JUNE 1962

Practical WIRELESS

2/-

FREE inside!

DOUBLE-SIDED **BLUEPRINT** for 7-TRANSISTOR M.W./L.W. POCKET PORTABLE

HI-FI F.M. TUNER

THE P.W. TROUBADOUR

THE P.W. EVEREST TUNER

CLYNE RADIO LTD.

THE COMPONENT SPECIALISTS

18 TOTTENHAM COURT ROAD, W.1 MUSeum 5929/0095
162 HOLLOWAY ROAD, LONDON N.7 NORth 6295/6/7
9 CAMBERWELL CHURCH STREET, S.E.5 RODney 2875

All post orders etc. to 162 HOLLOWAY ROAD, LONDON N.7

The "HIGHWAYMAN"

At last a quality Car Radio to build yourself, at an economical price. Look at these features:— ★ Attractive styling. ★ Push-pull output. ★ 3 latest Mullard transistors plus valves type EBF 83 and ECH 83. ★ No Buzz. High Output and sensitivity. ★ Printed circuit (newest type). 7" x 4" High flux p.m. speaker. ★ Medium and Long Waves. ★ Push Buttons for fingertip control. ★ Extremely low Battery consumption (less than ½ amp). ★ Easy to fit any make car (Positive earth only) ★ 12 volt operation. ★ Compact size measures only 7" x 7" x 2" deep. ★ Easy assembly, supplied with dial and drive already mounted.

All parts available separately, but if purchased at one time, the whole will be supplied at a special inclusive price of only **£10.19.6** Plus 4/- P. & P.

Parts list and comprehensive instruction booklet 2/6, post free. (Deducted from cost if complete parcel purchased later.)

A QUALITY F.M. TUNER UNIT TO BUILD YOURSELF!

Combines quality with simplicity of construction (only specially selected top-grade components are used). The refinements provided, and the performance achieved are equal to many commercial models at twice the price. ★ Guaranteed non-drift ★ Permeability tuning. ★ Freq. coverage 88-100 Mc/s. ★ Self powered using a good quality mains transformer and valve rectifier. ★ Fully drilled chassis. ★ F.M. Tuning Head by famous maker. ★ OA81 Balanced Diode output. ★ Magic-eye tuning indicator. ★ Two I.F. Stages and Discriminator. ★ Attractive maroon and gold glass dial. ★ Valves used: ECC85, two EF80s, EZ80 (rectifier) and magic-eye. ★ Attractive metal front panel as illus. finished in a choice of black crackle, glossy hammer green or grey enamel. ★ Everything supplied down to the last nut and bolt. All parts sold separately.

Special inclusive price for all components, full assembly instructions, circuit diagram, etc. **£6.12.6** Plus 5/- P. & P. Full assembly instructions, etc., available separately if required at 1/6 post free.

The "CLYMAX"

At last a 6-transistor pocket size superhet for Medium and Long Wave at a price you can afford. All required components

ONLY **£6.16.6**

Nothing more to buy! Plus 3/6 P. & P.

★ Completely self contained. No external aerial or earth required ★ Full medium wave coverage, plus switched Light programme on Long Wave. ★ Push-pull output—250 milliwatts. ★ Matched set of latest type Mullard transistors. ★ Genuine 3in. P.M. Speaker ★ High-Q Coils. ★ Ferrite rod aerial with high selectivity. ★ Size: 5¼ x 3¼ x 1⅞in Two-tone cabinet. ★ Precision etched printed circuit with components references clearly marked. Alignment service available. All parts available separately. Full assembly instructions and individually priced parts list 2/- post free.

SPECIAL OFFER !! EXPORT CHASSIS

by famous manufacturer

Medium and Two Short Waves

M.W. 200-550 metres
S.W. 1. 13-30 metres
S.W. 2. 31-90 metres
(Calibrated also in k/cs and M/cs.)

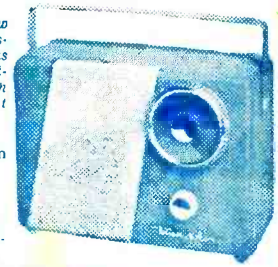
A five valve superhet chassis—ECH81, EF89, EBC81, EL84 and EZ80 for A.C. mains. 90/110/200/230/250 v. Four watts output, negative feedback. Push-button selection of gram. and wavechange. Volume on/off Tone and Tuning controls. Tropicalised high grade mains and output transformers, separate from main chassis, reduce hum and heat to a minimum. Attractive dial printed in Black, Gold and Red. Chassis dimensions 15in. long x 6in. deep x 7in. high (This includes mounting brackets which can be removed and reduces the depth to 5½in.) Dial aperture 13½ x 3in. Supplied complete with rotatable separate ferrite rod aerial. **Quantity strictly limited. AT BARGAIN PRICE OF £12.12.0** (P.T. Paid). Carriage and packing in U.K. only 7/6. H.P. available.

THE R.C. 3/4 WATT AMPLIFIER

Compare the advantages Treble, bass AND middle controls For crystal or magnetic pick-up A.C. Mains 200/250 v. Valve line-up; 6V6GT, 6SG7 metal 6X5GT. Negative feedback. Built on stove enamelled steel chassis, measuring only 8 x 4 x 1⅞in. Four engraved cream knobs are included in the price of the complete kit with all necessary practical and theoretical diagrams at **£4.5.0 only, plus 2/6 p. & p.** or Instruction Book fully illustrated for 1/- post free. This amplifier can be supplied, tested, and ready for use at £5.5.0 plus p. & p.

NEW! NEW! The "CRUSADER"

Our new four transistor plus diode portable, with big set quality.



★ Full Medium Wave coverage.
★ Completely self contained.
★ Five inch P.M. Speaker
★ Genuine high grade Mullard or Ediswan Transistors
★ New components throughout
★ Attractive two-tone blue/grey Vynide covered cabinet size 8 x 5¼ x 3⅛in. with adjustable carrying handle
★ Eyeletted chassis simplifies construction
★ Longer life with larger size PP7 battery

★ SPECIAL FEATURES! ★ SUPPLIED WITH JACK SOCKET FOR DIRECT CONNECTION TO CRYSTAL MICROPHONE FOR USE AS BABY ALARM, WITHOUT ANY MODIFICATION! ALSO FOR DIRECT CONNECTION TO CRYSTAL PICK-UP FOR USE AS A GRAMOPHONE AMPLIFIER! SUPPLIED COMPLETE WITH RECESSED SOCKET FOR DIRECT CONNECTION TO CAR AERIAL!

All required components including full instructions, solder, battery etc. at special inclusive price of ONLY **95/-** Plus 3/- P. & P. All parts available separately

Itemised parts list and full assembly instructions 1/6 post free

THE NEW SIGNAL INJECTION PROBE MODEL ITI-1

Ideal companion for the service-man and hobbyist, making rapid checks on radios, amplifiers, tuners, TV, etc. The ITI-1 injects a signal into the circuit at any given point. Produces a signal rich in harmonics from a miniature transistor oscillator, built into the probe. Powered by four standard pen-lite cells. Push-button operation and neon battery strength indicator. Price complete with batteries 52/6 only, plus 1/6 P. & P.

THE "BABYCALL"

At last! A Baby Alarm without untidy connecting wires. Can be used anywhere and transferred from room to room at will.

Consisting of two completely separate units—No extra wires or wiring between units—Just plug the "receiver unit" into *any* mains socket in the house (or next door) and you will immediately receive "loud and clear" sounds that the remote microphone unit is picking up, (from wherever it is plugged into). Operates by using the "house mains wiring" as the connecting link. Completely safe. Each unit is contained in an attractive modern "Slim line" type moulded cabinet. Handsome appearance, with Vynair front panel.

TCC Printed circuit board. TCC Capacitors. No "live" chassis. High flux loudspeaker. Easy to assemble. Dimensions 10" x 4" x 4¼" (deep) Each Unit.

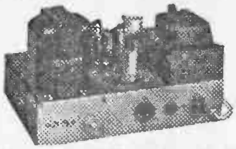
Complete Kit of Parts, including instruction booklet at special inclusive price of £5.19.6, plus 3/6 postage and packing. Itemised parts list and full assembly details 1/6, post free

N.B. This is a non-repeatable offer. Limited quantity only. Purchased complete from manufacturer. Worth Double!!

STERN'S MULLARD DESIGNS

Designed by MULLARD—presented by STERN'S strictly to specification

COMPLETE KIT OF PARTS MULLARD "5-10" MAIN AMPLIFIER



For use with the MULLARD 2-valve pre-amplifier with which undistorted power output of up to 10 watts is obtained. We supply **SPECIFIED COMPONENTS AND NEW MULLARD VALVES**, including **PARMEKO MAINS TRANSFORMER** and choice of the latest Ultra-Linear **PARMEKO** or the **PARTRIDGE** Output Transformer.

COMPLETE KIT OF PARTS (**PARMEKO** Output Trans.). **£10.0.0**

Alternatively we supply ASSEMBLED and TESTED. **£11.10.0** INCORPORATING PARTRIDGE OUTPUT TRANSFORMER, £1.6.0 EXTRA.

MULLARD'S PREAMPLIFIER TONE CONTROL UNIT

Employing two EF86 valves, and designed to operate with the MULLARD **MAIN AMPLIFIERS**, but also perfectly suitable for other makes.

PRICE COMPLETE KIT OF PARTS **£6.6.0** ASSEMBLED AND TESTED **£8.0.0**

Supplied strictly to **MULLARD'S SPECIFICATION** and incorporating:

- Equalisation for the latest R.I.A.A. characteristics.
- Input for Crystal Pick-ups, and variable reluctance magnetic types.
- Input (a) Direct from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier.
- Sensitive Microphone Channel. ● Wide range **BASS** and **TREBLE** Controls.

COMPLETE MULLARD "5-10" AMPLIFIER

The popular and very successful complete "5-10" incorporating Control Unit providing up to 10 watts high quality reproduction. Only Specified Components and new **MULLARD VALVES** are supplied including **PARMEKO MAINS TRANSFORMERS** and choice of the latest **PARMEKO** or **PARTRIDGE** ULTRA-Linear Output Transformers.

KIT OF PARTS **£11.10.0** OR ASSEMBLED and TESTED **£13.10.0**

H.P. Dep. £2.6.0. 12 months at 17/0. Dep. £2.14.0 12 months at 19/10

ABOVE incorporating PARTRIDGE OUTPUT TRANS. £1.6.0 extra.

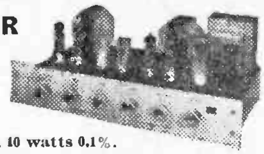
COMPLETE MULLARD "3-3"

THE IDEAL AMPLIFIER FOR A SMALL HIGH QUALITY INSTALLATION PROVIDING EXCELLENT REPRODUCTION OF UP TO 3 WATTS OUTPUT

COMPLETE KIT OF PARTS **£7.10.0** OR ASSEMBLED and TESTED **£8.19.6**

(plus 6/6 carriage and insurance) H.P. Terms: Deposit £2.0.0 and 8 months at £1.0.0. Complete to MULLARD'S SPECIFICATION including Mullard valves and a **PARMEKO OUTPUT TRANSFORMER.**

MULLARD'S "10 PLUS 10" STEREO AMPLIFIER



A high fidelity design based on the famous Mullard "5-10". Provides up to 10 watts (per channel) Superb reproduction. Frequency response flat to within 3 db from c/s. to 60 Kc/s at 50 Mw. Total Harmonic Distortion at 10 watts 0.1%.

(a) ASSEMBLED COMPLETE AMPLIFIER, including CONTROL UNIT (as illustrated)...... **£21.0.0**
Deposit £4.4.0, 12 months at £1.10.10.

(b) A complete KIT of PARTS...................... **£18.10.0**
Deposit £3.14.0, 12 months at £1.7.2.

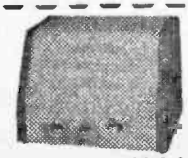
We also supply the assembled MAIN AMPLIFIER only (excludes control unit) for operation with our DUAL CHANNEL PREAMPLIFIER, this provides for a more versatile or elaborate installation and would be essential if a low output Magnetic Pick-Up, such as the Decca, is to be used.

(a) THE ASSEMBLED MAIN AMPLIFIER with the ASSEMBLED DUAL CHANNEL PREAMPLIFIER **£30.0.0**
Deposit £6.0.0, 12 months at £2.4.0.

(b) A complete KIT of PARTS for both Units....... **£26.0.0**
Deposit £5.4.0, 12 months at £1.18.2.

Illustrated and Descriptive Brochure available. Please enclose S.A.E.

STERN'S INTER-COMM BABY ALARM



A small versatile Unit employing the new MULLARD ECL86 valve and designed to provide two (or three) way conversation up to extreme distances Operates from A.C. mains 200 to 250 Volts.

PRICES . . . MASTER UNIT and ONE EXTENSION

KIT OF PARTS **£6.17.6** ASSEMBLED AND TESTED **£8.0.0**

Consists of a MASTER UNIT, size only 8¼ x 5¼ x 6in. and ONE EXTENSION (a second extension may be added to any time). The Master Unit incorporates switching and power supply and with the chassis completely isolated from the mains is operated in absolute safety. Cases covered in quality leatherette.

PRICE REDUCTIONS

(a) The KIT OF PARTS to build both the "5-10" Main Amplifier and the 2-valve PRE-AMP CONTROL UNIT H.P. Dep. £3.7.0 and 12 months at £1.2.9.......... **£15.15.0**

(b) The "5-10" and the 2-stage PRE-AMP both ASSEMBLED and TESTED H.P. Dep. £3.16.0 and 12 months of £1.7.8.......... **£18.18.0**

With Partridge O/put Transformer £1.6.0 extra.

RECORD PLAYERS

The Latest Models are in stock, many at reduced prices.

Send S.A.E. For Illustrated Leaflet.

THE NEW GARRARD "AUTO-SLIM" 4-speed Autochanger with Crystal Pick-up **£8.10.0**

COLLARO "JUNIOR" 4 SPEED SINGLE RECORD PLAYER with separate Crystal Pick-up Carriage and Insurance 5/- **£3.15.0**
Above Pick-up separately for £1.6.6

The **NEW COLLARO C60** 4-speed Autochanger unit with Studio "O" Pick-up...... **£7.19.6**

The **E.M.I.** 4-speed Single Record Player with Crystal Pick-up **£6.9.6**

B.S.R. MODEL UA14. A 4-speed mixer Autochanger with Crystal Pick-up **£7.10.0**
Available incorporating the **B.S.R. STEREO** Pick-up, plays L.P. and 78 Records **£8.13.10**

GARRARD MODEL TA/MkII 4-speed Player fitted high output Crystal Pick-up.. **£8.10.0**

GARRARD MODEL RC210. Autochanger 4-speeds. High output. Crystal Pick-up.. **£9.19.6**

Carriage and Insurance on each above 5/- extra.

SPECIAL CASH OFFER

This very attractive **PORTABLE AMPLIFIER CASE GRAM AMP.** together with a good quality **GRAM AMPLIFIER** and a matched **P.M. SPEAKER** ALL for ONLY **£8.7.6** (Plus 7/6 Carr. & Ins.)

The Amplifier consists of a 2-stage design incorporating 3 modern B.V.A. valves and has separate BASS and TREBLE CONTROLS.

The Portable Case will also accommodate almost any make of Autochanger and is attractively finished in Mushroom Grey Rexine.

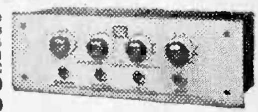
WE ALSO SUPPLY SEPARATELY—

(a) The 2-stage (plus Rectifier) **AMPLIFIER** **£4.2.6**

(b) The **PORTABLE CARRYING CASE** **£3.17.6**

(c) 6½in. **P.M. SPEAKER** 18/9. Carriage and Insurance 4/- extra.

MULLARD FOUR CHANNEL MIXER UNIT



Self powered with Cathode follower output. Incorporates Two inputs for MICROPHONES One for CRYSTAL PICK UP and a fourth for RADIO or TAPE

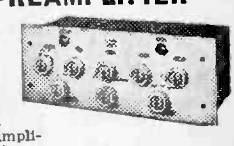
Complete Kit of Part **£8.8.0**

Assembled and Tested **£10.0.0**

TERMS: Deposit £2 and 12 months at 15/-.

MODEL I.L. one microphone input matched for moving coil or Ribbon Mike. £1.17.0 extra.

DUAL CHANNEL PREAMPLIFIER



Incorporates two Mullard 2-valve Preamplifiers combined into a Single unit enabling it to be used for both **STEREOPHONIC** or **MONAURAL** operation. It is designed primarily to operate with our range of **MULLARD MAIN AMPLIFIERS** but will also operate equally well with any make of Amplifiers requiring an input of 250 m/volts.

COMPLETE KIT OF PARTS **£12.10.0** H.P. £2.10.0 & 12 mths. at 18/4

ASSEMBLED AND TESTED **£15.0.0** H.P. £3.0.0 & 12 mths. at £1.2.0

STERN RADIO LTD.

BUILD A THREE SPEED HIGH QUALITY TAPE RECORDER LIKE THIS FOR £35.0.0

FOR THIS WE SUPPLY Deposit £7.0.0 12 months at £2.11.4

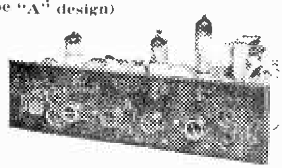
★ Complete Kit of Parts to Build the HFTR3 Tape Amplifier. ★ The New Collaro "Studio" Tape Deck. ★ Portable Carrying Case (as illustrated). ★ Rola/Celestion 10 x 6in. p.m. Loudspeaker. ★ ACOS Crystal Microphone and 1,200ft. Spool E.M.I. Tape.

ALTERNATIVELY WE SUPPLY THE COMPLETELY ASSEMBLED and GUARANTEED TAPE RECORDER FOR £39.10.0

H.P. Terms: Deposit £7.18.0 and 12 months of £2.17.11.

HF/TR3 MKII TAPE AMPLIFIER

(Mullard Type "A" design)



A very high quality Amplifier incorporating 3-speed treble equalisation, by the latest FEROXCUBE POT CORE INDUCTOR. FOR COLLARO-TRUVOX-BRENELL WEARITE Tape Decks. has GILSEN Output Transformer. Includes separate Power Supply Unit.

KIT OF PARTS **£13.13.0** Deposit £2.15.0. 12 months at £1.0.0.

ASSEMBLED and TESTED **£17.0.0** Deposit £3.8.0. 12 months at £1.4.11.

ADD "HI-FI" TAPE RECORDING TO YOUR EXISTING AUDIO INSTALLATION WITH

MULLARD TYPE "C" TAPE PRE-AMPLIFIER—ERASE UNIT

The "Hi-Fi" link to add full tape recording facilities to High Fidelity home installations. Incorporates FEROXCUBE POT CORE PUSH PULL OSCILLATOR and 3-speed treble equalisation by FEROXCUBE POT CORE INDUCTOR FOR WEARITE-COLLARO-TRUVOX OR BRENELL TAPE DECKS. Includes separate power Supply Unit.

KIT OF PARTS **£14.0.0** Deposit £2.16.0. 12 mths. at £1.0.6

OR ASSEMBLED **£17.0.0** Deposit £3.8.0 12 months at £1.4.11

(Excluding power unit £11.15.0 and £14.10.0 respectively.)

SPECIAL "COMBINED ORDER" PRICES

For Constructors with their own cabinet—WE OFFER—

(a) COMPLETE KIT to build the HF/TR3 Amplifier together with the COLLARO "STUDIO" DECK **£26.0.0**
Deposit £5.4.0. 12 monthly payments of £1.18.2

(b) As above but with the HF/TR3 supplied ASSEMBLED and TESTED **£29.10.0**
Deposit £5.18.0. 12 monthly payments of £2.3.4

(c) COMPLETE KIT to build the HF/TR3 AMPLIFIER with the BRENELL Mk. V TAPE DECK... **£42.0.0**
Deposit £8.8.0. 12 monthly payments of £3.1.7

(d) As above but with HF/TR3 supplied ASSEMBLED and TESTED **£45.10.0**
Deposit £9.2.0. 12 monthly payments of £3.6.9

(e) THE ASSEMBLED AND TESTED HF/TR3 AMPLIFIER with the WEARITE MODEL 4A DECK, incorporates Wearite Head Lift Transformer etc. **£60.10.0**
Deposit £12.12.0. 12 monthly payments of £4.8.9.

