
Price 19/6

Post and insurance 2/6. Speakers 3in. 12/6; 5in. 13/6; 6 x4in. 14/6.

MAINS POWER PACK

MAINS POWER PACK designed to operate transistor sets and amplifiers. Adjustable output 6 v.-9 12 volts for up to 500 mA (class B working). Takes the place of any of the following batteries: PR1, PP3, PP4, PP6, PP7, PP9, and others. Kit comprises: mains transformer-rectifier, smoothing and load resistor, 5,000 and 500 mfd. condensers, zener diode and instructions. Real snip at only 14/6, plus 3/6 post.

ACOS GP73 TURNOVER PICK-UP CARTRIDGE



For Stereo—L/P—and 78 records, fitted with two Stylii. Diamond for L/Ps, Sapphire for 78s. This is mounted and is standard replacement for most record players using Garrard, B.S.R., Collaro, etc., etc. The regular price of this cartridge is 55/-. We offer these new and perfect for 15/- (less than the price of stylii), plus 2/- post and ins.

PHOTO ELECTRIC KIT

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

THE SQUEALER

Sleight of hand - beat the beam

A game to amuse the children and defy the others is described in the November issue of *Practical Electronics* for this circuit we can supply as a kit: the light-cell, transistors and other component (not case or hardware) price is 50/- plus 3/6 post and insurance. Kit of Components for another game "The Might Light". Also described is available. Price 20/- plus 2/6.

MULLARD SILICON RECTIFIERS. 350 v. 100 mA. Removed from unused equipment, perfect. Ref. BY100, 4/6 each.

REED SWITCHES. A pair of contacts sealed into a glass tube. When a magnet comes close the contacts close immediately and the circuit is switched. For burglar alarms on doors or windows—moving displays for advertising—rev. or batch counting—relay circuits. New and perfect, price is 6/6 each. Magnets 1/- each.

½ MEG. POTS. By Erie, standard ¼in. spindle, 1in. long, 7d. each in doz. lots, otherwise 10d.

½ MEG. POTS WITH D.P SWITCH. Again by Erie. Standard size spindle 1in. length. 10d. each in doz. lots, otherwise 1/3 each.

RELAY SWITCHES. These enable micro switches, delicate thermostats or other low current devices to control up to 30 amps.—ideal to switch thermal storage heaters—motors, etc., made by the famous A.E.I. group these are listed at £25 each—you can buy if you hurry at a very keen price of 39/6 each and we will include diagrams and data. Mounted on panel size approximately 6 x 7 x 2in. deep.

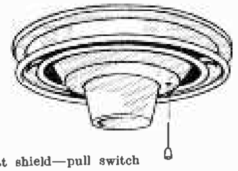
HEATER TRANSFORMERS, 6.3 v., 1½ amps., 5/6.

SEMI-CONDUCTOR BARGAINS

Type No.	*Price*	*Type No.*	*Price*	*Type No.*	*Price*
2N1727	15/-	MAT101	8/6	OC71	4/-
2N1728	10/-	MAT120	7/9	OC72	5/-
2N1742	25/-	MAT121	8/6	OC75	6/-
2N1747	25/-	OA5	5/-	OC76	5/-
2N1748	10/-	OA10	6/-	OC77	7/-
AC107	9/-	OA47	3/-	OC78	5/-
AC127	9/-	OA70	2/-	OC78D	5/-
ACY17	8/6	OA79	2/6	OC81	5/-
ACY18	5/6	OA81	2/6	OC81D	5/-
ACY19	6/6	OA85	3/-	OC82	5/-
ACY20	5/6	OA90	2/6	OC83	5/-
ACY21	6/-	OA91	2/6	OC84	6/-
ACY22	4/6	OA200	3/3	OC139	8/6
AF114	7/-	OA202	4/3	OC140	12/6
AF115	6/6	OC22	10/-	OC170	5/-
AF116	7/-	OC23	17/6	OC171	6/-
AF117	5/-	OC24	22/6	OC200	9/-
AF118	12/6	OC26	7/6	OC201	12/6
AF139	17/6	OC28	15/-	OC202	13/6
AF186	19/6	OC29	17/6	OC203	12/6
AFZ12	15/-	OC35	12/6	OCP71	19/6
ASZ21	15/-	OC36	15/-	ORP12	8/6
BC107	14/6	OC42	6/6	ORP60	5/-
BY100	5/6	OC44	5/-	SB078	6/6
BYZ13	7/6	OC45	4/-	SB305	8/6
MAT100	7/9	OC70	4/-	SB251	10/-

The above is a list of the more popular types in stock—we can also supply almost every semiconductor made—please send 1/6 for comprehensive list and equivalent data.

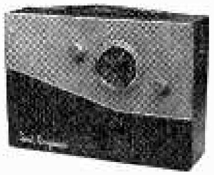
HEAT AND LIGHT UNIT



Bring luxury to your bathroom—have comforting heat where you now only have light—all the parts to build a full size (16in. diameter) model are now available—you will build it in an hour—12in. 750 watt circular silica glass encased element—opal bowl for up to 100 watt lamp—non-rust spun reflector—white enamelled base heat shield—pull switch magnificent unit as sold normally at £4.5.0 only 55/- plus 5/- post and insurance.

SUPERTONE G.C.V.

Saves you work—
It's partly built



Like its predecessors this latest Companion has full fi performance—such as only a good wooden cabinet and bifiux speaker can give, and due to its being partly built you will have it going in an evening. Note these features:

- All Mullard Transistors including 3 x AF117.
- Two-tone Cabinet, size 11 x 8 x 3in.
- All circuit requirements—Push-Pull output—A.V.C. and feed back, etc.
- Printed circuit board all wired only connections, e.g. to Volume control—W.C. Switch and Tuning Condenser.
- Pre-aligned IF stages complete with full instructions. Price only £3.19.6 plus 6/6 post and insurance.

THIS MONTH'S SNIP

3M SCOTCH TAPE

Brand new, unused and guaranteed perfect and not second in anyway — a connoisseurs tape on normal spools.

Standard Play	5in. 600ft.	9/-	Long Play	5in. 900ft.	11/6
	5¾in. 900ft.	11/6		5¾in. 1,200ft.	16/-
	7in. 1,200ft.	16/-		7in. 1,800ft.	23/-

£3 post free otherwise add 2/- post and insurance.

CASSETTE LOADED DICTATING MACHINE

Mains operated and with all accessories. Really fantastic offer a British made £31 outfit for only £10 brilliantly designed for speed and efficiency—cassette takes normal spools, drops in and out for easy loading—all normal functions—accessories include: stethoscopic earpiece and footswitch for typist—crystal microphone has on/off switch—telephone pick-up—tape reference pad—DON'T MISS THIS UNREPEATABLE OFFER—SEND TODAY £10 plus 7/6 post and insurance.

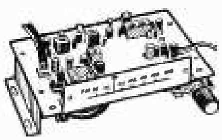
Note: If you wish to record in unusual places we have some as above but battery operated same price also spare Cassettes at 7/6 each, three for £1.

GARRARD RECORD PLAYERS

2000	£6. 9.6
3000	£7.19.6
AT6	£9. 19.6
AT60	£11.11.0
SP25	£10. 9.0
LAB80	£25. 0.0
SRP12	£3. 9.6

7/6 for post and insurance.

F.M. TUNER



of exceptional quality, giving really fantastic results with virtually no noise. Suitable for mains or battery operation. 6 transistors—three IF stages—double tuned discriminator. Complete, new, and built up all ready to work on chassis. Size 6in. x 4in. x 2in. with tuning scale and slow motion drive. A £12.12.0 tuner for only £8.10.0.

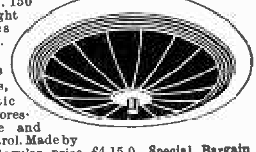
INTERCOM BARGAIN

Will save time and improve efficiency. Ideal in home—office—shop—surgery, etc. Complete outfit comprises Master unit and three substations each of which can call the master and have full-two-way working. No wiring problems as subs fitted with 60ft. twin flex and they plug into sockets. Also indluded is packet of staples—and battery. Nothing else to buy—£6.9.6, plus 3/6 post and insurance.

PP3 ELIMINATOR

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

CIRCULAR FLUORESCENT



Brings sunshine into your home. 150 watts of light but uses only 40 w. Beautiful fittings with glass, non-plastic centre, fluorescent tube and choke control. Made by Philips. Regular price £4.15.0. **Special Bargain price 65/-**, plus 8/6 c. and ins. Please state colour of glass centre, white, pink, blue, red, black, yellow or cream. Also whether plug into lamp holder or ceiling mounting model. 80 watt model 99/6.

THERMOSTATS

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

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

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

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

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

ELECTRIC BLANKET OUTFIT

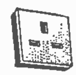
A 13 yard, 70 watt waterproof element with temperature control by Thermal balance—and a double pole blanket switch in pastel blue bakelite—with enclosed neon ON/OFF indication—both items ideal for renovating a defunct or doubtful blanket—supplied complete with layout and other instructions. Only 12/6, plus 1/6 post and ins.

SWAN KETTLE ELEMENTS

Made by famous "Best" company, suitable for most kettles. 1500 watts. 230/250 v. Normally 30/- each. Our Price 17/6 each.

HALF PRICE OFFER

G.E.C. 13A SWITCHED SOCKETS



Suitable for ring mains, etc. like the modern fused plug surface or sunk (flush) mounting type. 4/9 each, 54/- doz.

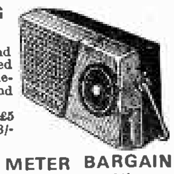
TUBULAR HEATERS

New and unused made by G.E.C.—rated at 60 watts per ft.—these are ideal in airing cupboards, bedrooms, offices, stores, greenhouses, etc., curtains or papers can touch them without fear of scorching or fire. Supplied complete with fixing brackets and available in the following sizes. Prices which are about ½ of list price includes carriage by B.R.S. 8ft. 30/-; 10ft. 36/-; 12ft. 42/-.

Also in twin assemblies (one pipe above the other) 4ft. 40/-; 5ft. 46/-; 6ft. 52/-.

FLUORESCENT LIGHT KITS. Comprising choke, lampholders, starter and two chrome tube clips. 20 watt 19/6. 40 watt 11/6. 80 watt 17/6. 65 watt 19/6.

NO SOLDERING POCKET 3



Lots of fun to build and good results when finished—complete kit with detailed instructions and crystal earpiece batteries 1/2 extra. £5 value. Only 19/6, plus 3/- post and insurance.

MOVING COIL METER BARGAIN

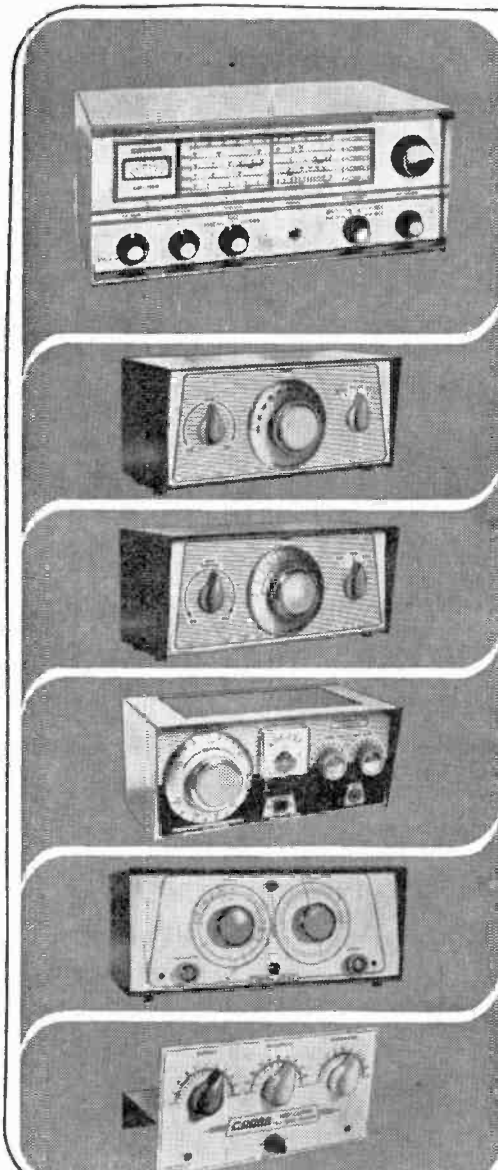
Panel meters are always being needed and they are jolly costly when you have to buy them in a hurry—so you should take advantage of this offer: 2in. moving coil flush mounting meters only 5/6. These are actually R.F. meters and cost about £3 each but if you don't want them for R.F. then all you have to do is to remove the thermocouple and you will have a 2-3 m.a. meter which you can make into almost anything by adding shunts or series resistor. These are ex-government of course.

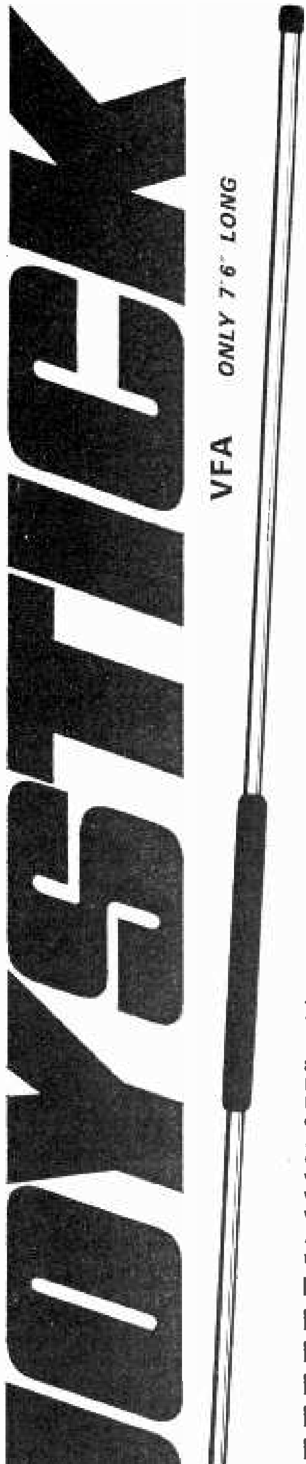
Where postage is not definitely stated as an extra then orders over £3 are post free. Below £3 add 2/9.

ELECTRONICS (CROYDON) LIMITED

(Dept. P. W.) 102/3 TAMWORTH RD., CROYDON, SURREY *(Opp. W. Croydon Stn.)*

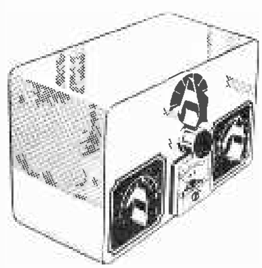
also at 266 LONDON ROAD, CROYDON, SURREY





AERIAL PROBLEMS SOLVED!

The revolutionary JOYSTICK AERIAL SYSTEMS presents a satisfactory solution to all the problems of restricted space receiving (and transmitting) aerials. A completely new range of tuning units have been designed to allow the maximum possible efficiency with absolute simplicity of tuning and operation. For reception on all amateur bands from 1·8 Mc/s to 30 Mc/s, for general short wave and broadcast reception including the medium wave band. This variable frequency aerial system has been acknowledged as the most successful solution to a host of aerial problems. Over 5,500 are in use all over the world (as at July 1966). Hundreds and hundreds of terrific testimonials may be seen at the Joystick Office—the selection shown here will prove the point.



Above: One of the new JOYMATCH 'EASY-TO-USE' units with built-in RF indicator

OUTSTANDING SIGNALS FROM THE JOYSTICK VFA CAN BE HEARD EVERY DAY ON THE AMATEUR AND MARINE BANDS. START THE SEASON WITH A SUPER AERIAL.

James C. Cox—Hull "I find it successful in all ways . . . am an avid SWL."

John Cramb—Eastbourne "Have indoor Joystick . . . am getting excellent results on my Codar CR45."

B.B. St. V. Moullin—Guernsey "Truly satisfied . . . GC-1U Mohican Rx performs with greater selectivity."

Raymond F. Bence—Cardiff "Joystick system certainly does its stuff."

UK AGENTS: G. W. Smith & Co. (Radio) Ltd., 3 Lisle Street, London, W.C.2; Brian J. Ayres & Co., 8 Hartfield Road, Wimbledon, London, S.W.19; Stephens-James Ltd., 70 Priory Road, Liverpool, 4; Chas. H. Young Ltd., 170/172 Corporation Street, Birmingham, 4; R.S.C. (Manchester) Ltd., 326 Argyle Street, Glasgow, C1; or ask your local dealer.

France: Vareduc-Comimex, 2 Rue Joseph-Riviere, Paris. Courbevoie, France.

West Germany: Ing. Hannes Bauer, 86 Bamberg, Hornthalstrasse 8, West Germany: Dressing GmbH, 45 Osnabruck, Bohmter Str, 32, West Germany; Stotz & Goessl. 8 Munchen 15, Bayerstrasse 3,

AND WORLD WIDE AGENCIES

U.S. Patent No. 3274600

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PARTRIDGE ELECTRONICS LTD.
CAISTER HOUSE, PROSPECT ROAD, BROADSTAIRS, KENT

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Why NOT BUILD ONE OF OUR PORTABLE TRANSISTOR RADIOS...

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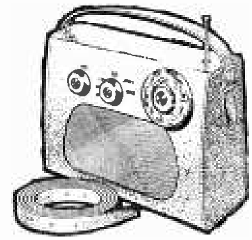

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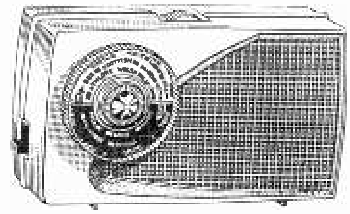

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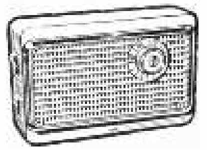

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Covers Medium and Long Waves and Trawler Band, a feature usually found in only the most expensive radios. On test Home, Light, Luxembourg and many Continental stations were received loud and clear. Designed round supersensitive Ferrite Rod Aerial and fine tone 3in. moving coil speaker, built into attractive black and gold case. Size 5¼ x 1¼ x 3¼in. (Uses 1289 battery available anywhere.)

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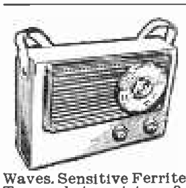

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TRANSONA SIX

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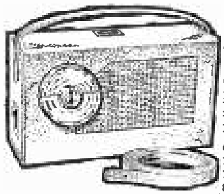
Total cost of all parts now only **59/6** P. & P. 3/6

Parts Price List and easy build plans 1/6 (Free with kit)

MELODY SIX



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Our latest completely portable transistor radio covering Medium and Long Waves. Incorporates pre-tagged circuit board, 3in. heavy duty speaker, top grade transistors, volume control, tuning condenser, wave change slide switch, sensitive 6in. Ferrite rod aerial. Push-pull output. Wonderful reception of BBC, Home and Light, 208 and many Continental stations. Handsome leather-look pocket size case, only 6¼ x 3¼ x 1¼in. approx. with gilt speaker grille and supplied with hand and shoulder straps.

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Covers Medium and Long Waves and Trawler Band. The ideal radio for home, car, or can be fitted with carrying strap for outdoor use. Completely portable—has built-in Ferrite rod aerial for wonderful reception. Special circuit incorporating 2 RF Stages, push-pull output, 3in. speaker (will drive large speaker). Size 7¼ x 5¼ x 1¼in. (Uses 9V battery, available anywhere.)

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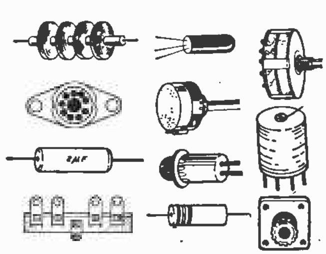

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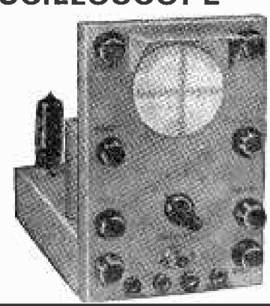

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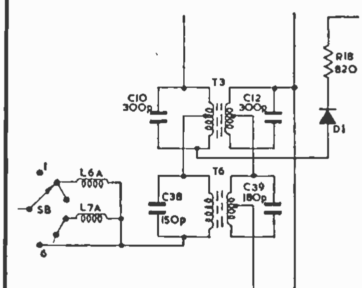

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PRACTICAL WIRELESS

VOL 42 No 9

issue 719

JANUARY 1967

TOPIC OF THE MONTH

Flights of Fancy?

IT is much easier to fly off into a hypothetical future of some vaguely distant time than to visualise what is going to happen in the immediate months ahead. This becomes depressingly clear to an editor about to write a seasonal leader on what 1967 holds for his readers. In fact, he will probably evade the issue by a few general observations!

For instance, amateur construction and activity will doubtless continue to follow industry, for the days when amateurs could lead with major developments are gone. The trend in commercial and military radio and communications is an inexorable march to tinier circuit elements; microminiaturisation.

Semiconductors and the scaling down of component sizes already determine the pattern for home constructors. And complete modules, like the spring, are acumin' in, taking things another step forward.

But the most spectacular event of recent times is the development of the microcircuit and it is significant that RCA in America is already using an integrated circuit unit in domestic TV sets. The unit has the equivalent of 12 transistors, 12 diodes and numerous resistors all contained on a single match-head size chip of silicon and housed in a transistor case. It performs the functions of 4·5Mc/s amplifier, limiter, noise rejector, f.m. demodulator, audio preamplifier and regulated power supplies!

Microcircuits cannot be repaired or altered; the cure for a defective unit is complete replacement. So that with a combination of ready-assembled units, modules and microcircuits, will the radio enthusiast of the future become a mere assembler needing little ability other than green fingers and a watchmakers' glass?

At this point it is perhaps as well to return to the present. And get back to those old-fashioned transistors!

NEWS AND COMMENT

Leader 643

News and Comment 644, 672

On the Short Waves *by John Guttridge and David Gibson, G3JDG* 650

Practically Wireless *by Henry* 658

BBC V.H.F. Sound Broadcasting Stations 671

Club Spot—Peterborough & District Amateur Radio Society 693

CONSTRUCTIONAL

The Explorer *by W. E. Bardgett* 646

Simple Electronic Organ *by J. M. Watt* 657

The Ten-Five Transmitter *by A. S. Carpenter, G3TYJ* 661

Tape Recorder Monitoring System *by L. McNamara, B.Sc.* 666

High-Z Sub-Min. Amplifier *by F. L. Thurston* 685

GENERAL ARTICLES

Set Manufacturing in the 20's *by C. H. Gardner* 652

Transfilters for I.F. Coupling *by Gordon J. King* 668

Power Supplies *by H. T. Kitchen* 676

FEBRUARY ISSUE WILL BE PUBLISHED ON JANUARY 6th

Merry Christmas and a Happy New Year

from the staff of Practical Wireless

W. N. STEVENS

D. L. Gibson, G3JDG   L. E. Howes, G3AYA   C. R. Riches   D. C. Rolfe

Oh it Hertz!

As a humble student of the noble science of electronics may I raise my voice in protest against your leader in the December issue.

The Hertz takes a fraction of a second to say, as compared with probably two or three seconds for "cycles-per-second". The symbol Hz is accomplished with a single sweep of the pen as compared to a staccato thundering of 30-odd ball points as a lecturer shouts "c/s".

No, I am a firm believer of this information and I am lucky in the fact that according to a brand new meter, the local Electricity Board is already supplying 50Hz mains to our laboratories.

May I add that though I agree with the retention of the term r.p.m. (mainly because there is no more easily pronounceable alternative) I like the term of i.p.s. for tape speed and would prefer the use of the B.S. term mile/h to the outdated and now unofficial m.p.h. or the imagination-inspiring idea of Fords.

This last term could be confusing in that the gentleman to be remembered to posterity by the expression had the Christian name of "Henry" and the devices that he manufactured had, amongst their controls, one called the "choke". I will leave you to reconsider the wisdom of such a term.

Bob Covington.
University of Southampton.

Pop on the Light

WITH reference to the Government's plan to abolish the pirates and use the BBC wavelength of 247m for an advertising station, this wavelength (Light Programme) cannot be heard in the West Country. If they are going to do this, they should use a frequency that can be heard in all parts of the country.

E. H. C. Terry. Paignton, Devon.

[*Editor's Note*] In the BBC annual report recently published, the Corporation says it is willing to run a round-the-clock programme of "pop" music and similar entertainment on 247m to replace pirate stations. The report points out, however, that since they would be obliged to honour "needle time" requirements it could not broadcast unlimited pop music. The BBC further states that it will not accept any advertising whatsoever.

These matters, however, and other related factors will not be finally settled until the publication of the Government White Paper on Broadcasting which has still not appeared at the time of going to press.

NEWS AND..

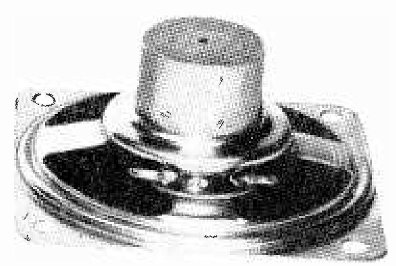
INTERNATIONAL RADIO COMMUNICATIONS EXHIBITION

After the opening of the Exhibition on Wednesday, October 26th, at 12 noon, H.R.H. Prince Philip, The Duke of Edinburgh, was able, for the first time, to hear his opening speech broadcast to the world, on radio amateur wavelengths, and hundreds of thousands of radio enthusiasts were able to listen to him, through the Radio Society's transmitting station in the exhibition on the call-sign "GB3RS", by kind permission of the GPO. The GPO were also showing colour television pictures, relayed by micro-wave link direct from the Post Office Tower. This was arranged in conjunction with the BBC. The Post Office research station was showing to the public, for the first time, developments from the laboratories on satellite reception and low-noise receivers and semiconductor equipment.

The Manufacturers' Award this year went to Contactor Switchgear (Electronics) Ltd., for their solid state transmitter and receiver types CSE2A10 and CSE2AR (see opposite).

The Horace Freeman Trophy went to M. H. Emmerson, G3OQD, for a transistorised s.s.b./a.m./c.w. transceiver covering 160–10 metres, and the Thorogood Plaque to S. F. Weber, G8ACC, for a 7W Transistorised Transmitter for 432Mc/s.

NEW PLESSEY 3in. SPEAKER



The Plessey Components Group have introduced a new 3in. loudspeaker for use under severe climatic conditions. The more common applications of this speaker will be in taxi, ambulance and police radios, where the unit is exposed to conditions of high temperature and humidity.

Investigations indicate that temperatures of up to 80°C are found in these applications during the summer months in the U.K. These high temperatures are frequently accompanied with conditions of high humidity, and can be followed by periods of low temperature and high humidity.

The new speaker has been designed to withstand these conditions without any loss of sensitivity. Chassis height is 0·6in. and when fitted with the 6,500 line motor unit the total height becomes 1·22 in.

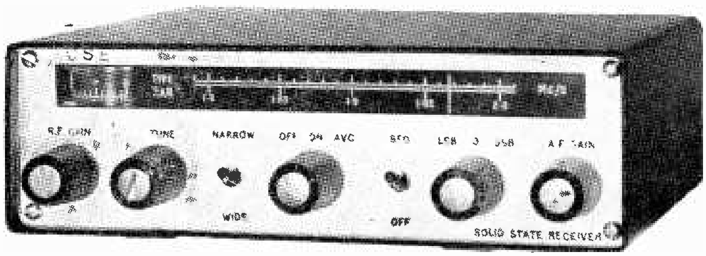
POP PROTESTS

The Postmaster General recently revealed that the Post Office had received 40 representations from Belgium, Czechoslovakia, France, Germany, Eire, Italy, Holland, Sweden and Yugoslavia concerning interference to local stations by pirate broadcasters operating around the UK. Trouble is not necessarily confined to fundamental channel interference since we have notes of at least one case where a pirate station is radiating spurious signals falling in the shipping band. (Radio 270, on 1672·5kc/s.)

As we go to press, the first prosecution of a pirate broadcaster (Radio 390 at Canterbury) began on November 24th. Also, the much heralded White Paper on Broadcasting had still made no appearance.

...COMMENT

CSE TYPE 2AR RECEIVER



A new silicon, solid state, 12V, 2Mc/s receiver complementary to the 2A10 transmitter has recently been marketed by Contactor Switchgear (Electronics) Ltd. Like the transmitter it is suitable for operation in mobile, fixed or portable locations from car or dry battery supply.

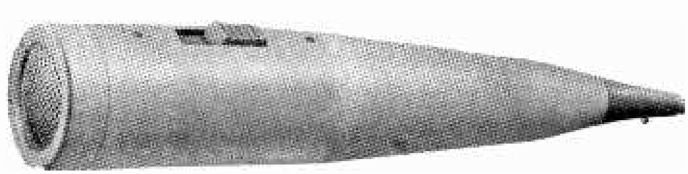
Specification: Supply, 12V d.c. at 120mA, quiescent, 280mA on a.f. peaks; Supply, may be + or — earthed; no adjustment necessary; supply reversal protection; Signal to noise ratio $1\mu V$ for 10dB $\frac{S+n}{n}$ measured at 80Ω; Signal input, fast multiple diode r.f. protection; Image rejection, better than 50dB; Selectivity, switched, 4kc/s and 8kc/s; Shape factor, 2·5:1 from 3dB down to 50dB down; Intermediate frequency, 511·5kc/s; AVC, fast attack 100m/sec., fast decay 400m/sec; AVC, will control 150mV at 80Ω input; AVC, delay switched in with B.F.O.: 1·5 sec; BFO, locked to ceramic resonator; and switched $\pm$2kc/s, lower sideband—centre—upper sideband; single control s.s.b. resolution by "Tune"; S. meter presentation of a.m.—c.w.—s.s.b. signals; Audio, transformerless; Output impedance, 1–10,000Ω; Audio output, 1·5W into 3Ω speaker; Size, identical to C.S.E. 2A10 transmitter, $8\frac{1}{4} \times 2\frac{1}{2} \times 6$in.; Supply input connector, Painton 4 pin retained—Audio connector, miniature jack, Aerial connector and standard Belling Lee 80Ω coax are supplied. Price £44 U.K.

WHAT THEY SAY!

Talking about girls wearing skirts so short that they could teach the birds and bees a few things, Sir Miles Thomas said in Birmingham recently "It's the day of the hi-fi and thigh-high."

Mini skirts are certainly commonplace, but is hi-fi; we doubt it?

MOVING COIL HAND MICROPHONE



Amplivox Ltd., Beresford Avenue, Wembley, Middlesex, announce the release of their new high fidelity moving coil microphone—the Elite.

This microphone has been introduced to meet a wide variety of applications in the fields of recording and communications. The Elite is available with or without switching arrangements and a variety of circuits are available to suit customers' requirements. The microphone has a response of from 50–15,000c/s.