(Carriage and Insurance on each above is 10/- extra.)

(a) The COLLARO "Studio" Deck with the Model "C" Preamplifier and POWER SUPPLY UNIT ASSEMBLED AND TESTED.......... **£29.10.0**
Deposit £5.18.0. 12 monthly payments of £2.3.3

(b) As above but the TYPE "C" Unit and POWER UNIT supplied as COMPLETE KIT OF PARTS **£26.10.0**
Deposit £5.6.0. 12 monthly payments of £1.18.10

(c) The BRENELL Mk. V Deck with the Model "C" PREAMPLIFIER and POWER UNIT. ASSEMBLED and TESTED **£46.0.0**
Deposit £9.4.0 and 12 months at £3.7.6

(d) As above but the Model "C" PREAMPLIFIER and POWER UNIT supplied as a COMPLETE KIT OF PARTS **£43.0.0**
Deposit £8.12.0. 12 monthly payments fo £3.3.1

(e) The WEARITE MODEL "4" DECK with ASSEMBLED and TESTED Model "C" PRE-AMPLIFIER AND POWER UNIT incorporating WEARITE HEAD LIFT TRANSFORMER, Etc. **£60.10.0**
Deposit £12.2.0 and 12 months at £4.8.9

(Carriage and Insurance on above is 10/- extra.)

The MODEL HFG/2R PORTABLE TAPE RECORDER

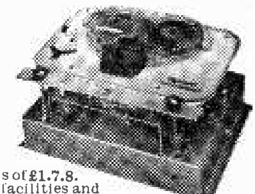
(Original Price £33.0.0)

FOR ONLY 22 gns.

H.P.Dep. £4.14.0.12months£1.13.9 *(Carr. and Ins. 10/- extra).* Incorporates THE LATEST GARRARD "MAGAZINE" TAPE DECK and a HIGH QUALITY AMPLIFIER which is entirely based on the very successful MULLARD TYPE "A" DESIGN and specifically developed to operate the GARRARD DECK. Price INCLUDES SUPPLY OF THE GARRARD TAPE MAGAZINE and 4in. SPOOL OF DOUBLE PLAY TAPE. Comprises a Twin Track Recorder operating at 3¾in/sec. speed and providing up to 1 hour 10 mins. playing time. Truly "Portable", weighs only 22 lbs. Outstanding features are excellent performance and simplicity of operation

THE 'ADD-A-DECK'

Incorporating GARRARD TAPE DECK and MODEL HF/G2P PRE-AMPLIFIER



Supplied on ONE CHASSIS (as illustrated) READY FOR USE **18 Gns.**

(Carr. & Ins. 10/- extra.)

Price includes Garrard Magazine and a 4 in. Spool Double Play Tape

H.P. Deposit £3.16.0, and 12 months of £1.7.8.

Provides complete tape recording facilities and designed to operate through the pick-up sockets of the standard type of RADIO RECEIVER, or an AMPLIFIER, from which really first class reproduction is obtained. It consists of a Twin Track Deck connected to the Pre-amplifier and operates at 3¾in/sec. speed providing up to 1 hr. 10 mins. playing time.

STEREO "TWIN THREE" AMPLIFIER with specially designed PORTABLE CASE

A most compact portable design consisting of TWIN CHANNEL AMPLIFIER based on the latest design by MULLARD LTD., incorporating top grade Output Transformers, and the new audio Triode-Pentode Valves Mullard E.C.L.86 Separate Bass and Treble controls. Suitable for use with Crystal Pick Ups, and capable of genuine high quality reproduction up to 3 Watts per channel.

A versatile stereo arrangement tested and guaranteed which can be assembled in the minimum of time.

PRICE for the ASSEMBLED AMPLIFIER. Two 8 x 5in. ROLA SPEAKERS and PORTABLE CASE **£14.0.0**
Deposit £2.16.0. 12 months at £1.0.6.

ASSEMBLED AMPLIFIER supplied for........ **£7.15.0**

Dept. P.W. 109 FLEET ST., LONDON, E.C.4

Telephone: FLEET STREET 5812/3/4

THE "STP-1" STEREO TAPE PRE-AMPLIFIER

DESIGNED TO OPERATE WITH

BRENELL Mk. V TAPE DECK, incorporating similar ¼-TRACK MINIFLUX TAPE HEADS.

COLLARO "STUDIO" TAPE DECK, incorporating the latest ¼-TRACK COLLARO TAPE HEADS.

- PUSH PULL OSCILLATOR CIRCUIT.
- 4-SPEED EQUALISATION.
- FERROXCUBE OSCILLATOR TRANSFORMER.
- SENSITIVE METER FOR SIGNAL LEVEL.
- SEPARATE GAIN CONTROLS in Each Channel.
- MULLARD VALVES INCORPORATED.

PRICE **£28.0.0** Including separate Power Supply Unit. Dep. £5.12.0 12 months £2.1.1.

COMBINED PRICE SCHEDULE

The "STP-1" PRE-AMPLIFIER is OFFERED with TAPE DECKS as follows:

BRENELL Mk. V 4-TRACK MODEL.................. **£67.0.0**
DEPOSIT £13.8.0. 12 months £4.18.3.

COLLARO "STUDIO" 4-TRACK MODEL............... **£45.0.0**
DEPOSIT £9. 12 months £3.6.0.

THE MULLARD "10 + 10" STEREO AMPLIFIER *(described opposite)* with the "STP-1" PRE-AMPLIFIER and one of the TAPE DECKS provides a COMPLETE Stereophonic Installation. WE OFFER "10 + 10" AMPLIFIER, "STP-1" PRE-AMPLIFIER and the TRUVOX.

As above with BRENELL Mk. V DECK **£87.0.0**
Deposit £17.8.0. 12 months £6.7.8.

As above with COLLARO "STUDIO" DECK **£65.0.0**
Deposit £12.12.0. 12 months £4.16.0.

DESCRIPTIVE LEAFLET AVAILABLE, PLEASE SEND S.A.E.

Brand new, individually checked and guaranteed

VALVES

AL60 6/-
AR8 5/-
ARDD5 2/-
ARP3 3/-
ARP4 3/6
ARP12 3/-
ARP21 5/6
ARP24 3/6
ARP34 4/-
ARTH2 7/-
ATP4 2/9
ATP7 5/6
AU1 5/-
AU4 5/-
AW3 4/-
AZ31 8/-
BS4A 5/6
BT45 15/-
BT9B 20/-
BT83 22/6
CV54 5/-
CV264 20/-
CY31 7/6
D41 3/3
D77 4/3
DA30 12/6
DAF70 35/-
DAF91 6/-
DAF96 7/6
DD41 4/-
DET5 15/-
DET19 3/6
DF22 7/-
DF39 4/-
DF72 7/6
DF91 3/3
DF96 8/-
DK96 7/3
DL92 6/-
DL94 6/-
DL96 8/-
EA50 1/6
EABC80 7/3
EAC91 4/6
EB34 1/6
EB91 3/9
EBC41 7/9

EBC90 5/-
EC52 8/-
EC70 10/-
EC90 20/-
ECC81 5/6
ECC82 6/6
ECC83 7/-
ECC84 7/-
ECC85 8/-
ECC91 4/-
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VORTEXION PORTABLE AMPLIFIER, for 200/250 v. A.C. or 12 v. D.C. 12 watt output, **£9.12.6.** Carriage 15/-.

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POWER SUPPLY UNIT. Input 200/250 v. A.C., 50 cycles. Output: 1, HT 280/350 v. 300 mA. smoothed; 2 MT 150/200 v. 40 mA. (positive earthed), 3, LT 18/25 v. 4 amp. D.C. smoothed (negative earthed). 2 relay switching, H.T. and M.T., safety switch fuses on A.C. and all D.C. Two 5Z3 for H.T., one 6X5 for M.T. Selenium rectifier for L.T. Ideal for Ham transmitters. Weight 45 lb. Dimensions 14 x 8¼ x 18in. Price **£12.10.0** including valves. P. & P. 25/-.

TELESCOPIC MAST. 34ft. Consisting of 6 sections of steel tubing of such internal and external diameter that the smaller sections may be collapsed with the largest section. Immediate erection. Absolutely complete with brackets, guys, pegs, spikes, etc., **£12.10.0.** Carriage and packing 18/-. As above but 20ft., **£7.10.0.** Carriage and packing 18/-.

MULTI-TESTER. 0-6-30-120-600-1,200 v. AC/DC. 0-120 microamp 000mA-300mA AC/DC. 0-30,000 ohms, 0-3 megohms. 10,000 ohms per volt. 3½" x 4½" x 1". Very clear and large scale. Price £4.10.0. P. & P. 3/-.

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R.206 FREQUENCY RANGE ADAPTOR, enabling the set to work on 50 kc/s.—30 mc/s., in 9 bands. **£4.10.0.** Carriage 6/-.

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AR 88's. Completely rebuilt with new PVC wiring. Type "D" **£75.** Type "LF" **£70.**

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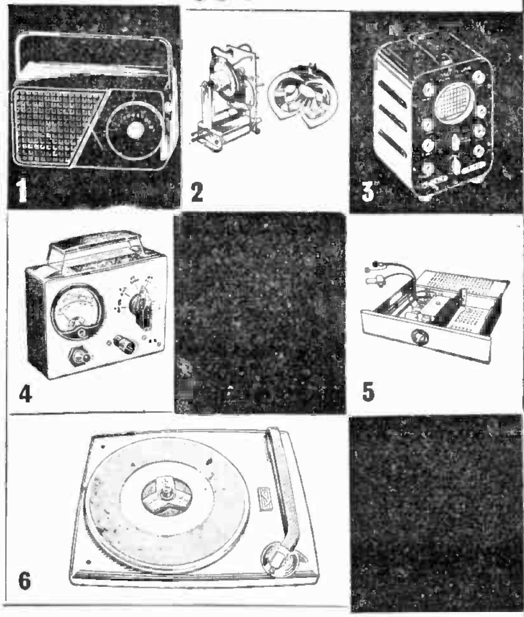

1. **3-TRANSISTOR POCKET RADIO with MINIATURE SPEAKER, FERRITE ROD and 2 GERMANIUM DIODES. The only 3-transistor radio available at the price.** Build it in 1 evening! Tunable over M/L waves. Complete with easy-to-follow instructions and all components (less batteries obtainable anywhere 1/3). **27/6.** P. & P. 2/6. (All parts available separately).
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3. **OSCILLOSCOPE for D.C. and A.C. APPLICATIONS.** Push-pull X amplifier; Fly-back suppression; Internal Time-base Scan Wave form available for external use: pulse output available for checking TV line O/P Transformers, etc. Provision for external—I/P and C.R.T. Brightness Modulation. A.C. mains 200/250 v., **£18.18.0**, P. & P. 8/- or **£4.13.0** deposit, plus P. & P. 8/- and 12 monthly payments of 26/6. FULL 12 MONTHS' GUARANTEE INCLUDING VALVES and TUBE.
4. **A.C./D.C. POCKET MULTI-METER KIT.** 2in. moving coil meter, scale, calibrated in A.C./D.C. volts, ohms and milliamps. Voltage range A.C./D.C. 0-50, 0-100, 0-250, 0-500. Milliamps 0-10, 0-100. Ohms ranges 0-10,000, 0-100,000 **24/6**, P. & P. 2/-. Wiring diagram **1/-**. free with parts.
5. **CHANNEL TUNER.** Will tune to all Band I and Band III stations. Complete with P.C.C.84 and P.C.F.80 valves (in series) I.F. 16-19 or 33-38. Can be modified as an aerial converter (instructions supplied), **32/6**, plus 4/- P. & P. **HEATER TRANSFORMER** to suit above, 200-250 v., **6/-**, plus 2/- P. & P.
6. **STAAR 45.** 9 VOLT BATTERY RECORD PLAYER Complete with pick-up and deck. A completely portable record player. Head is protected by a plastic dome, with a brush which cleans the stylus as it rises into playing position. 45 r.p.m. Automatic on-off switch, governed 9 v. motor, attractive 2 tone grey finish, **£2.14.6.** P. & P. 2/6. TRANSISTORISED AMPLIFIER can be used with the STAAR 45, output 1 watt. Size 4½ x 2¾in., printed circuit, tone and volume controls, 4 transistors. By altering 2 resistors, 2 watt output can be obtained. Push-pull output, complete with 3in. moving coil speaker. Built and tested, **49/6**, P. & P. 2/-.
9. **SIGNAL GENERATORS.** Cash **£7.5.0** or **30/-** deposit and 6 monthly payments of **21/6.** P. & P. 5/6. Coverage 100 kc/s to 100 Mc/s on fundamentals and 100 Mc/s to 200 Mc/s on harmonics. Case 10 x 6½ x 5½in. Three miniature valves and Metal Rectifier. A.C. mains 200/250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent. Modulated or unmodulated R.F. output continuously variable 100 millivolts. C.W. and mod. switch, variable A.F. output. Magic eye as output indicator. Accuracy ± 2 per cent.

10. **SIGNAL GENERATORS.** Cash **£5.5.0.** P. & P. 5/6. Coverage 120 kc/s to 84 Mc/s. Case 10 x 6¾ x 4¼in. Size of Scale 6½ x 3½in. 2 valves and rectifier. A.C. mains 230-250 v. Internal modulation of 400 c.p.s. to a depth of 30 per cent, modulated or unmodulated R.F. output continuously variable 100 millivolts. C.W. and mod. switch variable A.F. output and moving coil output meter. Accuracy ± 2 per cent.

CHANNEL TUNER I.F. 16-19 Mc/s. Continuously tunable from 174-216 Mc/s. Valves required—PCF80 and PCC84 (in series). Covers BBC and ITA ranges. Also Police Fire and Taxis etc. Brand new by famous maker, **10/-.** P. & P. 3/-.

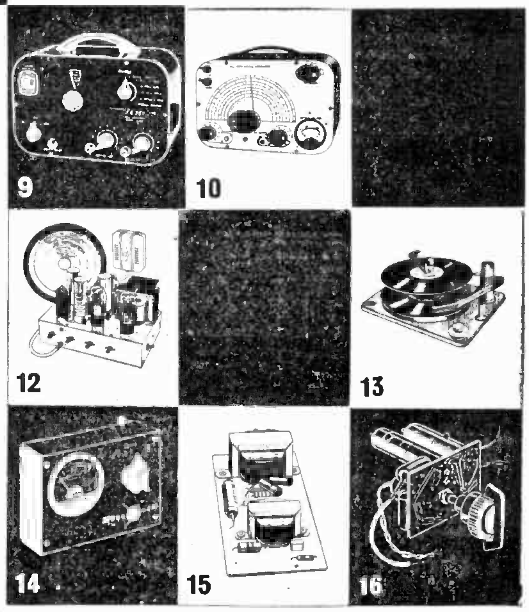
12. 8-watt **PUSH-PULL 5 VALVE AMPLIFIER.** A.C. mains 200-250 v. Size 10½ x 6¼ x 2¾in. 5 valves. For use with all makes and types of pick-up and mike. Negative feed back. Two inputs, mike and gram. and controls for same. Separate controls for Bass and Treble lift. Response flat from 40 cycles to 15 kc/s. ± 2 db down to 20 kc/s. Output 8 watts at 5 per cent total distortion. Noise level 40 db down all hum. Output transformer tapped for 3 and 15 ohms speech coils. For use with Std. or L.P. records musical instruments such as guitars, etc. Suitable for small halls, **£3.19.6.** P. & P. 6/-. Crystal mike to suit **15/-**, P. & P. 2/-. 8in. P.M. Speaker to suit **12/6**, P. & P. 2/-.

13. **B.S.R. MONARCH UA8 WITH FUL-FI HEAD.** 4-speed, plays 10 records, 12in., 10in., or 7in. at 16, 33, 45 or 78 r.p.m. Intermixes 7in., 10in. and 12in. records of the same speed. Has manual play position: colour brown. Dimensions: 12½ x 10¾in. Space required above baseboard 4¾in. below baseboard 2¾in. Fitted with Ful-Fi turnover crystal head. **£6.19.6**, P. & P. 5/6 **With Stereo Head £7.19.6.** P. & P. 5/6.

14. **TRANSISTOR TESTER.** For both P.N.P. and N.P.N. transistors incorporating moving coil meter. In metal case, size 4½ x 3¾ x 1¼in. Scale marked in gain and leakage. **19/6.** P. & P. 3/-.

15. **PUSH-PULL OUTPUT STAGE** inclusive of transistors with input and output transformers to match 3 ohms speech coil, suitable for use with the POCKET RADIO. Kit of parts, including transistors. **19/6**, P. & P. 2/-. Wiring diagram 1/6, free with parts.

16. **PORTABLE AMPLIFIER.** On printed circuit for A.C. Mains 200/250 v. Size 4 x 3in. with tone and volume control. Complete with Valves: ECL82 and EZ80. Output 2 watts, **39/6**, P. & P. 3/-.



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GOODS NOT DISPATCHED OUTSIDE U.K.

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SENSATIONAL STEREO OFFER

A complete set of parts to construct a good quality Stereo amplifier with an undistorted output total 6 watts. For A.C. mains input of 200-250 v. Including pair matched 6½in. speakers. Sensitivity 130 m.v. Ganged Vol. and Tone Controls. Preset balance control. Full instructions and point-to-point wiring diagrams supplied. Stereo Pick-up Head 19/9 extra with above only.

4 Gns. Carr. and pkg. 5/-

ALWAYS IN STOCK FULL RANGE OF LINEAR HI-FI AMPLIFIERS WITH OUTPUTS OF UP TO 100 WATTS. Cash or CREDIT TERMS. Carriage Free.

R.S.C. 30 WATT ULTRA LINEAR HIGH FIDELITY AMPLIFIER A10

A highly sensitive Push-Pull high output unit with self-contained Pre-amp. Tone Control Stages. Certified performance figures compare equally with most expensive amplifiers available. Hum level 70 db. down. Frequency response ±3 db. 30-30,000 c/s. A specially designed sectionally wound ultra linear output transformer is used with 807 output valves. All components are chosen for reliability. Six valves are used EF86, EF86, ECC83, 807, 807, GZ33. Separate Bass and Treble Controls are provided. Minimum input required for full output is only 12 millivolts so that **ANY KIND OF MICROPHONE OR PICK-UP IS SUITABLE.** The unit is designed for **CLUBS, SCHOOLS, THEATRES, DANCE HALLS or OUTDOOR FUNCTIONS**, etc. For use with Electronic **ORGAN, GUITAR, STRING BASS** etc. For standard or long-playing records, **OUTPUT SOCKET PROVIDES** L.T. and H.T. for a **RADIO FEEDER UNIT.** An extra input with associated vol. control is provided so that two separate inputs such as Gram. and 'Mike' can be mixed. Amplifier operates on 200-250 v. 50 c/s. A.C. Mains and has output for 3 and 15 ohm speakers. Complete Kit of parts with fully punched chassis and point-to-point wiring diagrams and instructions. If required perforated cover with carrying handles can be supplied for 19/9. The amplifier can be supplied, factory built with EL34 output valves and 12 months guarantee, for 14 Gns.

11 Gns. Carr. 10/-

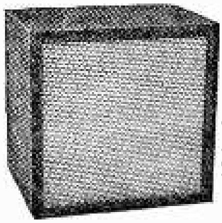
TERMS: DEPOSIT 33/9 and 9 monthly payments of **33/9.**
Suitable microphones and speakers available at competitive prices.

WE STOCK ARMSTRONG RADIOGRAM CHASSIS, GOODMANS and WHARFEDALE SPEAKERS. H.P. or Credit Terms available. No carriage charges on Mail Orders for above.