Further details may be obtained from Amplivox at the above-mentioned address.

Issues for Disposal

I HAVE the following issues of PRACTICAL WIRELESS for disposal: May, Sept., Oct., 1951; Mar., April, May, June, July, Aug., Oct., Nov., Dec. 1952; Jan., Feb., April, May, June, July, Aug., Sept., Oct., Nov., Dec., 1953; Jan., Feb., April, May, June, Aug., Oct., Nov., Dec., 1954; Sept., Nov., Dec. 1955; Jan., Feb., Mar., June, Sept., Oct., Nov., Dec. 1956; Jan., Feb., Mar., April, May, July, Aug., Sept., Oct., Nov., Dec. 1957; Jan., Feb., Mar., May, June, July, Aug., Sept., Oct., Nov., Dec. 1958; Jan., Feb., Mar., April, Nov. 1959; Sept. 1960; Feb., Mar., April, May, July, Aug., Sept., Oct., Nov. 1961; Jan., Feb., Mar., April, May, June, July, Aug., Sept., Oct., Nov., Dec. 1962; Jan., Mar., April, May, June, Oct., Nov., Dec. 1963; Jan 1964.

If any readers are interested, would they please contact me.

E. L. Lewin. 8 The Knoll, Hayes, Bromley, Kent.

Mobile Registration

PERHAPS C. P. Finn (Mobile Registration, September issue) would be interested in the registration number I saw recently. It was 1003 PF and on a Ford 105E van. Possibly a service van?

D. K. Agar. Loughton, Essex.

Wanted!

YOUNG radio enthusiasts willing to form a club in South London for young people (up to about 20). Meetings will be made as interesting and varied as possible with outings, competitions, etc. and always at least one Ham station on the air.

Will anyone interested let me know (write or phone ADD 6866). If the turn-out is reasonably large, the Sir Philip Game Boys' Club—near E. Croydon station—will let us use part of their premises.

If you are unable to come yourself, please tell your friends. All letters will be answered giving details of meetings when known.

A. D. A. Hansen, G3VLJ (aged 16). 99 Stretton Road, East Croydon. Surrey.

R1155 Information

I THINK Mr. Preston seems to have misread my R1155 information. It was meant to be helpful to anyone who could get back numbers.

If he would get the O.K. from W.W., S.W. Mag. and yourselves, he can have my information to copy.

John Tye. Dereham.

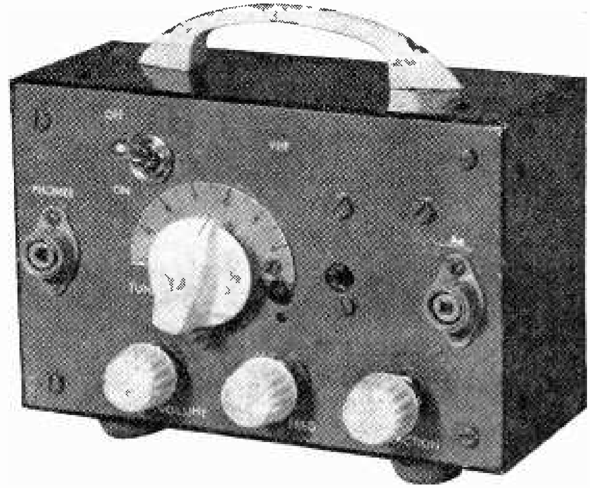
More News and Comment on Page 672

THE explorer

AM/FM VHF RECEIVER

By W.E.BARDGETT

COVER SUBJECT



A Four Transistor unit covering 65-170 Mc/s

A NUMBER of readers have indicated in recent correspondence an interest in constructing receivers which will explore the v.h.f ranges, including the 2 and 4 metre amateur bands. A valve receiver employing inexpensive surplus valves was described in the June, 1964 issue, and one advertiser offers a simple kit for a mains valve super-regenerative receiver employing the Flewelling circuit which requires few components, yet provides a means of exploring the v.h.f. bands at low cost. These receivers are, however, dependent upon mains power supplies. Very high frequency transistors are now available at reasonable cost which permit the construction of a tuner/receiver which can be entirely portable or can be used in a motor car feeding into the amplifying stages of a car radio. The receiver described may be fitted with coils of various sizes allowing coverage of the 2 and 4 metre amateur bands, the B.B.C. Band II f.m. transmissions and many others. The v.h.f. Explorer is a detector of amplitude modulated signals but can also receive f.m. transmissions although not at hi-fi quality.

SKILL REQUIRED

The construction of the receiver described should not be attempted by the absolute beginner, as the building requires a certain amount of skill. V.H.F. circuits must be leadless in the signal circuits, so that the components have to be soldered directly to each other with the shortest possible connections. The layout of the components must facilitate this lead-less construction and the proximity of the components concerned must take precedence over any

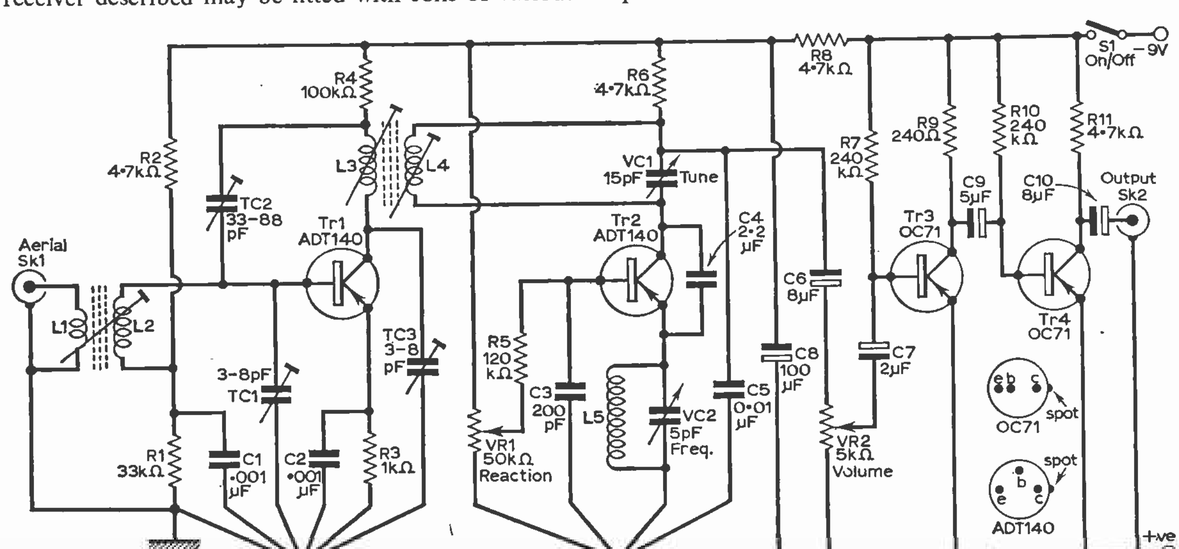


Fig. 1: Circuit diagram of the "Explorer" receiver.

claims for symmetry, or even accessibility. The need for this ultra short wiring cannot be too strongly stressed: without it, the losses in the signal circuits would be so great that the receiver would not work at all. To achieve successful results demands intricate construction, good soldering, patience and persistence, as well as an electric soldering iron with a small bit and pair of tweezers. On the other hand, the sense of achievement when results are finally obtained at v.h.f. is akin to that experienced by earlier generations when it was an event to receive radio transmissions at all.

V.H.F. transmissions have a relatively short range, and the amount of traffic picked up on a receiver of the type described will vary considerably between different parts of the country.

These are the two main warnings to those considering the construction of the receiver.

THE CIRCUIT

The receiver circuit is shown in Fig. 1. It consists of a tuned r.f. stage Tr1, with a neutralising capacitor and a self-quenching super-regenerative detector (Tr2); both employing alloy diffused transistors capable of operation up to 200Mc/s in the circuits shown. These two stages are followed by two conventional stages of audio amplification with an output capable of driving headphones. This is also suitable for feeding into a transistor or valve amplifier for loudspeaker reproduction. Whilst a sensitive pair of headphones may be driven directly, much improved results are obtained if the output is fed into a package transistor amplifier such as many advertisers offer, or into the amplifying stages of a car radio. The author has fitted a jack and socket before the amplifier section of his *Practical Wireless* "Autocrat" car radio (described in the November 1964 issue), so that the v.h.f. tuner can be fed into this.

CONTROLS

The aerial input socket Sk1 is a television-type co-axial socket for use with a dipole aerial. The second socket Sk2 is the output to headphones or amplifier. The on/off switch is of the toggle type. This was preferred to the type incorporated in the volume control as it is possible to see at a glance whether the tuner is switched on or not. The main tuning capacitor requires a 180° scale and knob/pointer, but as tuning is fairly broad a reduction drive is not necessary. The other controls consist of a volume control VR2, especially important if the output is to be fed into a transistor package amplifier without its own volume adjustment, a base bias potential adjuster VR1 which controls the regeneration of the super-regenerative detector and a quench frequency control VC2.

CONSTRUCTION

As super-regenerative detectors are radiators which would cause illegal interference if connected directly to an aerial or operated unscreened, an r.f./buffer stage must be used and the receiver must be contained in a metal case. All components, controls and sockets are fitted directly or by means of flanged panels to the front panel; of aluminium measuring 6 x 4in. This is then housed in a commercially pro-

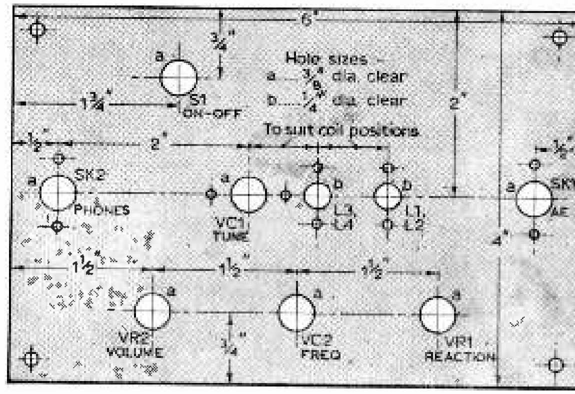


Fig. 2: Drilling dimensions of front panel.

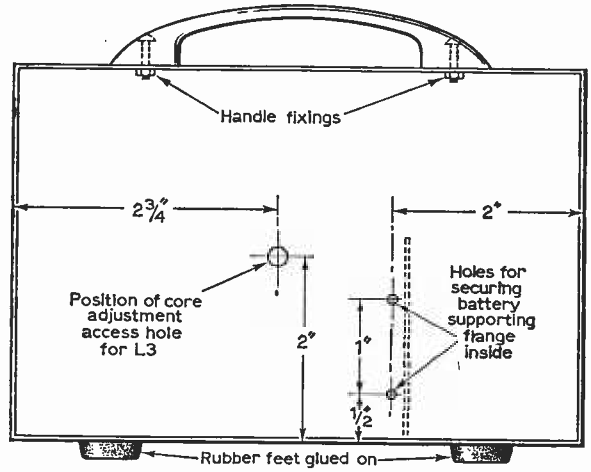


Fig. 3: Rear view of screening box.

Note:- Transistor Tr2 holder is secured to fixed plates of VC1,VC2

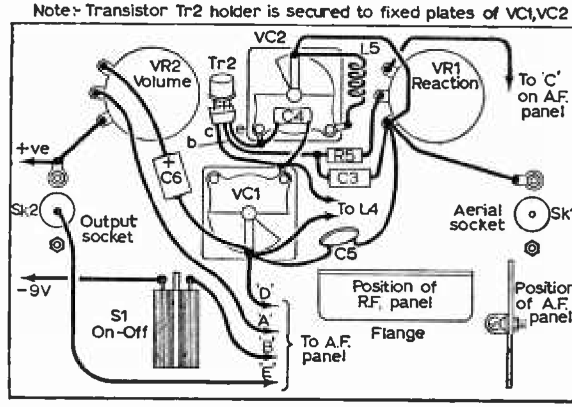


Fig. 4: Layout of components on rear of front panel.

duced metal screening box measuring 6 x 4 x 2½in, being attached to it by four self-tapping screws which go into the corner flanges on the box. The layout of controls and sockets on the front panel is shown in Fig. 2. The r.f. stage is not merely a buffer: it improves the signal/noise ratio sufficiently to make listening pleasant and makes selective what would otherwise be very broad band reception.

COILS

Details of the coils are given in Table 1. They are positioned and permeability tuned by two Aladdin plastic coil formers with dust cores. Coils L3 and L4, although on the same former, each have a separate dust core entering the former from opposite ends. A hole may be drilled in the rear of the screening box opposite the coil former of L3 and L4 as shown in Fig. 3, to permit adjustment of L3 core by means of a plastic trimming tool. The cores of L1, L2, and L4 may be adjusted in a similar way through the holes opposite the Aladdin formers on the front panel.

The positioning of the main components at the rear of the front panel is shown in Fig. 4, which also shows the wiring of the super-regenerative detector stage. The r.f. stage is constructed on a 2 x 1½in. paxolin shelf, held at right angles to the front panel by a narrow aluminium flange. The wiring and connection of components for the r.f. panel is shown in Fig. 6. All wiring should be completed on the shelf before it is fitted close to the Aladdin formers mounted on the front panel. The coils on these formers should be cut to give, by trial, the shortest and most direct connections to the transistor holder of Tr1 and to the variable capacitor VC1. Thick wire is highly desirable for v.h.f. and 16 s.w.g. is suggested. As the v.h.f. signals flow on the outer surface of the wire, tinned copper wire should be chosen. The tuned choke L5 is space-wound and self supporting being mounted directly on the quench frequency variable capacitor VC2. It should be at right angles to the other coils. The usual v.h.f. practice is followed of bringing all earth connections of each signal stage to a common point.

The a.f. stages are constructed on a 12 position tag board (two lines of 6 tags), which in turn is mounted on the front panel by means of an aluminium bracket in the position shown in Fig. 4. The wiring of the a.f. panel is shown in Fig. 5. Transistors Tr3 and Tr4 mounted on the tag board are bent back on their leads (which should be covered in p.v.c. sleeving), so that they are close to the board, and so permit the easy insertion of the receiver into its screening box. A heat sink must be used when soldering leads of transistors Tr3 and Tr4 to their tag connections: a pair of pointed nosed pliers will suffice. Transistors Tr1 and Tr2 should not be inserted in their transistor holders until all soldering is completed, and they must be removed when any subsequent soldering (e.g. for coil changing) takes place.

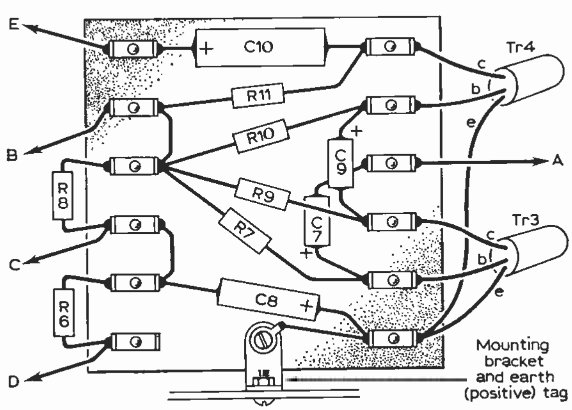


Fig. 5: Wiring of the a.f. panel.

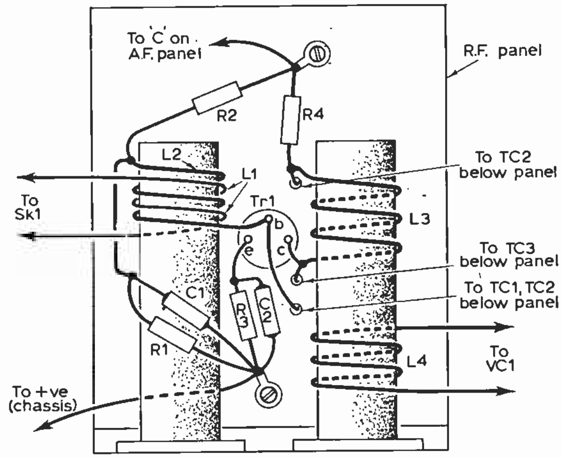


Fig. 6. Wiring of the r.f. panel. Below—Coil winding data.

Table I—Coil Details

Range 1 110 to 170Mc/s	L1. 2 turns 22 s.w.g. tinned copper p.v.c. covered on ¼in. Aladdin former with dust core (without screening can) interwound with L2.
	L2. 3 turns 16 s.w.g. tinned copper on same ¼in. Aladdin former with dust core and interwound with L1.
	L3 and L4. 3 turns each of 16 s.w.g. tinned copper adjacent to each other on same ¼in. Aladdin former with 2 dust cores, 1 to each coil, without screening can.
	L5. 28 turns 30 s.w.g. enamelled copper, self-supporting wound in screw thread of 0BA bolt and then removed.
Range 2 65 to 120Mc/s	L1. As in Range 1.
	L2. 5 turns 16 s.w.g. tinned copper on same ¼in. Aladdin former as L1 and interwound with L1 with dust core, without screening can.
	L3 and L4. 5 turns each of 16 s.w.g. tinned copper adjacent to each other on same ¼in. Aladdin former with 2 dust cores, 1 to each coil, without screening can.
	L5. As in Range 1.

AERIAL

The usual long wire domestic aerial is virtually useless at v.h.f. Plugging in the home television aerial will probably give some results, but it is advisable to construct a half-wave dipole aerial for the frequency range to be explored. The length across both arms of the dipole in inches is found by dividing 5616 by the frequency in megacycles. A telescopic quarter wave whip aerial may be connected as an alternative to a tapping point about the centre of L2.

TESTING AND OPERATION

All wiring should be checked carefully against the theoretical circuit diagram before a battery is connected to the receiver. A PP7 battery supplying 9 volts fits neatly into the case and is held in position by an aluminium flange bolted to the rear. Ensure that the correct battery connectors are fitted to the appropriate leads, as reversal of the battery polarity could ruin all the transistors.

Connect a dipole aerial to the aerial socket and a pair of headphones to the output socket or alternatively connect the output, preferably by a short length of co-axial cable, to the input of an amplifier. Switch on the receiver and advance the volume control VR2 as required. Rotate the regeneration control VR1 until the characteristic super-regenerative hiss is heard. If regeneration does not take place, adjust VC2 and/or move coils L3 and L4 a little further apart. Search for signals with the set just regenerating. The dust core of L3 and L4 should at first be well out towards opposing ends of the coil former in order to avoid increasing the the coupling and damping the regeneration. Set the trimmers and cores initially as follows, and adjust for best results when a signal is heard.

TC1 just fully out; TC2 just fully out; TC3 quarter closed; L1 and L2 core fully into coil; L3 core almost fully into coil; L4 core end just entering coil.

All final adjustments should be made on signals found by rotating VC1 slowly, and if necessary adjusting the core of L4.

By installing the coils for L1, L2, L3 and L4 of the size given for Range 1 in Table 1, it is possible on the prototype to pick up taxis and other mobile transmissions in the 165 to 174Mc/s allocation and even Band II television sound transmissions, but at this height in the frequency scale the receiver is approaching its limit and regeneration may be difficult to obtain over the full range of tuning of VC1. In appropriate areas there should be no difficulty, however, in hearing on Range 1 coils, the air to ground transmissions between 118 and 136Mc/s as well as the 2 metre amateur band (144Mc/s). Range 2 coils as described in figure 7 will allow the BBC f.m. band to be heard with mobile radio allocations on either side of it. The lower one between 71 and 87Mc/s is easily recognisable by the frequent Motoring Association transmissions about vehicle breakdowns. Not far from this on Range 2 is the 4 metre amateur allocation. Initial success is more likely if Range 2 coils are tried first.

★ components list

Resistors:		**Capacitors:**	
R1	33kΩ	C1	0·001μF ceramic
R2	4·7kΩ	C2	0·001μF ceramic
R3	1kΩ	C3	200pF ceramic
R4	100Ω	C4	2·2pF ceramic
R5	120kΩ	C5	0·01μF ceramic
R6	4·7kΩ	C6	8μF electrolytic
R7	240kΩ	C7	2μF electrolytic
R8	4·7kΩ	C8	100μF electrolytic
R9	240Ω	C9	5μF electrolytic
R10	240kΩ	C9	5μF electrolytic
R11	4·7kΩ	C10	8μF electrolytic

Variable Capacitors:

VC1 15pF air spaced bolt fixing insulated from panel
VC2 5pF air spaced spindle fixing

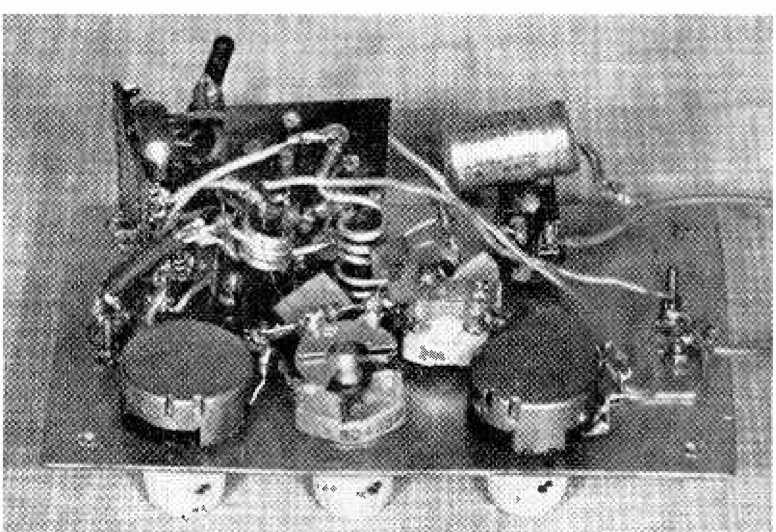
Transistors:	**Trimmer Capacitors:**
Tr1 ADT140 (Sinclair)	TC1 3-8pF beehive trimmer
Tr2 ADT140 (Sinclair)	TC2 3-8pF beehive trimmer
Tr3 OC71 (Mullard)	TC3 3-8pF beehive trimmer
Tr4 OC71 (Mullard)	

Potentiometers:

VR1 50kΩ VR2 5kΩ

Miscellaneous:

6 x 4in. aluminium front panel, 6 x 4 x 2½in. metal screening box, 2 x 1½in. paxolin panel, 1½ x ¾in. aluminium for panel flange, 2 x 2in. aluminium for battery flange, 1½ x 1½in. 12 position tag board, 1 single pole toggle switch, 1 aluminium bracket, wire, nuts, bolts, etc., 2 co-axial sockets, 2 transistor holders (Eagle Products), 2 battery connectors, 2 coil formers ¼in. Aladdin, 3 dust cores for formers, 3 small knobs, 1 tuning pointer knob with scale, 4 rubber feet, 1 carrying handle.



Rear of front panel, showing Range 1 coils fitted.

CONCLUSION

When signals are tuned, they should quench the super-regenerative hiss, so that the background is clear of noise. Super-regenerative receivers have the advantage of possessing built-in automatic volume control and noise limiting action, whilst the relatively broad tuning characteristics make band spread or reduction drives unnecessary. The gain of this type of receiver appears to be proportional to the frequency, so that at v.h.f. levels its performance can be quite phenomenal. ■

ON THE SHORT WAVES

MONTHLY NEWS FOR DX LISTENERS

Times in GMT
Frequencies in kc/s

THE BROADCAST BANDS

by JOHN GUTTRIDGE

Rumania: *Radio Bucharest* (P.O. Box 111, Bucharest) now transmits in English as follows: 1500—1530 15,380/11,940/11,810/11,900; 1930—2030 9,655/9,510/7,225; 2230—2300 7,195/6,190/155 (longwave); 0130—0230 11,810/9,750/9,660/6,190/6,150/6,080; 0300—0330, 0430—0500 as 0130 with the addition of 6,095. The station has also been reported outside the international broadcast bands on 10,650 with French at 1830 and 2030, Arabic 1900 and English 1930.

Sweden: *Radio Sweden* (Box 955, Stockholm) has changed the frequencies for some English transmissions, viz:—1100—1130 (Far East) 11,765; 1400—1430 and 1445—1515 (East North America) 17,840; 2345—0015 (Far East) 11,765; 0145—0125 (East North America) and 0315—0345 (West North America) 9,705.

Switzerland: *Swiss Broadcasting Corporation* (CH3000, Berne 16) is now on its winter schedule and has extended all its English transmissions by 15 minutes to 75 minutes. In addition there is a new experimental non-directional transmission at 0700 on 6,165 using a 250kW transmitter. Times and frequencies for beamed English transmissions are 0700 (Far East) 9,670/11,775/15,320; 1300 (India/Pakistan) 15,305/17,845/21,520; 0900 (Australia/S.E. Asia) 15,305/17,800/21,520; 1500 (Middle East) 9,655/9,665/11,715/15,305; 0900 (Africa) 17,770/21,460; 0115 (East North America) 5,965/6,120/9,535; 0500 (West North America) 5,965; 1500 (West North America) 15,130; 1100 (U.K.) 9,665/11,865; 1845 (U.K.) 6,045/7,220. Reception reports are requested particularly for the 0700 transmission. Full schedules may be obtained free of charge on application to the above address.

U.S.S.R.: *Radio Kiev* (Ukrainske Radio, Radio Centre, ul. Khreshchatik 24, Kiev) again using 6,020 for its English transmission at 1900—1930 on Mondays, Thursdays and Sundays. This transmission interferes with Radio Nederland on the same channel.

Radio Moscow has a new English transmission at 0000—0030 on 998 (medium waveband).

Radio Vilnius (Lieutvas TSR Radijas, ul Kanarskio 49, Vilnius) may be heard in English at 2230—2300 Sundays and Fridays on 1106 (medium waveband) under AFN Munich.

Vatican: *Vatican Radio* (Vatican City) uses the new frequency of 11,705 for Arabic at 1640 and French at 1720. These transmissions are additionally on 15,135.

Yugoslavia: *Radio Belgrade* (2 Hilendarska, Belgrade) now uses 6,100/7,200/9,505 for the 1830—1900 English transmission.

AFRICA

Algeria: *Radiodiffusion-Television Algerienne* (21 Boulevard des Martyrs, Algiers) now transmits as follows: French 0630—0830, 1700—2300 6,175; 1100—1430 11,835; Arabic 0600—0830 529/548/980 with the addition at 1200—2400 of 9,510/11,810; Kabyle 0600—0830 6,080/6,270; 1200—1430 9,685/11,715; 1700—2300 5,970/6,080/6,270/7,170/9,685. The new medium wave frequency of 529 is the same as that used by the Swiss Broadcasting Corporation and has caused considerable interference. As protests have been of no avail S.B.C. is planning to increase the power of its transmitter to at least 500kW.

Egypt (U.A.R.): *Cairo Radio* (P.O. Box 1186, Cairo) now uses the new frequency of 11,965 in parallel with 9,475 for its European Service between 1745 and 2315. English is from 2145—2315.

Ghana: *Ghana Radio and TV Corporation* (Broadcasting House, P.O. Box 1633, Accra) now uses 6,130/4,980 for its 1400—2215 English transmission.

Guinea (Portuguese): *Emissora Provincial da Guire* (Avenue da Republica, Brissau) has replaced 5,017 by 5,044. Has been heard 2100—2400.

Guinea (Spanish): *Emisora da Radiofusion Santa Isabel* (Apartmentado 195, Santa Isabel, Fernando Poo) has English 1900—1945 on 6,250.

Liberia: BBC West African Relay Station (C.E.X.B., Bush House, London, W.C.2., England) can be heard around 1800 on 9,555 under Radio Finland.

Morocco: *Radiodiffusion Television Marocaine* (1 Rue Pierre Parent, Rabat) has dropped its evening English, French, Spanish programme over 11,735/15,408. These frequencies are now used from 1900—2300 for a relay of the French home service.

Nigeria: *Nigerian Broadcasting Corporation* (Broadcasting House, Lagos) has English at 1500—1600, 1700—1900, 2100—2200 on 7,275/9,690/11,915/15,215. The 19m.b. transmitter has a temporary power of 10kW, the other outlets are all 100kW. Announcements incorrectly give 11,915 as 11,900. Around 2200 the home service on 4,990 may be heard.

South Africa: *Radio South Africa* (P.O. Box 8606, Johannesburg). According to this station's schedule its European English transmission at 2200—2255 is on 11,900/9,690. Numerous reports give the frequencies used as 9,720/11,785/15,205 however.

Sudan: *Sudan Broadcasting Service* (P.O. Box 572, Omdurman) is reported back on 4,990 with a good signal from 2000 onwards.

NORTH AMERICA

Canada: *Radio Canada* (P.O. Box 6000, Montreal) has replaced 15,320 by 15,365 for European service transmissions between 1100—1830. A new QSL is now being issued.

Thanks go this month to Roy Patrick, Swiss Broadcasting Corporation, A. B. Thompson, Brian Burling, D. J. Chandler and the International Short Wave Club for sending in information.

WE start this month with one minute's silence, all heads reverently bowed, please. Twenty metres has passed on to greener pastures—alas. Very few reports for 14Mc/s arrived and it looks like the band has been deserted, certainly by the s.w.l fraternity.

Where have all the s.w.l's gone, well you'd be surprised. Some 80% went all l.f., 5% cast a critical earhole on 15 metres and the remainder succumbed to tales of treasure trove on—yes, twenty-eight megacycles.

Topband is still quite good with the VO stations still at it on c.w. together with the odd W. Your scribe logged a GM3 on phone at 5 and 5 too. Didn't work him though (curses, foiled again).

On eighty, the usual sideband round tables, but a little careful listening produced half the States. Don't forget that the W's are permitted to squirt r.f. out right up to 4Mc/s.

Forty has been really good at times, just take a peep at the logs of the real s.w.l's who ventured forth and see what goodies you missed.

Fifteen, wide open at times and nearly always something of interest happening. A good band to watch now that ten is opening up.

Ten metres. Well I said all along it would happen and it has. One or two really terrific openings this month. Those lovely 'ole sunspots are doing us proud. Lets start with 28Mc/s this month and see what sort of things are about up there.

28 Megacycles

First log out of the hat comes from **A. Dorrogh** (Berks), Eddystone 730, 68 ft. l.w., all c.w.—CR6IV, CR7ER, CT1OZ, CT3AM, CX8CZ, DJ4SS, EL2AR, FH8CD, IT1ALG, K5HLP, LU4EK, LU5XE, OD5FC, OH2SB, OK1AHZ, PJ2AP, PY2CK, VS9AJC, VQ8BJ, WA2SEP, ZE1BP, ZS2OM, ZS9G, ZD8ARP, 5A3TN, 5N2AAF, 9J2VX, 9H1AF.