Jason FMT1 V.H.F/FM Radio Tuner design. Total costs of parts including valves. Tuning dial, Escutcheon, etc. **£6.19.9.**

LINEAR L45 MINIATURE 4/5 WATT QUALITY AMPLIFIER. Suitable for use with any record playing unit, and most microphones. Negative feed-back 12db. Separate Bass and Treble Controls. For A.C. mains input of 200-250 v. 50 c/s. Output for 2-3 ohm speaker. Three miniature Mullard valves used. Size of unit only 7-5-5¾in. high. Guaranteed for 12 months. Only **£5.19.6.** Send S.A.E. for illustrated leaflet. Terms: Deposit **22/6** and 5 monthly payments of **22/6.**

12in. 10 WATT HIGH QUALITY LOUD-SPEAKER IN POLISHED WALNUT FINISHED CABINET



Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only **£4.19.6** Carr. 5/-. Terms: Deposit **11/3** and 8 monthly payments of **11/3.**

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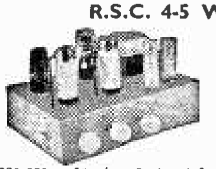

A highly-sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high fidelity pick-up heads, in addition to all other types of pick-ups and practically all 'mikes'. Separate Bass and Treble Controls are provided. These give full long-playing record equalisation. Hum level is negligible being 71 db. down 15 db. of Negative feedback is used. H.T. or 300 v. 25 mA. and L.T. or 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit, or Tape-Deck pre-amplifier. For A.C. mains input of 200-230-250 v. 50 c/s. Output for 2-3 ohm speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with Blue hammer finish and point-to-point wiring diagrams and instructions. Exceptional value at only £4.15.0, or assembled ready for use 25/- extra. Plus 3/6 carr.; or Deposit 22/6 and 5 monthly payments of 22/6 for assembled unit.

R.S.C. PORTABLE GUITABLE AMPLIFIERS. (For 200-250 v. A.C. Mains) **Junior 5 watts High Quality output.** Separate Bass and Treble "Cut" and "Boost" controls. Sensitivity 15 m.v., Twin inputs. High Flux 8in. Loudspeaker "built-in". Handsome, strongly made Cabinet (size approx. 14 x 14 x 7in.) finished in attractive and durable policrome, and fitted carrying handle. Terms. Deposit **£1** and 9 monthly payments of **£1.**

£8.19.6 Carr. 10/-

Senior 10 watts High Fidelity output Separate Bass and Treble "Cut" and "Boost" controls. Twin separately controlled high gain inputs so that two instruments such as Guitar and String Bass can be used at the same time. Two loudspeakers are incorporated, a high Flux 12in. for Bass notes and a 7 x 4 in. elliptical for Treble. Cabinet is well made and finished as Junior model. Size approx. 18 x 18 x 9in. H.P. Terms. Deposit **34/9** and 9 monthly payments of **34/9.** Carr. 10/-.

15 Gns.

Super Hi-Fi 15 Watt. All facilities as 10 watt. Cabinet size 20 x 15 x 13ins. Terms: Deposit **£2.11.6**, and nine monthly payments of **51/6. 22 gns.** Carr. 12/6.

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STANDARD MODEL. As above but for 12in. speakers. Size 20 x 15 x 13in. Especially recommended for Plessey Dual Concentric Speaker, **£5.19.6.** Suitable legs with brass ferrules, **25/-** per set of 4.
AUDIOTRON CORNER CONSOLE CABINETS. Polished walnut veneer finish. Pleasing design. Size 27x18x8ins. for 8 or 10in. speaker. **4 Gns.**
PLESSEY DUAL CONCENTRIC 12in. 15 ohms HIGH FIDELITY SPEAKER (12,000 lines) with built-in tweeter (completely separate elliptical speaker with choke, condensers, etc.) providing extraordinarily realistic reproduction when used with our A11 or similar amplifier. Rated 10 watts. Price only **£5.19.6.**
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TWEETERS. Plessey 3Ω **19/9**, 15Ω **25/9.**
HI-FI CRYSTAL PICK-UP HEADS. (Turnover type with sapphire stylus.) Acos. Standard replacement for Garrard, B.S.R. and Collaro, **19/9.** Acos Stereo-Monaural **49/9.** Ronette Stereo/Monaural **59/6.**
R.S.C. EQUIPMENT CABINET. Dimensions and outer appearance identical with Standard Bass Reflex Cabinet. Top hinged Bass board adjustable. Will take Tape Deck or Player Unit, and Amplifier plus F.M. or A.M./F.M. Unit. Only **6 gns.**
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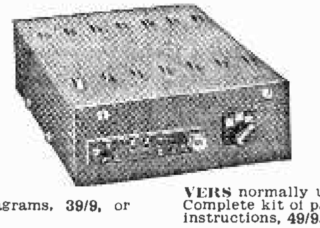
Type BM1. An all-dry battery eliminator. Size 5½ x 4½ x 2in. approx. Completely replaces battery supplying 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s is available. **Suitable for all battery portable receivers requiring 1.4 v. and 90 v.** This includes latest low consumption types.

Complete kit with diagrams, **39/9**, or ready to use, **46/6.**



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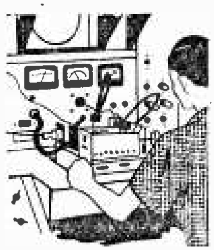

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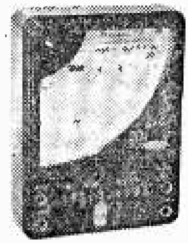

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Ranges: D.C. Voltage: 0-6-30-120-600-1,200 v. (10,000 o.p.v.).
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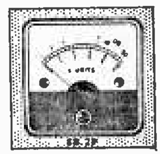
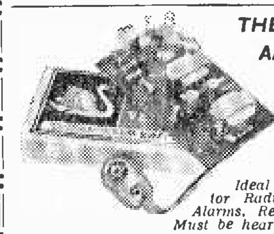
Precision built clear plastic miniature type. Featuring d'arsonval movements, jewelled bearing, silvered dials with black numerals and pointers. 1.21/32" square fronts, 1¼" overall depth. Owing to colossal sales of these meters our range has now been increased to include the following:

5 mA 27/6; 300 v. D.C. 27/6

all other types as previously advertised are still available.



THE MOST USEFUL AMPLIFIER EVER PRODUCED!



4 TRANSISTOR PUSH-PULL AMPLIFIER

Ideal for making powerful Transistor Radios, Tape Recorders, Baby Alarms, Record Player, Intercom., etc. Must be heard to be appreciated.

NOT A KIT—READY BUILT UNIT ONLY **52/6** P. & P. 1/6

WILL MATCH OUR 8 ohm Speaker at 16/6: Lapel Mike at 17/6: Telephone Pick-up Coil at 14/-. Can be run off PP3 at 2/6 or off A.C. Mains with our 1 A6P Battery Eliminator at 29/6.

TELEPHONE PICK-UP COIL

Suction type. Feeds into mike input of all Amplifiers, Tape Recorders, etc. Ideal for recording telephone conversations. ONLY **14/-** P. & P. 1/-.

HOW WOULD YOU LIKE TO OWN A TRANSISTORISED

RECORD PLAYER — RADIO
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ALL FOR ONLY

£6.19.6 P. & P. 5/-.

The following equipment, offered for the first time in this country, can be used to make any or all of the above units. Attractive carrying case, 45 r.p.m. motor unit with arm and Hi-Fi head, 2½in. super quality speaker, 4 transistor multi-purpose power amplifier. Crystal lapel microphone, M.W. coil, tuning condenser, crystal diode, volume control, plugs and sockets, all necessary components, wire solder, nuts and bolts, etc., and full easy to follow assembly instructions. (Batteries 5/- extra).

Send S.A.E. for leaflet

MINIATURE COMPONENTS

As previously advertised

PS.35 Sub-miniature plug and socket ..	3/6 pr.
CB.25 "Tiny" plug and socket	2/6 pr.
Telescopic 7"-30" Aerial	8/6 ea.
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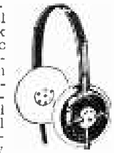
Please add P. & P. on above items

SF-20 RADIO EARPHONES



Hi-impedance-2,000 ohms-general use headset. Black and Ivory plastic cased electro-magnetic units with adjustable headband for comfortable fit. Individual listening for all types of applications. Individually packed, with flexible cord attached. 14/6, post paid.

PORTABLE MAINS SOLDERING IRON MODEL SP1

30 watts. For lightweight applications. Highly stable heat characteristics ensure long life and safety in use. Features a removable handle that may be used to cover the tip and barrel to permit the iron to be carried safely even while hot. Complete with Vinyl bag, mains lead and plug. All for only 18/9.

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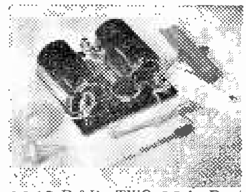

Can be set up with others for network practice in classrooms, groups, house to house, etc. Adjustable spring tension and contact clearance. Complete with buzzer, 50ft. wire on reel, ground spike and wire, crystal earphone, morse sheet. Only 6 ounces. Uses 1.5 v. battery.

19/6 P.&P. 2/6. TWO FOR **40/-** Post Free

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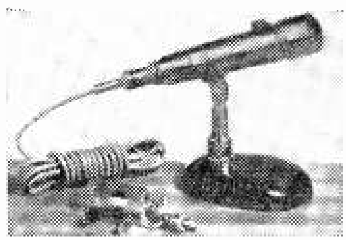


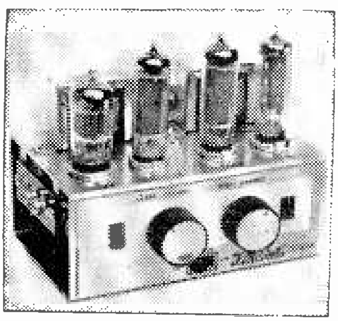
MODEL 100C

May be hand-held, stand mounted (either floor stand or desk stand) or suspended by lavalier cord. Response 60-10,000 Cps. Built in on/off switch. Output level—52db. Omni-directional head. Clips on or off standard stand adaptor permitting tilting for multi-angle use. Satin chrome finish.

Supplied complete with 7ft. of shielded cable, lavalier cord and desk stand.
Brand new Floor Stand and Base, suitable for above, 65/-. Carriage Paid.

ONLY **48/-**

TRUTEST 5 watt STEREO AMPLIFIER



- Individual Stereo Volume Balance Controls
- For both Stereo and Monaural
- Fully wired, ready for Stereo

Controls include stereo/mono switch, tone control switch and on/off switch. Inputs for crystal or ceramic cartridge. Speaker output terminals. A.C. mains. 230 v. Size 4¼ x 5¼ x 4¼in.

£6.19.6

Never before such value!

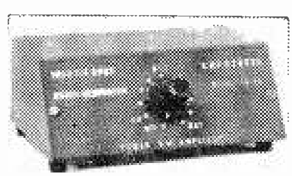
PORTABLE TRANS/RECEIVER SETS

Consisting of trans/receiver covering 7.4-9 Mc/s range up to 10 miles, complete with 5 valves, headphones, microphone, junction box and 6ft. telescopic aerial. Only requires 120 v. and 3 v. dry battery.

ONLY **60/-** Per Set P. & P. 4/-.

TWO FOR £6. Post Free
BATTERIES 20/- per set.

TRANSISTORISED 1000 C/S SPOT AUDIO GENERATOR



Battery operated simplest operation. Ideal for all types of alignment of amplifiers, receivers, transmitters. Used for measurement of gain, fault finding, distortion. Test all audio requirements. 39/

BRAND NEW PYE COMMUNICATION RECEIVERS

World coverage on these famous Communication Receivers. They are the simplest type to use yet bring in stations that will amaze you. The ideal domestic receiver for medium wave during the day with Amateur stations at night. **All have been converted to 230 v. A.C. mains and are guaranteed to work immediately.** Incorporate Wave Switch, Audio gain aerial trimmer, high and low tone control, station locking device, aerial and earth inputs, speaker output sockets, etc. Size 17 x 8 x 9½in. Black crackle finish front panel. On demonstration at 87 Tottenham Court Road.
P.C.R. Medium and long waves and 6-18 Mc/s. With speaker.

ONLY **£8.19.6** Carr. 10/6 each.

9V BATTERY CHARGER AND A.C. ELIMINATOR MODEL LA.6P

29/6 P.P. 1/6

A "MUST" for every transistor set owner! Over 20,000 already sold. Rush your order NOW.

Save those batteries by running your transistor set direct from A.C. Mains. Reactivate all your old 9V batteries.
Unit contains neon indicator and standard battery connections with nearly 2 yards of mains lead and plug. Also snap cord for connection to set.

BOOSTER TRANSISTOR RADIO SPEAKER

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Designed for use with transistor radios, valve radios, car radios, amplifiers, where quality reproduction of sound is required. Plugs into earpiece output socket of nearly all miniature sets. The cabinet is finished in beige leather with contemporary gold baffles at each end. Complete with 12ft. extension cord fitted with miniature plugs, individually cartoned and guaranteed. Size: 9½in. x 3¼in. diameter. **57/6** P. & P. 2/6.

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Superhet 7 v. 5 Waveband Chassis. Unused, less valves and power pack, **75/-.** Coil pack worth twice as much. Carriage and insurance 7/6.

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Transistor A.F. Equivalent to red spot. Sale price **2/6. 24/-** doz.

Bakelite Wall Switch, household type, **6/-** doz., one way **8/-** doz. two way.

Wall Switch by Crabtree, two way and off. Sale price **1/-** each.

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Multi-speed Motor with gearbox, works on A.C. or D.C. mains, gives any speed from 1 r.p.m. Sale price **17/6,** plus 2/6 postage.

Chest Microphone. excellent American make with adjustable mouthpiece, **6/6,** plus 1/6.

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R.F. 25 Tuner Unit. complete, new condition, Sale price **8/6.** plus 2/6 post.

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Packard Bell Pre-Amp. complete with 6SL7 and 28D7 valves, relay, leads, jacks, input and output transformers, etc., **7/6.** Plus 2/- post less case.

VCR517 Cathode Ray Tube is a plug in replacement for the VCR97, **8/6,** carriage and insurance **4/6.**

10 Valve 1½ metre Superhet contains 9 valves, 6 I.F. Transformers and hundreds of useful spares. Brand new **29/6.** Carriage and insurance **10/-.**

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Rotary Switch by Arrow carry 15 amp. A.C. 4 position hot, on, cold, off. Suitable hair drier, air-conditioning plant etc. **3/6,** post 1/-.

Sapphire Gramophone Needles, miniature or standard **78** r.p.m. type, **12/-** doz. **1/6** each.

Push-Pull Transformers, input and output, midget potted. Sale price **5/-** pair, plus 1/6.

Metal Rectifiers. 250 v. 60-80 mA, ideal for mains set or instrument, or to replace that expensive valve. Sale price 3/6.

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P.O. Type 3000 Relays. 2,000 ohm coil, 6 contacts **7/6.** 4 contacts **6/6,** 2 contacts **5/6.** plus postage 1/-.

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Centre Zero Meter 3½in. movement. Flush mounting, 500-0-500 micro Amp. Sale price **30/-,** plus 1/6 post.

Unbreakable mains leads, as fitted to electric razors, etc. Makes ideal lead for test meters. Twin 6ft. long **6d.** per lead, **5/-** doz.

MOST POPULAR PORTABLES or CAR RADIOS

" Works better than my 25 gn. '———' ! "

We hear this remark so many times and feel this is why our Companion portables are growing more and more popular.

The "Good Companion" Mk.II

In the "de-luxe" cabinet as illustrated it costs £10.19.6 to build—but what a set!

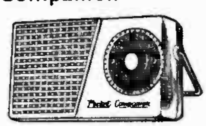
Scan these pages you will find nothing to compare with its specification. It uses transfilters instead of I.F. transformers, has variable feedback as well as all the usual features, A.V.C., Push-pull output, Ferrite Aerial, Slow Motion Tuning, etc. etc., and is a very powerful Medium & Long Wave set, conservatively rated at 750 mW. Every component used is by a famous maker, such as American Philco MADT R.F. transistors—Mullard A.F. transistors—Jackson Brother's tuning condensers—Rola-Celestion loudspeaker—Dubilier—T.C.C.—Morganite resistors and controls. Also full after sales service available.

You will definitely be doing the right thing if you buy a Good Companion.

The "Tremendo Companion"

If you don't mind the battery consumption being a little higher and you want really big output then order The "Tremendo". This has an undistorted output of almost 1¼ watts and is probably the most powerful home constructor set available today. Complete building cost of this is **£11.5.0,** which includes the transfilter (Mk.II circuit) batteries, cost **3/6** (two required).

The "Pocket Companion"



This is without doubt the most modern and best pocket set available. It uses the very latest I.F. transfilters, Philco R.F. transistors, airspaced tuning condenser in Superhet circuit covering M.W. and L.W. Complete building cost **£6.15.0.** Battery 2/-. Post & ins. 2/6. Data free with parts or separately 2/6.

T.R.F. POCKET PORTABLES

Still available as previously advertised, all are complete and with cabinet similar to "Pocket Companion".

THE "PIMPERNEL"

Five transistors, 3in. Moving Coil Speaker. **79/6.** plus 2/6 postage and insurance.

THE POCKET "4"

Undoubtedly the easiest to build set available, three transistors and one diode. **42/6.** plus 2/6 postage and insurance.

THE SOLDERLESS "3"

Two transistors, miniature earphone. Assembled like a Meccano set, ideal for juveniles and beginners. **37/6.** plus 2/6 postage and insurance.

CABINET AND PICK-UP

Cabinet for battery record player. Size approx. 9 x 11 x 5in. allows for 7 x 4in. speaker and amplifier. Nicely covered two tone. Must have cost at least £2 to make. New and perfect. Offered whilst stocks last 27/6. plus 4/6 post and insurance.

Cosmocord Pick-up

As illustrated with cartridge and headrest. Ready, new and perfect. Suitable for 45 or 33 records. Price **12/6.** plus 2/6 post and insurance.

Extra Special Offer

The above two items if ordered together will be supplied for **37/6,** plus 4/6 postage and insurance.

CLEARING DEPOT!

MORE unused, good quality equipment is being offered at very keen prices.

Mains Transformer, drop through chassis type, 250-0-250 v. at 80 mA, 6.3 v. at 2 amps, **12/6,** plus 2/6 post.

Mains Transformer, drop through chassis type, 250-0-250, 80 mA, 6.3 v., 2 amp. 5 v. 10 amp., **15/-,** plus post 2/6.

Filament Transformer. Upright mains type, 6.3 v., 1½ amp, **6/6** post 1/-.

Filament Transformer. upright Mtg. 6.3 v. 3 amp., unused, but tag panels **8/6** each, post 1/-.

Close Tolerance Mica Condensers. 50 assorted values up to 1,000 pF, **12/6.**

Double Fuse Holder Panel. Mounted for standard fuses, **2/-.**

Spindle Couplers for joining or extending **¼ in.** spindles, **6d.** each or **5/-** per dozen.

Octopus Clip adjustable, up to 4in. diameter, for joining hoses to poles etc., **6d.** each.

Torch or Radio Bulbs. 3.5 v. .3 amp or **2.5 v.** .3 amp., 3/6 per box of 25.

Precision Stud Switch. Made by Muirhead, 4 banks, 24 positions each, **17/6,** plus 1/6 post.

Wiring Cleats suitable for temporary lighting, 2 groove **1/9,** dozen pairs, 3 groove **2/-** dozen pairs, post 2/6.

Charging Cut-out Bakelite Case, suitable **6, 12** or 24 volts, **9/6,** plus 1/- post.

12 v. 5 amp. Selenium Charging Rectifier. 9/6, plus 2/- carriage.

Beginners Superhet. All components including metal chassis, valves, metal rectifier, coils, tuning condenser etc., with instructions, **£2.** post 3/-.

Don't stumble in the Dark. Two way switch outfit, comprises 30 yards multicore cable. Two 2 way switches, 2 wood blocks and full instructions. Price **9/6.** plus post and insurance 2/6.

Microphone miniature type. American made dynamic, size only 1⅛in. diameter, **2/6.**

Push Switch. Spring return on porcelain block, ideal basis of foot switch for sewing machine etc., price **4/6.** 1/- post.

Rotary Converter. doubles or halves car battery voltages. Thus you can have 12 v. from 6 v. battery, or v. from 12 v. battery. 24 from 12, etc., price **45/-,** plus 3/6 post.

Set o' I.F. Transformers for communications receiver, first class American make, **19/6** a set of 7, post etc., 1/-.

Power Resistor. 1,000 ohms tapped at 600, 300, 75 and 75. Conservatively rated 75 watts, **4/6.** post etc. 1/-.