Paul Baker (Monmouthshire), HE30, 45 ft. l.w., a.m. and s.s.b.—CR6DX, CR7FM, CX2DB, EA8EV, LZ1UF (using 10 watts), many PY's and UA's, UG6AZO, UW3IN, W1, 2, 3, 4, W5LDH, W8AOU, WAØFIX, ZC4KF, ZS1JH, ZS2OM, ZS9G, ZE3JJ, 5A1TK, 5N2AAF, 9G1DM, 9H1X and hoards of VE's.

F. Simpson (Hull), SR550, 80 ft., l.w., IT1JR, K4RLO, KØORR, KP4CPE, MP4TBO, PY2CK, SV1BH, VK6RU, VS9AJC, W5HWR/VP9, VE3NB, W3MSK, W4ZXI, W5VY, W8LYO, ZB2AM, ZC4MO, ZS8L, ZS6IW, ZE1AA, 5Z4AA, 9J2DT.

R. Iball (Notts) says, "28Mc/s really gone mad—terrific QRK from all modes, c.w., a.m., s.s.b.—all W districts heard except W6 and 7 on 24th." Bob's log included—CE6CA, ET3WH, KV4CI, LU4DM, OA4PF, PY2DTV, SVØWL, UM8AP, VE3AIU, VO1AW, VP7NX, W5PTG, W5FTD, WØKFL, YV5AXT, ZC4MO, 9J2FK. The receiver is an AR88, antenna 80ft. l.w., with 72Ω co-ax feed!

C. Peel (Staffs), S750 with PR30 pre-selector, 20-metre dipole in the loft, writes, "Things are looking up, some of these were on a.m. and very loud." Chris logged—HK1PAR, KV4CX, LU4EZ, LU2DIN, W4ZXI, W5KGT, W5GQG, W5IJQ, W7QFL, WØBAA, YV5ANF. This was between 1730 and 1830.

We could see many more logs for ten metres, but let's look down the other end and see what's new l.f.

Eighty and Forty

I was going to sneak in my own log for 7Mc/s but **N. Henbrey** (Sussex) heard twice as much from twice as far so I'll let him tell it instead. Using a 20-metre dipole into an EA12 Norman logged—CN8AW, CR6IV, JA2BAY, JA4BJO, JA6—AK, BZI, YB (yes, it's 7Mc/s), MP4BEU, OX3BX, OY7ML, PY3AVA, UB5UN, UD6BR, VK2AVA, VK2BLR, VK3MO, VK4EQ, VK7SM, VP6KL, ZC4MO, ZL1KG, 4X4BL, 9M2DW. Other periods of listening raised—CN8AW, HI8XAL, K1DTA, K2ISP, VE1ABZ, VE1AU, VP9DL, W1AQH, W1FZJ/P/KP4, W2GO, W3BMS, W4SIB, W5KFD, ZL3FT, ZL3GS, ZL4BO, ZL4LM. It's no good, I'll have to put an aerial up!

F. Simpson (Hull), again, heard—OX3LP, VO1FG, VE1IE, VE2PA/P2, VE3FUX, W1HKK, W2ZPO, W4SIB, W4IHK, WA2SFP, W1FZJ/KP4, YV5BTS, ZL3GS, ZL4LM, ZL4CH (Campbell Is.), all on 80, while a peep at 40 produced—K1PQT, PY1MIN, PY4ND, PY7AOT, UA3KBO, VK2AVA, WA2 MMY, WB2GBL, ZL2AAG, 5N2ABF.

Fifteen Metres

Peter Elliott (South Africa), 1950 Pye radiogram, 50 ft. l.w. heard this bunch on a.m.—CX—5AAM, 8XD/MM, DL—8HD, 5CG, ET3USA, F—3OX, 5RV, I1—MSG, NIC, ZM, LU—2DJT, 8BS, MP4BBA, PY—2DBB, 4AP, VK6—BS, QL, WA4—LNS, TJC, W—2AFV, 2DYZ, 5PMZ, 8HRV, 8PHJ, 9SOM, YA5RG, ZC4KF, ZP5JB, 4X4—BS, QA, 5N2AAR, 9L1TL, 9U5CB.

Chris Peel (Staffs), again plus S750 and PR30 sends a fantastic log for 21Mc/s—BV1USA, CE—3DM, 8A, CP1DR, CP6CC, CR6HG, CR7GF, CX3BBD, DU1—AP, BA, RA, EP3RO, EL2A, ET3WH, FK8CK (New Caledonia), FH8CD (Comoros Is.), FO8AB, HC1FF, HI8XAL, HKØAI (San Andres), W9WNV/HKØ (Baja Nuevo), HS1CB, HC4AK, JA2CJB, JA6DCE, JA8CE, KA8HC, KB6CZ (Baker Is.), KC4USP, KP4BKB, KV4XA, KZ5UR, KC6BO (Caroline Is.), KM6BI (Midway Is.), KJ6BZ, KG6ALW, KH6BB, KR6KS, KS6BH, KX6BQ, KW6EJ (Wake Is.), KL7BZO, LU1ACO, MP4TBM, PJ3CI, PYØXA (St. Peter and St. Paul Rocks), TF2WJF, 9L1NM/MM/TR8 (Gabon), VE4AO, 7G1ND, VE8AA, VK2EK, VK3IP, VK4DD, VK5ON, VK6KK, VK7PR, VK8AN, VK9DJ (some 57 VKs in all, too numerous to mention!), VP3HAJ, VP8IK,

—continued on page 694

C.H.GARDNER

Set manufacturing in the 20's

THE manufacture of radio and TV receivers is now big business dominated by the "big boys", who have a tendency to merge into still "bigger boys" with capital of astronomical amounts and facilities beyond the comprehension of the uninitiated.

Very different was the situation some 40 or more years ago. Many of the manufacturers of that period were enthusiastic amateurs who, convinced that they could produce better receivers than those already available, turned professional and entered the industry.

The emphasis was on quality rather than reduction of price. Eagerness from action came largely from technical rather than commercial considerations. At a later time, when the rapidly growing market seemed to offer the possibilities of considerable future riches, which by no means always eventuated, the more commercially inclined gentlemen were stirred into action, but that is a story of another period.

In the meantime the possibility of becoming the "Rolls Royce" of receiver producers became the target of many an enthusiast with little commercial experience and still less capital to put the idea into practical operation.

Up to the time of which we are writing, the home wireless receiver had generally consisted of a number of so-called "units". Each unit, which did just one job, consisted of a wooden box on which was mounted an ebonite panel. The necessary components were mounted on the underside, and the valves and control knobs on the top of the panel.

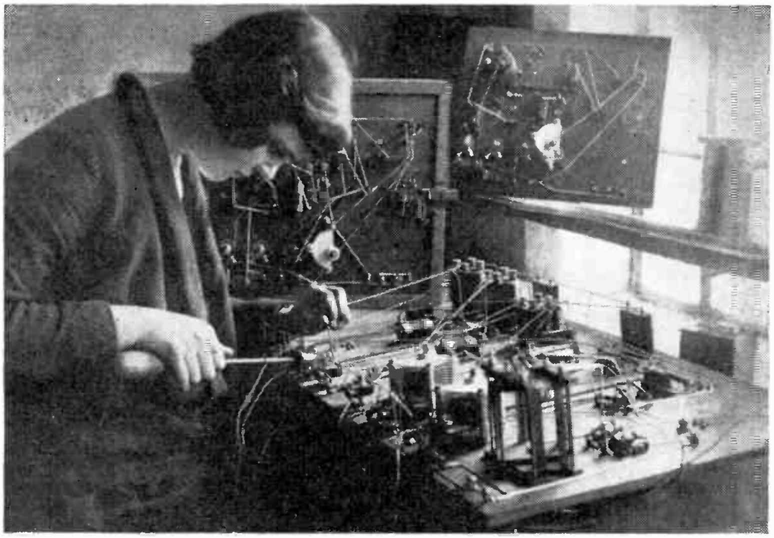
This early set looks more like a laboratory instrument than a receiver.

Numbers of terminals were provided for leads to batteries and to other "units".

This mass of boxes and flexible wires complete with batteries had to stand on the grand piano or large table and was not necessarily looked upon with favour by the lady of the house. The efficient operation of this conglomeration required considerable skill and, to put it mildly, the results were pretty awful!

So, until the matter was looked into a little more deeply, the task of designing something more suitable did not appear to offer any considerable difficulty. It was only when he really got down to matters that the designer realised that snags arose like the prickles on a hedgehog.

The earliest receivers had to rely for their sensitivity on their being operated on or near the point of self-oscillation. This resulted in reception being accompanied by grunts, howls and whistles to an extent which made the P.M.G. find it necessary to issue an edict that all future receivers must be incapable of feeding oscillations back into their



Wiring a 1924 six-valve receiver. Actual line-up was as follows: two h.f. stages, a detector, two low frequency and an audio output stage. Note the large pre-heat soldering iron used by the young lady and the large variometer aerial tuning unit.

aerials. In order to ensure this, a prototype of every new receiver to be put on the market had to be sent to the G.P.O. for test. If satisfactory it would be tied up with tape, sealed, and placed in their archives. Dire penalties awaited the manufacturer who departed from the design of the sealed model in his production run.

Here arose snag number one. The receiver had to operate with l.t., h.t., and bias supplied from batteries, the voltage of which varied considerably in use. Each valve had a rheostat in its filament circuit and "reaction" was obtained by the adjustment of the coupling of a pair of coils. Sensitivity also required the use of individually tuned aerial and h.f. circuits which varied the propensity of the receiver to go into oscillation by the accuracy of their settings. If the circuitry was so arranged that oscillation was impossible even when the set was in use by a ham-handed user, its general sensitivity was pretty dreadful.

You may well wonder why a high degree of sensitivity was required. The answer was that the user of that period had a strong DX complex and the performance of a receiver was measured by the number of transmissions it could receive, even if such transmissions had little or no entertainment value.

It was the desire of every designer of this period to produce a receiver which could be operated by "Grandma". In point of fact, few sets could be correctly adjusted even by *Pater Familias* unless he was a wireless enthusiast, a matter which was realised by many potential purchasers. Any advance in this direction was a major breakthrough and cause for considerable excitement for the designer. It was possible to allow one's enthusiasm to extend too far, as when the author presented a receiver to his company chairman with the suggestion that any fool could operate it and that he should try it and see!

It would be misleading to suggest that there was an entire lack of interest in good quality reproduction, but good reproduction was judged more from the angles of clarity and absence of discordant harmonics than from the ability to reproduce an extended scale. But even this simple requirement had conflicting interests.

The use of a suitable output valve meant a heavy drain on the h.t. battery and indicated the use of large capacity cells with a consequent appreciable increase in bulk and in cost of replacement. Frequent replacement of an expensive h.t. battery was a matter which soon told against the popularity of any receiver. It was not unusual to provide a switch in order that the final stage could be cut out at will and reception obtained from headphones or at a reduced loudspeaker level.

The loudspeakers available at the time suffered from a defect well described as "tinniness", a defect which could be to some extent reduced by a suitable loading of the intervalve transformer with capacitance and resistance. Variations of the loading allowed of a switch labelled "Speech" "Music" and "Mellow" to be provided on the panel. It is perhaps unnecessary to mention that, without this switch, speech was inclined to give the impression that the speaker had left his teeth at home or had

A common practice for early designers was to house their "babies" in shiny oak or mahogany cabinets such as this.

hurried to the studio with his mouth still full of porridge.

Until broadcasting had really got going, "wireless" had been almost entirely a male hobby and even often thought of as a bit of a nuisance by the rest of the family, but when father, on rare occasions, could be prevailed upon to stop knob twiddling, and leave the dials set on a BBC station, sufficient interest was aroused to engender an idea that a broadcast receiver might well be a welcome addition to the home providing it would "fit in" with the general room furniture.

No matter how much knobs, dials and switches might appeal to papa and enable him to impress his friends by his skill in adjusting them, they could not be considered as an attribute in the drawing-room. Construction of the receiver had still remained on the general principle of mounting valves and controls on one side of an ebonite panel, the wiring and components being mounted on the other.

It was not difficult to arrange for the panel to be held upright in a cabinet with folding doors which could shut away the controls when not in use. The batteries could be contained in an additional compartment, thus doing away with the necessity of unsightly wires.

For those conversant with modern methods of manufacture of TV and radio cabinets an extract from a catalogue of 1924 may be amusing: *"All our cabinets are hand made by skilled cabinet makers out of genuine seasoned oak or mahogany and undergo a french polishing process by experts, which requires three weeks to complete".*

In the same catalogue of receivers the manufacturer askes the potential purchaser if he *"would like to have his drawing room carpet ruined by acid accidentally spilled from an accumulator for* *which no proper provision has been made"*. It will be seen that it was still advisable to provide arguments in favour of self-contained receivers.

Highly polished ebonite panels were in favour. One supplier, without warning the set manufacturer, used a process which entailed the use of tinfoil on the surface, the tinfoil later being removed leaving a very high gloss indeed. It also left an invisible conducting surface on the panels which accounted for the production of a quantity of sets which entirely failed to function on test, and, incidentally some headaches in the test department before the cause was discovered!

Wiring of the receiver was by means of uninsulated tinned copper wire. This was somewhat of a work of art as not only must wires cross at different levels but it was thought necessary that adjacent wires should cross at right angles in order to avoid undesirable coupling. The result was beautiful to behold but not always as expected. Shorter cuts often proved to be more effective. For a reason which it is difficult to recall, square sectioned wire came into use. One's chief recollection of this wire was the difficulty experienced in making good soldered joints when using it.

Components such as intervalve transformers, resistors, capacitors and valves were usually purchased from specialist manufacturers by the smaller set manufacturer, but many other components were produced by themselves, often being of their own design and providing greater individuality for their own sets. This gave an opportunity for ingenuity, not always successful.

The standard type of filament adjustable rheostat was apt to be rough and noisy during adjustment. One manufacturer evolved an ingenious design for this component in which the variable contact was made by a curved strip made to rock over the turns of resistance wire by the movement of a cam turned by the adjusting knob.

This operated noiselessly and the movement was velvety but, alas, the designer had omitted to remember that some frictional contact was essential to keep the track clean. As this particular receiver carried with it a two-year guarantee, the final result was by no means in the manufacturer's favour.

The quality, performance and finish of many of the receivers produced by these small manufacturers was exceptional. They were designed and made by craftsmen who loved their work, but their demise was almost inevitable. A few survived to be taken over by larger concerns with more practical ideas concerning mass markets and more capital available to put such ideas into operation. Some were unable to survive the more difficult times and closed their doors, but for many years one came across samples of their products the owners of which contended that they remained superior to the later mass-produced receivers which had become available.

But technical development of a major nature soon took place and the only monument that remained could sometimes be spotted by the knowing in the shape of a cigar cabinet or medicine chest in which, alas, on opening the doors no highly polished ebonite panel could any longer be seen. ■

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SIMPLE ELECTRONIC ORGAN

J. M. WATT

THE first problem in this project was to find an oscillator capable of producing a pleasant sounding note, and whose pitch could be varied easily over a suitably wide range.

After experimenting with capacitive/inductive oscillators it was decided that they were unsuitable for two reasons. They were difficult to adjust when their pitch was varied, and the finished unit would be rather large due to the size of suitable inductances, chokes and transformers, etc.

Attention was then concentrated on the ever-popular multivibrator, and although this type of circuit did produce a satisfactory range of approximately one octave, the notes produced were very harsh and unmusical.

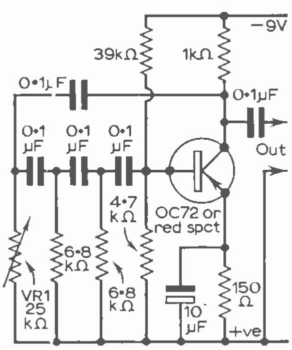

Fig. 1: Sine wave generator.

It was finally decided to try the phase-shift oscillator. This seemed promising since the output waveform approaches a pure sine wave if the transistor is not driven too hard. A circuit for such an oscillator appeared in PRACTICAL WIRELESS, August, 1962.

The note produced by this circuit was both musical and easily variable, but since this circuit was originally designed to give a frequency of 1kc/s, it had to be modified to produce notes in the 200—500c/s range. This was achieved by increasing the capacity in the phase-shift network as shown in Fig. 1.

The 25kΩ potentiometer VR1 proved capable of varying the note over a limited range. If a greater range is required then a switch must be employed to vary the value of one or more of the components in the phase-shift network.

The oscillator in the form shown produces a continuous note which, although variable, is not interrupted. This can be remedied by introducing a bell press type switch to break the battery supply.

The amplifier used for the completed organ was a two-stage circuit, using the final two stages (driver and class B output), of a transistor radio. The circuit used was, in fact, taken from a PRACTICAL WIRELESS Blueprint for a transistor superhet.

Using simple capacitive coupling between oscillator and amplifier, it was found that a very much harsher note was produced than had been obtained when the oscillator was tested using a tape recorder as an amplifier. It was then discovered that if the oscillator and amplifier were supplied from different batteries, and a large value resistor and a capacitor were introduced between the positive line of the two units, this note could be considerably mellowed.

The final circuit is shown in Fig. 2. Although it uses OC72 transistors, red spot surplus types can be substituted in the first two stages. The final stage could also employ surplus transistors as the distortion produced, due to these devices being unmatched, etc., should not prove objectionable. Also, there seems no reason to suppose that other surplus items should not be used.

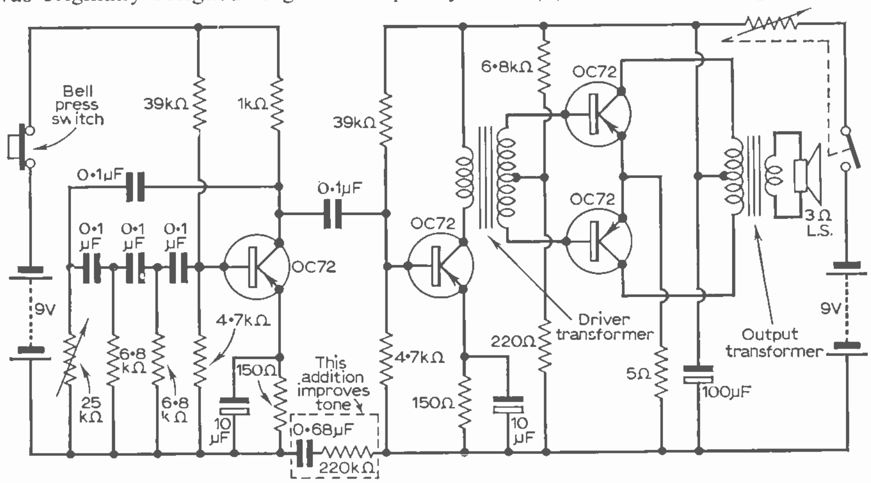

Fig. 2: Complete circuit of the organ.

Constructional details have been purposely omitted as the constructor may wish to vary the size of the instrument and include a keyboard instead of the variable resistor. The prototype was built on a piece of perspex 6 x 2½ in.

If a keyboard is required, then a small perspex key may be used which will press down on to a hairgrip.

practically wireless commentary by HENRY

No 29

Look out ahead!

JAN. 1: Made a few resolutions, just to be in the fashion. Keep my solder bit bright, always check component colour coding before snipping the end-wires, never switch on until I've re-checked the drawing, file my PRACTICAL WIRELESS copies in order . . .

Jan. 2: Decided to make a start on constructional projects. Sorted through blue-prints. Found interesting trouble-shooting chart. Pinned on workshop wall. Not a bad day for a Monday.

Jan. 3: More back copies than I thought, but some puzzling gaps. Must look up diaries for 1963. Don't know how I came to miss the *Malvern* that summer. Must try a few transistor designs. Noted that F-E-T circuits are promised—time *that* breakthrough broke through. In the meantime, must classify building projects.

Jan 4/5: Too busy to enter log last night. Uncle Joe called. Very interested in shack, especially 12W transmitter under bench. Wanted to dust it off and get on the air. Had to explain PMG requirements. Dare not swamp neighbours with TVI just as we have settled the car-parking controversy.

Everyone is entitled to a rest

Jan. 6: Commenced multi-purpose pre-amp. Lucky, project just fits baby-alarm unit. Pity to have discarded that one because of a little feedback problem. Women just do not understand these things. Still, suppose Junior will not be needing it, now he is going to school.

Jan. 7: Unfair to wife yesterday. Very interested in projects. Wants door-answering intercom. Suppose pre-amp could be adapted. Would speaker/mic signal be OK for input. Must ask John Law . . . *Memo, look up current issue for Query Coupon.*

Jan. 9: Unable to enter log yesterday, owing to domestic strife. Wife no right to lend PRACTICAL WIRELESS to Uncle Joe. We still haven't had the garden-hose returned. Trouble patched up, however, but had to promise early completion intercom. Decided against P-C board, will use support-wire method. Crude, but good enough for some equipment makers.

Jan. 12: Good progress with intercom. Decided against boot-strap input—not quite sure how it works. Must write Darlington—or was it the G.M./E.C.D. pair who dealt with semiconductors? Check when index complete. Had to use pair OC72 in Georgie's radio—should' get away with OC71 in intercom circuit though—cheap enough, anyway.

Jan. 16: Hopeless task. Wife has practically sold intercom idea to neighbours. Never get five made by Valentine's Day. Job lot of parts arrived today. Spent two hours sorting and identifying resistors.

Jan. 17: Mysterious note from Uncle Joe. CQ HPE U HRD RPT OM. BCNU. Not if I can help it! Must look up issues with R.A.E. lessons. Forgotten most of my Ham Code. Was it a year ago the S.W. Pocket Guide came out in P.W.? Time flies.

Please close the betting shops

Jan. 18: Flies indeed! Must concentrate on prototype intercom. Mass production out of question — quite apart from expense. Problems with power supply. Chassis not big enough, not her's—intercom's.

Jan. 20: Wonder if Wagner power supply would do. July '66. He says he knocked it up from his "bits box". Wish he could see mine—full of unusable oddments. I need two OC26, two OA85, two silicon diodes, two meters . . . pity I hadn't kept up the no smoking resolution a bit longer.

Jan. 27: Scrapped intercom.

Jan. 28: Memo—look up transistorised mixers. Memo—check address intercom suppliers. Can't imagine how they produce the things so cheaply. Wonder how Uncle Joe got hold of the address?

Jan. 30: Must check index. Must look up *Practical Television* copies—may be closed-circuit design for visual intercom. Could perhaps modify the old transmitter. That should knock Uncle Joe for six!

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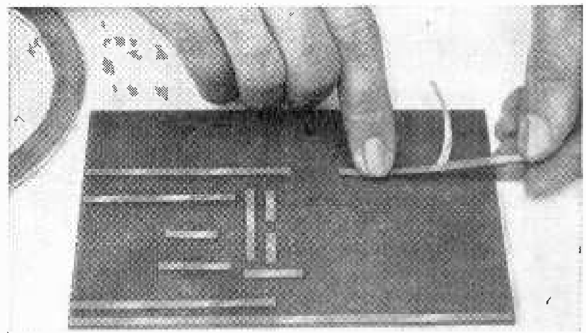

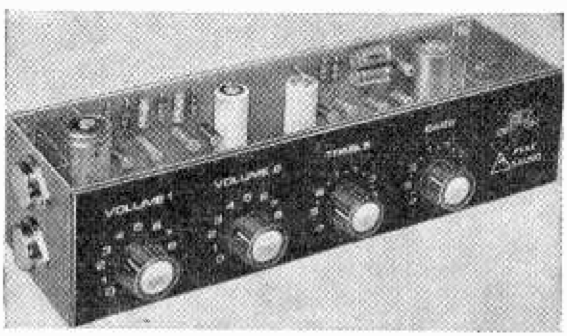

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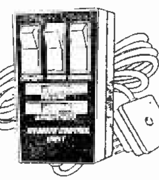

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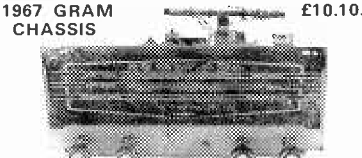

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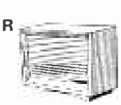

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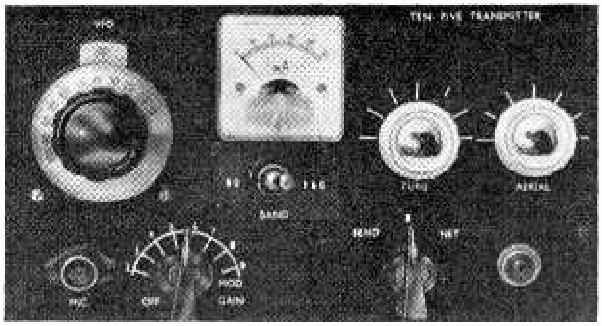


by
A.S.CARPENTER
G3TYJ

THE "Ten-Five" transmitter is a two-band affair which may be used with the "Ten-Five" transistorised communications - type receiver described earlier in these pages. Small in size, the transmitter would, if stood on a single page of "P.W.", fail to cover it completely!

Valves are used throughout, for although transistorised transmitters are entering the amateur sphere, these do tend to be expensive to construct. The "Ten-Five" transmitter weighs 3½ lb., is virtually of sandwich box proportions, and is intended for use on the "80" and "160" metre amateur bands for a.m. phone working.

Arrangements are such that the transmitter may be used under "Fixed Station" conditions, requiring 300V d.c. @ 100mA and 6·3V a.c. @ 3A. Alternatively a 12V d.c. car battery plus d.c.-d.c. transistorised converter may be connected whereupon portable, mobile, etc., working becomes feasible. The mode of powering required may be selected at will, it merely being necessary to exchange a pair of Noval plugs, the intention being to allow the transmitter to be moved from shack to car, or *vice versa,* as required. It must be emphasised, however, that at the time of writing only "fixed station" tests have been carried out using a mains-powered p.s.u. and 6·3V a.c. heaters.

The "Ten-Five" transmitter may be loaded comfortably to the 10W maximum input permitted on "Top Band" whilst on "80", 12W input is possible.

R.F. Stage Circuitry

As may be seen from Fig. 1 no trick circuitry is employed, the aim being reliability. Valve types other than specified may be used in certain cases, *provided* basing differences are noted. A 5763 has been used for V2 and a EL84 for V4 quite successfully; the specified types are preferred, however.

A Clapp v.f.o. is arranged around the triode section of V1, L1 in conjunction with VC1 tuning over the frequency range 1·75—2·0Mc/s. The band edges are adjusted at the setting-up stage, using the dust core of the coil, VC1 and trimmer TC1. Tuning is accomplished mechanically by means of a vernier reduction drive located on the front panel, the intermediary being a *flexible* insulated coupler.

The v.f.o. output is extracted from the cathode circuit of the triode and injected into V1B which functions as a buffer stage on "Top Band" and a frequency doubler for "80" metre working.

Selection of the fundamental or second harmonic frequency is carried out automatically, depending on the position of the panel-fitted band switch, S3. Fixed tuning is applied to L2 in each case, and this is adjusted at the setting-up stage and thereafter requires no alteration.

The output frequency selected from the anode of V1B is fed to V2, the p.a. stage via C11, tank coil L3 also being switched automatically via S3b.

Metering the cathode circuit of the p.a. permits grid drive current to be read when the function switch is set to "Net". On "Transmit" the meter reads cathode current and is used for tuning-up operations. Approximately 2mA of grid drive is obtained at band centre and falls off slightly at band edges.

Modulator Stages

A crystal microphone may be plugged into Sk1, V3 operates as a conventional two-stage speech amplifier, values of resistor and coupling capacitor combinations being selected to favour voice frequencies. Decoupling and smoothing for the speech amplifier stages, plus the screen circuit of V4, is by means of R17 and C22, R19 being included to offer a discharge path for electrolytic capacitor C22 which would otherwise be left in a charged state each time the function switch was moved from "Transmit".

The valve specified for the speech amplifier stages has an amplification factor of 100 and it is thus desirable to include the modulation gain control VR1. Some trouble was experienced in the prototype due to parasitic oscillation which was finally traced to V3. The inclusion of R13 and C17 proved beneficial but normally these two items

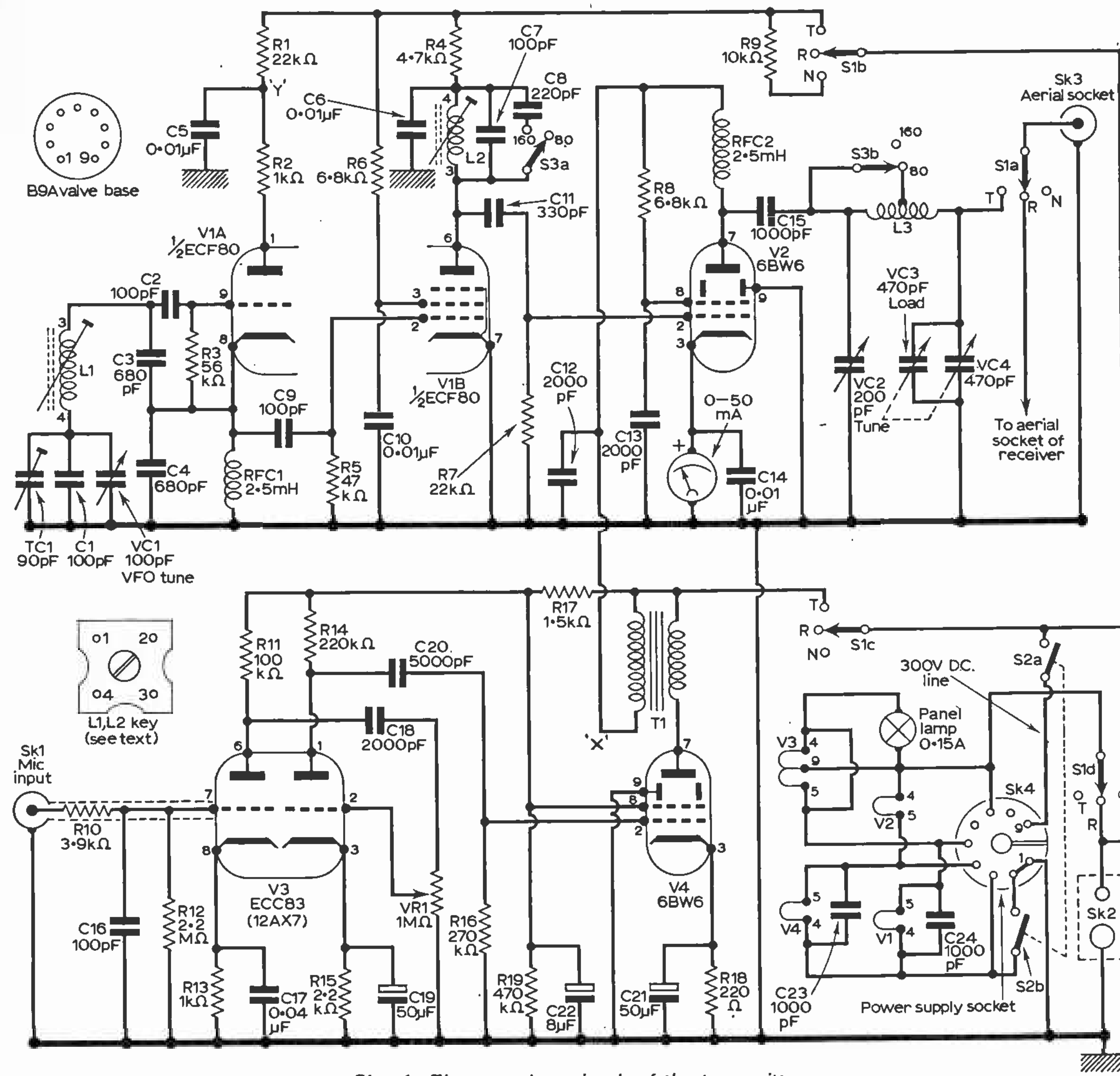


Fig. 1: The complete circuit of the transmitter.

would not be needed. T1 is a half-wave type mains transformer, the low voltage windings being ignored. It is possible to make use of a push-pull (or centre-tapped) output transformer in this position if it is of generous physical and electrical proportions. Such a transformer should be connected as shown in Fig. 2, the secondary winding(s) being ignored; if this circuit is analysed, however, it will be found to be identical with that of T1, Fig. 1.

Operation Switching

The function switch S1 permits three operations, viz., "Receive" (or "Stand By"), "Net", "Transmit", whilst for "On/Off" purposes S2 does duty, this being ganged with VR1.

With the function switch at "Receive" and S2 closed, h.t. is normally present but is not applied to the transmitter valves. The valve heaters are "On" together with the panel lamp and the aerial is connected to the receiver. By moving the function switch to "Net", h.t. is applied to the v.f.o. and buffer, whereupon the panel meter reads one sub-division, i.e., 2mA approximately. Subsequent setting of the function switch to "Transmit" enables h.t. to be supplied to the p.a. and modulator stages. If a 15W lamp "load" is now connected to Sk3, this will glow quite brightly if VC2 and VC3 are correctly adjusted. Speaking or whistling into the microphone should then cause the lamp to brighten slightly on peaks.

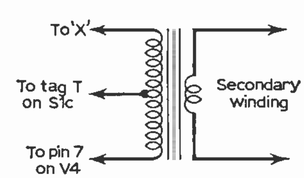


Fig. 2: Alternative modulation transformer connections.

Resistor R9 is included to maintain the potential at point "Y" identical in both "Net" and "Transmit" positions of the function switch.

Socket Sk2 is intended for use when the transmitter heaters are in 12V d.c. connection. The wiring of the plug associated with Sk4 decides whether the valves have their heaters in 6V or 12V connection—and Sk2 is associated with Sk4 via S1D. In the "Receive" and "Net" positions of the function switch, 12V d.c. (assuming use of a car battery), is thus available at Sk2 for feeding a transistorised unit—the "Ten-Five" Receiver, for example, although such receivers must be protected during "Transmit" periods!

Power Supply Plugs

The wiring of the two plugs—*looking at the pins*—for either 6·3V or 12V heaters is shown in Fig. 3 *a* and *b* respectively. Plug "A" inserted, arranges the valve heaters in parallel as shown at *a*, whilst Plug "B" results in parallel-series connection as indicated at *b*, the panel lamp being placed across V3 automatically. If no lamp is used a 47Ω resistor should be wired in its place to compensate for the dissimilar heater current rating of V3; it is also necessary to use a lamp holder that allows complete isolation from chassis. It is advisable also to use dissimilar plugs at the p.s.u. ends of the two cables so that the incorrect unit cannot be accidentally connected.

Mechanical

Only two pieces of aluminium are required, one for the panel, the other for the chassis. Panel dimensions and necessary data are given in Fig. 4. Constructors may use suitable items already to hand for VC2 and VC3, receiver-type items being satisfactory. Both of these capacitors are fitted to the panel direct.

A combined chassis/layout diagram is shown in Fig. 5. The chassis is bolted to the panel, its rear being supported by a 1in. deep flange carrying sockets Sk2, Sk3 (which should be a flush mounting item) and Sk4.

The v.f.o. is separated from the other items by a metal screen, and small brackets are required to support VC1 and L3. Skirted valveholders are used in the V1 and V3 positions. The insulated flexible coupler used between the drive mechanism and VC1 is essential, not only to eliminate hand effects, but also to simplify a minor angle problem that exists due to the slight backward slope of the panel. Care is required in connection with the v.f.o. components and short lengths of stiff copper wire should be used.

Any windings associated with tags 1 and 2 on L1, L2, should be carefully removed prior to fixing. The tank coil is centre tapped and consists of 65 turns of 24 s.w.g. enamelled copper wire close wound on a former 1in. diameter and 2in. long. It is essential to use high-grade modern miniature components since space is at a premium to some extent. Commence construction wiring by completing the heater circuits and do use screened cable from Sk1 across to V3. Rigidity of all components and wiring must be aimed at.

Conventional tests consist of checking all wiring thoroughly and using an ohmmeter to ensure that no short circuits exist between the h.t. line and the chassis but that a return circuit does exist to chassis

★ components list

Resistors:—10%, ½W
- R1 22kΩ
- R2 1kΩ
- R3 56kΩ
- R4 4·7kΩ
- R5 470kΩ
- R6 6·8kΩ
- R7 22kΩ
- R8 6·8kΩ 1W
- R9 10kΩ 1W
- R10 3·9kΩ
- R11 100kΩ
- R12 2·2MΩ
- R13 1kΩ
- R14 220kΩ
- R15 2·2kΩ
- R16 270kΩ
- R17 1·5kΩ 1W
- R18 220Ω 1W
- R19 470kΩ
- VR1 1MΩ (log.)

Coils:
- L1 QO8 } Osmor
- L2 QA4 } Osmor
- L3 See text

Valves:
- V1 ECF80
- V2 6BW6
- V3 ECC83
- V4 6BW6

Capacitors:
- C1 100pf silver mica
- C2 100pf silver mica
- C3 680pf silver mica
- C4 680pF silver mica
- C5 10,000pF ceramic
- C6 10,000pF ceramic
- C7 100pF silver mica
- C8 220pF silver mica (see text)
- C9 100pF silver mica
- C10 10,000pF ceramic
- C11 330pF silver mica
- C12 2000pF ceramic
- C13 2000pF ceramic
- C14 10,000pF ceramic
- C15 1000pF ceramic
- C16 100pF ceramic
- C17 0·04μF paper
- C18 2000pF ceramic
- C19 50μF, 6V electrolytic
- C20 5000pF ceramic
- C21 50μF, 25V electrolytic
- C22 8μF, 350V electrolytic
- C23 1000pF ceramic
- C24 1000pF ceramic
- VC1 100pF variable, type C804
- VC2 200pF variable } see text
- VC3 470pf twin-gang } see text
- TC1 100pf postage stamp type trimmer

Switches:
- S1 4-pole, 3-way Miniature rotary type
- S2 2-pole On/Off, ganged with VR1
- S3 D.P.D.T. Toggle (or slide) type

Sockets:
- Sk1 Surface mounting type TV coaxial socket
- Sk2 Miniature non-reversible insulated 2-pin socket
- Sk3 Flush mounting type TV coaxial socket
- Sk4 Noval valve holder

Drive:
Vernier Dial, ratio 8 : 1, calibrated 0–100 over 180°, 2-in. diameter—T502

Chokes:
RFC1, RFC2 } 2·5mH Ferrite cored type CH1 (Alpha Radio Supply Co., 103 Leeds Terrace, Wintoun Street, Leeds)

Panel Lens and Bush:
Type D149, Bulgin (Red) plus lamp, 0·15A, 6V and insulated holder

Miscellaneous:
Insulated flexible coupler, Four valve holders (B9A), two with skirts and screening cans. Transformer T1 See text. Miniature Plastic panel meter, 0–50mA. Four control knobs. Coil former, 1in. diameter x 2in. Oddments aluminium for brackets and screen, Grommets, 6BA nuts and bolts, wire, solder tags, tag strips, etc.

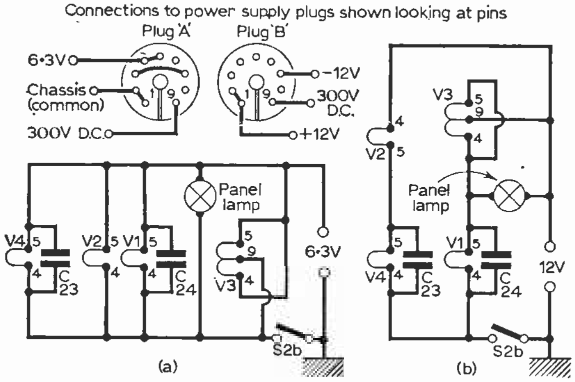


Fig. 3(a): Power supply plug wiring for 6·3V a.c. heaters; (b): power supply plug wiring for 12V d.c. heaters.

from all valve grids and cathodes. Particular care should be taken regarding the function switch wiring to see that it is correct.

Coil L1 should receive attention next, the aim being to adjust it via its dust core and in conjunction with TC1 and VC1 so that the maximum tunable range of frequencies is 1·75-2·0Mc/s. With TC1 set to about half capacitance and the vanes of VC1 fully closed, a g.d.o. is adjusted to 1·75Mc/s and coupled to L1. The core of the coil is then rotated slowly until a sharp dip is indicated by the g.d.o. meter. The g.d.o. is then retuned to 2·0Mc/s and VC1 rotated until the appropriate dip is again noted. On inspection the vanes of VC1 should be almost fully disengaged, otherwise the inductance value of L1 is incorrect. Repeat the procedure again, although after a short time it will be found possible to obtain the exact frequency swing required when VC1 is moved from maximum to minimum capacitance. Should excessive frequency coverage result it may be necessary to "pad" the circuit a little, i.e., by inserting a fixed capacitor of approximately 100-300pF in series with VC1. When the required coverage results, the core of L1 should be lightly sealed together with TC1.

The transmitter may now be connected to a p.s.u. after adjusting the function switch to "Receive" and checking that S2 is "open". With power applied to the p.s.u. the panel lamp and valve heaters should light when S2 is closed. No attempt at putting out a signal should be made at this stage for the v.f.o. may be inoperative. To check the v.f.o. lift the "earthy" end of R5 and insert a meter set to read 0-5mA. Move the function switch to "Net" and observe the meter reading. Using the blade of a screwdriver, momentarily short-circuit tags 3 and 4 of L1 whereupon the current reading should increase sharply, returning to a low value immediately the screwdriver is removed. If no change in the meter reading occurs the v.f.o. is not functioning and it is useless proceeding further until the fault has been cleared. Likely faults are a low-emission triode section of the valve, incorrect or faulty capacitor or resistor values or an open-circuit r.f. choke, etc.

The buffer/doubler may be checked by transferring the external meter to the "earthy" end of R7 and reconnecting R5 to chassis. The 50mA panel meter can be used instead and R7 left *in situ* but a more positive indication results from inclusion of an external meter adjusted to read 0-10mA.

VC1 should now be adjusted for 1825 kc/s output, set S3A to "80" and adjust the core of L2 carefully to give the highest possible meter reading; this should be about 2mA. The core of L2 is now sealed and S3 closed, whereupon a similar reading should be obtained on "Top Band". The value of C8 is fairly critical and experiment is likely in this connection—or a trimmer may be fitted instead.

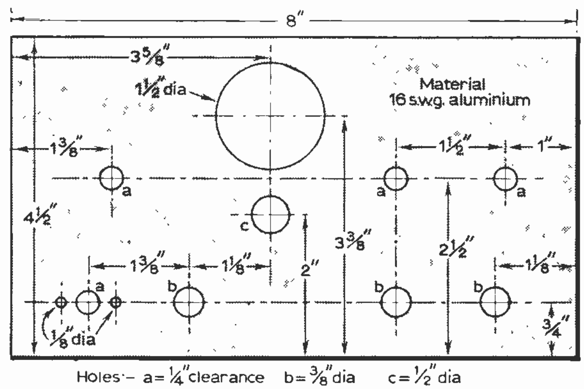
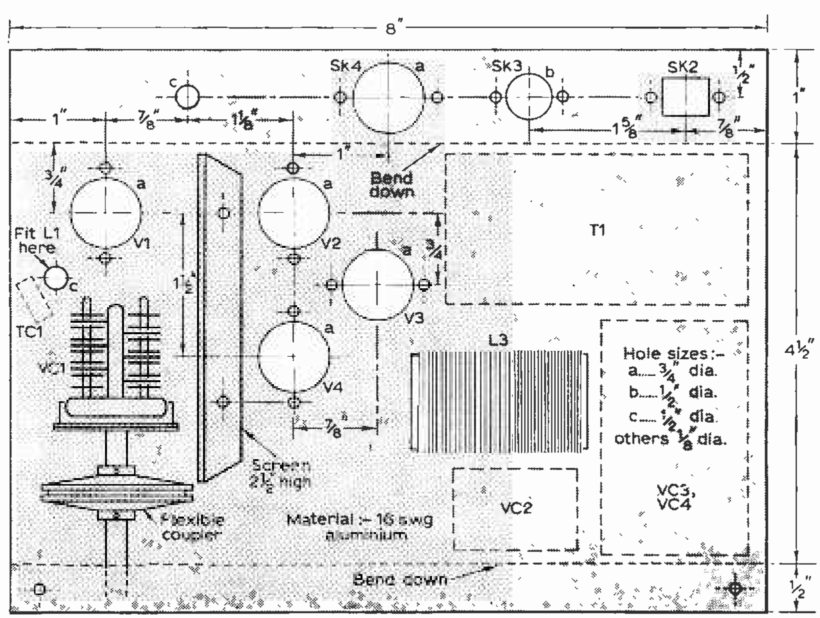


Fig. 4: Main panel dimensions and drilling details.

Fig. 5: Chassis dimensions and main component locations.

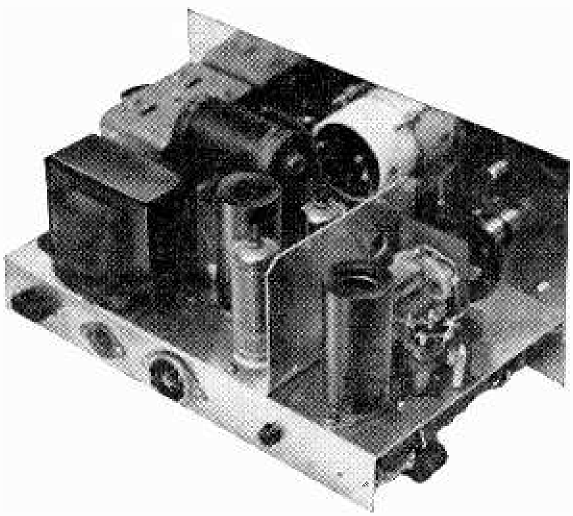


Checks should be finally made with a wavemeter to prove that L2 is in fact tuned to 1825 kc/s and 3650 kc/s when S3a is in its "closed" and "open" positions respectively.

With the external meter removed and R7 chassis-connected again the panel meter should indicate —2mA—at either position of the band switch when the function switch is at "Net".

Further Tests and Checks

The modulator may be checked by setting the function switch to "Receive", removing V2, plugging in a crystal microphone and connecting a pair of high impedance headphones across the secondary winding of T1. With the function switch rotated



Photograph showing positioning of major components. Note screen shielding V1 and v.f.o. components.

to "Transmit" speech should sound crisp and clear when VR1 is suitably adjusted. If high pitched whistles are heard at any setting of VR1 suspect parasitic oscillations; these are very likely to occur if V3 is not fitted with a screening can, for example. Grid "stopper" resistors of approximately 10kΩ are usually a cure for parasitic oscillations.

The transmitter function switch may now be returned to "Receive", the phones removed, V2 replaced, a 15W lamp "load" connected to Sk3 (an aerial must not be connected) and VC2 plus VC3 so set that their vanes are each fully enmeshed. Move the function switch to "Net" to check that drive is present then go over to "Transmit". The panel meter should now show an almost full scale deflection if the valves are healthy, therefore *quickly* rotate VC2 until the meter reading dips to a low value, say, 10-15mA. Now open up the vanes of VC3 a little until the meter reading increases, immediately retuning VC2 to lower it as far as is possible. Again open VC3 and again readjust VC2 as before until the *dipped* meter reading is approximately 30mA. The lamp "load" will be glowing quite brightly now and should visibly brighten further on speaking into the microphone.

Air-Testing the "Ten-Five"

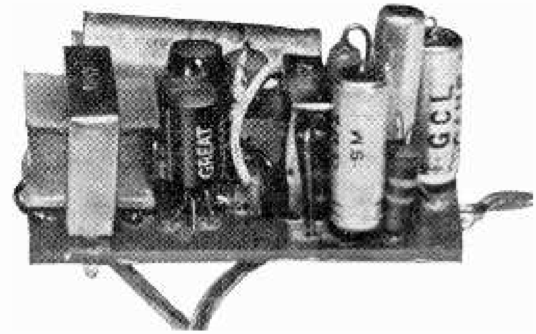
The transmitter may now be considered ready for air testing and some form of r.f. indicating device (a Wavemeter for example) will be found useful at this stage to monitor radiated signals and confirm that they are within the appropriate Amateur band. Tests with the prototype were made using a G5RV dipole with a 102ft. top, the feeders being strapped together at the station end for "Top Band" working.

The transmitter tuning and loading controls will normally need readjustment when an actual aerial is connected in place of the dummy "lamp load". Find a quiet spot on the band selected set the transmitter function switch to "Net" and tune the v.f.o. to the receiver frequency, at the same time checking grid current on the panel meter. The receiver is next silenced, or partially muted, the transmitter function switch rotated to "Transmit", small tuning adjustments made and a call sent.

Thereafter it is merely necessary to go through the normal formalities and generally get the "feel" of the transmitter whilst learning from reports received how well, or otherwise, that it works.

When optimum results have been achieved and any small adjustments required made, the v.f.o. and buffer/doubler stages should be rechecked frequency-wise; the cores and trimmer(s) sealed firmly; a graph drawn relating scale readings to frequency for each band preferably by means of a crystal frequency marker/receiver/transmitter combination; and all nuts and bolts given a spot of varnish. ■

TAPE RECORDER MONITORING SYSTEM



L. McNAMARA, B.Sc

SOME time ago, the writer assembled the tuner unit described in the September 1965 issue of PRACTICAL WIRELESS for use with his tape recorder, a Phillips model 3541. The results were highly satisfactory—well up to the author's claims—and it provided pleasant listening and clear recordings. However, with this recorder it is impossible to record and listen simultaneously without the use of monitoring headphones. It was therefore decided to investigate the possibility of a modification to permit this.

The Amplifier

The amplifier incorporated in the recorder uses three valves and a rectifier. With switching, the audio output valve, an ECL82, functions as the erase oscillator when the machine is set to record. Very extensive changes would be called for if audio output and oscillator functions were required at the same time. It is possible to employ either a transistorised erase oscillator or to provide an auxiliary audio amplifier. The first option would require modification of the switching in the recorder, as well as some unusual components, such as a new oscillator coil matched for transistor use, whereas the parts for an audio amplifier were to hand. Fig. 1 shows a common-emitter driver stage followed by a transformer-coupled push-pull output pair. This type of amplifier was chosen in preference to the more recent transformerless style, since the latter requires a high-resistance loudspeaker, rather than the 3Ω type employed with valve circuits.

Fig. 2 displays the layout of the printed circuit board, which was produced by the now-familiar method of painting the required pattern on a copper-clad paxolin sheet and removing the unprotected areas of copper by etching in ferric chloride ($FeCl_3$) solution.

On completion, the unit can be tested using a battery power supply. The input to the amplifier is taken from the sockets provided on the tape recorder, with the output going to the extension speaker sockets. The amplifier will then reproduce the monitored signal through the internal loudspeaker of the recorder. However, as one of each pair of sockets is earthed, care must be taken to ensure that the earth side in each case is taken to the positive line of the amplifier, in order to avoid undesirable feedback effects. Those who have completed the project in last September's issue will already have a power supply able to provide the low voltage d.c. built into their machines. As readers will remember, that writer recommended the use of

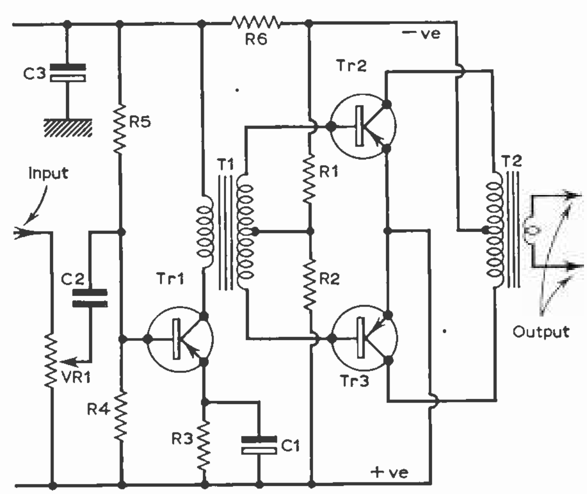


Fig. 1: The circuit diagram of the auxiliary audio amplifier.

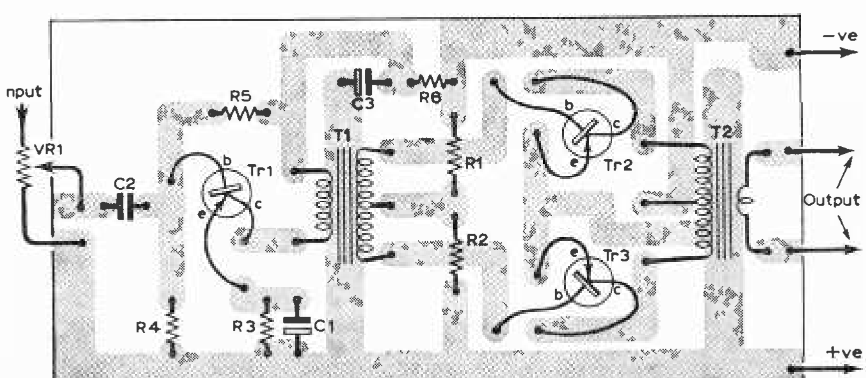


Fig. 2: The printed circuit board with components shown as seen through the panel.

a silicon diode to rectify the 6·3 volt a.c. heater supply. Due to the lower voltage, however, the output of the amplifier will be slightly lower than that obtainable with a 9V supply. Since the current required by the 3-valve amplifier of the recorder is considerably greater than that required by the transistorised units to be added, there is no reason why the latter should not be put in series with the former, with a resistor in parallel to cope with the extra current. All the h.t. from the rectifier must flow through the earthed centre tap of the secondary of the mains transformer in the full-wave rectifier system regularly employed. A d.c. voltage will therefore appear across a resistor inserted between this centre tap and earth. This arrangement also has the advantage, when used to power transistorised apparatus, that the earth is positive with respect to the transformer tap.

Value of R7

The current required by the valve amplifier is first measured by inserting a milliammeter in the circuit between the transformer centre-tap and earth; in the recorder the current was approximately 50mA, and the add-on units 25mA at 9 volts full volume. Therefore (50-25)=25mA must flow through the by-pass resistor. Ohm's Law is used to determine the value of this resistor. $\frac{9}{25 \times 0{\cdot}001} = \frac{9{,}000}{25} = 360$ ohms. The power dissipated in this resistor $= I^2R = (0{\cdot}025)^2 \times 360 = 0{\cdot}225$ watts. A $\frac{1}{2}$ watt component of the nearest preferred value (330Ω), would suffice; however, as failure would leave the amplifier to carry the full 50mA, a more conservative rating of at least 1 watt should be used. A very large smoothing capacitor must be used across this resistor in order to eliminate hum, and also to provide for the large variation in current drawn by the output transistors of the amplifier which operates in class B.

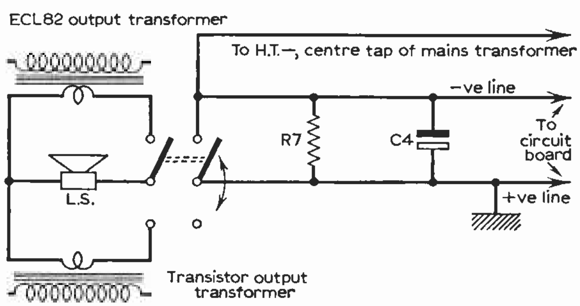


Fig. 3: H.T. and output transformer switching.

★ components list

Resistors:		Capacitors:	
R1	4·7kΩ	C1	50μF
R2	100Ω	C2	0·01μF } 9v
R3	1kΩ	C3	100μF } 9v
R4	10kΩ	C4	320μF 12v working
R5	47kΩ (39kΩ for 6v operation)	**Transistors:**	
		Tr1	OC81D
		Tr2	} matched pr. OC82
R6	680Ω	Tr3	} matched pr. OC82
R7	370Ω 1 watt	T1	driver trans
		T2	output trans

Miscellaneous:
5kΩ potentiometer. 2 pole 2 way slide switch. Repanco type TT45, TT46 are suitable.

Class B

In this mode the current drawn depends on the volume level. Details of the mounting in the recorder are not given, but a volume control and a separate 2-pole 2-way slide switch must be used. One pole of the switch is used to bring the secondary of the ECL82 output transformer, or the transistor transformer into circuit when required; the other switches off the unit by connecting the centre tap of the mains transformer to earth. The input to the unit is now taken internally from the monitor socket; it is quite simple to solder the screening and core of a length of mike cable to the earth and signal sockets respectively.

The amplifier greatly increases the scope of the tuner, and it is now much easier to tune the station one wishes to record. Finally, the amplifier, when switched off, leaves the circuitry of the recorder unchanged for normal microphone work, and of course the facility to monitor with headphones remains. ■

transfilters for I

Go
J.

IT is conventional practice to couple i.f. amplifiers through tuned couplings which, of course, are the i.f. transformers. These are resonated to the intermediate-frequency by adjustments either to the inductance of the coupled windings, using dust-iron tuning cores, or to the parallel capacitance across them, using trimmer capacitors, as shown respectively at (a) and (b) in Fig. 1.

THE TRANSFILTER

With the development of piezoelectric ceramics, an entirely new type of i.f. coupling has appeared in recent years. This is sometimes called the *transfilter*, so called because it uses piezoelectric "filter" elements arranged in a kind of electromechanical coupling between the coupled stages. However, before we can understand how these operate and how they are applied in circcuit, we shall have to learn a little about the subject of piezoelectricity and modern piezoelectric ceramics.

Piezoelectricity is not a recent discovery. It has been known since the start of radio itself, and it is the nature of electricity produced by crystal pick-ups, crystal microphones and other crystal transducers. Early devices of this kind employed water soluble crystals, such as Rochelle salt, which were easily damaged by excessive pressure and by temperature and humidity effects. The latest devices use more robust man-processed crystals, based on ceramics, as we shall see.

Years ago it was discovered that when a certain type and cut of crystal is subjected to mechanical stress there occurs an electric charge across two selected faces. This charge is piezoelectricity. It was also discovered that by applying an electric charge or voltage across the two faces a mechanical movement takes place in the crystal. This is sometimes called the *motor effect*.

Naturally formed crystals are possessed of crystal sections, making up the whole crystal, arranged in a definite pattern relating to a specific cut, and the direction of piezoelectric activity is related to a certain axis. This crystalline make-up is created by nature during the growth of the crystal.

Ordinary, unprocessed ceramics, however, do not exhibit strong piezoelectric activity because the material is composed of randomly orientated crystal sections, by the application of a strong electrostatic field during the manufacturing process, the individual crystal sections are caused to reorientate along a common axis in the required direction. This process gets the whole crystal mass, as it were, to act as a single, polarised crystal. The crystal as a whole then develops strong piezoelectric tendencies, which remain when the electrostatic polarising field is removed.

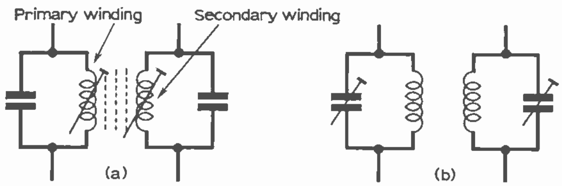
The greater physical strength of piezoelectric ceramics, coupled with their greater resistance to temperature and humidity, give them considerable advantage over the water soluble crystals, and as a consequence they are now taking over many of the jobs held formerly by the earlier crystals. We now have the so-called ceramic pick-up, ceramic microphone, and so forth. In pick-ups and microphones, the sound vibrations are coupled to the faces of the ceramic insert in such a manner that the insert is put under mechanical stress in sympathy with the vibrations, and an audio voltage (signal), varying in accordance with the stresses, is developed across the terminals.

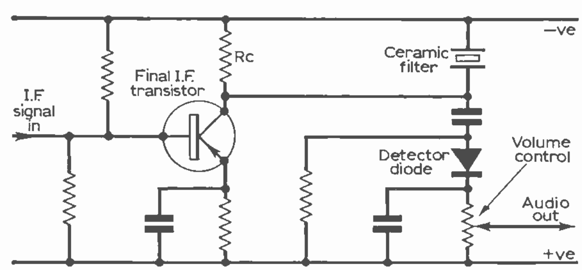
Crystal and ceramic loudspeakers (tweeters) work the other way round. The crystal insert is caused to impart its vibrations to a diaphragm, the vibrations resulting, of course, from the application of an audio voltage to the insert. Ceramic elements of this kind are sometimes called *transducers*, and are found at either end of PAL colour television delay lines, in audio echo devices and so on. The action is that the applied signal causes a crystal vibration at the sending end, which is translated back again to signal voltage at the receiving end, a time delay being given by the nature of the mechanical coupling between the two elements.

Like any mechanical structure, a piece of piezoelectric ceramic when cut to certain dimensions will exhibit specific modes of vibration directly related to those dimensions. This, indeed, is how quartz crystal controls the frequency of an oscillator. It is

Fig. 1 (below): Conventional i.f. transformer; (a) dust-iron core tuning and (b) trimmer tuning.

Fig. 2 (right): A ceramic filter as the final i.f. coupling to the detector.





F. coupling

critically dimensioned by grinding to vibrate at the required controlled frequency. A tuning fork is the same.

CERAMIC FILTER

We now have sufficient information fully to understand the application of ceramics to i.f. couplings. Suppose that a disc of piezoelectric ceramic is dimensioned to "vibrate" at 470kc/s, the standard i.f., and that it is connected in place of the i.f. transformer between the final i.f. stage and the detector, as shown in Fig. 2.

Clearly, if the i.f. signal applied to this final stage is also 470kc/s, the ceramic disc will be subjected to a voltage across its face of frequency equal to its own resonant frequency. The ceramic disc will thus set up a vibration, and it will act very much like an ordinary tuned circuit at that frequency. It will effectively amplify the i.f. signals in the collector of the i.f. amplifier, and reject signals that are outside its response range.