Battery Charger or Power Pack, output variable 160-200 v. at ½ amp., in metal case, **27/6,** post etc. **5/-.**

Dashpot Delayed Contactor. American make type No. R011D, adjustment to delay opening or closing. Heavy duty contacts and secondary microswitch. Operating coil voltage 110 at 50 cycles, but can be used off 230 v. mains through stepdown transformer, choke etc. Price **37/6.** post etc. 2/-.

Toggle Switch, standard type, metal body. Borgin or similar good maker, **1/3** each, or **12/-** dozen.

Silicon Diodes. these are okay for h.f. or l.f., and have a very high backward/forward ratio: **2/6** each, or 6 for **12/-.**

Trigger Valve-gas filled type No. G240/2D on octal base. Price **9/6,** post and insurance 1/6. (8).

Voltage Stabilizer type No. N82 striking volts 140, operating volts 87, regulation 5 v. at 30-180 mA. Mounted on 4 pin base. Price 8/6, plus 1/6 post and insurance.

Suppressor Condenser. Stop your drill or other appliance interfering with yours or your neighbours radio or T.V. Simple instructions **1/6** each.

Medresco Hearing Aid as supplied by National Health. New and in good working order. Complete with case, plugs and earphone, but not batteries. Price **£3.15.0,** plus 1/6 postage and insurance.

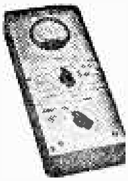
Please include enough for postage and request "Clearing Depot List", for details of many other items.

Introducing the J.B. Range of Transistors

Try these, you will be very pleased——

JB1. All wave mixer (replaces OC45 etc.) .. 6/6
JB3. I.F. Amplifier (replaces OC44 etc.) .. 4/6
JB4. A.F. Driver (replaces OC81D etc.) .. 5/-
JB6. Output matched pair (replaces OC81 etc.) .. 13/-
Special offer set of six matched for superhet 25/-
Special offer set of four matched for Amplifier (1 watt) .. 17/-

A.C./D.C. Multimeter Kit

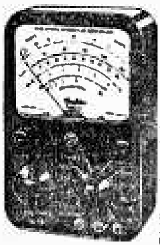


Ranges: D.C. volts 0-5, 0-50, 0-100, 0-500, 0-1,000 A.C. volts 0-5, 0-50, 0-100, 0-500, 0-1,000 D.C. milliamps 0-5, 0-100, 0-500. Ohms 0-50,000 with internal batteries. 0-500,000 with external batteries Measures A.C./D.C. volts, D.C. current and ohms. All the essential parts including metal case, 2in. moving coil meter, selected resistors, wire for shunts, range selector, switches, calibrated scale and full instructions. Price 24/6, plus 2/6 post and insurance.

Blueprint Receiver

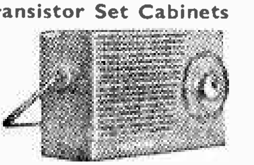
The Regency (April). All parts available for this receiver 75/-. A suitable cabinet, 25/- extra.

The Taylor Meter Model 127A



A pocket size meter but with a big scale and a sensitivity of 20,000 ohms per volt D.C., therefor an ideal unit for television servicing—robustly made and complete with leads and prods—20 ranges as follows: D.C. current 50 microamps. to 1 amp. D.C. voltages—0-1,000 volt in seven ranges (25 kV) with external probe, optional extra. Volts A.C.—0-2,500 in six ranges. Ohms—0-20 meg. ohm in three ranges (self-controlled). Self-contained. 3in. movement. Price £10 or 10/- deposit and 23 fortnightly payments of 10/-. Non-callers add 5/-, carriage and insurance.

Transistor Set Cabinets

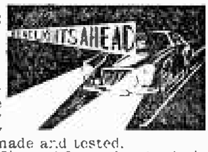


Very modern cream cabinet, size 5¼ x 3 x 1⅝in. with chrome handle, tuning knob and scale. Price 7/6, plus 1/6 postage and packing.
Special quotations for quantities.

P.W. BLUEPRINT SERVICE

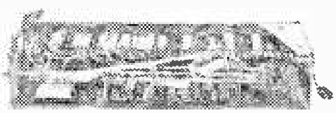
We try to hold stocks of parts for all the P.W. Blueprint sets, and we will be glad to help you. When ordering please mention the month of issue and the of the Blueprint set in question. Mark your order P.W. Blueprint Service.

"DIPYT" Automatic Headlamp Dimmer



A transistorised device for automatically dipping headlamps so leaving driver's hands and feet free for emergency, could easily avoid an accident. We now offer such a device ready made and tested.
The unit measures 5 x 2 x 5in. and fits under the dash, it is very easy to wire into the circuit and can also be used to control side lamps for parking.
Price of unit is £10.19.6, carr. paid, diagram and instructions free with unit or separate 2/6. (Agents Wanted).

THIS MONTH'S SNIP

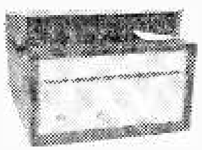


BREAKDOWN UNIT. Contains a mass of components, and must have cost the Government at least £20.
Contents:- Over 50 paper tubular and mica condensers values up to .05 mFd. Over 50 carbon resistors, various wattages and values—6 Yaxley switches—6 I.F. transformers, dust covered suitable for TV or rewinding—7 octal valve holders.
Many useful sundries—chokes, valve top clips, tag boards, plugs, switch, springs, etc., weighs 6lbs.
Secure one of these whilst stocks last, price only 9/6, plus 3/6, postage and packing.

TRANSFILTERS

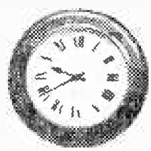
These ceramic devices save alignment problems and improve performance. Use instead of I.F. transformer. Complete with circuit, 8/6 each.

PHILCO RECORD PLAYER CABINET



Two tone, covered with high grade rexine, fitted with rubber feet. The front is particularly nice being made of tygan with a horizontal gold bar. Size approximately 14½in. wide, 8½in. deep, 16½in. long. Will take BSR or similar record player or tape deck and amplifier. Must have cost at least £3 each, our special snip price 35/- each. carriage and insurance 6/6.

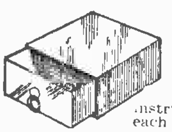
11" WALLCLOCK



Ex G.P.O. impulse operated, in good working order.

Bargain at **15/-** plus 4/6. post and insurance.

Component Storage Drawers



Stout board construction, these drawers are ideal for small parts. Supplied complete with simple erection instructions—1/6 each or 12 drawers each 6 x 2¼ x 6¼in., 13/6, post 2/-.

Yaxley Switches

All new and unused and in first class condition

1 pole, 2 way	1/6;	1 pole, 3 way	1/6
1 pole, 4 way	1/9;	1 pole, 5 way	2/6
1 pole, 7 way	3/-;	1 pole, 9 way	3/-
1 pole, 11 way	3/-	1 pole, 12 way	3/3
2 pole, 2 way	2/-;	2 pole, 4 way	2/6
2 pole, 5 way	3/6	2 pole, 6 way	3/6
2 pole, 12 way	5/6	3 pole, 3 way	2/-
3 pole, 6 way	3/6;	3 pole, 12 way	8/6
4 pole, 2 way	2/-;	4 pole, 3 way	3/-
4 pole, 4 way	3/6;	4 pole, 5 way	4/6
4 pole, 6 way	5/6;	4 pole, 11 way	10/6
4 pole, 12 way	11/6;	5 pole, 3 way	3/6
5 pole, 6 way	7/-;	5 pole, 12 way	14/6
6 pole, 2 way	2/6;	6 pole, 3 way	3/6
6 pole, 6 way	8/6;	6 pole, 11 way	16/6
6 pole, 12 way	17/6;	8 pole, 2 way	3/6
8 pole, 4 way	4/6;	8 pole, 6 way	11/6
8 pole, 12 way	23/6;	12 pole, 2 way	3/6
12 pole, 5 way	16/6;	12 way fader	3/6

6 pole, 6 way, shorting 3/6

Big stocks of most types
Special prices for quantities.

Blueprint Receiver

The International SW2

All components to make up this receiver as described in the April issue are available. Price 39/6, plus 2/6 postage and insurance. Note this price does not include cabinet, baking tin or headphone.

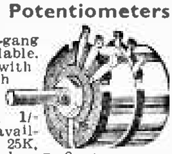
Motor with blower attached

24 volts D.C., but will work on 12 volts. For cooling equipment or can be adapted as car heater. 15/-, plus 1/6.

Rotary Converter

24 volts D.C. to 230 volts, 50 cycle A.C. with automatic regulator, this is complete in a grey steel case for silent running and it is rated 100 watts though this is a Navy rating, which usually can be considerably exceeded. Ideal to operate TV set on boat, etc. These are big units and can only be viewed by prior arrangement. Price £27.10.0 each, carriage at cost.

Morganite Potentiometers



Single and 2-gang types available, standard size with good length spindle, all new and boxed. **Single types**, 1/- each, values available: 5K, 10K, 25K, 50K, 100K, 250K, 1 meg., 2 meg.
Gang type 3/- each—values available: 5K + 5K, 100K ± 100K ½ meg. ± ½ meg. 2 meg. ± 2 meg.

Infra Red Monocular Equipment

This is portable equipment, made originally for military use. It is a complete viewing device, having an infra red cell with optical lens system and Zambini pile to provide the EHT. Complete with leather case for easy carrying, these devices are sold in their sealed packages as collected from the Ministry, and they must not be opened during the daylight. Sold as received, believed to be in good working order, but without guarantee. Price £4.10.0, plus 5/- carriage and insurance.

Transistor Components

Send S.A.E. for our new price list, just printed.

ELECTRONIC PRECISION EQUIPMENT LTD.

post orders are dealt with from Eastbourne, so for prompt attention please post your orders to 66 Grove Road, Eastbourne, marked Department 7. Callers may use any one of the Companies below.

266 London Road, Croydon.	29 Stroud Green Rd., Finsbury Park, N.4.	520 High Street North Manor Park, E.12.	42-46 Windmill Hill, Ruislip, Middx.	246 High Street, Harlesden, N.W.10.
Phone: CRO 6558	Phone: ARChway 1049	Phone: ILFord 1011	Phone: RUIslip 5780	Phone: ELGar 4444
Half day Wednesday	Half day Thursday	Half day Thursday	Half day Wednesday	Half day Thursday

UNIVERSAL AVOMETERS
Guaranteed perfect working order. Supplied complete with Leads, Batteries and Instructions.
Model "D", 34 range .. £8.19.6
Model "7", 50 range .. £11.10.0
Model "8", 20,000 Ω/volt model .... 15 Gns.
Registered Post 5/- extra.

SET OF S.T.C. TRANSISTORS
1 R.F., 2 x I.F., 1 driver, 2 x output plus GD17 diode. Brand New, 19/6. P. & P. 9d.

MINE DETECTORS No. 4A
Will detect all types of metal. Complete equipment with instructions. 39/6. Carr. 10/6. Batteries 8/- extra.

AUTO TRANSFORMER
Step Up. Step Down. 115-200-250 volts. 15 w. 9/-; 60 w. 12/6; 150 w. 18/6; 500 w. 67/6; 1000 w. 99/6. Postage extra. 1500 w. £6.19.6.

Class D. WAVEMETERS No. 2
Frequency coverage 1.2-19.2 Mc/s. Operation 12 volt D.C. or 230 volt A.C. Complete with valves, crystal and calib. charts (Like BC.221). Complete with valves, crystal £6.19.6. Carriage 10/-.

230/250 volt A.C. MOTORS
Size 4in. x 3in. dia. 90 watt rating. 5,000 r.p.m. ¼in. drive shaft. Brand New. 22/6 each. P. & P. 1/6.

SELENIUM L.T. RECTIFIERS
Full wave bridge connected.

12/18v. 1½A.	3/9	24/36v. 2A.	9/9
12/18v. 2½A.	6/3	24/36v. 4A.	15/9
12/18v. 4A.	8/6	24/36v. 10A.	45/-
12/18v. 5A.	11/9	24/36v. 15A.	47/6
12/18v. 6A.	12/3	48/60v. 2A.	18/6
12/18v. 10A.	22/6	48/60v. 10A.	82/6
12/18v. 15A.	37/6	PLEASE ADD	
24/36v. 1A.	7/3	POSTAGE.	

L.T. TRANSFORMERS
All Primaries tapped 200/250 volts.
3.5, 9 or 17 volts, 1 amp......9/9
Ditto 2 amp, 14/3. Ditto 4 amp, 16/6
9 or 17 volt, 6 amp..............26/-
3, 4, 5, 6, 8, 10, 12, 18, 20, 24 or 30 volt, 2 amp..................18/6
Ditto 4 amp......................27/6
Please add postage.

PARMEKO TABLE TOP TRANSFORMER
230v. Primary, 620-0-620v. 250 mA, tapped 550 and 375v. 2 x 5v. 3 amp, 45/- each. P. & P. 5/-.

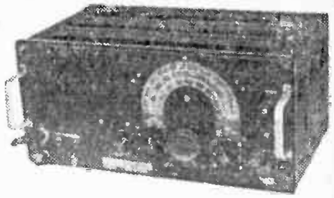
PAINTON MINIATURE JONES PLUGS/SOCKETS
2 pin. 2/6 pr.; 4-pin. 3/6 pr.; 6-pin. 4/- pr.; 8-pin. 4/6 pr.; 12-pin. 5/6 pr.; 33-pin. 10/6 pr. Postage extra.

G.E.C. SELECTEST MULTI-RANGE TESTMETERS

1,000 ohms per volt. 37 ranges. A.C./D.C. Fitted with automatic cut out. Supplied in perfect condition. Complete with batteries and leads. £9.19.6 each. Reg. post 5/- extra.

P.C.R. COMMUNICATION RECEIVERS
6 valves. Frequency coverage on three bands: 850-2,000 metres, 190-550 metres, 6-18 Mc/s. Super slow motion drive, A.E. trimmer, tone control, built-in speaker. AS NEW £6.19.6. Carriage 7/6.

P.C.R.3 Communications Receiver. 190-550 metres, 2-7 Mc/s, 7-23 Mc/s. Output for phone or 3Ω speaker AS NEW 8 Gns. Carr. 7/6. Both above models are available with internal power unit to operate on 200/250 volt A.C. at 39/6 extra or alternatively plug-in external power units are 35/-.



Circuit and details supplied.

R.C.A. AR88 L.F. RECEIVERS
World famous 14 valve receiver. Frequency coverage on six bands 75-550 kc/s and 1.5-30 Mc/s. Variable selectivity, crystal, B.F.O., mechanical bandspread, noise limiter, etc. operation 110/200/250V A.C. output for phone or 3Ω speaker. Supplied in perfect working order. £32.10.0 ea. Carr. 30/-.

NATIONAL H.R.O. RECEIVERS
Senior Model, table or rack mounting. Supplied with a full set of 9 coils covering 50kc/s-30Mc/s. Special features include: S meter, crystal phasing, B.F.O. etc. Output for phones or speaker. Supplied fully tested, superb condition throughout, 21 Gns. Carr. 10/-. Power units available 59/6 extra.

R.206 MARK II RECEIVERS
Superb Receivers covering 550 kc/s-30 Mc/s on 6 bands. B.F.O. variable bandwidth, noise limiter, etc. Output for speaker or phones. Power requirements 250v. H.T., 12v. L.T. Supplied brand new and fully tested. £15 each. Carriage £2 extra.

CLASS "D" WAVEMETERS MK. II
Frequency coverage, 1,900-4,000 kc/s and 4,000-8,000 kc/s. 6 volt D.C. input. Supplied complete with crystal and spare 6 volt vibrator. Brand New with instructions. 59/6 each. P. & P. 3/6.

COLLARO STUDIO TAPE TRANSCRIPTORS
Very latest model with interlock button and fitted with Bradmatic heads, 3 speeds, 1⅞", 3¾", 7½" per sec., 3 motors, digital counter, press button switching. Complete with instructions and spare 7-inch spool. Supplied Brand New and Guaranteed. 10 Gns. each. P. & P. 3/6.

FIELD TELEPHONES TYPE F
Ideal for all intercom. systems, house, garage, office building sites, etc. Generator bell ringing, 2 line connection. Supplied complete with batteries and wooden carrying case, fully tested. £4.19.6 per pair. P. & P. 5/-.

COMBINATION PRECISION VOLTMETER/AMMETER
A.C. and D.C. 2 separate precision instruments housed in polished wood case. Manufactured by Elliott Bros. 6in. scales, knife edge pointers, Ranges: Volts A.C. and D.C. 160, 300 and 600 volts. Amps A.C. and D.C. 25, 50, 150 and 200 amp. Supplied with all current shunts, leads and leather carrying case. Ideal for labs, schools, etc. Brand New, fully checked. £9.19.6 each. Carriage 7/6.

TRANSISTOR BARGAINS

XA103	3/6	XA123	7/6	OC45	6/6	White Spot	3/-
XA104	4/6	XA124	7/6	OC44	6/6	Yellow Spot	2/6
XB112	3/-	XA125	7/6	OC75	6/6	Yellow Green	3/-
XC141	10/-	XA126	7/6	OC74 pr.	12/6	Yellow/Red	4/6

Please add postage.

R.C.A. AR88D RECEIVERS
14 valves. Frequency coverage on 6 bands 550 kc/s-32 Mc/s. Variable selectivity, crystal, B.F.O., mechanical bandspread, noise limiter, etc. Operation 110/200/250 volt A.C. Output for phone or speaker. £35 each. Carriage 30/-.

C.B.S. AMERICAN RECORDING TAPE
Finest quality by the most famous American Co.
All fitted with Leader Tape and Stop Foil.

5in. std. play. 600ft. ..	13/-	5¾in. dble. play. 1800ft...	37/-
5in. long play, 900ft ..	16/6	7in. std. play, 1200ft ..	21/-
5in. dble play 1200ft..	32/-	7in. long play, 1800ft ..	28/6
5¾in. long play, 1200ft	19/6	7in. dble play, 2400ft ..	47/-

Spare Spools: 3in. 1/-, 4in. 1/9, 5in. 2/-, 5¾in. 2/3, 7in. 2/6.
Plastic Spool Containers: 5in. 1/6, 5¾in. 2/-, 7in. 2/3.
SEND FOR FULL LISTS. *Please Add Postage*

COLLINS T.C.S. RECEIVERS
Superb 7 valve short wave receivers. Frequency coverage on 3 bands 1.5-12 Mc/s. Circuit incorporates B.F.O., R.F. and A.F. gain controls, etc. Power requirements 225 v. H.T., 4 v. L.T. Supplied brand new with circuit. £6.19.6 ea. Carr. 7/6.

SET OF MULLARD TRANSISTORS
1xOC44, 2xOC45, 1xOC81D, 2xOC81. Brand New, 30/-. P. & P. 9d.

CADMIUM SULPHIDE PHOTOCELLS
Type PX1/1. Sub-miniature, wire ended. Extremely sensitive. 12/6 each. P. & P. 6d. Data supplied.

PERSONAL EARPHONES
Complete with Lead, Jack and Plug. Available High (crystal) or Low (mag.) imp. 5/- each. P. & P. 6d.

CR.100 SPARES KITS
Contain 15 valves, condenser and resistor packs, pots, output transformer, etc. Brand New, 59/6 each. P. & P. 3/6.

24 D.C. volt PUMPS
100 G.P.H. impeller type. 15/6 each. P. & P. 2/6.

B.T.H. 18-inch SPEAKERS
Heavy Duty type, 15 ohm speech coil. £9.19.6 each. Carriage 10/-.

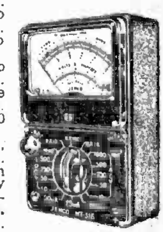
PRECISION A.C./D.C. VOLTMETERS
0-160v. and 0-320v. 8in. mirror scale with knife edge pointer. Housed in polished wooden cases, ideal for schools, labs., etc. Supplied brand new. £5.19.6 each. P. & P. 3/6.

AR88D SPARES
Complete Wavechange Switch Assembly with Screens, New, Boxed 17/6 each. P. & P. 2/6. 1st I.F. Transformer, Boxed, 3/6. P. & P. 9d.

1,000 watt ISOLATION TRANSFORMERS
230 volt Primary, 230 volt Secondary. Ex-Admiralty. Boxed, £5 each. Carriage 10/-.

7.5 kVA AUTO TRANSFORMER
Step Up, Step Down. 115-230 volts. Brand New. Boxed. £15 each. Carriage 10/-.