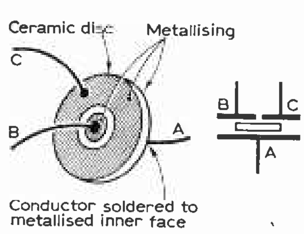
The sharpness of the response curve will depend on the nature of the ceramic filter and associated circuit parameters. High "Q" values can be obtained if required, and the filter can be analysed into equivalent components of inductance, capacitance and resistance, just like any ordinary L-C tuned filter.

Now, by the use of two ceramic filters arranged in such a manner as to be mechanical coupled, a ceramic transformer action can be obtained. The first element, corresponding to the primary of an ordinary transformer (see Fig. 1), is caused to vibrate, due to the signal, and this vibration is transmitted directly into the second element, corresponding to the secondary of an ordinary transformer. The practical arrangement of this is shown in Fig. 3.

Here the ceramic element is in the form of a small disc, previously polarised to suit the requirements. One face is completely metallised, while the opposite face (that shown in Fig. 3) carries a metallised inner area and a metallised outer ring, the two being isolated from each other.

Fig. 3: The nature of a disc transfilter (a) and its symbol (b)

Fig. 4: (extreme right) A transfilter i.f. coupling, using the piezoelectric transformer principle.



The primary filter section consists of the piezo action between the fully metallised face and the metallised inner area on the opposite side of the disc, while the effective secondary is between the fully metallised face and the outer metallised ring.

TRANSFORMER ACTION

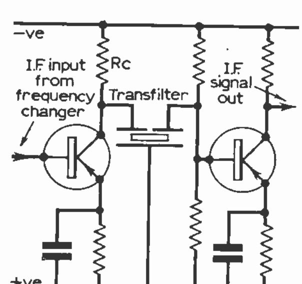
The ceramic is dimensioned to be mechanically resonant to the i.f. Thus, in the presence of an i.f. signal the primary section of the filter will vibrate, and similar vibrations will be incited into the secondary section, across the faces of which will develop the "transformed" i.f. signal. It will be understood, of course, that the secondary section vibrations are translated into corresponding signal voltage by the piezoelectric effect.

Apart from tuning the amplifier, conventional i.f. transformers also serve as matching devices between, say, the collector of one transistor and the base of the subsequent stage. Ceramic transformers, or transfilters, can also satisfy this matching requirement. This is because the mechanical impedance, and consequently the electrical impedance, of the primary can be made different from that of the secondary. Transfilters are generally employed in transistor circuits, and are thus designed to have collector-to-base matching impedances.

Figure 4 shows the circuit of a transfilter coupling between two transistor i.f. emplifiers. Ordinary transformer windings, of course, possess d.c. continuity, but since transfilters fail to have this attribute, collector resistor Rc is necessary. In the base circuit connection is direct, along with the base potential-divider resistors. This is also seen at the collector in Fig. 2. To an extra matching artifice, it is sometimes necessary to introduce a little capacitance in the base circuit, between the transfilter and transistor.

OVERTONES

Like quartz crystals, ceramic filter elements have so-called secondary modes of vibration or resonance, termed *overtones*. In filter applications these can cause trouble by creating unwanted i.f. responses, but a practical way of overcoming this problem is to make the first coupling a conventional i.f. transformer, say, between the frequency changer and the first i.f. stage. This provides unwanted signal rejection in the order of 60dB, sufficient for most purposes.



It is not uncommon, incidentally, for the filter elements to be dimensioned for the main resonance to fall at half the required i.f. The first overtone is then used to give the nominal i.f. For example, the filters may be cut to resonate at 175kc/s, giving the first overtone at 470kc/s.

The reason for this is that a filter cut for a fundamental resonance of 470kc/s would be only one-eighth of an inch in radius, which is rather small and difficult to handle. By reducing the fundamental frequency to 175kc/s, the radius is increased to about a quarter inch, which is more reasonable.

Another style of construction is shown in Fig. 5. A bar of ceramic is here used instead of a disc, and its two major faces are metal coated over half their length. The third electrode is plated at the end edge of the other half of the ceramic. The section of ceramic sandwich between the two large electrodes is polarised in the thickness direction, while the uncovered section is length polarised.

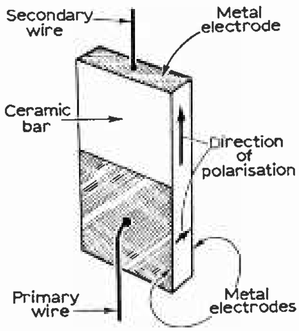
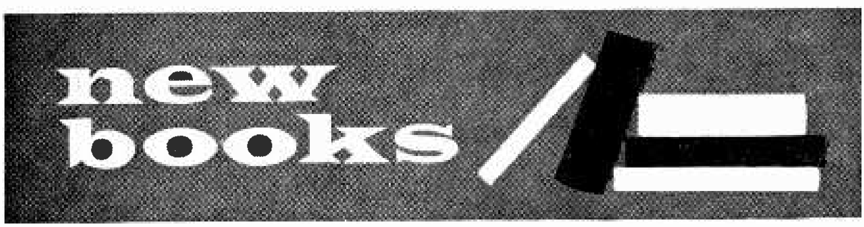


Fig. 5—An alternative method of ceramic transformer construction when a high, critical, step-up ratio is required.

This nature of construction has certain advantages for applications where large, critically valued step-up ratios are needed, having in mind that the voltage and impedance ratio bears a direct relationship to the dimensions of the effective primary and secondary sections of the ceramic.

In conclusion, it is interesting to reflect that piezoelectric ceramics are being used in applications requiring high voltage generation. One firm already holds a patent for ceramic car ignition systems, while ceramics are already being used for producing a large spark for lighting gas fires, the ceramic being stressed by advancing the gas regulator!

There is reason to believe that one day we may see piezoelectric ceramics as the prime element in television e.h.t. systems, especially in colour sets demanding 25kV or so of e.h.t. One thing about it, ceramic is a very good insulator! ■



MICROWAVE VALVES.
By C. H. Dix & W. H. Aldous. Published by Iliffe Books Ltd. 275 pages. Size 8½ x 5½. Price 55s.

MOST books on this subject have been directed at advanced students, but this time we have something intended for those educated to graduate or HNC level. It follows the predictable (and perhaps inevitable) pattern of discussing first principles and developing into an examination of the various types of microwave valves and their construction and applications. The authors keep well in mind the level for which they are writing and restrict mathematics only essential to an understanding of the principles involved. This is a welcome addition to radio literature, in particular to one of the few remaining fields in which the thermionic valve still reigns supreme.—*LB.*

TRANSISTOR BIAS TABLES.
By E. Wolfendale. Published by Iliffe Books Ltd. 71 pages. Size 9¾ x 7¼. Price 21s.

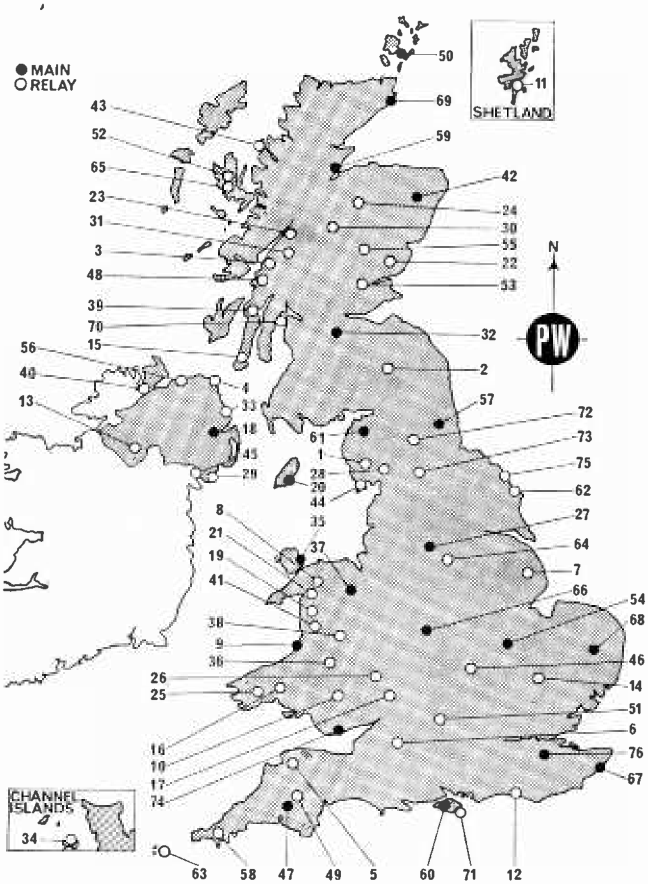
THIS is actually a collection of accurately computed tables for those engaged on designing transistor amplifiers. The tables can be used either directly, to provide the values of the three resistors required for the conventional bias circuit, or as a starting point for more detailed bias circuit analysis. Six introductory pages outline the aims of the tables and describe their use. Eleven values of collector current are given and for each there are five values of supply voltage each occupying a full page. Other data includes the values of transistor parameters in conventional bias circuits and the range of junction temperatures over which the transistor is required to operate. The complex calculations were achieved using a digital computor. A great time saver for the designer.—*WNS.*

QUESTIONS AND ANSWERS ON AUDIO.
QUESTIONS AND ANSWERS ON TRANSISTORS.
QUESTIONS AND ANSWERS ON ELECTRONICS.
QUESTIONS AND ANSWERS ON RADIO AND TELEVISION.
Published by George Newnes Ltd. Price 8s. each.

THIS set of four volumes are compact pocket books, size 6¾in. x 4½in. in stiff covers, running to around 100 pages or more. The format is identical in that each chapter consists of set question followed by explanatory text. While the reviewer is not particularly enamoured of the Q and A approach, it must be admitted that the style does not jar so much as usual, probably because the Q's are single-line only.

The first three volumes are written by Clement Brown and the fourth by H. W. Hellyer. In all cases the material does what it sets out to do in providing an easily readable account of the subject matter by packing in a considerable amount of very useful information in the space provided. Although the approach in general is for the lesser experienced reader, no one need feel ashamed to be seen dipping into these pages for the level of writing is commendably high. But undoubtedly these pocket books are ideal for those just embarking on the subjects and can be thoroughly recommended. The price, too, is commendably cheap.—*NWS.*

BBC V.H.F. SOUND BROADCASTING STATIONS



	Location	Version of Home Service	Frequencies (Mc/s) Home	Light	Third	Max. ERP†
1	+Ambleside					
2	Ashkirk	Scottish	93·5	89·1	91·3	18kW•
3	+Ballachulish					
4	Ballycastle	N. Ireland	93·4	89·0	91·2	40W•
5	Barnstaple	West	92·9	88·5	90·7	150W•
6	+Bath	West	93·2	88·8	91.0	35W•
7	+Belmont	North	93·1	88·8	90·9	15kW•
8	+Betws-y-Coed					
9	Blaen-plwyf	Welsh	93·1	88·7	90·9	60kW
10	Brecon	Welsh	93·3	88·9	91·1	10W•
11	Bressay	Scottish	92·7	88·3	90·5	10kW•
12	+Brighton	West	94·5	90·1	92·3	25W•
13	Brougher Mountain	N. Ireland	93·3	88·9	91·1	2·5kW
14	Cambridge	Midland	93·3	88·9	91·1	20W•
15	+Campbeltown					
16	Carmarthen	Welsh	92·9	88·5	90·7	10W•
17	Churchdown Hill	Midland	93·4	89·0	91·2	25W•
18	Divis	N. Ireland	94·5	90·1	92·3	60kW
19	+Dolgellau	Welsh	94·5	90·1	92·3	
20	Douglas	North	92·8	88·4	90·6	6kW•
21	+Ffestiniog					
22	Forfar	Scottish	92·7	88·3	90·5	10kW•
23	Fort William	Scottish	93·7	89·3	91·5	1·5kW
24	Grantown	Scottish	94·2	89·8	92·0	350W•
25	Haverfordwest	Welsh	93·7	89·3	91·5	10kW•
26	Hereford	Midland	94·1	89·7	91·9	25W•

	Location	Version of Home Service	Frequencies (Mc/s) Home	Light	Third	Max. ERP†
27	Holme Moss	North	93·7	89·3	91·5	120kW
28	Kendal	North	93·1	88·7	90·9	25W•
29	+Kilkeel	N. Ireland	93·2	88·8	91·0	25W•
30	+Kingussie	Scottish	93·5	89·1	91·3	35W•
31	Kinlochleven	Scottish	94·1	89·7	91·9	2W
32	Kirk o'Shotts	Scottish	94·3	89·9	92·1	120kW
33	Larne	N. Ireland	93·5	89·1	91·3	15W•
34	Les Platons	West	97·1	91·1	94·75	1·5kW•
35	Llanddona	Welsh	94·0	89·6	91·8	12kW
36	Llandrindod Wells	Welsh	93·5	89·1	91·3	1.5kW
37	Llangollen	Welsh	93·25	88·85	91·05	10kW•
38	+Llanidloes	Welsh	92·5	88·1	90·3	5W
39	+Lochgilphead					
40	Londonderry	N. Ireland	92·7	88·3	90·55	13kW•
41	Machynlleth	Welsh	93·8	89·4	91·6	60W •
42	Meldrum	Scottish	93·1	88·7	90·9	60kW
43	Melvaig	Scottish	93·5	89·1	91·3	22kW•
44	Morecambe Bay	North	94·4	90·0	92·2	4kW•
45	Newry	N. Ireland	93·0	88·6	90·8	30W•
46	+Northampton	Midland	93·3	88·9	91·1	60W•
47	North Hessary Tor	West	92·5	88·1	90·3	60kW
48	Oban	Scottish	93·3	88·9	91·1	1·5kW
49	Okehampton	West	93·1	88·7	90·9	15W•
50	Orkney	Scottish	93·7	89·3	91·5	20kW•
51	Oxford	{ Midland West	93·9 95·85	89·5	91·7	22kW•
52	Penifiler	Scottish	93·9	89·5	91·7	6W•
53	Perth	Scottish	93·7	89·3	91·5	15W•
54	Peterborough	Midland	94·5	90·1	92·3	20kW•
55	Pitlochry	Scottish	93·6	89·2	91·4	200W•
56	+Portrush					
57	Pontop Pike	North	92·9	88·5	90·7	60kW
58	Redruth	West	94·1	89·7	91·9	9kW•
59	Rosemarkie	Scottish	94·0	89·6	91·8	12kW•
60	Rowridge	West	92·9	88·5	90·7	60kW
61	Sandale	{ Scottish North	92·5 94·7	88·1	90·3	120kW
62	Scarborough	North	94·3	89·9	92·1	25W •
63	+Scilly					
64	Sheffield	North	94·3	89·9	92·1	60W
65	Skriaig	Scottish	92·9	88·5	90·7	10kW•
66	Sutton Coldfield	Midland	92·7	88·3	90·5	120kW
67	Swingate	London	94·4	90·0	92·4	7kW•
68	Tacolneston	Midland	94·1	89·7	91·9	120kW
69	Thrumster	Scottish	94·5	90·1	92·3	10kW•
70	Toward	Scottish	92·9	88·5	90·7	250W•
71	+Ventnor					
72	Weardale	North	94·1	89·7	91·9	100W•
73	+Wensleydale/Swaledale					
74	Wenvoe	{ Welsh West	94·3 92·125	89·95	96·8	120kW
75	+Whitby	North	94·0	89·6	91·8	40W•
76	Wrotham	London	93·5	89·1	91·3	120kW

• Directional aerial.

+ Station not in service at date of issue of this sheet; where frequencies or ERP are not shown, these are not finalized.

† ERP figures given are the same for each programme.

A Question of Phonetics

THANK you for publishing my letter in the November issue. I would like to mention, however, that the NATO alphabet is uniform, whereas that used by amateurs varies considerably. For instance, I heard a Ham on 80m using very different phonetics when repeating his callsign in the same transmission.
Charles Mitchell. Oxford.

I SHOULD like to point out that amateurs do not use a definite phonetic alphabet. It seems to me that they use the first word that comes into their heads. The phonetic alphabet contained in the Geneva Radio Regulations 1959 has been very carefully compiled to reduce ambiguity to a minimum, and I think it would be wise policy for Hams to adopt this alphabet.
E. R. Lisle. Maidstone, Kent.

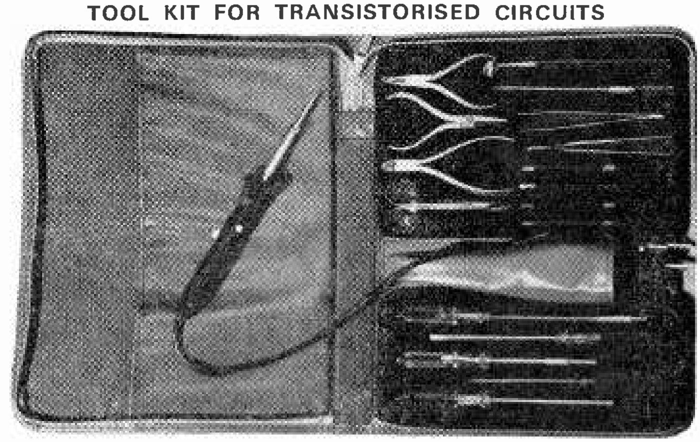
I WOULD like to make it clear that the NATO code is used by all Marine radio operators, both on ship and on shore stations, throughout the non-Communist area of Europe. When you include all the fishing vessel skippers who use the M.F. R/T channels, those in favour of Mr. Mitchell's theory are considerably in excess of your estimate. Surely, it would be fairer to do as Mr. Mitchell suggests and have the amateurs fall in line and use the NATO code. It is, after all, a very good, easily understood one and at least has the advantage of being "standard" and not subject to local or regional variations.
G. M. Christie.
2nd Engr. Officer. Orkney, Scotland.

WITH reference to your comment on Mr. Mitchell's letter, another quick count would reveal that most Hams use numerous words for the same letter. For their own benefit, I suggest they start using the officially recognised handbook.
N. Farrand. Mansfield, Nottinghamshire.

I WAS amazed by your comment on Mr. Mitchell's letter. The differentiation of letters by phonetics is by sound. Many different letters have a similar phonetic sound and vice-versa. The purpose of the NATO system is to minimise ambiguity of sound. The phonetics were chosen by people who knew what was necessary to achieve the object: (a) no phonetic can be confused with another of this system; (b) the choice of words is such that each is intrinsically clear.
R. W. Goulden. Harrogate, Yorkshire.

NEWS AND..

TOOL KIT FOR TRANSISTORISED CIRCUITS



This Transistor Tool Kit 1900 TR contains 18 tools held in cut-out plastic foam to eliminate retaining straps. The selection includes a 14 mm magnifying contact mirror, a 30W soldering pencil, a flexible screwdriver, a screw-positioner, hook tweezers for removing excess solder and a special side cutting nipper. Amongst the more conventional tools are miniature screwdrivers in five sizes, 2 sizes of grub screw screwdrivers and one for Phillips screws, a crown shear and two pairs of specially shaped electrician's pliers.

The complete kit weighs just over 2lbs. and measures 10 x 13 x 1½ in. A large pocket is provided for documents and there is ample room for small additional accessories. The price is 10 guineas, from Henri Picard & Frere, Ltd., 34/35 Furnival Street, London, E.C.4.

STC ENTERS HOBBIES MARKET

Standard Telephones and Cables Limited, has acquired the business patents and other assets of Electroniques (Felixstowe) Limited, and has incorporated this enterprise into a new fully comprehensive electronic component/equipment supply service.

Operating under the name Electroniques (proprietors STC Ltd.), this service is part of Electronic Services Division—STC, the "same-day despatch" organisation formed in January 1965 which supplies industry with components by return of post.

A logical development of this industrial venture, Electroniques offers to hobbyists a similar service covering a vast selection of equipments, test sets, modules, components, tools and accessories.

The address for enquiries regarding the Electroniques hobbies supply service is: Electroniques (proprietors STC Ltd.), Edinburgh Way, Harlow, Essex.

STEREO DECODER FROM HEATHKIT

From Daystrom Ltd. of Gloucester comes the Heathkit f.m. stereo decoder SD-1. Audio frequency response is ±2dB 50c/s to 15c/s. Output impedance (each channel) 20kΩ. Output voltage (each channel) 250mV. Input signal voltage 0·4V min. from discriminator output of f.m. tuner. Channel separation (1kc/s) 30dB. Hum and noise level —55dB. Transistor complement 7 x 2N2712. Dimensions 3¼ x 3¼ x 9in. Power requirements 105–125 and 210–250V a.c. 50–60c/s 10W. Price is £8 10s. (kit) or £12.5s.

...COMMENT

THOSE JAP TWO-WAY RADIOS

"At last, the P.M.G. has been able to initiate a successful prosecution of a user of a Jap walkie-talkie outfit. Though the defendant got away with a magisterial admonition and the payment of costs, the point was finally established that the operation of these sets—which work in the 27 Mc/s band—is illegal. The case gained wide publicity, which might have the effect of warning dealers not to sell them to the general public. Indeed, dealers are well aware that their use is prohibited—except by licensed amateurs in our *28Mc/s* band—so that anyone prosecuted in future could almost certainly sue the dealer who sold him the thing, and recover damages and costs."—"Short Wave Magazine" November, 1966.

NEW TAPE RECORDER FROM ELIZABETHAN

The LZ 612 tape recorder, made in Britain by Elizabethan Electronics has an output of 5W. Mic. input impedence is 400Ω at 200μV. Radio input 100kΩ, 80mV, Pickup input 330kΩ, 300mV. Monitor output 10kΩ, 300mV. Power output 5 watts—push-pull Class "B" output stage. Semiconductors used are BC109+3, AC128+6, OC81, AC127, AD161, AD162, OA81 diode for the tape and power amplifier unit and BC113, BC115, BZX17 diode for the power supply unit (mains).

Playing time is 2 x 30 mins. with C.60 Cassette, 2 x 45 mins. with C.90 Cassette. Loud speaker is a 10in. Goodmans. Hi flux 11,000 lines/sq.cm. Bass Res., 55c.p.s. Geon damped curvilinear cone. Dimensions are 17¾ x 12⅞ x 7½in. deep. Weight is 18lbs. less battery. The LZ612 retails at 45 guineas.

SIMPLIFIED SOLDERING

Multicore Solders Ltd. have published a new booklet entitled "Hints on Soldering". The purpose of the booklet is to demonstrate to handymen and others that soldering is straight forward and not a difficult operation providing a few simple basic rules are followed. It is distributed to the public through the trade.

TRANSMITTING STATIONS FOR BELGIUM

Two 30 kilowatt h.f. Marconi Self-Tuning (MST) radio transmitters are to be installed at Belgium's advanced communications centre at Ruiselede. These self-tuning transmitters are fully automatic and will be remotely controlled over land lines from a centre three kilometres away.

An Offer to Readers

BACK in 1918 my late father became interested in radio, and as much as a later generation of amateurs did after the last war, he acquired a considerable quantity of World War I ex-WD radio material—field receiving sets, transmitters, valves, and so on. A fair amount of this stuff has been stored in my attic for many years.

I shall shortly be moving to a smaller house and the attic must be cleared. I am writing therefore to ask if you could suggest a club, institution or other body likely to be interested in acquiring this old material. I am not expecting money for this material, but would be very happy to donate it to a suitable recipient.

W. Lloyd-Thomas. South Wales.

[*If any organisation is interested in any of this equipment for their museums, etc., would they please write to me so that suitable applicants may be put in touch with Mr. Lloyd-Thomas—Editor.*]

Great Circle Calculations

REGARDING the article by W. E. Rigg. 9J2AA, in the August issue, I have been able to secure the Weir Charts mentioned in the article. They are obtainable from any Admiralty chart dealer and are numbered: 5000. Modified Weir 0° to 65° and 5001. Modified Weir 65° to 80°. Both these charts are large, but smaller ones can be obtained viz., 5000A and 5001A. Also a description on page 97 of "The Admiralty Manual of Navigation" Vol. III.

F. A. Connop Behenna, B.R.S. 20042. Swansea, S. Wales.

19 Set for V.H.F.

From recent correspondence in our magazine, I understand several readers are interested in the v.h.f. frequencies. I also understand that most surplus gear for v.h.f. is crystal controlled. But these people can buy, for a small sum, the old 19 set and obtain wonderful results from the "B" set. On such a rig I have used plug-in coils—yes on v.h.f.! —and had marvellous results, with no other mods other than the changing of the little coil at the front of the set. I have also had this set down to the radio control bands, and very good it was, too.

T. Heslop. Brandon, Co. Durham.

POWER SUPPLIES

by H. T. Kitchen

ALL electronic equipment requires a source of power without which it cannot function. It is not proposed to cover battery operation in this article, it is proposed instead, to examine mains power supplies in some detail because these can vary from the very simple to the very complex. There are also several fundamental requirements that are not always appreciated, or are overlooked, when designing a power supply.

Where valves are concerned, the power supply will have to provide a low voltage for the filaments, usually 6·3V. It may have to provide the voltage in one of several ways; floating, i.e. neither side connected to chassis; centre-tapped, i.e. the winding is in two halves, the centre being connected to chassis; or simply with one end connected to chassis and the other used to feed the filaments. If a filament winding has no centre tap it is possible to provide an artificial centre tap by connecting two 47Ω or 100Ω resistors across it in series, using their junction as the centre tap. A potentiometer can fulfill the same purpose with its wiper connected to chassis, in which case the "centre tap" can be varied so that either end of the winding can be earthed at will, or it can be set at any intermediate position desired. This potentiometer is known as a "humdinger" and can be used to minimise hum signals flowing in the circuit. A leakage from heater to cathode or heater to grid would allow these hum signals to flow, as would siting of the heater wires near a low signal level grid. The humdinger minimises hum by introducing a voltage of opposite phase, to cancel out the original offending signal.

Valves also require a source of high tension voltage which must be rectified by means of a valve or metal rectifier (in this context the term "metal" includes selenium, silicon and germanium, fed from a suitable high voltage winding on the mains transformer. (Universal or a.c./d.c. power supplies which do not use a transformer will be covered later in the article.) The primary requirements of this rectifier is that it should be able to handle the voltage fed into it, and supply the current demands of the circuit it supplies. There are three main ways of converting the AV fed to the rectifier into the DV required by the circuits (1) half wave (2) full wave and (3) bridge; see Fig. 1. The circuit configuration is independent of the type of rectifier, apart from the heater supply required by the valve. In all cases the output from the rectifier is positive, though it can if necessary, be reversed so that its output is negative. Its action is to remove one of the peaks of the alternating voltage fed into it, leaving us with a pulsating DV output, that is in its present form, totally unsuited to feeding the majority of electronic equipment. This can be readily appreciated from Fig. 2 which shows the raw rectified AV input/output waveforms from a half wave rectifier.

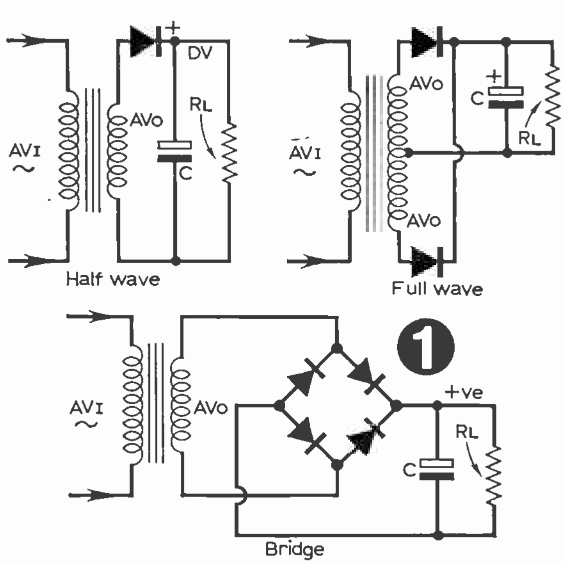
Figure 3 shows the action of the full wave rectifier, from which it will be seen that the rectifiers conduct twice per cycle instead of once as in the half wave circuit. Consequently the output will consist of twice as many positive (or negative) peaks. The rectifiers do not conduct simultaneously, but conduct in anti phase, i.e., MR1 conducts when MR2 is non-conducting and vice versa. With the normal 50c/s mains the output from MR1, MR2 will pulsate at 100c/s.

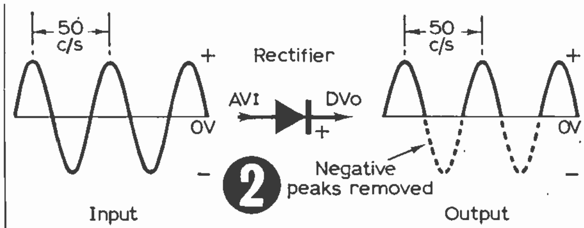
VALVES OR METAL RECTIFIERS

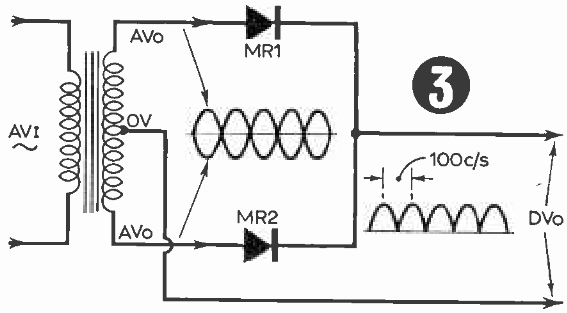
The choice between a valve rectifier and a metal rectifier requires careful consideration as both have their advantages and disadvantages. For normal amateur usage, their voltage and current ratings can be regarded as being identical, so that the difference has to be resolved in terms of instantaneous current supply *at the moment of switching on*. The valve rectifier has a heater which requires a certain warming up time, which in the case of indirectly heated valves is quite appreciable, before the valve will conduct. The valves which form the load will also have been warming up at roughly the same rate, so that the output voltage at the rectifier's cathode will not differ very greatly at any given moment.

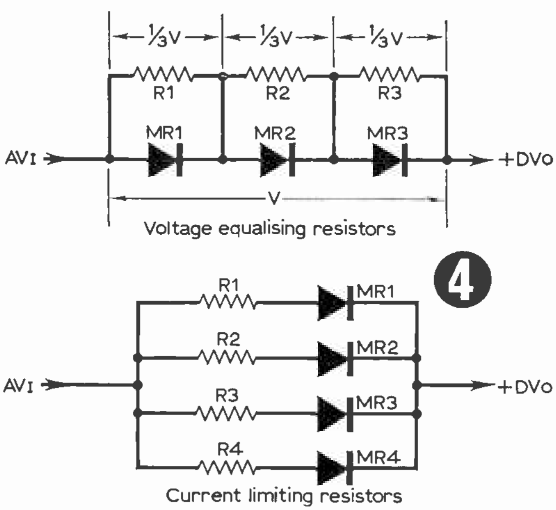
The metal rectifier does not have to be heated and conducts immediately the power is switched on. The valves forming the load will not have warmed up, so that the current drawn will be negligible, resulting in the h.t. voltage rising not to its working level but to a level of $AV.\sqrt{2}$ which in the case of a 300V AV input will be 425V, until such time as the valves warm up and start drawing current. This is not the only disadvantage of the metal rectifier, for at the moment of switching on, the following reservoir capacitor will be discharged and will therefore act as a virtual dead short across the rectifier. The initial current surge will be limited only by the total series resistance as presented by the transformer winding, necessitating the inclusion of a surge limiting resistor either immediately preceding or following the rectifier. This current surge will take place with a valve rectifier if the power is switched off and then immediately switched on again, before the cathode has time to cool down. Failure of rectifiers is often accelerated by continual switching off and on without allowing adequate cooling down time.

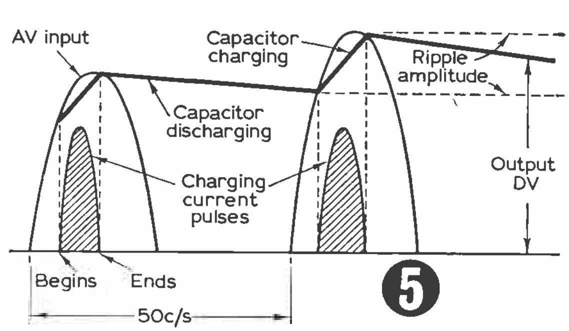
Directly heated valve rectifiers fall midway between the metal and the indirectly heated valve types as far as current surges are concerned, and are more prone to failure with continual switching off and on as the DV power output is obtained from the heater itself, which will thus go open circuit.

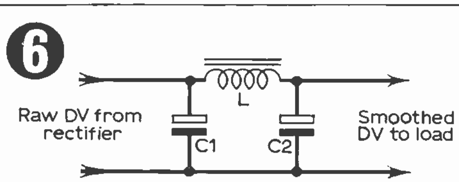


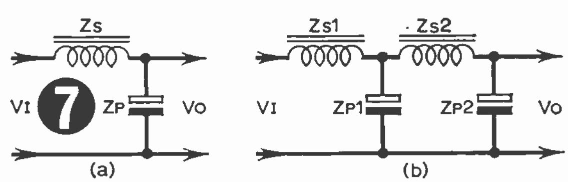












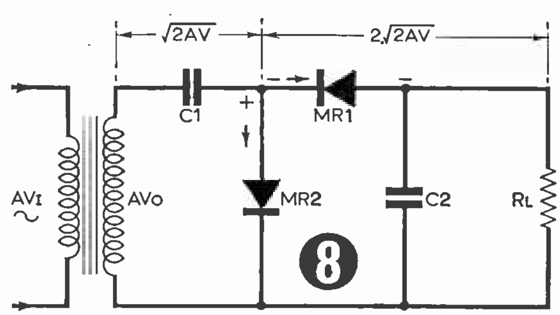


Fig. 1: Rectifier configurations.
Fig. 2: Before and after with a diode in the line.
Fig 3: Ripple frequency after full-wave rectification is twice the original frequency.
Fig. 4: Rectifiers in series and parallel.
Fig. 5: Action of the reservoir capacitor.
Fig. 6: Conventional π smoothing section.
Fig. 7: Impedance considerations for the single section (a) and for the double section (b).
Fig. 8: Simple voltage doubler.

Valve rectifiers are somewhat critical as regards siting and positioning unlike metal rectifiers, unless of the finned variety, which require proper positioning with the fins in a vertical position. The magnetic field from a mains transformer can be quite strong, and valve rectifiers are averse to being in a strong magnetic field. It is inadvisable to mount some types in a horizontal position as the internals can expand when hot, allowing parts to come into contact which would normally be kept apart if mounted correctly. If in doubt the maker's literature should be consulted.

SERIES OR PARALLEL

Rectifiers can be connected in series or parallel providing some simple precautions are taken to equalise the loading so that it is shared equally between the total number of rectifiers. With series connection, each rectifier should be shunted by a moderately high value resistor so that differences in forward/reverse resistances are minimised. With parallel connection each rectifier should have a series resistor carefully chosen to have negligible effect on the current drawn. By this means the current is distributed more evenly, the resistor serving to limit the current passed by any rectifier whose forward resistance may be lower than its fellows.

SMOOTHING

Whatever rectifying configuration we use we are still left with a DV that pulsates between its positive peak value and zero. In order to provide a more acceptable DV we may connect a capacitor across the output from the rectifier. This is C in Figs. 1 a,b,c, and its effect upon the pulsating voltage is illustrated in Fig. 5 in which the capacitor is charged to a value of $\sqrt{2}$.AV or to the peak value of the AV input during which time the rectifier passes current. The rectifier will not pass any current until such time as the instantaneous AV value exceeds the DV across the capacitor. This is where the resistor RL, representing the external load, comes in by discharging C, and sets into motion the following cycle of events. C is charged by every positive peak from the rectifier. On the negative swings the voltage starts to fall due to the lack of of the charging pulses. The capacitor now starts to discharge into RL at the normal exponential discharge rate, so maintaining the DV at an average value less than its peak, but appreciably greater than zero, the actual value depending on the value of C and the current demands of RL. By making C very large or reducing I. RL and DV can be maintained at a level approaching the peak voltage. As the AV falls below the voltage across C, the rectifier current diminishes until it ceases completely when AV = O.

The voltage across the rectifier differs appreciably when C is connected across the output. Without C, the maximum voltage across the rectifier is equal to AV but with C in circuit this increases to 2AV.$\sqrt{2}$ which is the sum of the DV and AV components, and is due to the fact that without C the rectifier passes current during the positive peaks, but with C in circuit the current flows for only a short portion of each peak. During negative going peaks the current is supplied by C discharging into RL until it is met by the next positive peak which charges C again. Since the transformer supplies the current demands of RL it is necessary for the average value of the current pulse in each cycle to equal the mean current output, which requires a very large peak current value in relation to the mean current. All these effects are illustrated in Fig. 5.

IMPROVING THE SMOOTHING

We now have a partially smoothed pulsating DV supply which varies from the PK value of the AV input, to a value determined by CI where C is the reservoir capacitor and I the current drawn by RL. This is the amplitude of the ripple voltage, as the variations are termed, with the charge/discharge portions having a saw tooth appearance. Whilst this partially smoothed DV is obviously preferable to raw or unsmoothed DV for most applications, it is, as a rule unacceptable even in its present form, particularly when used to power equipment that handles low level signals. Stages that handle signals in the mV region obviously require an h.t. supply having a correspondingly lower level of ripple voltage if the output is not to contain a large percentage of h.t. induced hum. This additional smoothing can be provided in one of two ways. At one time the standard, if not only method, was by inserting an iron cored choke in series with the h.t. supply with a capacitor following, these components forming with the capacitor already present, a low pass π section filter which will be recognised as forming the conventional smoothing circuit. The operation of these components Fig. 6 is quite simple. C1 and C2 are made sufficiently large in capacity to present the ripple voltage with a low impedance path to earth, whilst the choke presents a fairly high series impedance to the same signal, having a very low ZF (zero frequency, i.e. d.c.) resistance in order to minimise the voltage dropped across it. LC smoothing can be very effective but it has the disadvantage that the current passing through the coil has a tendency to create a strong magnetic field in the vicinity of the choke. Although this may be of little consequence in some applications, there is a very real danger that nearby inductors may be within the range of the magnetic field which will not only have a steady state due to the passage of the ZF current, but also a field varying at 50c/s or 100c/s (depending whether half wave or full wave rectification is being employed). This field, which will be somewhat weaker than the steady state field, may react inductively with other inductors, such as tape replay heads, bass or treble boost coils, etc., and result in hum being introduced into the signal. The steady state field is not without its dangers since it can magnetize tape record replay heads with an attendant increase in the general noise level. Where such a choke is mounted close to the c.r.t. of an oscilloscope or TV receiver, the magnetic field can play havoc with the display. Care is therefore necessary when choosing the site for such a choke.

EXTRA SMOOTHING SECTIONS

It is possible to connect several such π sections in series where a really pure DV output is required, each section being considered as a divider network where a high impedance (the choke) is connected in series with a low impedance section (the capacitor) the ripple being reduced approximately by $\frac{1}{n} = \frac{ZP}{ZP+Zs}$ where $\frac{1}{n}$ is the reduction factor and Zp and Zs the high and low or parallel and series impedance sections of Fig. 7. If two sections are placed in series with identical components, the degree of filtering afforded is given by $\frac{1}{n^2} = \frac{ZP_1}{ZP_1+ZS_1} \cdot \frac{ZP_2}{ZP_2+ZS_2}$. This process can be carried on indefinitely, in which case the degree of filtering will be equal to $\frac{1}{n}$ where x represents the number of sections.

When magnetic fields cannot be tolerated and the current demands are not excessive, the choke can be replaced by a resistor. Since the steady state DV and the ripple voltage are affected equally by such a resistor, it will be obvious that either the current drawn by the load will have to be limited or the value of the resistor will have to be kept as low as possible. Some compensation for a low value R can be had by making C1 and C2 larger in capacity when compared to the original LC configuration. The calculation of the reduction in ripple is complicated by the fact that the resistive and capacitive reactances are 90° out of phase and so we have to use vectors to arrive at an answer. For the curious, $\frac{1}{n}$ is equal to $\frac{\frac{1}{wc}}{\sqrt{R^2+(\frac{1}{wc})^2}}$, though my own crude but effective method is to select R so that not too much voltage is lost and then pile on the capacitors! RC smoothing is free from magnetic fields but can generate much heat if an appreciable current is passed through R, and for this reason is mostly used on high voltage low current applications, such as smoothing out oscilloscope e.h.t. supplies where voltages are in the kV region and currents in the μA or mA region. Resistances are measured in 100kΩ values and capacitors in $\frac{1}{10\text{'s}}$ of a μF.

VOLTAGE DOUBLER

We come now to an application where rectifiers not only provide DV from an AV input, but increase it as well, to twice the input voltage or even higher, but usually at the expense of a reduction in the amount of current that can be drawn from the input. The application concerns the voltage doubling, trebling, quadrupling, etc. configurations, of which the simplest, the doubler, is shown in Fig. 8. The operation of this circuit which rectifies the AV input voltage and increases it by a factor of $2.\sqrt{2}$AV is quite simple, and can be commenced at the moment the input to C1 becomes positive. At this instant MR2 conducts, placing a virtual short across C1 which is charged to a voltage of $\sqrt{2}$AV As the polarity to C1 is changed to negative, MR2 cuts off or does not conduct. MR1 however is "facing" the right way and does conduct. Since C1 has already been charged up by the previous pulse, the output from MR1 will consist of this voltage plus the transformer secondary voltage so that the final charge across C2 is $2.\sqrt{2}$AV. It must be remembered that C1 is charged to the peak value of the AV, not to its RMS value.

The current output from a voltage doubler is limited not only by the transformer and MR1, MR2, but also by the value of C1 and cannot therefore compare with voltage increases obtained by a straightforward voltage step up transformer. The idea can be extended indefinitely but, as would be expected, the increase in voltage is accompanied by a corresponding decrease in current. Assuming 100% efficiency (needless to say this cannot be achieved), the current is halved every time the voltage is doubled, thus keeping the wattage constant.

WATCH CURRENT AND VOLTAGE RATINGS

Although voltage doublers are most commonly employed in providing high voltage low current outputs, such as the e.h.t. supply for an oscilloscope where V is in the 1 to 3kV region and I around a mA, it is possible to use a voltage doubler to supply, say, 450v from the normal mains, at a current ranging from a few mA to 100mA or more. The value of C1 can range between 0·1μF and 1·0μF for the oscilloscope e.h.t., to 100μA or more for the high current power pack. The capacitor used in this position must be rated at least $2.\sqrt{2}$ the input voltage, so that a secondary having an output of 300V RMS would require C1 to have a working voltage of at least 840V. It is not a bad idea to rate all components rather more conservatively than is absolutely necessary, as this improves the safety margin and leads to a longer and more reliable working life for the equipment as a whole. Thus a 1kV component for the previous example would be preferable to the bare minimum of 840V, whilst a 1·5kV component would double the safety margin.

The same remarks apply to the two rectifiers which should have adequate voltage ratings as well as the more obvious current ratings. During its conducting state MR2 has to withstand the full peak voltage applied to it and during its non-conducting state the peak voltage, plus the voltage across C1. During its conducting state, the voltage applied to MR1 is the PK.AV input plus the voltage across C1 and during its non conducting state it has to withstand the PK.AV input until C1 is charged up. Again, the principle of conservative rating is well worth applying.

The design of low voltage power supplies can be carried out along similar lines, as long as we bear in mind that the series impedance as represented by the choke or resistor must have a very low ZF resistance in order to minimise the voltage dropped across it. As a general rule, RC smoothing is uneconomical when applied to low voltage, high current, supplies because the DV dropped across it is "lost" as far as the terminal voltage is concerned. Where such a voltage loss is unacceptable resort must be made to LC smoothing. If the choke is

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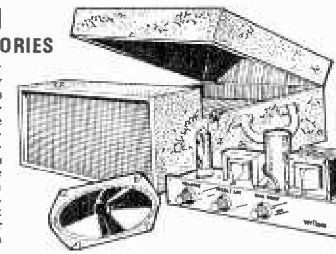

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5¾in. 1,200ft. Long Play	12	6
7in. 1,200ft. Standard	12	6
7in. 1,800ft. Long Play	15	0
TENSILIZED POLYESTER		
3¼in. 600ft. Double Play	11	6
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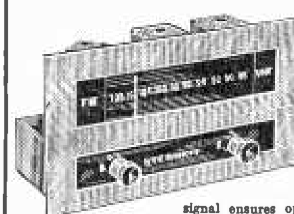

Specially designed for the Amateur builder, a new sensitive tuner unit that provides stable, interference-free reception of BBC FM transmissions. High quality output signal ensures optimum performance from any Hi-Fi audio system; superb styling makes for harmonious installation with existing equipment. Reliable easily aligned circuit employs RF stage, tuned anode tuned grid freq. changer, 2 IF's Noise Limiter and Ratio Detector. Input sens. 100mV for 40 db. Distortion less than 1% at full deviation. Power req. 200v at 20mA and 6.3v at 1.8A. Panel black and silver grey, size 8 × 5in.

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TEST 7 POCKET MULTIMETER

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wound with heavy gauge wire, the ZF resistance can be made negligible whilst still maintaining a high inductive reactance to AV. Capacitances are generally much higher with low voltage supplies, values up to 5000μF are common. The rectifiers used for low voltage supplies are almost without exception of the metal variety, arranged either in a full wave or bridge configuration. The latter has the advantage that there are always two rectifiers in series at *any one instant,* and the maximum inverse voltage across any one rectifier out of a series pair is only half the terminal voltage. This makes it possible to use lower voltage rectifiers having correspondingly higher current ratings than would be possible with the normal full wave or half wave configurations.

REGULATION

The voltage output of a power supply is not fixed, but varies with the current drawn from it, the voltage falling with increasing current, until a limit is reached when no more current can be extracted *even if the output is short circuited to earth.* Since the output terminals of the supply are s/c to earth, it will be obvious that the resistance limiting the flow of current cannot be external to the power supply but must be integral with, or contained within, the power supply itself. This resistance is made up of the resistance of the transformers windings in series with the internal resistance of the valve. Although the overall internal resistance is more of academic than of practical interest, it is worth pursuing a little further because it affects the regulation of the power supply (which is the variation in terminal voltage caused by varying current) and that is one aspect that is of interest to many people, particularly those who are of an experimental turn of mind.

CALCULATING INTERNAL RESISTANCE

The internal resistance of a power supply can be considered as a resistance in series with the terminal voltage and can be calculated by a number of means. The obvious method of short circuiting the output terminals and measuring the flow of current is used for the low voltage batteries but is impractical and possibly destructive when applied to mains powered supplies. In any case it smacks of the "brute force and ignorance" technique and as such need not concern us further.

An alternative and more elegant way is to measure the terminal voltage for any given current drawn, and then measure it again at a different current. If we call the first voltage and current readings E^1 and I^1 and the second voltage and current readings E^2 and I^2, the internal resistance will be given by the simple equation $\frac{E^1}{I} \times \frac{E^2}{I^2} = R$ (internal) where IR is the internal resistance. Let us take an example from a simple power pack the author uses for non critical applications. At a current output of 25mA the terminal voltage is 250V falling to 230V at 60mA. Substituting for E^1 I^1 and E^2 I^2 we have $\frac{250}{25} \times \frac{60}{230}$ or R (internal) = 38Ω, to the nearest round figure.

Yet another method is to measure the open circuit terminal voltage with a low consumption voltmeter and then connect a load into circuit and measure, if possible, the instantaneous change in voltage. The voltmeter must have no overshoot and must respond very quickly if the reading is to have any pretensions to accuracy. In this case R (internal) $= \frac{E^1 - E^2}{E^1} \times RL$ where RL is the external load resistance, and E^1 and E^2 the "before and after" voltages. In my own view the method is inferior (from the amateur's point of view, and excluding professional establishments) to the previous method since it relies on the operator having a very swift—and sure—hand and eye when reading and noting the voltage change, as well as on a suitable voltmeter.

CONSTANT VOLTAGE

If it is essential to maintain the output terminal voltage constant, irrespective of varying current demands, recourse will have to be made to a stabilised or regulated supply. A very simple and crude form of this would be a variable resistor in series with the output voltage which could be manually adjusted to maintain the terminal voltage reasonably constant. Such a device would be wasteful of power since the excess voltage has to be dropped across it, but even more serious is the fact that this device would be useful only if the rate of current change was slow enough to enable human mind and muscle to keep in step with it, quite apart from the fact that some means of indicating the varying voltage (or current) would be required. There is also the tedium of continually adjusting such a resistor to be considered, as well as the fact that human eye, mind and muscle can no longer be able to keep up with the rate of change should it become excessively fast.

A comparatively simple, but more effective and completely automatic means of maintaining a reasonably constant output voltage can be provided by a gas filled diode in series with a resistor, with the input applied across both and the output extracted across the neon Fig. 9a. If the unstabilised input voltage increases, the diode passes more current whilst the resulting voltage increase is dropped across R1. If the current output increases, the diode passes correspondingly less current, thus maintaining a reasonably constant output voltage.

There are a number of inherent disadvantages. The output voltage is fixed and cannot be varied, except by substituting another diode having a different working voltage. The maximum working voltage of a single diode is only about 150V (VR150/30 diode) though this can be increased by connecting a number of diodes in series, in which case parallel, voltage equalising resistors, across each diode are desirable, rather in the fashion of series connected rectifiers. The working voltage is usually lower than the igniting voltage, about 115V with a working voltage of 85V, so that sufficient voltage

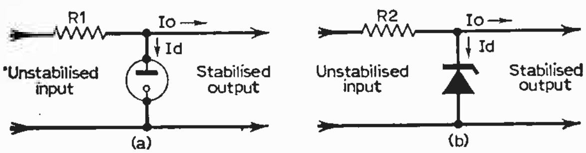

Fig. 9: Simple stabilisers: (a) thermionic or gas filled device; (b) Zener diode.

must be available, though this is not usually a serious matter. The lowest working voltage is in the region of 55V (Ferranti G55/1K diode) and there is no way of countering this. Finally, the range of control is somewhat limited by the minimum and maximum currents the diode can pass. Exceeding the maximum life will seriously impair the diode's working life and efficiency, whilst the effect of under running the diode will again impair its efficiency. If, as is common practice, the diode is decoupled by a capacitor, the effect of current starvation will probably cause the pair to act as a relaxation oscillator. A popular reference diode is the Mullard 85A2 with a working voltage of 85V and min. and max. currents of 1mA and 10mA respectively, between which the voltage change is 3V from the nominal. If the voltage change is to be kept within very close limits the current through the diode must be also closely maintained. For instance, at a steady tube current of 6mA. The voltage will remain constant with 0·5% for the whole of its working life.

LOW VOLTAGE STABILISATION

For the stabilisation of low voltages use can be made of Zener diodes. These are operated the "wrong way round", beyond the breakdown point, so that they pass very little current until the breakdown point is reached, after which they conduct heavily. Unlike gas diodes, Zeners do not require a higher igniting voltage, their igniting and working voltages are one and the same. In other respects, they can be dealt with in a similar manner to the gas filled diodes by selecting the series resistor to pass the appropriate current through the Zener and extracting the stabilised output from across it. Like gas filled diodes they do not permit any voltage variation, though a number can be connected in series.

It is possible to increase the regulated current output from both the gas filled diode and the Zener diode by replacing the former with a valve cathode follower and the latter by a transistor emitter follower. The stabilisation ratio, however, is comparatively low, commonly less than a factor of 10, with an output impedance in the case of the valve cathode follower of $\frac{1}{gm}$. The stabilisation factor can be increased greatly, by as much as several thousand times, and the output impedance reduced to less than an ohm by interposing a high gain error amplifier between the reference voltage and the output voltage variation. The differences between the two voltages are then amplified, and fed into the grid of the cathode follower valve, or, in the case of the transistor emitter follower, into the base. Fig. 10 illustrates the basic valve regulator in which V1 is the series cathode follower or regulator valve, V2 is the high gain error amplifier and V3 the reference voltage diode. The operation of the circuit is quite simple and is as follows. The voltage across V1 controls the terminal or output voltage and is itself controlled by the negative grid bias derived from R1 which is the anode load of the error amplifier V2. The cathode of V2 is held at a constant potential by the voltage across the reference diode V3. The grid bias for V2 is derived from a potentiometer across the output voltage and is variable about the cathode potential. As the wiper of the potentiometer is rotated towards R3 the grid is made more negative than the cathode with a corresponding decrease in the anode current. A decrease in anode current is accompanied by a decrease in the voltage dropped across R1 which is passed to the grid of V1 as a positive bias voltage which causes the valve to pass an increased voltage. Conversely as the wiper is rotated towards R2 the grid of V2 is made more positive with respect to cathode, the valve passes more current, and the voltage dropped across R1 increases. The decrease in V2 anode voltage is passed to V1 grid as a negative bias voltage which causes the anode current to fall. Thus we can arrange for the terminal voltage to be varied within moderately wide limits.

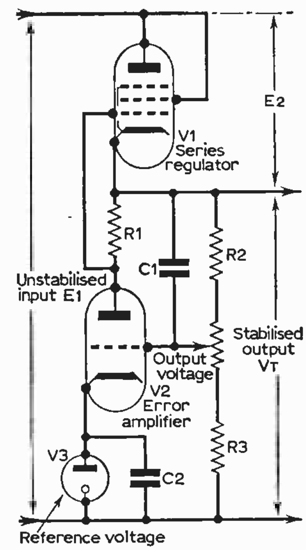

Fig. 10: Basic stabiliser circuit.

VARYING CURRENT DEMANDS

The variation of terminal voltage with varying current demands is compensated for in a similar manner. Suppose that from a state of no load, the power supply is called upon to supply a sudden load. The terminal voltage will begin to fall, and a portion of the voltage change will be passed to the grid of V2 via the potentiometer. The valves bias will undergo a change as already described, resulting in a changed bias for V2 which will therefore pass an increased current to compensate for the sudden load. And, of course, the reverse will apply if a load is suddenly disconnected from circuit.

Since the circuit operates by amplifying changes in the output voltage, it will become apparent that this output voltage is continually varying, and that 100% regulation is never realised. If we call the voltage applied to the regulator valve E1 and the voltage dropped across the regulator valve E2 and the terminal voltage VT, the gain of the error amplifier n, we can calculate the correction voltage

—continued on page 690

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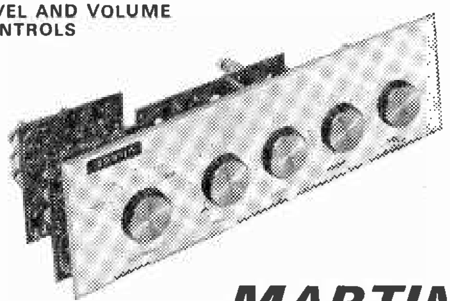

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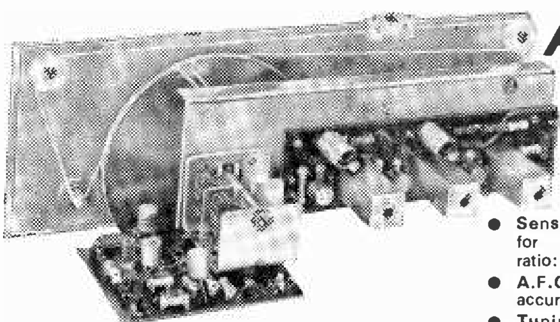

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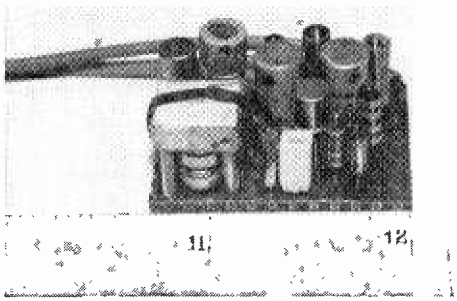


by F. L. THURSTON

ONE of the major disadvantages of the crystal microphone is that, if it is to give good reproduction at the lower audio frequencies without undue loss of signal strength, it must feed into a very high impedance load, preferably in the order of several megohms. At these high impedances, feeder lines, from the microphone to the amplifier, are very prone to stray signal "pick up" from unwanted sources, such as the mains, etc. To overcome this trouble, it is normal practice to use screened cable as the feeder, but, even so, trouble is still experienced, and the feeder lines have to be kept reasonably short, and the versatility of the crystal microphone is thus restricted.

If a low impedance load and feeder line can be used, however, very little trouble with unwanted pick up will be experienced, and very long cables can be used. Thus, one way of overcoming the disadvantage of the conventional crystal microphone is to build an impedance converter into the feeder line, preferably as near as possible to the crystal microphone, or, better still, in the actual microphone case. In this latter instance, the converter must be complete with batteries and on/off switch, and the whole unit must be exceptionally compact. The unit that forms the basis of this article meets this requirement very well.

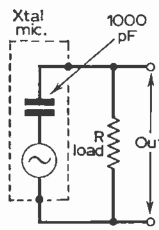
This unit, shown in the photograph against a half-crown for size comparison, is complete with three miniature batteries and an on/off switch, but measures a mere $1\frac{1}{4}$in. x $\frac{7}{8}$in. x $\frac{5}{8}$in., giving a volume of less than 0·7 cubic inches! A three transistor circuit is used, and the unit gives an input impedance of approximately 8MΩ.

Circuit Theory

As shown in Fig. 1, the equivalent circuit of a crystal microphone can be shown as a voltage generator in series with a small capacitance, usually in the order of 1,000pF. When the microphone is connected to a resistive external load, the resistance and this capacitor are effectively in series, and thus act as a potential divider network, but, as one arm of this potential divider is reactive, the attenuation factor will vary with frequency, being greatest at the low end of the frequency spectrum. To give a reasonably linear response over the entire audio band, therefore, the impedance of the external load must be kept high, relative to the output impedance of the crystal microphone, at all operating frequencies. In practice, this means that the input impedance of the external load must be very high, in the order of 5MΩ or greater.

Having cleared up this point, we can now consider the means of obtaining this high impedance. Quite clearly, because of size limitations, transistor circuitry must be used; unfortunately, however, the transistor is basically a low impedance device.

The most basic way of obtaining a reasonably high input impedance, using transistors, is to employ the emitter follower mode of operation, as shown in Fig. 2a. Here, the input is applied to the base of the transistor, and the output is taken from the emitter; R1 is simply a base-bias resistor, while R2 forms the emitter load. The input impedance of this circuit is equal to the emitter load, R2,



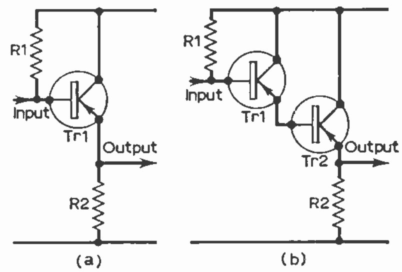


Fig. 1 (left): Equivalent circuit of crystal microphone feeding a resistive load.
Fig. 2a (centre): Emitter-follower circuit for high input impedance.
Fig. 2b (right): Super-Alpha pair for very high input impedances.

multiplied by the current gain of the transistor. Thus, with $R2 = 10k\Omega$, and current gain$=100$, an input impedance 1 MΩ may be achieved.

In practice, the value of the emitter load has to be kept within reasonable limits, and the actual current gains of transistors are rarely greater than a few hundred, so that impedances of greater than a couple of megohms can rarely be obtained with this type of circuit. If greater impedances than this are required, the effective current gain of the transistor must be increased by artificial means, and the most popular way of doing this is shown in Fig. 2b.

Super-Alpha Pair

Here, two transistors are used, with the base of one connected directly with the emitter of the other, and the two collectors joined together. The resulting assembly forms a three terminal network, and can be regarded as a single transistor in which the effective current gain is the product of the two individual transistor gains, i.e., if both transistors have gains of 100, the effective gain of the pair is equal to 10,000. Because of the very high current gain that is obtained with this connection, the circuit is often known as the "Super-Alpha Pair". The only real snag with both the emitter follower and the Super-Alpha pair is that the voltage gain of each circuit is very slightly less than 1; the power gain, however, is high.

In the two circuits that have been discussed so far, "ideal" conditions have been assumed as far as the input impedances are concerned, so as not to confuse the issues too much. In practice, of course, conditions are far from ideal, and matters are complicated by such details as the need for base-biasing networks, leakage impedances of the transistors, etc. These difficulties are made clear in Fig. 3a, which shows the effective input circuit of a practical emitter follower of Super-Alpha pair.

Here, Z_T = the transistors input impedance as calculated by the simple formula outlined above; unfortunately, this impedance is shunted by Z_B, the impedance of the base-bias network, and also by

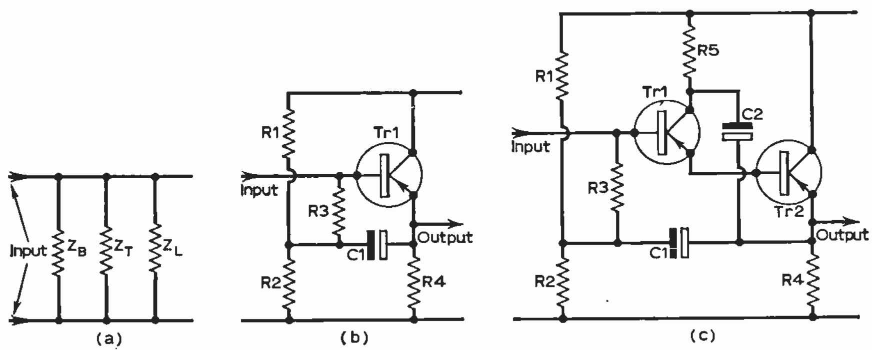


Fig. 3a: The effective input circuit of an emitter follower.
Fig. 3b: "Bootstrapping", applied to the base-bias network.
Fig. 3c: "Bootstrapping", applied to both Z_B and Z_L.

the internal leakage impedance, Z_L, of the actual transistor. Thus, the actual input impedance to the transistor input is equal to the value of all three individual impedances in parallel. To obtain really high input impedances, therefore, it is necessary to eliminate the effects of Z_B and Z_L.