20,000 O.P.V. TESTMETERS
A.C. and D.C. voltage up to 1000 v. D.C. Current up to 500 mA. Resistance up to 5 megohm. Capacitance up to 0.1 mFd. Decibels —20 to +36. Brand New, Guaranteed. Supplied with Leads, Battery and instructions. 5 Gns. each. P. & P. 2/6.



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

Practical Wireless

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Contents

ANOTHER BLUEPRINT

ANOTHER double-sided blueprint is presented free with every copy of this issue; the two sides cover Designs Nos. 3 and 6 in our series of six graded constructional articles. Design No. 3 (The Troubadour) is a seven-transistor pocket portable receiver which has been designed to fit into a readily available plastic cabinet. Blueprint 3 gives complete details of the circuit employed in the receiver and also clear diagrams of the wiring on both sides of the paxolin panel which forms the "chassis" of the set. The diagrams are in fact considerably larger than the actual receiver and with their aid, no difficulty should be experienced in making the set. The Troubadour covers both medium and long waves and will give good reception of BBC programmes and a large number of Continental programmes (especially in the evening).

The Everest Tuner—Design No. 6—is a six-valve unit for reception of the Home, Light, and Third (or Network Three) programmes on the BBC's VHF/F.M. service. As is well known, reception of medium and long wave broadcasts, anywhere except close to the transmitter, is marred, particularly at night, by interference between stations operating on adjacent wavelengths. The broadcasts on VHF provide a means of obtaining interference-free reception over a wide area and the Everest Tuner has been designed to take account of this fact. Broadcasts on VHF are also of greater fidelity both as regards frequency response and dynamic range and the Everest will provide a high quality signal suitable for feeding to a hi-fi amplifier.

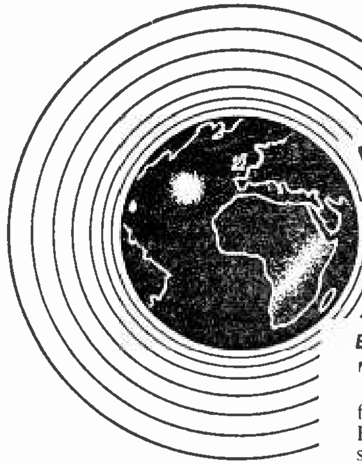
The use of switch-tuning for the three programmes simplifies the tuning of the receiver for the non-technical user and is made possible by crystal control of the local oscillator circuit in each of the three switched positions. Thus, tuning drift is eliminated and construction made easier.

COMMERCIAL RADIO

Although the report of the Pilkington Committee has not yet been received, and it is not known whether it will recommend the introduction of commercial radio stations in Great Britain, there have been several demonstrations of the form which commercial broadcasts would take if eventually permitted. One such was recently given in Bristol on closed-circuit—permission for a public broadcast had been refused. Two hours listening was provided to demonstrate the possible coverage of a day's programmes and the advertisements in the broadcasts included good support by both national firms and local traders, no charge being made for the programme time. Publicity was given in the local Press and attendance at the demonstration included representatives of more than 50 of the independent radio companies in other parts of the country.

Demonstrations of this sort seem to us to be of great value in enabling the possibilities of commercial radio to be explored without actually transmitting programmes. Certainly, it is more constructive than operating "pirate" transmitters which can only cause more overcrowding of the medium wave broadcast band.

Our next issue dated July, will be published on June 7th.



ROUND THE WORLD of WIRELESS

NEWS AT HOME AND ABROAD

Broadcast Receiving Licences

THE following statement shows the approximate number of Broadcast Receiving Licences in force at the end of February, 1962, in respect of wireless receiving stations situated within the various Postal Regions of England, Wales, Scotland and Northern Ireland. The numbers include Licences issued to blind persons without payment.

Region	*Total*
London	648,410
Home Counties	599,572
Midland	434,334
North Eastern	465,049
North Western	401,655
South Western	355,385
Wales and Border Counties	206,133
Total England and Wales	3,110,538
Scotland	335,886
Northern Ireland	107,385
Grand Total	3,553,809

Embassy Send-off for Demonstration Unit

AN attaché of the Belgian Embassy in London, M. Jean Coene, inspected a mobile demonstration unit belonging to the Westminster firm of Avo Limited before it left London for Belgium recently on an extended tour of the Continent.

The unit carries a complete range of Avo's electrical, electronic and nucleonic measuring instruments for demonstrations at Government departments, technical colleges and industrial concerns in Belgium as well as in Holland, Denmark, Sweden and Norway.

Equipment Exhibition in Milan

TO promote sales in the rapidly expanding market for electronic equipment in Italy, EMI Electronics Ltd. held a special exhibition of latest equipment in the Museo Nazionale della Scienza e della Technica in Milan during March.

Senior members of Italian industrial and scientific organisations visited the exhibition and saw films featuring the EMIDEC range of fully-transistorised electronic computers and EMI machine tool control system.

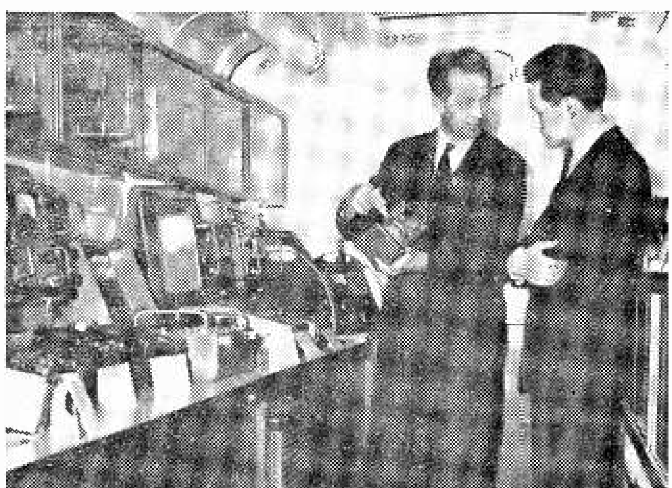
Among the exhibits were EMI closed-circuit television, nuclear health monitoring equipment, professional tape recorders, oscilloscopes, stroboscopes and special electronic tubes and valves. The EMIAC II analogue computer was also shown.

A working model of the EMI Robotug driverless truck and a scale model of an EMIDEC 1100 electronic digital computer were also displayed.

Equipment for New Ships

THREE new ships which have just been completed are fitted with radio, radar, intercommunication, navigational and other equipment supplied by the Telecommunications Division of Associated Electrical Industries Ltd. They are the "Ocean Transport", built for the Houlder Line Ltd.; the "Teakwood", for John I. Jacobs and Co. Ltd.; and the "Clan Graham", built for the Clan Line Steamers Ltd.

Equipment supplied for the "Ocean Transport" includes main W.T. R.T. transmitter,



M. Jean Coene (right), an attaché at the Belgian Embassy in London, is seen here inspecting one of the instruments in the Avo mobile demonstration unit before it left London today for Belgium on an extended tour of the Continent.

H.F. W.T. transmitter, main receiver, portable lifeboat equipment, "escort" radar, broadcast receiver with seven loudspeakers and an emergency assembly.

For the "Teakwood" the main W.T. R.T. transmitter, H.F. W.T. transmitter, main receiver, emergency assembly, portable lifeboat equipment, communal aerial system with 45 outlet boxes, escort chart plan with reflection plotter, Bergen Nautik log, echo sounder 28-channel VHF transmitter/receiver and direction finders have been supplied.

The "Clan Graham" has been fitted with a main W.T. transmitter, H.F. W.T. transmitter, main receiver, emergency assembly, 28-channel transmitter/receiver reflection plotter and broadcast receiver.

Public Address Equipment for Theatre

PUBLIC address equipment for the theatre-assembly hall at the Harrow (Middlesex) factory of Kodak Ltd. has been supplied and installed by Associated Electrical Industries Ltd. The equipment is used for dances, theatrical productions and other social functions.

The apparatus includes a main control console housing 60W amplifiers, turntable and control panels, a portable transistorised mixer unit and loudspeakers on both sides of the hall consisting of two 5ft. line source loudspeaker units, two 18in. bass speakers and two pressure horn speakers.

EEV Klystron for Marconi Traffic Radar

A NEW application for English Electric Klystrons has been found in the Marconi "Peta" Traffic Radar equipment. More than 60 sets of this equipment are now in use with police forces at home and overseas.

The klystron used in this equipment is the K357, a low voltage reflex type operating in the range 10660—10720Mc/s and giving a typical output power of 12mW.

It was specially developed by English Electric Valve Co. Ltd. for this application with its requirements for low power consumption, portability and a long and reliable life.

The Marconi Sea-EVA (Electronic Velocity Analyser), was experimentally demonstrated recently to a technical representative of the Dunlop Sports Co. Ltd. as being suitable for gathering data on golf balls.

Testing Golf Balls

TO the manufacturer of golf balls it is important to have precise and continuous information of the speed of the ball in flight, but this has hitherto been impossible.

Recently the Marconi Sea-EVA (electronic velocity analyser), the normal function of which is to provide an extremely accurate assessment of aircraft landing speeds on carriers, was experimentally demonstrated to a technical representative of the Dunlop Sports Co. Ltd. as being suitable for gathering data on golf balls. The data (velocity/time) is displayed in graphical form on a teledeltos paper recorder for subsequent analysis and storage.

Motorists Radio Service

THE Automobile Association announced today that it has asked the Pilkington Committee on Broadcasting to recommend that approval be given for the A.A. to operate an on-the-spot local road and traffic information service to motorists, obtainable through their car radios.

The A.A. has asked for a frequency on the medium wavelength on which broadcasts can be made over a radius of 10 to 12 miles, and for permission to operate a mobile broadcasting unit which would "cover" big outdoor events attracting thousands of motorists such as race meetings, agricultural shows and public displays.

An A.A. spokesman said: "As long ago as 1956 the A.A. was exploring the possibility of providing a broadcast service of information for motorists listening on car radios.

Hi-Fi in U.S. Trade Centre

HI-FI sound amplifying equipment has been installed by Associated Electrical Industries Ltd. in the United States Trade Centre in London. This is an exhibition centre where ranges of American-made goods are displayed by the manufacturers themselves or by their accredited U.K. importers to the trade in Britain. The system, ordered by the U.S. Embassy from the Sound Equipment Group of AEI Electronic Apparatus Division, is used for making announcements but later it is intended to relay music.

The large size and awkward shape of the centre presented problems which made it difficult to obtain good sound coverage. Furthermore, the difficulties were increased when exhibition stands were erected. These were overcome by siting selected loudspeakers on baffle boards which were substituted for the existing acoustic tiles of the ceiling at certain points.

PRICE 7/6

Practical Wireless

EVEREST TUNER

BLUEPRINT 6

PUBLISHED BY GEO. NEWNES LTD., TOWER HOUSE, SOUTHAMPTON STREET, LONDON W.C.2.

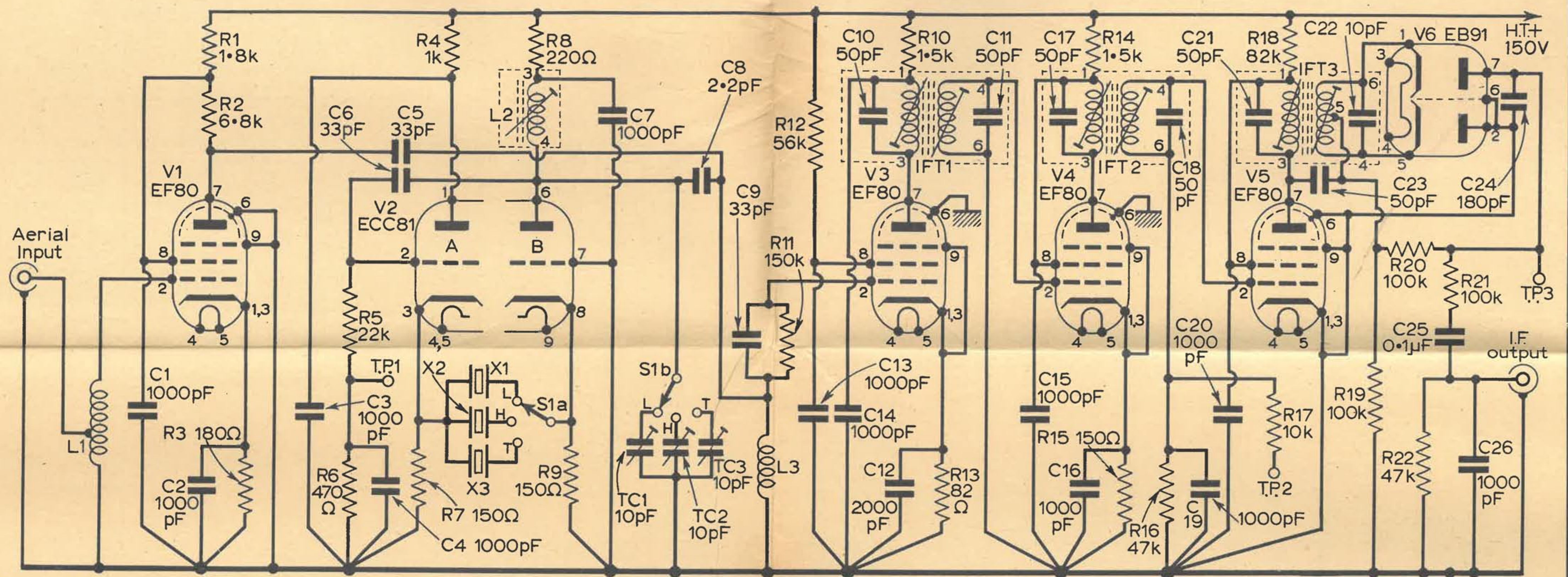


Fig. 1 — The circuit diagram.

For switch wiring see Fig. 5

Tags marked 'M.C.' denote earthing connections to chassis

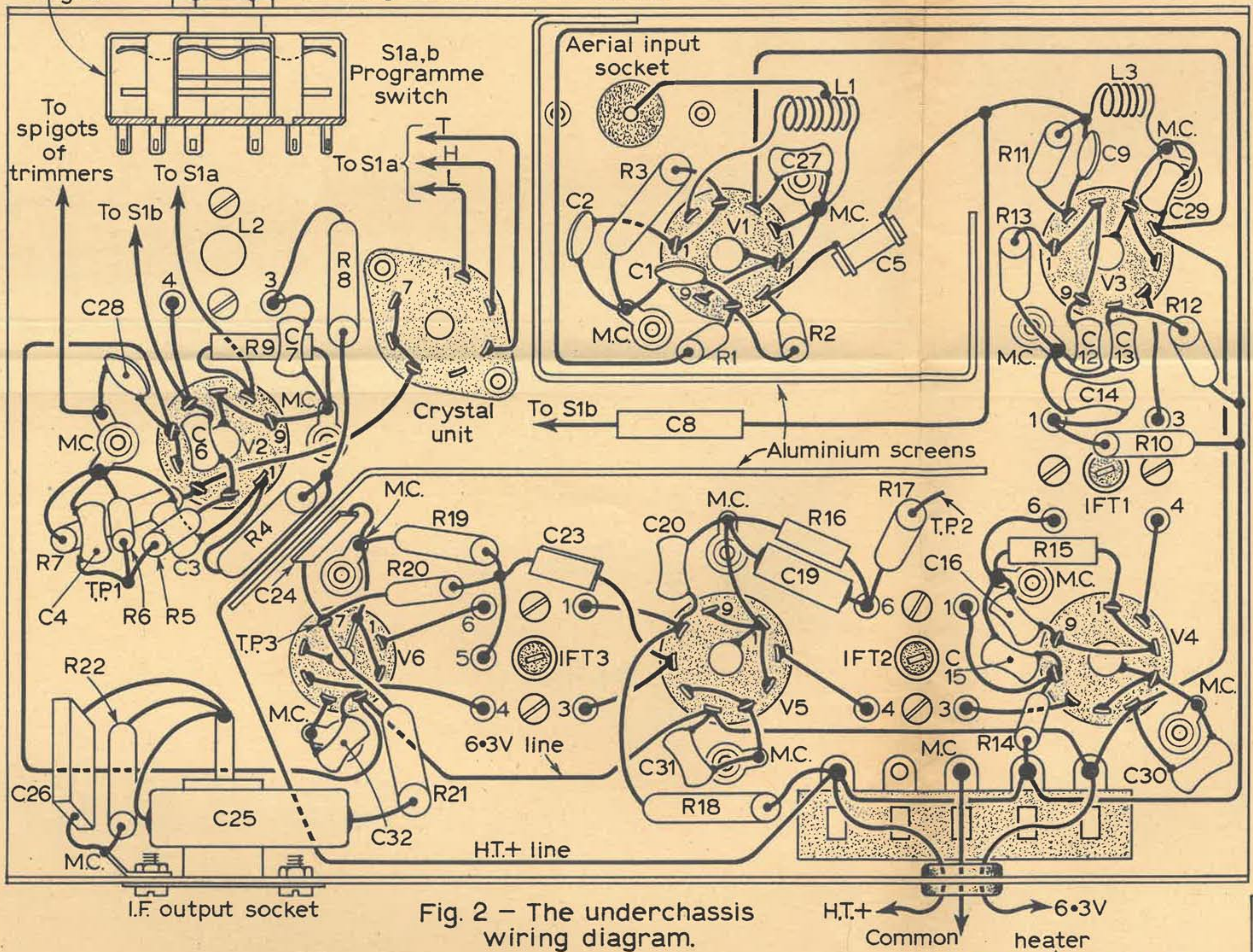


Fig. 2 — The underchassis wiring diagram.

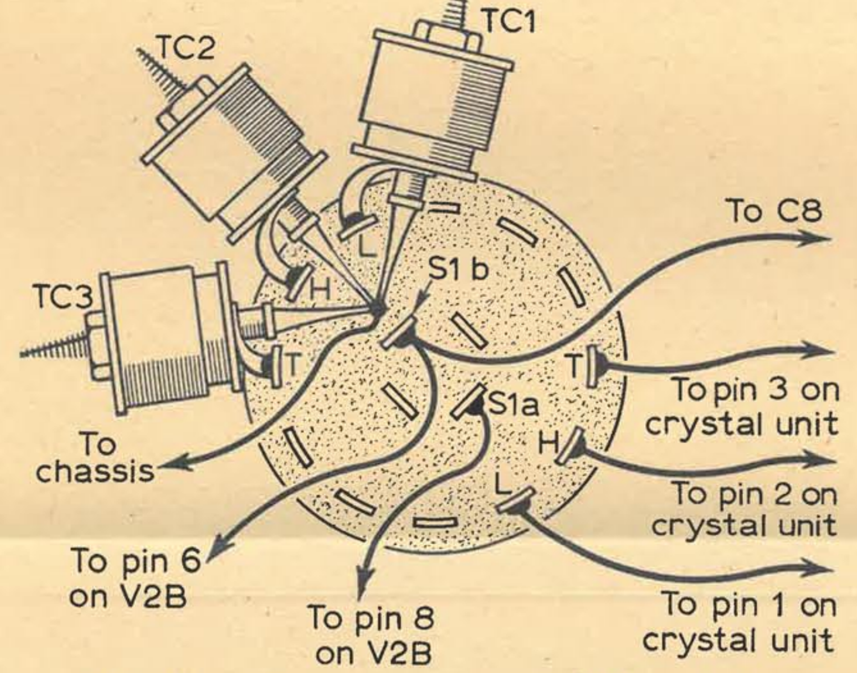


Fig. 5 — Programme-switch wiring.

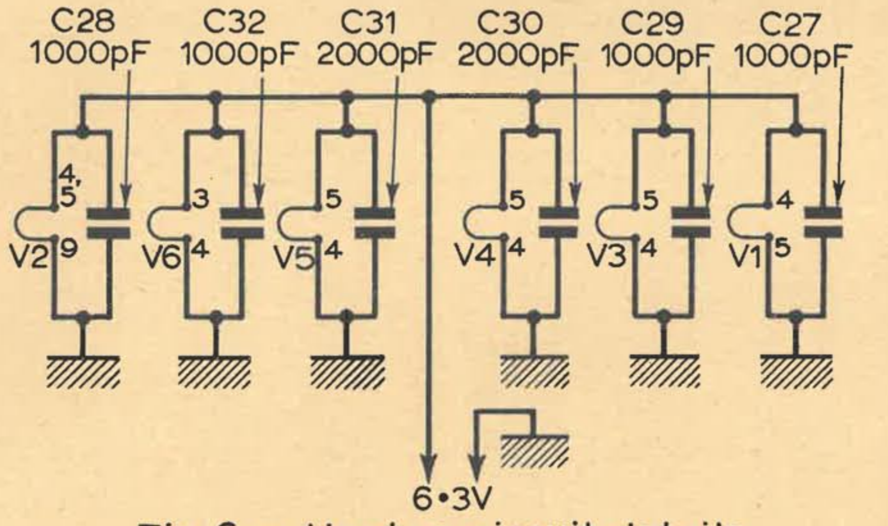


Fig. 6 — Heater circuit details.

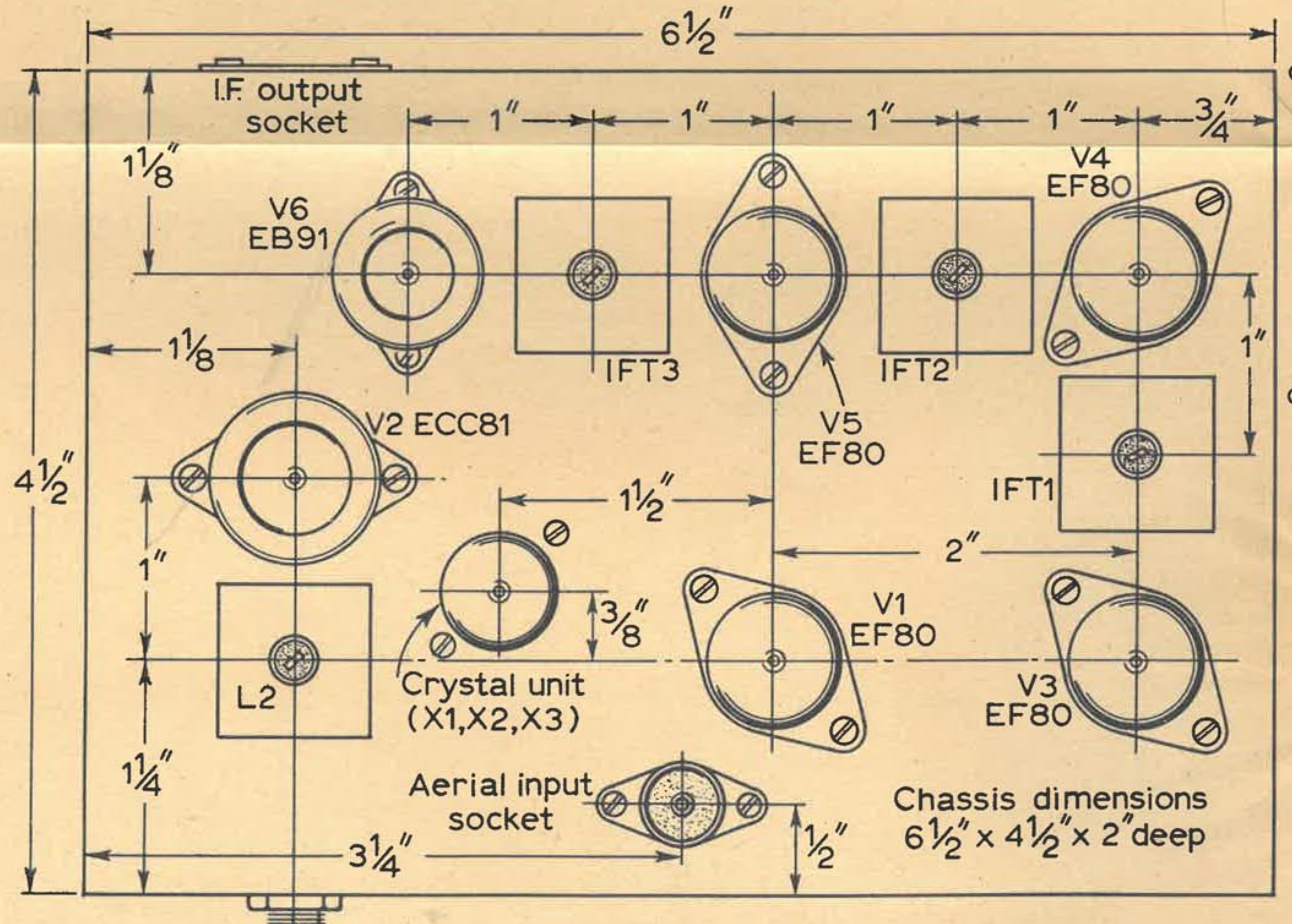


Fig. 3 — The above-chassis layout.

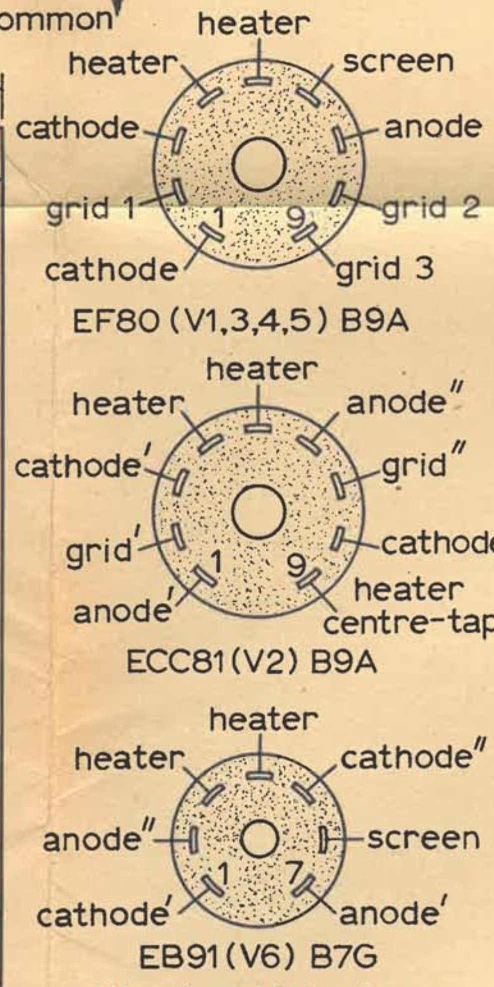


Fig. 4 — Valvebase details

COMPONENTS LIST

Resistors:
(All ¼W, 10% unless otherwise stated.)

R1	1·8k	R12	56k
R2	6·8k	R13	82Ω
R3	180Ω	R14	1·5k
R4	1k	R15	150Ω
R5	22k	R16	47k
R6	470Ω	R17	10k
R7	150Ω	R18	82k
R8	220Ω	R19	100k*
R9	150Ω	R20	100k*
R10	1·5k	R21	100k†
R11	150k	R22	47k

* Matched to 1% † see text

Capacitors:

C1	1000pF ceramic
C2	1000pF ceramic
C3	1000pF ceramic
C4	1000pF ceramic
C5	33pF ceramic
C6	33pF ceramic
C7	1000pF ceramic
C8	2·2pF ceramic
C9	33pF ceramic
C10	50pF 1% min. silver-mica
C11	50pF 1% min. silver-mica
C12	2000pF ceramic
C13	1000pF ceramic
C14	1000pF ceramic
C15	1000pF ceramic
C16	1000pF ceramic
C17	50pF 1% min. silver-mica
C18	50pF 1% min. silver-mica
C19	1000pF ceramic
C20	1000pF ceramic
C21	50pF 1% min. silver-mica
C22	10pF ± 1pF min. silver-mica
C23	50pF 1% min. silver-mica
C24	180pF 10% silver-mica
C25	0·1μF paper 250VW
C26	1000pF 10% silver-mica
C27	1000pF ceramic
C28	1000pF ceramic
C29	1000pF ceramic
C30	2000pF ceramic
C31	2000pF ceramic
C32	1000pF ceramic
TC1, TC2, TC3	10pF bee-hive trimmers

Coils:
L1, L2 see text

I.F. Transformers:
For winding details, see text

Valves (Mullard):
V1 EF80, V2 ECC81, V3 EF80, V4 EF80, V5 EF80, V6 EB91

Crystal Unit (Brimar):
See text

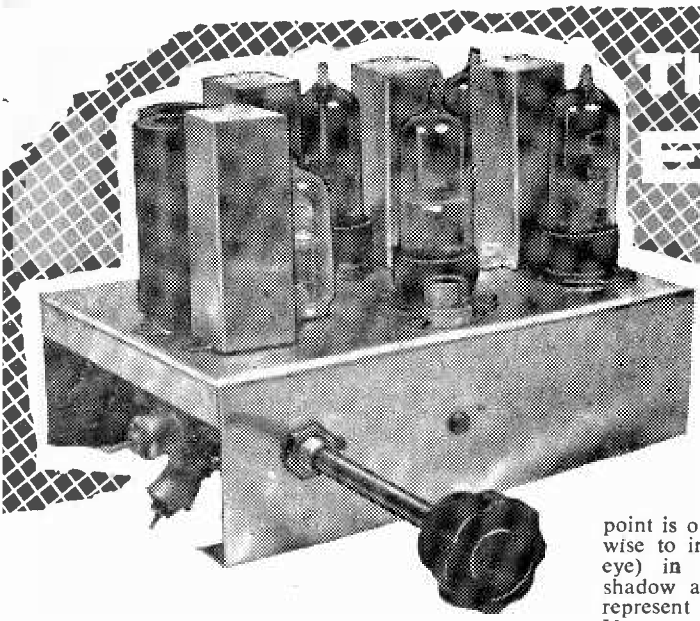
Coil Formers etc. (Aladdin):
Four 2¼in. formers, cans, eyeletted paxolin wafers and eight dust cores

Chassis (aluminium):
About 6½in. x 4½in. x 2in. (see text)

Programme Switch:
4-pole, 3-way

Miscellaneous:
Five B9A valveholders (all with skirts; one with can, for ECC81); two B7G valveholders (one with skirt and can); aluminium sheet for underchassis screens (see text); connecting wire, sleeving and wire for coil winding (see text); tag-strip; two coaxial sockets; etc.

The P.W. EVEREST TUNER



By S. F. Raymond

A SWITCH-TUNED, VHF/F.M. TUNER.

THIS receiver is a tuner unit for the BBC's VHF/F.M. service and is intended for use with a hi-fi amplifier (if the best results are to be obtained from it). It is a superhet which uses the standard intermediate frequency of 10·7Mc/s. Six valves are used, two of which are "double" types—a double triode and a double diode. The six valves perform the following functions: R.F. amplifier; local oscillator; mixer; I.F. amplifier; limiter and discriminator.

R.F. and Oscillator Circuits

The R.F. stage uses an EF80 in a conventional circuit (see Fig. 1 on the Blueprint), the purpose of this stage is two-fold; firstly, it amplifies the signal from the aerial and, secondly, it isolates the oscillator circuit from the aerial, thus preventing radiation from the receiver which might otherwise interfere with reception on neighbouring receivers.

The oscillator circuit is not conventional and is designed to eliminate the criticism that F.M. receivers are difficult to tune (at least so far as non-technical users are concerned). One of the difficulties in most home-built F.M. receivers is the drift of tuning with time as the set warms up; of course, this can be eliminated by the use of combinations of capacitors having negative and positive temperature coefficients, but for most amateurs, this would complicate the construction of the receiver too much. Another difficulty is that of tuning the receiver accurately; F.M. receivers differ from A.M. receivers in that, off tune, they generally give a distorted output rather than a diminished output. The correct tuning point is often very hard to locate by ear, and it is wise to include a visual tuning indicator (magic-eye) in the design. Maximum or minimum shadow angle in the indicator can be made to represent the correct tuning point of the receiver. However, the inclusion of such an indicator increases the expense of the set and does not sufficiently simplify the tuning of the receiver for the lay user.

The difficulties mentioned above can be eliminated by the use of a switch-tuned oscillator circuit in which a three-position switch is used to select the three available programmes — Home, Light, and Third (or Network Three). In order to do this, of course, the oscillator circuit must be inherently stable both with time and temperature

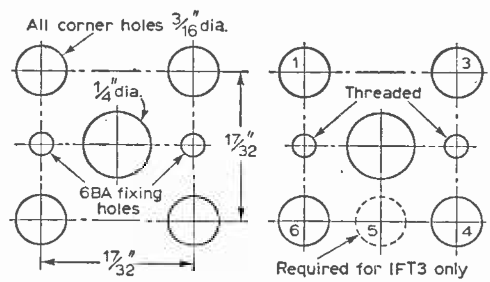
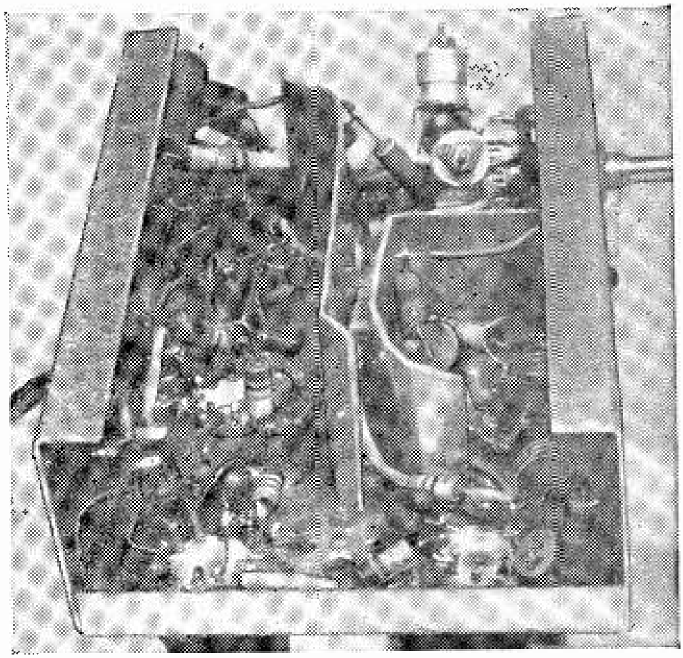


Fig. 7—The chassis drilling dimensions for the coil-former bases.

so that no appreciable drift occurs. The usual method of doing this is to use some form of automatic frequency control (AFC). A voltage is derived from the output of the receiver which is proportional to the error in tuning. This voltage is used to operate a device connected in the oscillator circuit which is in effect a voltage-dependent capacitor. The sense of the voltage is arranged so that if the tuning of the set varies, the oscillator tuning is altered to correct the error. In the oscillator circuit of this receiver, tuning drift is eliminated rather than corrected. This is made possible by the use of crystal control of each of the three frequencies required for reception of programmes.



The underchassis wiring of the Everest.

Crystal Unit

The three crystals used are enclosed in a glass envelope rather like a valve and in fact the unit fits a B7G valveholder. Of course, the crystal unit must be purchased bearing in mind the area in which it is to be used since the required frequencies will differ from area to area. The units are made by Standard Telephones and Cables Ltd., and a table giving the type numbers for various areas is given on page 118. The type required must be specified when ordering.

The oscillator circuit uses an ECC81 double triode (V2), the crystal unit being connected between the two cathodes, and the tuning trimmers between chassis and one of the anodes. The switching can be seen in Fig. 1 on the Blueprint.

The R.F. and oscillator valves are connected via C5 and C8 respectively to the mixer valve (V3). The oscillator circuit operates on the fifth overtone of the crystal in use at 10.7Mc/s below the signal frequency; the difference frequency (10.7Mc/s) is picked out in the anode circuit of V3 by the primary of IFT1.

The I.F. signals are passed to the grid of V4, the I.F. amplifier, via the secondary of IFT1. After amplification, the signals reach the grid of V5, the limiter, via IFT2.

The Limiter

Here, it is necessary to explain the function and operation of the limiter stage. As is well known, with frequency modulation, the amplitude of the carrier radiated from the transmitter is kept at a constant level and only the frequency is varied. The detector circuit in an F.M. receiver is therefore not required to respond to an A.M. signal. Also, the effects of external interference on the broadcasts received should be minimised as much as possible in order to ensure reception of high quality and high entertainment value. Most interference is mainly amplitude modulated and if the detector in the F.M. set will respond to A.M. then a method will have to be found to remove the amplitude modulation prior to the detector. This is the function of the limiter stage.

The limiter valve is operated with low anode and screen grid potentials; this has the effect of reducing the voltages necessary at the grid of the valve to give saturated anode current and to cut off the anode current completely. The result is that if the input signal is large enough, the valve anode current is saturated and cut off on alternate

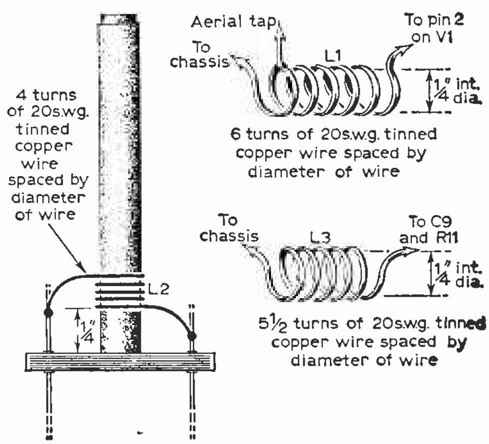


Fig. 8—The construction of L1, L2, and L3.

BLUEPRINT 6

signal half-cycles. The peak excursions of the waveform are cut off by this process and, as it is the peaks which are mainly affected by amplitude modulation, this is removed or reduced considerably. The valve operates with grid current flowing and the time constant of the components in the grid circuit (R16 and C19) is arranged further to reduce the effects of amplitude modulation.

Discriminator Circuit

The detector circuit or discriminator comprises IFT3 and V6, a double diode. The circuit used is of the Foster-Seeley type rather than the ratio type—it was felt that the former circuit would make construction easier for the amateur constructor. The operation of the circuit will not be dealt with here since it can be found in many text-books.

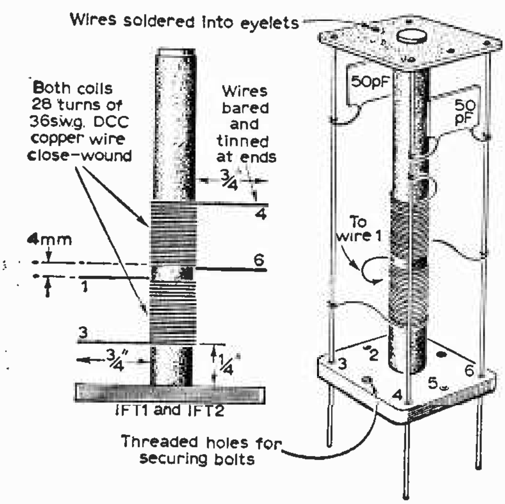


Fig. 9—The winding data for IFT1 and IFT2.

The audio output appears across R19 and R20 which are in effect in series across V6A and V6B. The audio signals are fed via R21 and C25 to the audio output socket. R22 and C26 comprise the de-emphasis network (at the transmitter, the higher audio frequencies are emphasised and must be corrected in the receiver).

The power supply used for the tuner should give a well smoothed H.T. output at about 150V and be rated at 50mA. A 6·3V supply is needed for the valve heaters; it should be rated at 2A.

Construction

Construction of the receiver should begin with drilling and preparing the chassis (see Fig. 3). The chassis can be made larger than that given on the Blueprint if desired and this would give improved heat dissipation (to be mentioned next month). Chassis drilling details for the I.F. transformers are given in Fig. 7 (page 116).

When the chassis has been prepared, the coils and transformers should be constructed. Full details are given in Figs. 8, 9 and 10. L1 and L3 can be close-wound on a former of about ¼in. diameter, such as a pencil, which is then removed, and L2 can be wound direct on to its former. Note that L1 and L3 are self-supporting and use no former—see Fig. 8. Finally, the turns of each coil can be pulled apart to give the correct turns-spacing.

The tinned copper wire used for the coil and transformer lead-out wires (18 or 20s.w.g.) should be prepared by unwinding about 4ft. from the reel and clamping the end in a vice. The other end is then gripped in a pair of pliers and the wire is stretched until a distinct "give" is felt and the wire lengthens slightly. The wire will now be found to be stiff and springy.