Dealing first with Z_B, the method of overcoming the unwanted shunting effect of the base-bias network is shown in Fig. 3b. Here, the method is shown applied to an emitter follower circuit, although it can be applied equally well to the Super-Alpha pair. R1 and R2 are the base-bias resistors, using the potential divider method of bias, and R3 is an isolating resistor interposed between the R1-R2 junction and the base of the transistor. The signal input is applied directly to Tr1 base. The output of the circuit is taken from across R4, the emitter load.

Circuit Action

When an input signal is applied to Tr1 base, the output signal appears at the emitter in the same phase and at almost the same amplitude, so that, for practical purposes, it can be accepted that the two signals are identical in form. In Fig. 3b, the signal from Tr1 emitter is fed, via the large capacitor, C1, to the junction of R1 and R2; thus, the same a.c. signal appears at each end of the isolating resistor, R3, and no a.c. current flows in that resistor. It follows that since no current flows in R3 as the result of the applied a.c. signal, that resistor must represent an infinitely large impedance to a.c., although to d.c. it appears as its normal value, and the shunting effect of Z_B is effectively overcome.

In practice, the isolating resistor will not appear as an infinitely large impedance, as the voltage gain of the emitter follower is slightly less than one. The impedance of the resistor is, however, increased by a substantial amount, and if, for example, the voltage gain of the emitter follower is 0·99 and the value of R3=100kΩ, the effective impedance of R3 will equal 10MΩ, i.e., its effective value is increased by 100 times. This technique of increasing the apparent impedance of a component is known as "Bootstrapping".

A similar "Bootstrap" technique can be used to overcome the shunting effect of the leakage impedance, Z_L, as shown in Fig. 3c. Here, the effect of leakage is minimised by ensuring that, as far as a.c. is concerned, there is no voltage difference between the collector of Tr1 and the emitter of Tr2, and an infinite impedance is thus represented between these two points. This is achieved by connecting resistor R5 between the collector of Tr1 and the negative supply line, and feeding the a.c. signal from the emitter of Tr2 to Tr1 collector via capacitor C2. In this case, of

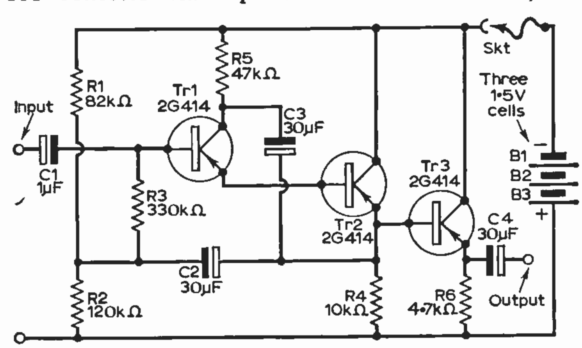


Fig. 4a: Circuit diagram of the complete unit. See text and Fig. 4c for details of Skt and battery holder.

course, the leakage impedance is normally high (in the order of a couple of Megohms) even without bootstrapping, so that effective leakage impedances in the order of hundreds of megohms can be obtained with little difficulty. In Fig. 3c the base-bias network is also shown Bootstrapped, and a super-alpha pair is used, so that the effective input impedance is virtually that obtained from the simple "emitter load x current gain" formula.

The Circuit

The circuit diagram of the sub-miniature high impedance amplifier is shown in Fig 4a, and con-

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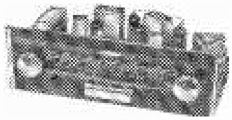
A ready built and aligned factory Unit 6 transistor plus 5 diodes designed to connoisseur standards. Size 4½" x 3" ready for connecting to existing transistor tuner Multiplex O/P. 12v—18v supply. Full technical specification details S.A.E.
Price £9.10.0, plus 3/6 carriage.

SINCLAIR KITS

We are Specialists, we carry full stocks of these world-famous all-British designs as advertised and give prompt delivery.

MICRO-6 six stage vest-pocket rcvr. (kit)	59/6
MICRO-FM seven transistor FM tuner-rcvr. (kit)	£5.19.6
Z.12 combined 12w. amp. and pre-amp. built	89/6
STEREO 25 de luxe pre-amp/control unit (stereo) built	£9.19.6

6 VALVE AM/FM TUNER UNIT



Med. 190 m., 550 m., V.H.F.—86 Mc/s-103 Mc/s., 6 valves and metal rectifier. Self-contained power unit. Magic-eye, 3 push-button controls, on/off, Med., VHF. Diodes and high output sockets with gain control. Illuminated 2-colour perspex dial 11¼ x 4in., chassis size 11½in. x 4in. x 5¾in. Strongly recommended for use with Mullard amplifiers below. For A.C. mains 200/250 v. **Unbeatable value.** Complete kit, inc. Power Pack as illustrated, 11 gns. Carr. 7/6. Ditto less Power Pack 10 gns. Carr. 7/6. Circuit and Const. details 4/6. Free with kit.

MULLARD "3-3" & "5-10" HI-FI AMPLIFIERS
3 OHM AND 15 OHM OUTPUT

"3-3" Amp. 3-valve Hi-Fi quality at reasonable cost. Bass Boost and Treble controls, quality sectional output transformer. 40 c/s-25 kc/s ± 1 dB. 100 mV. for 3W, less than 1% distortion. Bronze escutcheon panel. Complete Kit only £7.10.0. Carr. 7/6. Wired and tested, £9.10.0.

MULLARD "5-10" AMPLIFIER—5 valves 10W, 3 and 15 ohms output. Mullard's famous circuit with heavy duty ultra-linear quality output tfr. Basic amplifier kit price £9.19.6. Carr. 7/6. Ready built 11½ gns.

2-VALVE PRE-AMP. UNIT. Based on Mullard's famous 2-valve (2 x EF86) circuit with full equalisation with volume, bass, treble, and 5-position selector switch. Size 9in. x 6in. x 2½in. Complete kit £6.12.6. Ready built £8.10.0. Carr. 5/6.

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TRS RADIO COMPONENT SPECIALISTS
Established 1946

70 BRIGSTOCK ROAD, THORNTON HEATH, SURREY
Tel.: THO 2188 Hours 9 a.m.—6 p.m. 1 p.m. Wednesdays

sists of Tr1 and Tr2 wired as a super-alpha pair, with the base-bias network R1-R2 Bootstrapped via C2, and the leakage impedance Bootstrapped via R5 and C3. To prevent the emitter resistor, R4, from being shunted by an external load, an additional emitter follower is interposed between Tr2 emitter and the output of the unit, this emitter follower, Tr3, having its base direct coupled to Tr2 emitter. The input impedance measured on the prototype was 8MΩ.

Construction

The constructional details of the unit are made clear in Fig. 4b and in the photograph. Being so compact, the unit is somewhat "fiddly" to build, and construction is thus best carried out "by numbers", as follows:—

(1). Cut the Veroboard panel to size and break the copper strips as shown, using either a small drill or the special tool that is available for the job. Now drill the two 1/16th inch diameter holes, as indicated. Note that this Veroboard uses 0·1in. hole spacing, which is a far smaller matrix than that normally used. In the case of difficulty, this size of Veroboard can be obtained from the address shown in the components list.

(2). Solder the shorting link in place from 7H to 7E, using sleeved wire. Solder R2 in place between 8A and 8F, with the resistor flush on the face of the panel.

(3). Now solder the remaining components in place, mounting them all vertically and as close to the panel as possible, in the following order: C3, Tr1, R4, C2, C1, R5, R1, R3, R6, Tr2, Tr3 and C4.

(4). Take a Radio Spares 3-pin transistor holder and carefully modify it as shown in the inset, cutting away the body with the aid of a fret saw and file until only a single socket remains, then solder it in place in hole 6H on the Veroboard panel. This socket, in conjunction with a lead from the battery supply, then acts as an on/off switch.

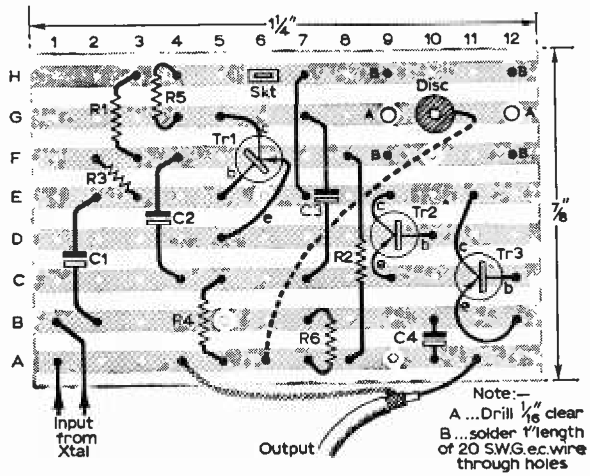

Fig. 4b: Wiring details of the Veroboard. Care should be taken when soldering transistors directly in circuit.

(5). Take four 1in. lengths of 20 s.w.g. enamelled copper wire and, after baring ⅛in. of one end, solder one wire into each of the following holes, keeping the wire vertical; 9F, 9H, 12F and 12H. Now cover these wires, except the one in hole 12F, with sleeving, and temporarily fit the three sub-miniature 1½ volt cells in place in the resulting "cage", and cut off the top of the 4 wires just below the top of the upper cell. Now remove the three cells from the cage.

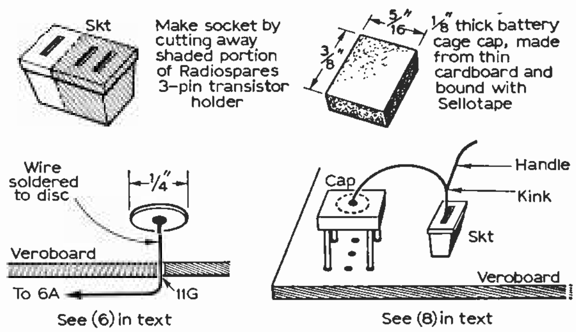

Fig. 4c: Details of battery "cage" and switch. The transistor holder (top right) is cut to resemble the miniature switch Skt (bottom left). See text for full details.

(6). Take a small piece of tin or copper sheet, and cut it into a disc a little less than ¼in. diameter. On the prototype, a piece of metal strip taken from the inside of a PP3 battery was used. Solder the disc to a length of fine gauge sleeved copper wire, and thread the wire through hole 11G in the Veroboard, with the disc on the component side of the panel; apply a dab of Bostik to the underside of the disc and then glue it in place on the panel. Take the free end of the wire and solder it in hole 6A.

(7). Make the battery cage cap from thin cardboard, in the form of a 4-sided tray, as shown in the inset, first cutting and folding the cap and then binding it in shape with Selotape. The cap should be a close fit over the top of the cage.

(8). Cut a small disc from sheet tin, etc., the disc being slightly over ⅛in. diameter, and solder it to a length of fine copper wire. Make a small hole in the top of the cardboard cap with a pin, and thread the wire through the hole, with the disc on the inside of the cap. Apply a drop of Bostic to the underside of the disc and glue it in place on the cap, taking great care not to smear the face of the disc, which acts as the negative battery contact, with glue. Take the free length of wire and bend it as shown, the 'kink' fitting into the socket of the modified transistor holder and thus acting as an on/off switch.

(9). With the cap in place on top of the cage, thread a length of rubber band through the two 1/16th holes in the Veroboard panel and hook the band over the cap; from the underside of the panel, pull the elastic band reasonably tight and tie the two ends into a knot, thereby ensuring that the cap is held firmly in contact with the batteries.

(10). Remove the cap and fit the three batteries in place, one on top of the other and with the negative terminals uppermost. Now replace the cap and secure it in place with the rubber band. Solder the units output lead with its core to hole 11A and its screen to hole 4A. Connect the crystal microphone between holes 1A and 1B. Now connect the lead from the battery cap into the small socket, and carry out a simple functional test of the unit. The unit is now ready for use, and can be fitted into the microphone case, where it can be secured in place either with adhesive or with cotton-wool packing.

It may be noted that, for the sake of miniaturisation, 2G414 type transistors have been used in making the unit, and these happen to be v.h.f. types. Because of this, the unit will give a linear frequency response up to a couple of Megacycles, and thus makes a very useful high impedance buffer for use with test equipment, etc., where signal levels are less than approx 2 volts peak-to-peak. The input impedance of the unit is, of course, much higher than that of most 'scopes, V.T.V.M.'s, etc. ■

★ components list

Resistors:

R1 82kΩ
R2 120kΩ
R3 330kΩ
R4 10kΩ
R5 47kΩ
R6 4·7kΩ
all ⅛ watt. carbon

Capacitors:

C1 1μF, C2 30μF, C3 30μF, C4 30μF — sub-miniature electrolytics 6V wkg.

Semiconductors:

Tr1 2G414, Tr2 2G414, Tr3 2G414 — (Texas)

Miscellaneous:

Veroboard with 0·1in. hole spacing, transistor holder 3-pin (Radio Spares). 3 Mercury cells type 312, wire, sleeving, etc.

Note.—In case of difficulty, all components may be obtained from Newbury Radio (Forest Gate) Ltd., 274 Romford Road, Forest Gate, London, E.7.

POWER SUPPLIES

—*continued from page 682*

that will oppose the variation in VT. This will be equal to n.VT, whilst VT = E1 − E2 = E1 (1 + n) $\simeq \frac{E1}{n}$ since the gain of the error amplifier n is considerably greater than unity. This is really another way of saying that any mains input variations together with the ripple voltage remaining after initial smoothing are reduced by a factor of $\frac{1}{n}$.

In a well designed circuit, the output impedance at ZF will be under one ohm, with ripple voltages of only a few mV and output variation of 1% or better between no load and full load conditions for a mains input variation of up to 15%.

Up to now we have ignored the two capacitors in Fig. 10. C from the output voltage to the grid of V2 serves to feed back any ripple voltages or signal voltages that may be flowing into the power supply from equipment being run from it. These are therefore subject to the same degree of attenuation as are the surge voltages caused by the switching on or off of external loads. Typical values are from 0·1μF to 0·5μF.

Capacitor C2 across the neon serves to short circuit the internally generated noise that all neons are subject to, to varying degrees. A point to watch is that the neon is not suffering from current starvation, as it very easily can if R1 is made very high in value in an attempt to increase the gain of the error amplifier. A current starved neon and a capacitor in parallel could very easily act as a relaxation oscillator, thereby defeating the very object of including the capacitor. A very common dodge is to feed the neon with current by means of a resistor from the unstabilised h.t. line.

TRANSISTOR ERROR AMPLIFIERS

Low voltage power supplies utilise transistors for the error amplifier and series emitter follower regulator with a Zener diode for the reference voltage. The principle of operation is exactly the same as for valve stabilisers. Although the basic circuitry is quite simple it is possible that the ultimate circuit will be considerably more complex. The single series regulator valve of Fig. 10 can be replaced by a number of valves in parallel to increase the current capacity of the supply and the triode error amplifier can be replaced by a single pentode or a twin triode arranged as a cascode amplifier. This is often adopted because a single triode is incapable of supplying the large amplification factor necessary for adequate stabilisation. The voltage gain of a pentode is greater than a triode but the internal noise level is also greater so that what one gains on the swings one loses on the roundabouts. A circuit that can supply a very high gain with a low internal noise level is the cascode where two triodes are used, one acting as the anode load of the second.

CONTINUED NEXT MONTH

'Q' MULTIPLIER

We have been informed by Electroniques that the reference given for L1 in the components list for the 'Q' multiplier for the R1155 is incorrect. The correct part number is QL4 and the price is 7s. 6d., plus postage. Since Electroniques has been acquired by Standard Telephones and Cables Ltd., sales enquiries should be sent to the Sales Office, Edinburgh Way, Harlow, Essex.

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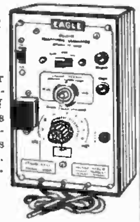
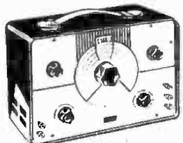


TT.144 DYNAMIC TRANSISTOR TESTER
Tests in-circuit or out of circuit. Identifies PNP and NPN types. Indicates electrode open circuits, short circuits and current drain. Complete with instructions,
£4.10.0

TT.145 DE-LUXE TRANSISTOR DIODE TESTER **£9.7.6**

MULTI METERS

T.20A 1,000 o.p.v.	£2.15.6
TK.25 1,000 o.p.v.	£2.15.6
EP.10K 10,000 o.p.v.	£4.17.6
EP.10KN 10,000 o.p.v.	£5.8.0
EP.20K 20,000 o.p.v.	£5.19.6
EP.20KS 20,000 o.p.v.	£6.8.0
EP.30K 30,000 o.p.v.	£7.19.6
EP.30KN 30,000 o.p.v.	£9.0.0
EP.50KN 50,000 o.p.v.	£11.19.6
EP.100KN 100,000 o.p.v.	£14.19.6



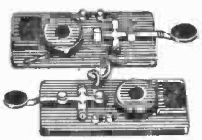
TE-188. RF SIGNAL GENERATOR
A stable wide range signal generator with a range of 120 Kc/s–260Mc/s on 6 bands. Features a large 4½in. vernier tuned, etched circular dial for easy accurate frequency adjustments. Complete with instructions. **£20.15.0**

TE190. SINE SQUARE WAVE AUDIO GENERATOR
SINE WAVE: 20–200,000 cps in four bands.
SQUARE WAVE: 60–30,000 cps. Input impedance 0–5,000 ohms. Especially designed for HI-FI Radio and TV Service men who require a dependable instrument. **£21.19.6**

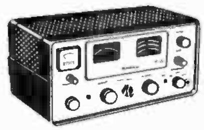
LA9P. AC ELIMINATOR
with a double wound step down transformer to operate 9v Radios, etc., from AC Mains. **£1.8.6**

FSW1. FOOT SWITCH

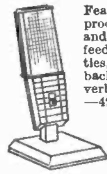
Snap action foot switch with skid proof rubber base pad. Plugs into your Tape Recorder remote control system but special adaptor supplied enables this to be used with all other Tape Recorders. **24/-**



MCK.2. MORSE CODE KIT
Two station morse code kit supplied with instructions, 50ft. of connection wire and morse code charts. **£2.2.0**



SR165. ALL BAND COMMUNICATION RECEIVER
This entirely new professional type communication receiver features frequency coverage of 535 Kc/s–30 Mc/s for complete general coverage. In particular ham bands are arranged in the same calibration scale, so that the band switching can be accomplished rapidly. **£48.0.0**



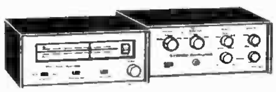
UD40H CARDOID DYNAMIC MICROPHONE
Features a pop-proof diaphragm and superior anti feed-back properties, reduces feed-back and room reverberation. O/p: —42 db. Response: 60–12,000 cps; 50K ohm impedance £6.6.

DM31C. CARDOID DYNAMIC MICROPHONE
Superb quality with ball head for distributed cardoid front-al pick-up. Output: —52db. Response: 40–13,000 cps. Impedance 50k ohm.
£7.7.0.

DM24HL
A goose-neck dual impedance microphone 600 ohm – 50K ohm. Response: 50–11,000 cps.
£6.6.0.

27 other microphones available.

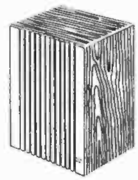
EAGLE SA100. 10W INTEGRATED STEREO AMPLIFIER



A compact, versatile integrated unit for monaural or stereophonic reproduction from record player, tape recorder and tuner. Power output 5 watts per channel. Frequency response 40–20,000 c.p.s.
£18.0.0

EAGLE AFM100. AM-FM TUNER
Combines a host of advanced features that easily make it the finest AM-FM tuner in its class. A tuned RF stage on FM, AFC circuit and a heavy flywheel giving smooth but effortless tuning, built in AM Ferrite aerial. FM.88–108Mc. AM 535–1605 K/s. **£29.0.0**

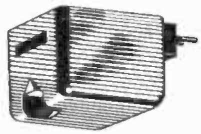
MS80. 20W ROSEWOOD SPEAKER SYSTEM



The perfect answer for the music lover who wants full range fidelity in a compact system. Features an 8in. full range high compliance speaker with an output capacity of 20 watts RMS. Frequency response: 30–20,000 c.p.s. Resonant frequency: 30–40 c.p.s. Sensitivity: 97 db/w. Flux density: Over 12,000. Impedance: 16 ohm. Size 14½in. high x 10⁵/₁₆in. wide x 8in. deep. **£14.14.0**

As well as this beautifully designed speaker there are two other models MS65. 10 watts RMS at £12.12.0 and MS40 5 watts RMS £8.10.0.
All three speakers are finished in magnificent rosewood and the entire cabinet filled with acoustic damping material.

EAGLE PRODUCTS
MAGNETIC STEREO CARTRIDGES

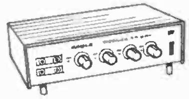


M1007G GOLD
Response: 20-20,000 cps
Output: 5MV at 1Kc/5cm/Sec.
Stylus: 0.5 Mil diamond
Tracking Pressure 1–2.5 grams.
£6.12.6

M1007F. SILVER
Response: 20-18,000 cps
Output: 10MV at 1Kc/5cm/Sec.
Stylus: 0.7 Mil diamond
Tracking Pressure 2–4 grams.
£5.14.6

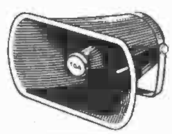
Both feature singularly smooth reproduction and incisive separation of stereo channels

ALL TRANSISTOR PUBLIC ADDRESS AMPLIFIERS



Two new models offering the last word in P.A. amplification. All transistorised circuit, negative feedback circuit reduces distortion to a minimum. Two mike inputs high and low with individual controls. Plus inputs for TAPE, TUNER and RECORD PLAYER.
PA540 35 Watts **£36.0.0**
PA541 50 Watts **£56.0.0**
Other P.A. models available.

SC10F. RECTANGULAR REFLEX HORN SPEAKER



An outstanding combination of reflex horn and driver unit for car mounting, to deliver wide angle high quality reproduction. Weatherproof, waterproof and shockproof. Output 10 watts. **£7.15.0**

Also available SC5F: 5 watts, £4.2.6 and SC15F: 15 watts £14.12.6.

FOR FULL DETAILS OF THESE AND MANY OTHER ITEMS SEND FOR FREE COMPREHENSIVE CATALOGUE, EAGLE NEWS AND ORDER FORM. ALL ITEMS AVAILABLE POST FREE AND COVERED BY 12 MONTHS' GUARANTEE.

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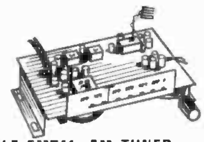
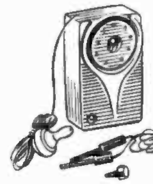
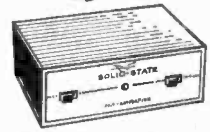


EAGLE FMT41. FM TUNER
Sub-miniature 6 transistor 3 diode F.M. Tuner. Covers 88-108 Mc. Operates from 9-volt battery, micro miniature circuit giving brilliant FM reception. Ready to use, simply connect to your Hi Fi amplifier. Instructions supplied.
£8.10.0

EG304
Sub-miniature 3 watt transistorised push-pull radio amplifier on printed circuit. Ideal unit for Intercoms, Baby Alarms, Radio Tuners, etc. Complete with circuit and instructions. **£3.12.6**
Also available EG104. One Watt **£3.2.6**
and EG2004 250 mW **£2.5.0**



CSK.10
Self-powered crystal set kit with private earphone. Supplied complete with instructions.
18/6



ALL TRANSISTOR MONO & STEREO PRE AMPLIFIERS
Provide extra stage of amplification for use with magnetic cartridges, tape and microphone inputs. Both models feature wide band pass range, 20-20,000 cps.
PRE 301 MONO £4.12.6
PRE 302 STEREO £5.15.0

WI-2. TRANSISTORISED WIRELESS INTERCOM
No wires, no installation needed, simply plug them into AC power point and talk. Units have press-to-talk lock switch and on-off volume control. Ideal Intercom or Baby Alarm for home, office, factory. **£14.12.0** Complete.

DP303. DOOR PHONE INTERCOM
Ultra sensitive transistorized intercom designed so that you may answer the door from within for greater convenience and safety.
£4.12.6 Other intercoms available.

WIRELESS MICROPHONES

WM909 (as illustrated) Pocket FM Wireless transmitter complete with tie-pin microphone. Transmits clearly up to 100 yds. and is fully tunable over the entire FM band. Simply used with an FM radio or tuner. **£14.0.0**
Also available WM808 **£21.0.0**
Professional stick type FM Wireless Microphone. These cannot be operated in U.K.

RELDA RADIO LTD
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87 Tottenham Court Road, London, W.1.

CLUB SPOT

No. 13 PETERBOROUGH AMATEUR RADIO SOCIETY

RADIO Clubs are noted for having their headquarters in somewhat peculiar premises, but perhaps the Peterborough & District Amateur Radio Society is the only one in the world to have its "home" in a 100-year-old windmill.

Visitors are always welcome on Club nights (Fridays) at the mill, which is behind the Peacock Inn on the London Road, and they will see the Club's own station G3DQW in operation—on all bands from Top to Two.

There is a 200 feet long-wire aerial for the high-frequency bands, whilst for 146Mc/s, an 8-over-8 slot-fed beam is mounted high above the mill, well over 70 feet from the ground, and free from all man-made static.

The mast goes right down through three floors to the shack, and is rotated bodily by the hand-draulic or "Armstrong" method—two brawny members pull on a car steering wheel, and set the beam accurately in any direction by watching compass-bearings painted on the floor . . . Rather unusual, yes, but it works well—as the many v.h.f. contacts from '3DQW will confirm!

The gear includes a mint HRO senior, which was kindly donated to the Club, and a CR100 and LG50 as well as much other equipment loaned by various members.

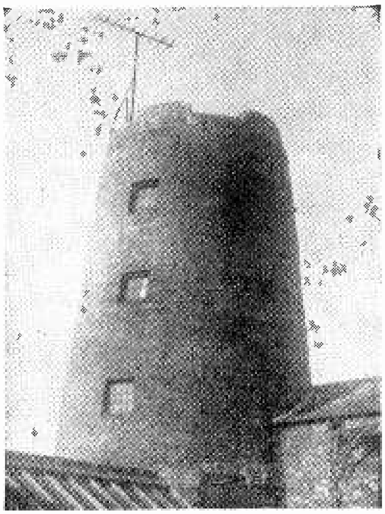
Latest interest is in Amateur Television, and junior members are busy building a multi-element array for 420Mc/s—cutting down old TV aerials.

Well-situated from every point of view, the Mill is only a few minutes' walking distance from the centre of Peterborough, near the bus station, and next to a large car park. It is immediately behind a public house, and only a stone's-throw from the Posh football ground—in fact, members can have a free grandstand view from the top of the mill.

The Peterborough A.R.S. is also unique in having its own private riverside site on the banks of the Nene, with plenty of mooring space for boats, grassy banks for picnicing, and a boat-house, changing-room and even a power-house. A large punt and a small rowing-boat have been given to the Club. Members can swim, sunbathe, or picnic to their heart's content, and the site makes an ideal venue for barbecues and Field Days—there's no t.v.i.

During the summer months, members spend weekends camping by the river, as well as taking part in both National Field Day and v.h.f. Field Day. Direction-finding contests are organised, and a "Bucket and Spade" party was held at Hunstanton for several summers.

For the past two years, a Mobile Rally has been



The Club house is an old windmill. The fact that it is next to a pub is pure coincidence. On the right is the Club station G3DQW. On the key G3HXR, logging G3KPO.

run at Peterborough on August Bank Holiday, attracting hundreds of visitors from all over the East Midlands. A popular feature this August was a free trip down the river by motor launch—repeated over and over again, with Jack and Leslie at the helm.

During the winter months, lectures and demonstrations are held at Peterborough Technical College, where the Society members are granted every facility — including the use of the electronics laboratory, lecture hall and cinema for technical film shows.

An eighty-metre dipole aerial has been erected by members above the College, which holds its own transmitting licence and callsign composed of its initials—G3PTC. Demonstrations of the latest amateur and professional radio equipment have been given at regular intervals, including those on single sideband transceivers, teleprinters, radio-astronomy, direction finding, and amateur television.

Classes for the Radio Amateur Examination are held annually, and this winter G3KPO has 17 in the class—by a coincidence, the same number as last winter. Incidentally, one of that class, Colin Whyles, is already "on the air" as G3VRS.

[Congratulations, Colin—Ed.]

The Society endeavours to provide "something for everyone", from veteran old-timer to youngest shortwave listener. This is borne out by the number of visits which have been paid to local places of interest, such as the electricity generating station, the automatic telephone exchange, and the local

Making a 420 Mc/s beam for amateur TV work. Enthusiasts left to right are Michael Bond, Bill Yeomans, Mervyn Carver, and Barry Ellery

television transmitting station.

Club junk sales have also been very popular, as well as the bulk purchase of ex-government surplus radar equipment. A quantity of this was stripped down into individual components by the members, and re-distributed in handy plastic bags.

The present Peterborough A.R.S. began in quite a small way in March 1960, when a few enthusiasts gathered one evening at the home of the Hon. secretary and decided to go ahead with its formation. From the outset, every assistance was given by the principal and staff of the Technical College, and this proved a tremendous advantage to the Club.

Its chairman is "Gus", Mr. C. J. Guscott G3HXR, and vice-chairman Ted Barnes G2BYI, whilst the "Hon. sec." is Douglas Byrne, G3KPO, who is also Area Representative of the RSGB. Incidentally, Douglas is endeavouring to get together a "Radio Museum" of old wireless gear, books and magazines from the twenties or early thirties, and would appreciate a postcard from any reader who could help. His address is—"Jersey House", Eye, Peterborough.

At this summer's three-day Agricultural Show at Peterborough, the Club were invited to operate a Transmitting Station—and put GB3PAS on the air, using a Swan 350 and KW2000 as well as a.m. gear, A Mosley tri-band beam was erected on an iron tower specially constructed for the show by s.w.l. Jack Warrington and Leslie Critchley, G3EEL. As might have been expected, contact was established with all parts of the globe—and thousands saw "amateur radio" in operation for the first time. The inclement weather was no handicap—for the station was snug and dry in a large wooden garage, loaned by a local firm.