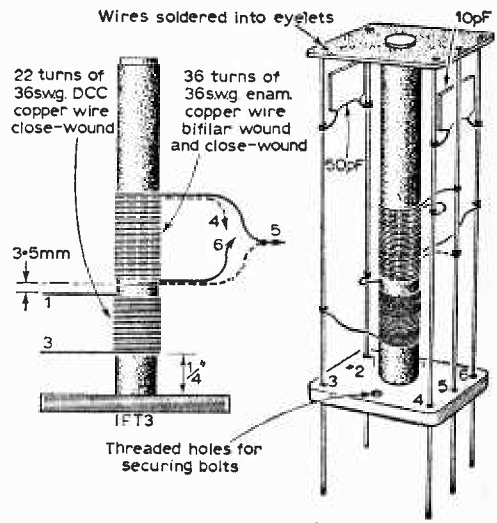


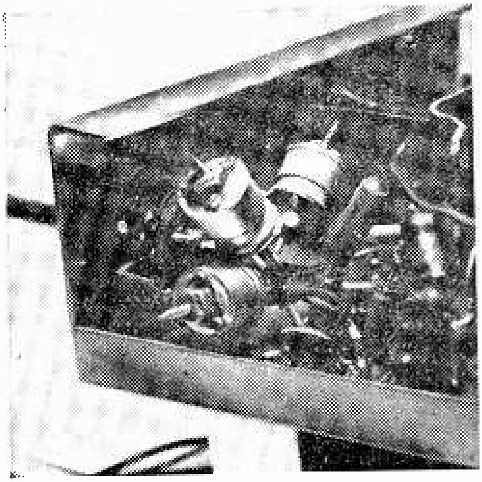
Fig. 10—The construction of IFT3.

TABLE 1

STC Crystal	BBC Transmitters	Crystal Frequencies (Mc/s)		
		LIGHT	THIRD	HOME
4434/A	Wrotham	78·4	80·6	82·8
4434/B	Peterborough	79·4	81·6	83·8
4434/C	Rosemarkie	78·9	81·1	83·3
4434/D	N.H. Tor	77·4	79·6	81·8
4434/E	Sutton Coldfield	77·6	79·8	82·0
4434/F	Pontop Pike	77·8	80·0	82·2
4434/G	Meldrum	78·0	80·2	82·4
4434/G	Blaen Plwyf	78·0	80·2	82·4
4434/H	Holme Moss	78·6	80·8	83·0
4434/F	Rowridge	77·8	80·0	82·2
4434/B	Divis	79·4	81·6	83·8
4434/J	Douglas	77·7	89·9	82·1
4434/K	Kirk O'Shots	79·2	81·4	83·6
4434/C	Llanddona	78·9	81·1	83·3
4434/L	Llangollen	78·2	80·4	82·6

Standard Telephones and Cables Limited, Quartz Crystal Division, Harlow, Essex

Before L2 can be fixed in position, two 5in. wires, prepared as described above, must be passed through holes 3 and 4 in the base of the coil former and soldered to the eyelets leaving about 1in. to project inside the coil can and about 4in. outside. The screening can may then be placed in position and the retaining lugs bent over. A meter can be used to check that neither wire is contacting the screening can.



The arrangement of the concentric trimmers around the programme switch.

Making IFT1 and IFT2

In the construction of IFT1 and IFT2 (Fig. 9), the coil nearest to the base of the former is wound on first. The coil wire is anchored by passing it through one of the eyelets and a few overlapping turns wound on. The required number of turns, side by side, then follow and a further number of overlapping turns is wound on. Balsa cement is then thinly applied to the turns to fix them in position. When the cement is dry, the surplus (overlapping) turns are unwound and the ends of the coil reduced to ¾in. in length and bared for about ⅛in. and tinned with solder.

In order to wind the second coil, several overlapping turns of wire are wound on to the former touching the lower winding and in the same direction. Then, about 35 turns should be wound on and anchored with Balsa cement. When the cement has dried, turns should be unwound from the end of the coil nearest to the lower coil until the start of the second coil is at the required distance from the lower coil—4mm. Turns should then be removed from the upper coil until the correct number of turns remains (28).

Completing the I.F. Transformers

The ends of the second coil are, like the first, shortened to about ¾in. and bared for about ¼in. and tinned with solder. The eyeletted paxolin wafers should now be placed in position at the tops of the formers. The 18 or 20s.w.g. tinned copper wire that was previously stretched and straightened may now be cut into lengths of about 5in. and passed through holes 1, 3, 4 and 6 of the formers of IFT1 and IFT2 (Fig. 9). The wires should be soldered to the two eyelets through which each passes, one in the base of the coil and one in the paxolin wafer at the top of the coil. Care should be taken to ensure that the wires do not protrude so far through the eyelets in the paxolin wafer that they will contact the screening can of the coil when this is in position.

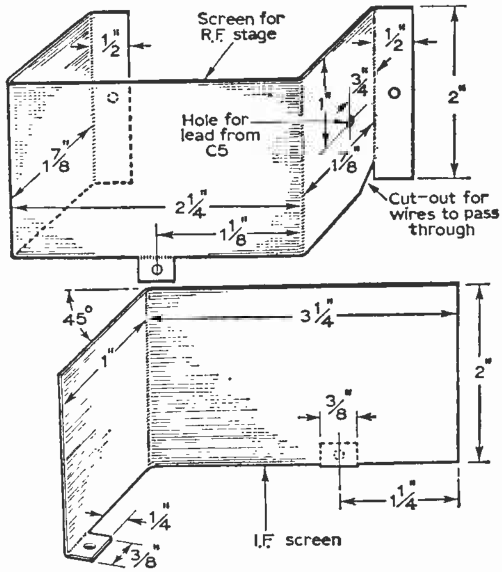


Fig. 11 (top)—The dimensions of the R.F. screen.
Fig. 12 (bottom)—The dimensions of the I.F. screen.

The ends of the coils can now be soldered to their appropriate wires taking care not to make bulky joints which will contact the screening can. Next, the 50pF condensers can be soldered to the wire connections as shown in Fig. 9, positioning them at the tops of the coils.

Meter Check

If a meter is available, it is as well at this stage to check that there is continuity between wires 1 and 3 and 4 and 6 of the coils. The screening cans may now be placed over the formers and the fixing lugs bent over to hold them in position (make sure that the holes in the lugs coincide with the threaded holes in the bases of the coil formers). The meter may now be used to check that none of the coil wires is shorting to the cans.

Making IFT3

For IFT3, the lower winding is wound on in the same manner as for IFT1 and ITF2. Full winding details are given in Fig. 10. The upper winding of ITT3 is "bifilar" wound. This is wound by taking two 1yd lengths of the coil wire (36s.w.g. enam. in this instance) and winding on the required number of turns (18 turns of the double wire are required making in effect 36 turns). The spacing between the two coils is 3.5mm and must be accurate even if several attempts at winding the coils have to be made.

(Continued on page 145)

How to make A.C. AMMETERS

USING READILY AVAILABLE TRANSFORMERS TO GIVE LINEAR SCALES ON HOME-BUILT METERS

(Continued from page 30 of the May issue)

By S. W. Hunt

THE method of calculating the main shunt value was described last month. Fig. 4 shows the universal shunt arrangement (which can be extended to any desired number of ranges, by tapping at suitable points), and the calculation of the authors' shunt is given in full below Fig. 4 as a typical example.

Trial and Error

It may also be mentioned that trial-and-error methods for making shunts are equally permissible for the non-mathematical experimenter, provided these are made carefully, and at first using very small test currents, so that there is no danger of overloading the meter movement. Several yards of bare tinned copper wire of about 0·7mm diameter can be stretched zig-zag between two supports and fed with a small known A.C. current from a heater transformer and series resistor. Short thick leads with test-prods are connected to the winding "a" of the transformer (Fig. 2 last month), and touched very close together on to the current-carrying wire. The prods are then slowly slid apart until the meter shows the deflection desired for the current flowing in the wire. The length of wire then between the two test-prods is the length of the same wire required for the necessary shunt, and it should be measured and cut off from insulated wire of the same diameter.

This procedure just described should be made for the most sensitive range desired. For all higher ranges, this shunt will be tapped, and the taps can be found by trial-and-error as follows: the required shunt for the most sensitive range having been found as above, it should be cut and soldered to the transformer winding "a", using for the present bare wire. The test prods are now wired in series with a low voltage A.C. supply and variable resistor set so that the desired full-scale current flows when the prods are shorted together. One prod is then securely fixed to one end of the existing shunt, which is going to be the "common" terminal (it does not matter which is taken). The other prod is at first also touched on to this point, and then slowly slid away along the existing shunt, until the meter reads full-scale. The moving prod has then arrived at the correct point for making a tap for the range in question. In this way, all the taps for all the desired ranges can be found, and in fact this method is probably the simpler, even for mathematically minded constructors, if many ranges are desired. It is in cases of one single range, or at most two ranges, that calculation is simpler and quicker than trial-and-error. To complete the trial-and-error method, there is still one final step. When all taps required on the experimental shunt have been located, the question of current-carrying capacity must be considered when replacing the experimental shunt by separate final shunts between the input terminals of the various ranges. Each sub-shunt must be capable of carrying the current represented by the input terminal to which it is connected on the side away from the common terminal. Any length of wire, as shunt between two terminals, which is to be capable of

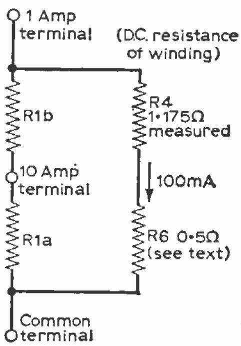


Fig. 4—The circuit of a 2-range universal shunt.

CALCULATIONS:

1A range:

$$R1a + R1b = \frac{100R4 + 50}{I - 100} = \frac{(100 \times 1{\cdot}175) + 50}{1000 - 100} = 0{\cdot}186\Omega$$

10A range:

Here R1a is the shunt, and R1b is added to R4. Thus,

$$R1a = \frac{100\,(R4 + R1b) + 50}{I - 100} = \frac{100\,(1{\cdot}175 + R1b) + 50}{10{,}000 - 100}$$

which simplifies to

$$99R1a - R1b = 1{\cdot}675\Omega$$

The equations are thus:

$$99R1a - R1b = 1{\cdot}675 \quad \ldots (1)$$

$$R1a + R1b = 0{\cdot}186 \quad \ldots (2)$$

(1) + (2) give $100R1a = 1{\cdot}861$

$$R1a = 0{\cdot}0186\Omega$$

Thus, from (2),

$$R1b = 0{\cdot}167\Omega$$

carrying a current "n"-times larger than its actual rated current, must be replaced by "n" strands of the same wire in parallel, each "n" times as long, when making the final sub-shunts. Current-rating should be very conservative, to avoid any heating, which would cause variation of copper resistance and consequent drift of readings. Not more than 2A per strand of 0·7mm diameter tinned copper wire should be allowed. This does not, of course, apply for the experimental shunt for determining the position of taps—but work at high current should then be rapid, so as not to give the shunt wire time to heat up.

Of course, copper is in one sense undesirable for shunts because of its high temperature coefficient of resistance, but the use of resistance wires has its problems, too. Most resistance wires in the hands of the amateur cannot take solder, so that pinches and cleats are required, with consequent dangers of insecure contacts after a time, which —in the author's experience—can often cause errors exceeding the thermal errors of copper, in such low-resistance circuits. If the constructor has solderable resistance wire available, all well and good The author has a type known as Isotan-Soft, which solders excellently, has an extremely low temperature coefficient, and good current-capacity. With great difficulty he has been able to obtain two reels of this, one of 10Ω per yard, and the other of 2·5Ω per yard. But the necessary lengths for the shunts here required are very short with this wire, so that cutting error easily exceeds the thermal errors of copper. Thus, in spite of the availability of resistance wire which could be soldered, copper shunts were chosen.

The trial-and-error systematic method of making shunts and universal shunts, described above, is of course not limited to the type of A.C. ammeter described in this article. It is applicable just as well to D.C. shunting of moving-coil meters.

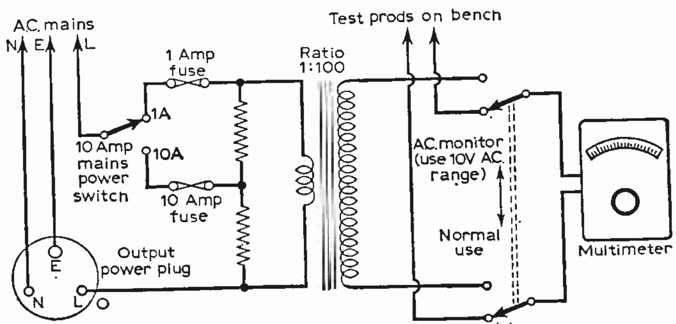


Fig. 5—An adaptor mains-monitor for a multimeter.

D.C. Ranges

The type of A.C. ammeter described in this article is, of course, not usable on D.C., though D.C. within the rated A.C. range values should normally cause no damage: apart from possibly an initial kick, the meter reading is simply zero on D.C. It is, however, a very useful and neat extension for the ambitious constructor to make R3 in Fig. 1 (last month) in the form of a universal shunt as just described, fitted with its own set of terminals. The meter is then usable on A.C. or as a D.C. ammeter, according to which set of terminals is used. It is not necessary to disconnect R2 or the rectifier when using the D.C. shunt; these components cause no disturbance. Thus no switching whatsoever is required.

The extensions can be carried even further: the negative side of the meter, bottom of R3, and the *A.C. amps common* terminal may be wired together and used as common/minus for everything, A.C. and D.C. The positive meter terminal may be connected through the usual series resistors to further terminals, giving D.C. voltage ranges. In the same way (but now switching is required), A.C. voltage and ohms ranges may be added, to complete a whole multimeter. Alternatively, merely the transformer and main shunt R1 are required, the winding "b" of the transformer feeding direct into an existing multimeter on a low voltage A.C. range. The author has built such a unit as an addition to his multimeter, which is fixed (removable at will) on a bracket above the workbench. The 10V A.C. range is used. It has a resistance of 40k, which transforms to 4Ω at the input to the 1:100 transformer, and with these values the shunts were calculated accordingly, as described above. Fig. 5 shows the circuit of this unit, in fact built as a mains-power consumption meter in series with the mains power-plugs on the workbench.

Calibration

As already said as a main feature of this type of A.C. ammeter, the scale is virtually linear, as for a D.C. moving-coil ammeter. There is, however, a very slight remaining cramping below about 10% of full scale, and thus calibration is advisable for best accuracy. This is not essential, however, and a linear scale 0 to 10 will do reasonably well, the final adjustment being made with R2 as described in the text above.

Marking the Scale

The author suggests the following procedure, which automatically includes any calibration necessary:

The meter should first of all be connected up into the circuitry as described in this article, and all shunts, etc. finalised, working on full-scale deflections on the *existing-scale* of the meter. The current should then be reduced in steps of one-tenth of an amp, working on the 1A range. The corresponding readings on the existing scale should be noted for later use. The current itself may be measured either with another ready calibrated A.C. ammeter in series, or by measuring the voltage drop across a known series resistor, using the lowest A.C. voltage range of a multimeter.

The meter should then be opened and the scaleplate carefully removed by unscrewing the two holding screws. Whilst working on this scaleplate, the meter casing should be closed again to avoid unnecessary entry of dirt or other foreign bodies.

(Continued on page 146)

SERVICING TAPE RECORDERS

THE MAGNETIC RECORDING TAPE

(Continued from page 54 of the May issue)

By T. S. Smith

A GENERAL picture of the recording process and the various circuit sections involved has been given in previous articles in this series; this article will be concerned with a more detailed discussion. Let us begin with the tape itself. It is not intended to delve into the construction of magnetic recording tape in any detail, but one or two points will be of interest. Magnetic recording tape was first made with paper as the base, but it was not long afterwards that cellulose acetate took its place. Then development was towards a polyvinyl chloride (PVC) base. The overall development in this direction is just about being completed by the use of a polyester film base, and this is now replacing PVC tape—in America it is used almost exclusively.

Magnetic recording tape requires about six major features. These are [i] freedom from "pinholes", thereby reducing drop-out effects ("drop-outs" refer to lack of recording due to some imperfection in the tape); [ii] good flexibility, which permits the tape to remain in intimate contact with the heads (it also facilitates winding); [iii] maximum strength to avoid frequent breakages; [iv] high resistance to temperature changes and storage defects; [v] immunity to curling and good dimensional stability over a wide range of conditions of temperature and humidity; and [vi] the best possible finish to avoid undue wear of the heads and to enhance recording and replay quality.

All these features are given by the modern tapes now available and, as already intimated, improvements are always being made towards better and better quality. The tape base is, of course, coated with an iron oxide of characteristics to provide low noise and good high-frequency sensitivity (i.e., high coercivity—see page 53, May issue). Where the base is of PVC, a homogeneous mixture of the plastic and the magnetic material is arranged in the form of a finish for the working side of the tape. Even so, some of the oxide ultimately leaves the tape and often finds its way on to the heads and associated mechanism, as we shall see later. The recording pattern, in terms of magnetism, is thus imparted to the oxide side of the tape, and in that way the sound signals are stored.

Tape Tracks

There are three chief recording systems. These are sometimes called "whole track", "half track" and "quarter track" (or "single track", "two-track" and "four-track" respectively) and are illustrated in Fig. 9.

Single-track recording (Fig. 9a) is used essentially by professional recordists for extremely high quality studio work at a tape speed of 30in./sec. Two-track recording (Fig. 9b) is practised by the majority of amateur operators, and most domestic recorders in present use employ two-track working. This type of recording is also used professionally. Four-track recording (Fig. 9c) is gradually becoming more popular, but there are several schools of thought concerning the desirability of dividing a ¼in. tape into four tracks.

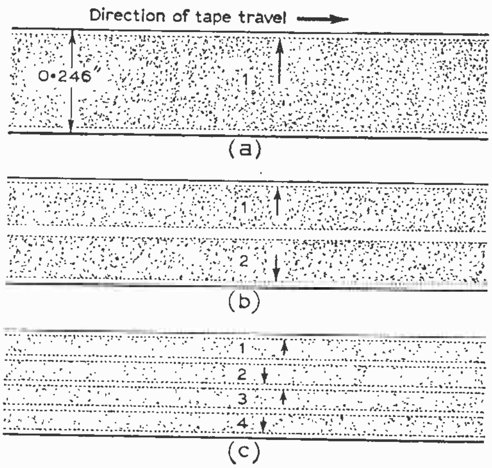


Fig. 9—Recording tracks and directions: (a) single track recording, (b) two-track recording and (c) four-track recording. (The arrows on the tracks indicate the top of each track during the recording process.)

There is no doubt that it is possible to secure better results in a less exacting manner by using as much tape width as possible. With full-track recording, the replay gap length covers about 0·215in. of the oxide face. With half-track operation this is reduced to about 0·1in., with 0·03in. between the two tracks, and with four-track working the width of each track is about 0·043in., with 0·025in. spacing between the tracks.

However, at the time of writing it would seem that four-track parameters have not been finalised, since some machines are arranged for 0·039in. and (at least one) 0·031in. track widths. The track spacing also tends to differ somewhat, as also do the equalisation recommendations.

General Parameters

The generally recommended direction of tape motion (for all systems) is from left to right with the coated side of the tape away from the observer and the recording being made on the upper track. It is thus usually necessary to remove the spools and invert the tape (by transposing the two spools) for recording and replay on the other track unless the machine features switching to enable recordings to be made on the lower track with the tape movement reversed.

Four-track operation is undoubtedly useful for stereo work as it gives the same playing time as mono on a two-track system (assuming the same speed, of course). A four-track record/replay head has two gaps and two windings. Thus, in one direction of the spools two tracks are catered for and by changing over the spools (as for two-track working) the other two tracks are produced. This arrangement gives compatibility for playing back two-track tapes—as will be seen shortly.

The idea can be better understood by reference to Fig. 10. In Fig. 10a it will be seen that with the tape placed on the left-hand spool and travelling in the direction shown, tracks 1 and 3 can be recorded or replayed. If we assume two-channel stereo, then track 1 will accommodate the signal of one channel (A), and track 3 the signal of the other channel (B). In order to record on the other two available tracks the tape is simply inverted as shown by the positions of tracks 1 and 3 in Fig. 10b. Tracks 4 and 2 may then be recorded or replayed.