After lengthy negotiations by the Society's officials, who pointed out the great publicity value of amateur radio, the Town Council agreed to supply local radio amateurs with QSL cards free of charge, as well as for Club use with G3DQW and in connection with special exhibition stations.

These fine QSL cards are printed on glossy paper, and show a photograph of Peterborough Cathedral and the City coat-of-arms on one side, with the usual report data and space for remarks on the reverse. All the individual amateur has to do is to overprint his callsign, and name and address.

THE AMATEUR BANDS

—continued from page 651

VS9ARV, VQ9HP (Seychelles), VR6TC (Tom Christian on Pitcairn Is.), VU2TX, all W districts 1—Ø, XW8BS, YA1DXE, ZD8ARC, XD9BE, ZL1AXB, plus many others including ZL4CH, ZL5AA (Scott Base Antarctica), 3A2CP, 5H3AC, 5U7AK (Niger), 5X5UW, 5Z4IR, 5R8AS, 5W1AZ (Western Samoa), 6O1PK, 6Y5AR, 7Q7LC, 9J2VX, 9K2AM (Kuwait), 9M2BO, 9M6MQ, 9N1BJ (Nepal), 9V1GH.

Finale

That's it for this year, and vy fb it's been too, especially this last month. 28 and 21 really starting to come into their own. Watch 28 next year, things will really start to hum. DX on 80 and 40 for the stalwarts. Twenty and 160 dying out?

Contests for December. The only one in my diary is the 70Mc/s c.w., and that was on the 4th. January is not much better. The Affiliated Societies contest on January 14—15th, and on the 29th, is the 144Mc/s c.w. contest. Anyone listen higher than 30Mc/s? No excuse now that the v.h.f. Explorer circuit is on show. (See page 646).

Your scribe is still at it on topband with a 5763 and 10 watts to 140ft., endfed. Reports welcome, both phone and c.w. Careful, the phone may be a.m. but will probably be f.m. (B.F.O. out, a.v.c. off).

Many thanks for the fine logs, a very MX (Merry Christmas in c.w.) and a real cool yule to the way out cats. (Like endsville man). Hpe cu next yr. 73 from G3JDG.

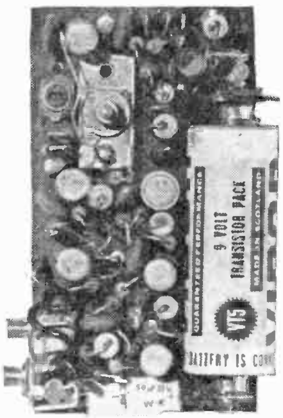
P.S.—Deadline for festive keen types is 26th.

SINCLAIR MICRO FM

POCKET SIZE COMBINED FM TUNER/RECEIVER

THE ONLY SET OF ITS KIND IN THE WORLD

- 7 TRANSISTORS 2 DIODES
- LOW I.F. ELIMINATES NEED FOR ALIGNMENT
- OPERATES FROM STANDARD SELF CONTAINED 9v BATTERY
- ONE OUTPUT FOR AMPLIFIER ONE FOR PERSONAL LISTENING



Anyone can build it!

This is a marvellous set to build and use. It has so many unique, original features that it is years ahead of any FM design ever produced for the home constructor. It is so professional in its appearance and performance too. With the Sinclair Micro FM there are simply no problems of alignment, so it is ready to use just as soon as you have built it, and unlike any other FM Set in the world, the Micro FM is a double purpose unit which you can use both to feed to a hi-fi system or tape recorder and as a self-contained pocket FM portable. The sensitivity of the Micro FM is such that it will operate satisfactorily using its own telescopic aerial in al, but the very poorest reception areas. Quality is outstandingly good because of the system of pulse counting discrimination used, and although this set is no bigger than a packet of 10 cigarettes it uses a standard 9 volt self contained battery. Powerful A.F.C. makes tuning simple. Backed by Sinclair service facilities and the Sinclair guarantee, anyone can go ahead and build the Micro FM straight away and with assured success.

Complete kit including transistors, telescopic aerial, case, earpiece and instructions.

£5.19.6

TECHNICAL DESCRIPTION

Self-contained double-purpose FM superhet using 7 transistors and 2 diodes. The R.F. amplifier is followed by a self-oscillating mixer and three stages of I.F. amplification which dispense with I.F. transformers and all problems of alignment. The final I.F. amplifier produces a square wave which is detected to produce the original modulation exactly. The pulse-counting discriminator ensures better audio quality. Two outputs are provided—one is for feeding to amplifier or recorder and the other enables the Micro FM to be used as an independent self-contained pocket portable. A.F.C. "locks" the programme tuned in. The telescopic aerial included is sufficient in all but the worst signal areas.

- ★ Size: 2 13/16 x 1 11/16 x 3/4 in.
- ★ Pulse counting discriminator
- ★ Low I.F. completely eliminates alignment problems
- ★ Tunes from 88 to 108 Mc/s
- ★ Audio response: 10 to 20,000 c/s ± 1dB
- ★ Signal to Noise Ratio: 30dB at 30 microvolts
- ★ Plastic case with brushed and polished aluminium front and spun aluminium tuning dial

sinclair *world pace-setter in electronics*

SINCLAIR MICRO-6

The kit that builds into the world's smallest radio

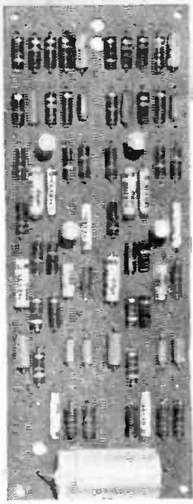
This is the kit that builds into a M.W. set against which a matchbox looks enormous. Yet it is completely self-contained, including aerial and batteries and virtually plays anywhere. Its clever six-stage circuit (2 R.F., double diode detector, 3 A.F.) ensures all you want in a radio today—power, range, quality and selectivity. A.G.C. counteracts fading, bandspread brings in Luxembourg like a local station. There is great pleasure to be had in building the Micro-6, and it makes a highly acceptable gift with its white, gold and black case and amazing performance.

- Size 1 1/5 in. x 1 3/10 in. x 1/2 in.
- Weight: One Ounce
- Easily built in an evening

Complete kit with earpiece, case and instructions.

59/6

ORDER FORM AND MORE SINCLAIR DESIGNS ON FOLLOWING PAGES



Performance figures obtained with the Stereo 25 fed to two Z.12s all powered by a PZ.3 mains power supply unit.

- **SENSITIVITY** for 10 watts into 1.5 ohms load per channel.
  Mic.—2 mV into 50K ohms.
  Pick-up—3 mV into 50K ohms.
  Radio—20 mV into 4.7K ohms.
- **FREQUENCY RESPONSE** (Mic. and Radio)—25 c/s. to 30 kc/s. ± 1dB extending to 100 kc/s ± 3dB.

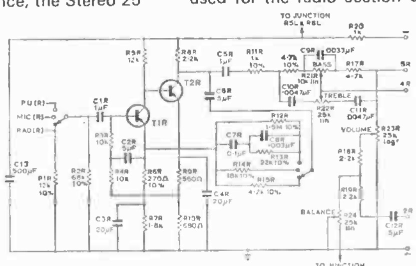
SINCLAIR STEREO 25

ALL-PURPOSE DE-LUXE PRE-AMP/CONTROL UNIT

Using only the finest possible matched components in circuitry developed specially by Sinclair Radionics own research laboratories, the SINCLAIR STEREO 25 Pre-amplifier and Tone Control Unit is for use in any stereo system where it is intended to take fullest advantage of today's best amplifier and auxiliary equipment systems. When used for feeding into two Z.12's., there is even greater advantage for there is appreciable saving also in what you have to spend to get first class hi-fi. In appearance, the Stereo 25 reflects the professional elegance which characterises all Sinclair designs. The front panel is in solid aluminium brush finished and polished in horizontal sections. Solid aluminium knobs are fitted. Mounting the unit is simple and it will enhance any hi-fi furnishing scheme in which it is used. A PZ.3 is recommended for powering the Stereo 25 and two Z.12's stereo assembly. For complete hi-fi coverage a Sinclair FM should be used for the radio section of your installation.

TECHNICAL DESCRIPTION

- **EQUALISATION**—Correct to within ± 1dB on RIAA curve from 50 c/s to 20 kc/s.
- **TONE CONTROLS**
  Treble + 12dB to —10dB at 10 kc/s.
  Bass + 15dB to —12dB at 100 c/s.
- **SIZE**—6¼in. x 2¾in. x 2⅛in. overall, plus knobs.
- **FINISH**—Front panel sectioned in brushed and polished solid aluminium with solid aluminium knobs. Black figuring on front panel.



STEREO 25. ONE CHANNEL ONLY

BUILT, TESTED AND GUARANTEED

£9.19.6

Circuit Diagram shows one channel of the Stereo 25 pre-amp and Control Unit.

sinclair ***world pace-setter in electronics***

"Does all you claim"

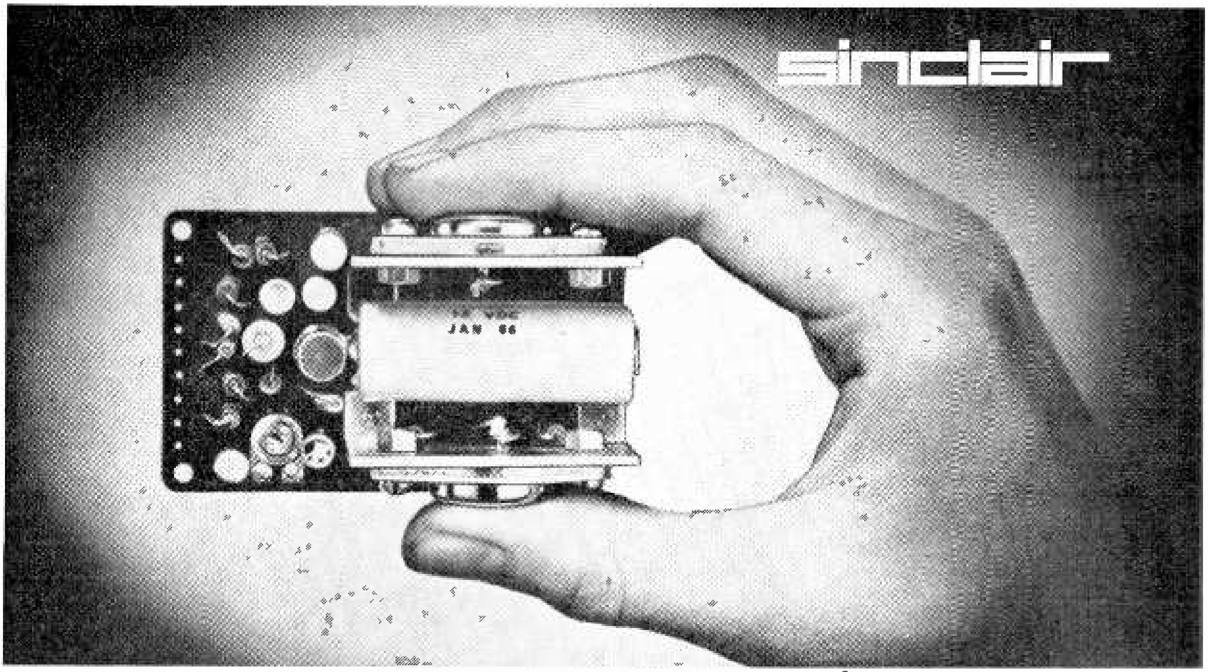
So writes V.C.W. of London S.W.17 who is a keen and critical enthusiast for building unusual designs. He says:

"Micro FM assembly instructions are complete and plain, and when finished the set is truly amazing and does all you claim. Reception up and down the country proved strong, signal quality is very good and station "locking" excellent. Recording programmes through a good quality machine was all one could wish for, and I continue to be amazed at the performance the set puts up".

"I have received your Z.12 amplifier. I am extremely pleased with its performance, and it is well worth the cost. Thank you for your prompt delivery."
B.R.L., Howick, Auckland, N.Z.

"Much to my delight, the tuner (Micro FM) performs splendidly, fully justifying the modest outlay called for. The tuner picks up all the F.M. programmes. I am now anxious to purchase two Z.12 amplifiers."
P.E.R., Florida, Transvaal

WE ARE LOOKING FOR PHOTOS showing Sinclair equipment in use in any interesting or unusual way anywhere in the world. **£3.3.0** will be paid for each picture we publish. A brief story should accompany each one. All photos received will be posted back.



SINCLAIR Z.12

COMBINED 12 WATT HI-FI AMPLIFIER AND PRE-AMP FOR OPERATING FROM 6-20V. D.C.

The amazing adaptability and rugged construction of this very powerful and exceptionally compact amplifier make it possible to use just one type of unit with outstanding success in an unusually wide variety of applications. Eight special H.F. transistors are used in a highly original circuit to achieve the characteristics demanded of any quality amplifier irrespective of price, yet this Sinclair unit costs only 89/6 and includes its own integrated pre-amplifier. The Z.12 accepts radio, microphone and pick-up inputs. Detailed instructions for connecting these, matched for mono and stereo are given in the manual supplied with every unit. Where it is required to run the Z.12 from mains supply, the PZ.3 is recommended. Those wishing to have a ready made pre-amp control unit can feed inputs via the Stereo 25, which, with two Z.12s will provide the finest stereophonic hi-fi possible—and the saving in cost is considerable.

USE IT FOR HI-FI ELECTRICAL GUITAR, CAR RADIO, P.A. INTERCOM, INSTRUMENTATION, ETC.

● SIZE 3in. x 1¾in. x 1¼in. ● FANTASTIC POWER! 12 WATTS R.M.S. CONTINUOUS SINE WAVE (24 W. PEAK); 15 WATTS R.M.S. MUSIC POWER (30 W PEAK) ● **REQUIRES FROM 6 TO 20V. OPERATING POWER** ● **HI-FI PERFORMANCE AT A FRACTION OF THE USUAL COST**

READY BUILT, TESTED AND GUARANTEED, WITH MANUAL **89/6**

If you prefer not to cut this page, please refer to P.W.167 when writing your order.

SINCLAIR PZ.3 POWER SUPPLY UNIT

Transistorised techniques are used to achieve phenomenally good smoothing, thus assuring ideal operating conditions. Ripple is a barely measurable 0.05 V. Will power two Z.12's and the Stereo 25 with ease. **79/6**

THE SET THAT STOLE THE SHOW

THE SINCLAIR MICROVISION POCKET TV RECEIVER provided a world wide sensation when shown for the first time at the recent 1966 Radio and TV Exhibition. This fantastic British set tunes over 13 channels on bands 1 and 3, operates from six self-contained "Penlite" batteries and measures only 4in. x 2½in. x 2in. Despite the minute proportions of this 30 transistor receiver, quality from the exclusively designed tube and loudspeaker is superb. This amazing Sinclair triumph will be available early in 1967 at a cost of 49 gns.

SINCLAIR MICROVISION
The world's only pocket T.V.!

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P.W.167

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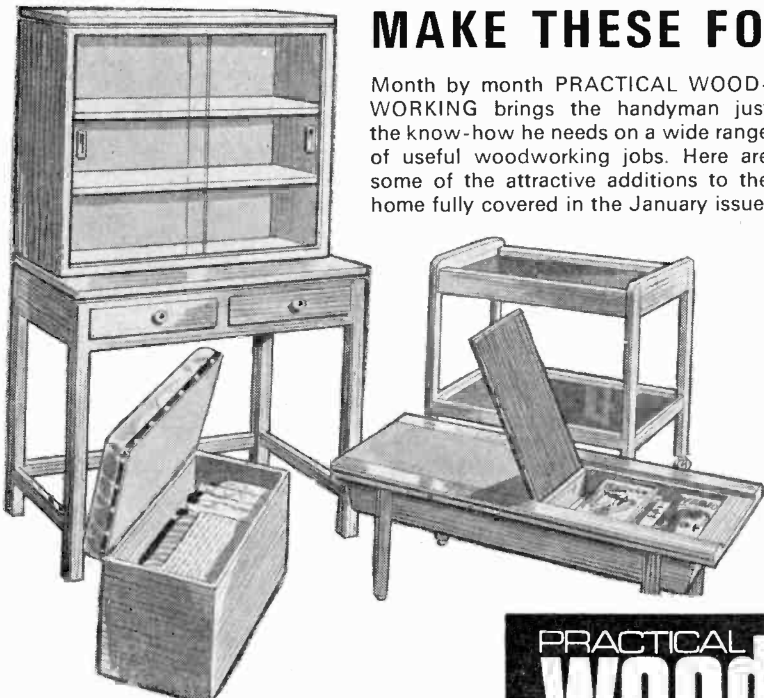

Month by month PRACTICAL WOODWORKING brings the handyman just the know-how he needs on a wide range of useful woodworking jobs. Here are some of the attractive additions to the home fully covered in the January issue.

TELEPHONE DESK & SEAT
A handsome desk to house your telephone . . . a cupboard for directories . . . a cushioned seat for comfort . . . all easy to make from full constructional details.

CABINET, TABLE & TROLLEY SUITE
A space-saving 3-piecer.

OCCASIONAL TABLE
Modern, low-line in appearance and specially designed to store books and magazines.

BLANKET BOX
To store blankets when winter's over. Also makes a handy seat.

UTILITY DISPLAY SHELVES
Simple to make for those odd corners.

CLOAKROOM MIRROR
Framed in Wood, with a generous shelf for clothes-brushes.

Plus PLAN SHEET for SINGLE-LIGHT, FULLY-GLAZED EXTERIOR DOOR.

JANUARY ISSUE OUT NOW — 2/6
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PRACTICAL
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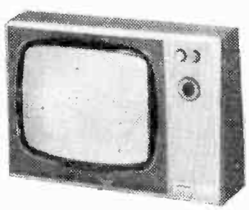
17 in.—£11.10.0 **TWO-YEAR GUARANTEE EX-RENTAL TELEVISIONS**

Channels all areas
Carr., Ins. 30/-



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WIDE RANGE OF MODELS SIZES AND PRICES

DEMONSTRATIONS DAILY

TWO-YEAR GUARANTEED TUBES

14 in.	**59/6**
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21 in. and all Slimline Tubes	**99/6**

100 % REGUNNED
Add 10/- or old tube.
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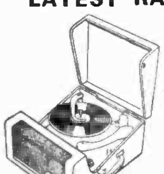
Ex-Maintenance Tested Tubes
17″ 35/- 14″ 15/-
Most makes and Types (Not Slimline) Carr. 5/-

LATEST RADIOGRAM CABINETS £9.10.0



Brand new long low design in veneered English walnut, dia. 40 x 16 x 15½ in. Carr. 30/-. Also Small Cabinets £6.19.6. Radiogram/Cocktail Cabinets (Personal Shoppers.) Free List.

TV Turret Tuners, 2/6. New less valves. **Slim models, 5/-.** Press button models, **19/6.** P & P. 2/6.

VALVES, £1 per 100. Assorted TV and Radio. Surplus ex-rental dismantled receivers. Post 4/6. Send for list.

RECORD PLAYER CABINETS, 49/6. Latest designed covered cabinets. Takes any modern Autochanger.

TRANSISTOR CASES 19/6 9½″ × 6½″ × 3½″ P. & P. 2/6.

DUKE & CO. (LONDON) LTD.
621/3 Romford Road, E.12 ILF 6001-2-3

Richard Allan
HIGH FIDELITY
Module

SPECIFICATION—**Bass Unit:** Natural resonance 40 c.p.s. Flux density 14,000 Gauss. Total flux 56,000 Maxwells. **Tweeter Unit:** Flux density 6,000 Gauss. Total flux 9,000 Maxwells. **Overall:** Height 11in. (28 cm), width 6½in. (16.5 cm), depth 2½in. (6.4 cm), weight 5 lb. (2.3 kg). Power handling 10 watts in recommended enclosure. Impedance 5, 8 or 15 ohms.

TECHNICAL DETAILS:

The unit is a compact and self contained loudspeaker system which only needs to be fitted into a simple cabinet of the recommended design to produce a high fidelity loudspeaker of the highest quality.

The unit consists of a 5in. bass unit, 4in. tweeter and crossover network mounted on a duralumin plate which forms the front panel of the complete enclosure.

The method of assembly of the module is unique in that the cone and synthetic rubber surround of the 5in. bass unit are mounted directly on to the duralumin front panel and the ceramic magnet is supported on substantial pillars attached to the panel. The conventional chassis with all its disadvantages is thus eliminated.

The tweeter is a special version of the 460T unit with a doped cambric surround and extremely light suspension system.

The crossover network is a five element circuit using ferrite cored inductors and reversible electrolytic capacitors mounted on a printed circuit board.

Free constructional details of the recommended cabinet are readily available from us.

Where larger power handling is required several units may be mounted in a larger cabinet, multiple units may also be mounted in a column enclosure to form a high power handling, high quality line source. The unit may also be mounted directly into existing equipment or in cavities in walls etc.

The unit forms the drive system of the 'Minette' enclosure, for details see separate leaflet. Patents applied for.

Price £8 plus £1.8.3 tax

For further details contact:
RICHARD ALLAN RADIO LIMITED
Bradford Rd, Gomersal, nr Leeds, Yorks.
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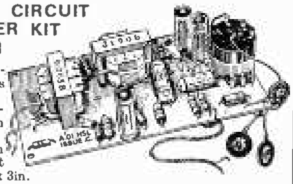
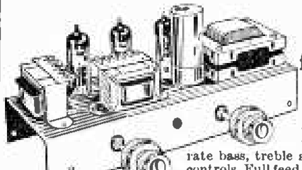
HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT Type TA1



● Peak output in excess if 1½ watts. ● All standard British components. ● Built on printed circuit panel, size 6 x 3in. ● Generous size Driver and Output Transformers. ● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GET 114 or 81 Mullard OC81D and matched pair of OC81 o/p). ● 9 volt operation. ● Everything supplied, wire, battery clips, solder, etc. ● Comprehensive easy to follow instructions and circuit diagram 1/6. (Free with Kit). All parts sold separately.
SPECIAL PRICE 45/-. P. & P. 3/-.
Also ready built and tested, **52/6.** P. & P. 3/-.
A pair of TA1s are ideal for stereo.

STEREO AMPLIFIER

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



ONLY **£4.19.6** P. & P. 6/6

Super Deluxe version with ECL86 valves separate bass, treble and balance controls. Full feed back. **8 gns.** P. & P. 6/6

6 TRANSISTOR AND DIODE SUPERHET

A first-class 2 waveband transistor superhet. ● Printed circuit panel (size 8½ x 2¾in.). ● 3 pre-aligned IF transformers. ● High-gain Ferrite Rod Aerial. ● All First-grade transistors. ● Car aerial winding. ● Push-pull output ● All parts supplied with simple instructions. **All parts sold separately.** Set of parts if purchased at one time ONLY **£4.5.0.** P. & P. 2/6 (Circuit diagram 2/-. Free with set of parts.)

35 OHM SPEAKERS

Suitable for use with above. 2in. Goodmans. Ideal replacement for most pocket portables, **8/6; 3½in. 12/6;** 7 x 4in., **21/-;** P. & P. 2/- per speaker.

Portable CABINET

Size approx. 9½ x 6½ x 3½in. Suitable for above using 3½in. speaker, **25/-.** P. & P. 2/6.

COIL AND TRANSFORMER SET FOR TRANSISTOR SUPERHET

3 IF transformers one oscillator coil one driver transformer and wound Ferrite aerial (med. long and car aerial coupling), **32/6** complete post 2/-. 6 transistor printed circuit board to match **8/6.** Post 1/-. Circuit diagram 1/6 extra.

MINIATURE PRECISION AIR-SPACED TWO GANG TUNING CONDENSER. 176+176 p.F. size 1½"w x ⅞d x 1¼"h with vanes open. Built in trimmers **5/-.** P. & P. 1/-

BRAND NEW TRANSISTOR BARGAINS

GET 15 (Matched Pair) **15/-;** V15/10p, **10/-;** OC71 **5/-;** OC76 **6/-;** AF117 **7/6.**
Set of Mullard 6 transistors OC44, 2—OC45 OC81D matched pair OC81 **25/-,** ORP12 Cadmium Sulphide Cell **10/6.**

EDISWAN MAZDA

PXA101 **6/6;** XA103 **6/6.**
R.F.1. Pack: 1—PXA102 Mixer; 2—PXA101 I.F. Amp. (Equiv. OC44 and OC45) 10/6
R.F. 2 Pack: 2—PXA101 I.F. 1—PXA102 Osc.1—PXA102 Mixer 12/6
L.F.6 Pack: Consisting of PXB113 Driver Matched pair. PX171 mounted complete with heat sinks (Equiv. OC81D and OC81) 12/6
ALL TRANSISTORS POST FREE.

TAPE DECKS

B.S.R. MONARDECK (Single speed) 3¾in. per sec., simple control, uses 5¾in. spools, **£6.15.0** plus 7/6 carr. and ins. (Tapes extra).
LATEST COLLARO MAGNAVOX 363 TAPE DECK DE LUXE. Three speeds, 2 track, takes up to 7in. spools, **10 gns.** Plus 7/6 Carr. & ins. on each (Tapes extra).

PORTABLE TAPE RECORDER CASE

Beautifully made and expansively finished in dark grey heavy grade rexine. Satin Chrome metal grille front and chrome fittings. Speaker aperture 9" x 4". Overall size 15½" w. x 15" d. x 7¾" h. Will take any standard tape deck or single record player. Limited number only. Worth at least **£5.** OUR PRICE **49/6.** P. & P. 5/-. Brand new and unused.

ACOS CRYSTAL MIKES. High imp. For desk or hand use. High sensitivity, **18/6.** P. & P. 1/6.
TSL CRYSTAL STICK MIKE. Listed at **45/-.** Our price **18/6.** P. & P. 1/6.

QUALITY RECORD PLAYER AMPLIFIER

A top-quality record player amplifier. This amplifier (was used in a 29 gn. record player) employs heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, Treble and Volume controls Complete with output transformer matched for 3 ohm speaker. Size 7in. w. x 2½in. d. x 5½in. h. Ready built and tested. **PRICE 69/6.** P. & P. 4/9.
ALSO AVAILABLE mounted on board with output transformer and 6in. speaker ready to fit into cabinet below. **PRICE 89/6.** P. & P. 5/9.

QUALITY PORTABLE R/P CABINET

Uncut motor board. Will take above amplifier and B.S.R. or GARRARD Autochanger or Single Record Player Unit. Size 18 x 14 x 8½in.
Price £3.9.6. Carr. 7/6.

4-SPEED PLAYER UNIT BARGAINS

All brand new in maker's original packing.

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B.S.R. TU/12 .... **£3.9.6** Carr. 5/6.
GARRARD SP25 De Luxe .. **£12.10.6** Carr. 5/6.
B.S.R. GU7 with unit mounted pickup arm. **£4.18.8** Carr. 5/6.

AUTO CHANGERS

Latest B.S.R. UA25 Super slim **£6. 2.6**
GARRARD 1000 with special Hi-Fi cartridge.. **£6.19.6**
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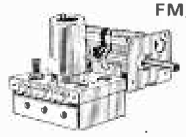

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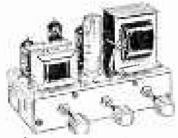

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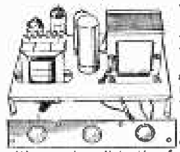

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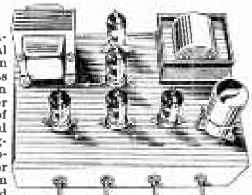

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Output Transistors can be used in place of OC81 with better results. **4/6** each, **7/6** for 2, **42/-** a dozen.

C.W.O. p. and p. 2/6d in the pound

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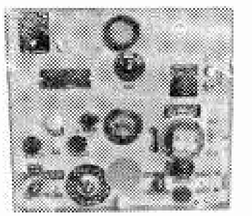
MARCONI CANADIAN RECEIVER No. 52



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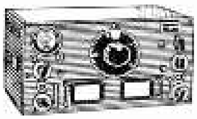

In excellent tested condition. Complete with 9 coils 50 Kc/s-30 Mc/s and Power Unit. £31.10.0. Carr. 30/-.

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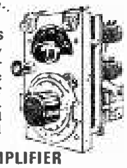

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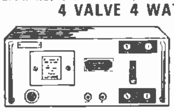

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These sets cover the range of 2-8 mcs. in two switched bands, using R/T and C.W. incorporating netting control, internal speaker and internal P.U. for 200/250 V.A.C., A. 12 volt D.C. version available. A meter is used for checking the set while in operation, using 13 valves, (3 EL32 in final transmitter output) transmitter automatically tunes to the same F.X. as receiver, which uses one R.F. and two I.F. stages, being extremely sensitive and selective.
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These sets have been made to stand up to the hardest of wear and working conditions.
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(continued on next page)

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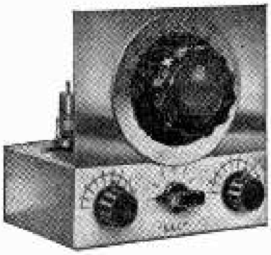

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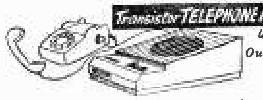

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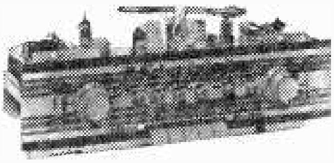

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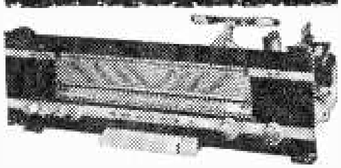

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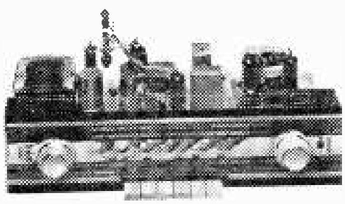

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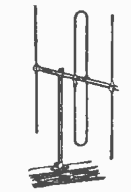

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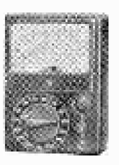

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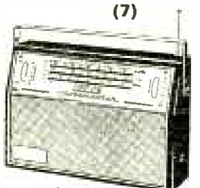

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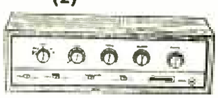

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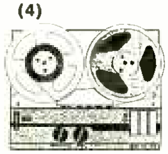

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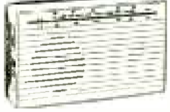

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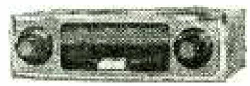

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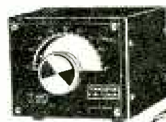

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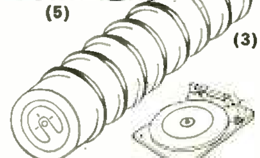

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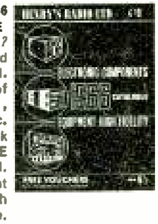

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