On four-track mono it is usual first to record on track 1 with gap A, reverse the tape physically by transposing the spools to record on track 2 with gap B, reverse the tape again to record on track 3 with gap B and finally reverse the tape to record on track 4 with gap A. Replay, of course, follows exactly the same pattern.

There is, at least, one tape deck, shortly to become generally available, which will replay mono on four tracks, automatically switching from the finished track to the next and so on through the whole tape. When the four tracks have been played in that manner the whole process is automatically repeated if required. The track configuration is somewhat different in this case, since the tape direction changes on track change.

It should be noted that the signal across the replay head winding of a four-track system is appreciably below that on a single or two-track system and, for that reason, greater amplification is essential fully to drive the power amplifier. Moreover, for equipment of a given specification, the signal-to-noise ratio on four-track working is poorer than that on single or two-track systems. The equalisation required for optimum replay quality also differs as the track width is made smaller.

Four-track Compatibility

The two gaps of a four-track recorder are arranged so that they will scan a part of the track of a two-track mono or stereo tape record. Fig. 11 shows how this is accomplished. When replaying a two-track mono recording, for example, gap A works in conjunction with track 1. For the other track gap A is still used and the tape is inverted as for normal two-track working.

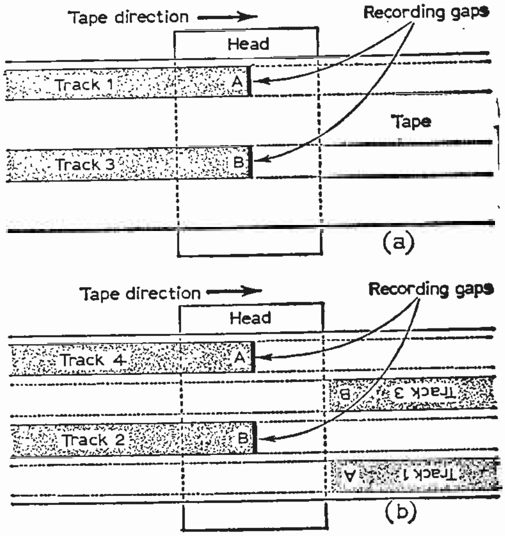


Fig. 10—These diagrams show how the four tracks are put into order by the use of two gaps and tape reversal.

For stereo, gaps A and B are used simultaneously, as is already the case with two-track stereo. Although the gaps embrace only a part of the recorded track, the signal is nevertheless complete, but the output across the replay winding will be of a smaller level as compared with that obtained from a head with a gap embracing the whole of the track width.

Of course, one is sometimes tempted to arrange a machine in a way that the second track is recorded by switching gaps, thereby avoiding removing the spools and inverting the tape. There is nothing against this technically provided the "recording sense" of the tape is clearly labelled for future reference. (Some two-track and four-track machines have switching and multiple heads to enable recordings to be made on all tracks without the need to transpose the spools, at the same time keeping to the correct recording senses.)

In future articles in this series we shall be investigating the detailed mechanism of specific tape decks, but there are several items which are common to all decks and these will be considered first.

Heads and Their Alignment

To achieve optimum high-frequency performance from any tape recorder the gap of the replay head must be exactly at right-angles to the edges of the tape except where a machine is used solely to replay its own recordings. In this case any effects occur equally on record and replay and the results of a small misalignment are counteracted. However, where the same machine is used to replay either tape records or recordings produced on another machine, misalignment will produce undue background noise and loss of treble.

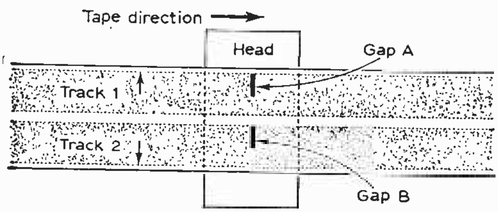


Fig. 11—How a four-track, two-gap head can be used to replay two-track stereo or mono recordings. For mono, gap A only is used and track 2 is replayed by inverting the tape, while for stereo both gaps are used simultaneously.

Most machines provide adjustments for setting both the angle of the face of the head to the vertical and the angle of the gap itself to the vertical (known as azimuth adjustment). These adjustments are provided in a diversity of ways, depending upon the design and type of machine, but a popular arrangement incorporates three adjusting screws arranged appropriately around the baseplate of the head as shown in Fig. 12. Coiled springs or rubber washers are sometimes used between the head baseplate and the panel of the deck at each screw to maintain a constant tension and to hold the head firm at all adjustment settings.

The idea is first to set the face angle adjustment so that when the tape is running past the head with the pressure pad released and with the tape guides in correct alignment the tape remains in contact with the centre of the gap area over its whole width without curling, twisting or jumping. Under this condition the face of the head will be parallel with the back of the tape.

Azimuth Angle Adjustment

There is only one method of setting the azimuth angle for optimum results and that is by playing back a test tape carrying a constant level, high frequency recording. Test tapes of this nature are available commercially. The azimuth screws should then be very carefully adjusted to give maximum output of the test tone.

As small changes in level at high frequencies are extremely difficult to detect by ear an A.C. voltmeter or output meter, which is capable of responding to the test tone, should either be connected across the loudspeaker or across a suitable load resistor used in place of the loudspeaker. The load resistor should be of the wire-wound variety and its resistance should closely approximate to the impedance of the loudspeaker.

The replay volume control should be adjusted to give a little under half-scale deflection on the meter, but care should be taken to avoid overloading the replay amplifier in order to achieve sufficient deflection. If the desired deflection

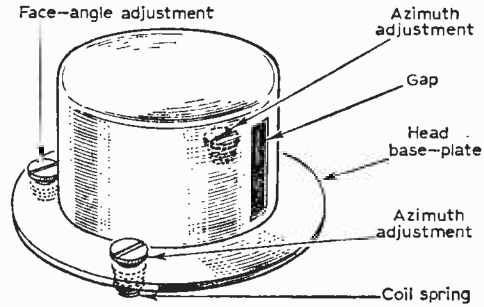


Fig. 12—One arrangement used for the face-angle adjustment and the azimuth adjustment of the record/replay head.

cannot be obtained with the replay volume control set to about three-quarters, a more sensitive output meter or A.C. voltmeter is required.

On two- and four-track machines the height of the head is of considerable importance to ensure correct alignment with all tracks. It may be necessary, therefore, first to set the height for maximum output on one track of a multi-track test tape (frequency is not so important here). Then the face-angle adjustment must be set and, finally, the azimuth adjustment for maximum high-frequency response. All the other tracks should then be in correct alignment.

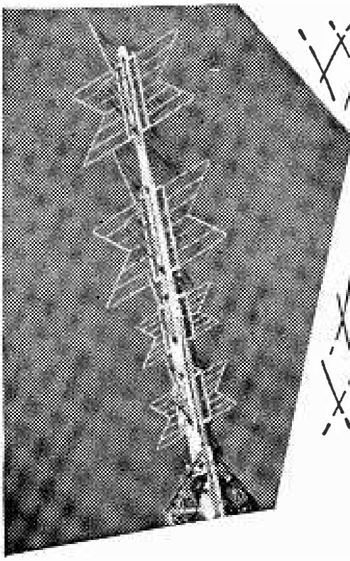
On some machines the height of the head may not be adjustable, as the azimuth adjustment may pivot on a small dimple on the head baseplate, in which case there may be only two adjusting screws. On the other hand, some machines have four adjusting screws, which are best dealt with in pairs. Normally it is not desirable to interfere with the overall height of the head, the main adjustment being that of the azimuth, which can usually be set without disturbing any of the other adjustments.

Magnetised Tools

Residual magnetism is a very real danger so far as tape recorders are concerned, and it is most important that all adjustments in proximity to the heads and associated mechanism are carried out with non-magnetic tools. Almost all steel screwdrivers, for example, used for radio work are endowed with slight magnetism, picked up from loudspeaker fields and so on.

Non-magnetic screwdrivers are available and a set is well worth acquiring if much work is done on tape recorders. A bulk eraser can be used for clearing magnetism from small tools, and there are other methods of dealing with the problem, as will be given later. It must be remembered, though, that residual magnetism on a tape guide, mu-metal screen or head, considerably impairs the noise performance and can introduce hiss on to a tape record which was previously noise free.

(To be continued)



On Your Wavelength

By THERMION

MY recent comments on some old-time long wave signals and experiments has, as I expected, brought a number of comments from readers, amongst which is an interesting one from a Mr. Atkin of the Western Isles, who tells me that the long waves are not, in fact, dead. He says, "As one of the 'older' experimenters referred to, I was interested in your note on long wave radio communication (April issue). I well remember the first radio signals I ever heard, back early in 1921, when I listened on a crystal receiver to Eiffel Tower (FL) and Nauen (Germany) on 2600 and 3200m respectively. These were both spark transmitters, and to reach these long wavelengths we had strings of honeycomb coils, in series, festooned around the shack! I also well remember the 'signals from Mars' experiment, and recall reading a description of the 30-valve (all triodes) receiver, but I never found out what the results were.

"But my purpose in writing to you is to point out that these long and very long wavelengths are by no means unoccupied at the present time. I myself have logged quite recently about 20 or 30 stations between 14kc/s and 150kc/s—all modern CW or MCW valve transmitters—on a rather old four valve marine (TRF) receiver. Also, the American Navy is operating at least half-a-dozen stations in the U.S.A. between 14kc/s and 70kc/s, and, of course, our own GBR (Rugby) is still active daily on 16kc/s, with a transmitter which has been completely rebuilt and modernised since the last war. Its horseshoe aerial of 1000ft masts has been a landmark for many years besides the main Euston/Crewe railway at Hillmorton, just outside Rugby.

"Last but not least I myself am at this moment a maintenance engineer at a navigator transmitting station here, transmitting continuously on a frequency of 133kc/s. Other stations of this type (there are 16 in the British Isles alone), use frequencies around 125, 86 and 70kc/s. These stations, of course, are not used for communication purposes, but transmit a continuous-wave carrier which operates automatic navigational and position-finding equipment on board ships and aircraft. So the long waves are by no means dead, or even dying!

"In closing, I may mention that I have been a reader of PRACTICAL WIRELESS (and its predecessor AMATEUR WIRELESS) since issue No. 1, and have therefore been reading your column for something like 40 years!"

It was certainly nice to hear from a reader of such long standing. I am, of course, aware of the Rugby and similar transmissions, but when first I mentioned long waves, I was thinking more of the much longer wavelengths such as were used for the above-mentioned "Mars signals", and it is these, I feel, which may eventually prove most interesting. Still, only time will tell!

Meteorological Research

Shortly after I had finished writing the above note, I received a letter from a reader in Germany giving very similar notes concerning Rugby etc., but adding the information that the ultra long waves are used extensively in meteorological research on tracking thunderstorms, as the latter radiate particularly efficiently at these frequencies. He goes on to say that there is little point is using the ultra long waves for communications, as echo-satellites and directional VHF will give a better combination of range and signal-to-noise ratio. Yet for meteorological purposes, the ultra long waves continue to be of high value, as such stations can track thunderstorms and regions of atmospheric disturbance, and locate them accurately on the map, even if they are thousands of miles distant from the tracking receiving stations.

Peculiar Faults

I have received a lot of correspondence at different times on faults of a strange nature, which normal servicing procedures or techniques could not solve. I must say that one of which I recently heard was indeed strange, and just shows how careful one has to be, and in fact makes one think that besides being an electrician, a good radioman has also to be a chemist! This fault arose because an amateur constructor had used a particular adhesive to stick some silk-covered wire to a former made of paxolin or some similar material. Apparently a chemical action has been set up by the adhesive and paxolin in combination, and this had attacked the silk covering of the wire. The wire was rather thin and it had been eaten away by the the corrosion to a length of over $\frac{1}{4}$in.

Any more cases of chemical trouble?

POWER Rectifier Circuits

common and uncommon

A SURVEY OF PRINCIPLES OF PRACTICAL IMPORTANCE, AND USES OF SUCH CIRCUITS

By L. N. Nash

A NUMBER of very useful and thorough practical articles have appeared in recent months in PRACTICAL WIRELESS and *Practical Television* concerning rectifiers, rectifier circuits, metal rectifiers, crystal diodes, etc. It is now felt that a useful addition to this series would be a practical discussion of power-rectifier circuits in particular, and consequently the author has compiled the present article from his own practical experience in the workshop, in building the most varied of such circuits.

Varied Circuits

After a preliminary discussion of some important general principles, and a brief survey of conventional circuits as a brief recapitulation of more detailed material in past articles, the author will proceed to introduce a number of more unusual and unconventional power-rectifier circuits, pointing out their individual advantages and disadvantages. These circuits form the actual main subject of this article. All circuits given have actually been built and used by the author, principally in the form of the power-supply portion of a chassis of equipment. Where actual component values are quoted in the diagrams, these may be used directly by constructors if they wish to build any of the circuits concerned as power-supply portions of a chassis of equipment for any purpose they may desire. All circuits bearing specific component values have been built and proved by the author. Those circuits intended to illustrate only a principle, however, will bear a note to that effect since some component values specified will be approximate, and the circuits should then be treated merely as the basis for the constructor's own experiments.

Naturally, if the same circuit is desired, but a different output voltage or current or both, modifications may be necessary even to those component values specified. It is highly likely that the constructor will have gained sufficient knowledge from this article and other rectifier-articles in this magazine to be able to judge the extent and direction of such possibly necessary modifications.

Construction and Layout

It is assumed that almost all power-rectifier circuits connected with the normal experimenter's work receive a 50c/s mains-frequency input, so that all questions of critical layout and short wiring as arising in high-frequency circuits do not apply here. The layout is thus not in any way critical in any of the circuits, and leads of even considerable length are perfectly tolerable if deemed necessary for any particular purpose, such as bringing a particular switch or fuse to the front panel, etc.

Far more important is the question of adequate and substantial insulation. Many modern wires with plastic insulation soften at relatively low temperatures, and it is inadvisable, for example, to run such wires unprotected hard against cores of transformers which heat up considerably in normal operation. A good quality oil-fabric sleeving should be used for such wires at all such danger points, and for voltages above about 500 it is the author's practice to use two such sleevings pushed over each other, having different diameters to suit. All leads going through the chassis should be protected by substantial rubber grommets. Apart from the danger of mechanical damage by chafing, unprotected chassis holes for wires promote danger of flashover at higher voltages, due to the concentration of the electrostatic field at sharp corners. This is very important here, because it is for the various higher voltage rectifier circuits that the full advantages of the unusual circuits to be introduced in this article become apparent.

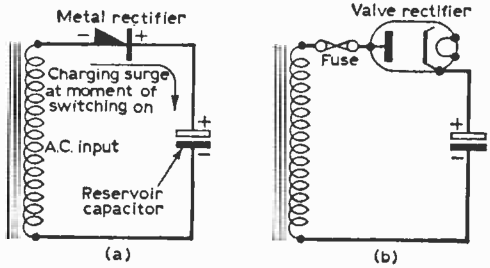


Fig. 1a—A fuse taken direct from the transformer to the rectifier would be likely to blow easily on switching on, due to the charging surge of the reservoir condenser; b—with a valve rectifier, the condenser charges more slowly as the valve heats up.

Fusing Considerations

It is necessary to use switches of adequate voltage rating, and to pay proper attention to any fuses that may be deemed necessary. A fuse in the lead direct from the transformer to the rectifier protects against rectifier and smoothing condenser faults as well as output overloads, but has the disadvantage of easily blowing upon switching on, due to the charging surge of the reservoir condenser (Fig. 1a). This trouble is present if a metal rectifier is used. With a valve rectifier, the reservoir condenser charges more slowly as the valve heats up, and thus this form of fuse is then more applicable (Fig. 1b).

It is of course necessary to use a sufficient number of fuses to ensure complete cut-off in the event of a failure. Thus, in the conventional full-wave valve rectifier circuit of Fig. 2, a single fuse placed at A will protect against output overloads, but a pair of fuses is necessary at B and C to protect adequately against internal faults of the circuit as well as output overloads. A single fuse at D is to be considered dangerous, as in the event of a short between anode and cathode of one diode, the transformer winding is then shorted through the other diode on one half-cycle, which renders the transfer of the fuse from A to D pointless.

Comprehensive Protection

In small power units of normal voltage output, an output fuse at A and a mains fuse in the transformer primary circuit (which takes care of internal faults) are sufficient. But for high-voltage or high power units, this simple protection is not sufficient. If other circuits (heaters, subsidiary H.T. voltages, etc.) are fed from the same large transformer, it may be impossible to make the rating of the mains primary fuse low enough for it to blow before excessive fault currents could flow in the faulty recifier circuit in question. In such cases fuses at such positions as B and C in Fig. 2 are necessary. For conventional rectifier circuits, the matter need not be taken too critically, but for the more unusual circuits, where faults could have a whole chain of expensive consequences, proper fuse protection is well worth the extra expense and trouble. This does not mean that the unusual circuits here to be discussed are in any way unreliable or prone to breakdown due to improper operation of components other than under specified conditions. On the contrary, no components are operated under other than permissible conditions in the specified circuits, and the author has found a high degree of reliability of such circuits, under periods of continuous operation even as long as a week at a time.

Modulation Hum

A rectifier is the basis of normal detector circuits, as will be known to all experimenters. The question of "detection", i.e. removal of the audio or video signal from the modulated R.F. carrier, is in principle little different from the reverse process, that of "modulation" of the R.F. carrier with the audio signal at the transmitter, so that in principle the same rectifier circuit could function for both purposes.

If in any way the wiring connected to a power rectifier picks up an R.F. signal, over the mains wiring in the house, or by any other available process, then the rectifier (be it a valve or a metal rectifier, that makes no difference) will invariably modulate this picked-up signal with the 50c/s mains hum, in addition to any modulation it may already have. If now the same circumstances which led the rectifier wiring to receive the R.F. signal enable it to be radiated again, then any receiver picking up this re-radiated signal cannot distinguish the original modulation from the distant transmitter from this local "modulation hum". Consequently a powerful hum is present on the radio concerned, but only when stations are tuned in. Normally only local stations are affected, as distant weak stations provide insufficient signal at the power rectifier. However, it is perfectly possible for even weak stations to be affected if the power rectifier circuit picks up and modulates an R.F. signal and re-radiates it to an I.F. stage in a poorly screened receiver. In such a case hum will be present as soon as any station whatsoever is tuned in.

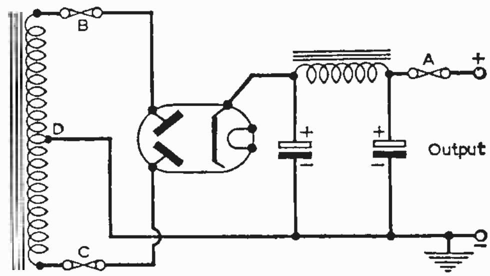
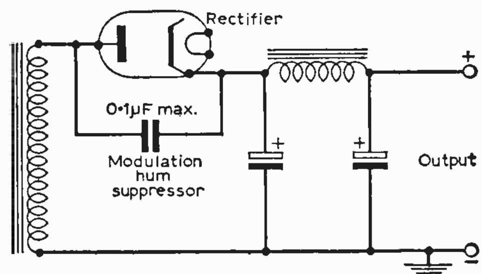


Fig. 2 (above)—Possible positions for fuses in a full-wave rectifier circuit.

Fig. 3 (below)—Shunting a condenser across a power rectifier, to remove modulation hum.



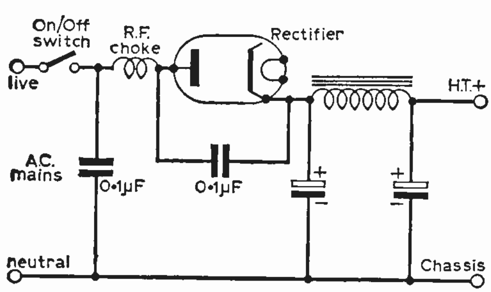
Remedies

Now for the practical consequences of this discussion! Two measures are available to combat modulation hum. The first is to render the power rectifier inoperative as a rectifier for R.F. whilst being unaffected at mains frequency. This is achieved by shunting a condenser across it between anode and cathode. Naturally, this shunt condenser (see Fig. 3) forms an A.C. bleeder together with the reservoir condenser, and thus increases the A.C. ripple on the D.C. output. Thus there is an upper limit to the size of the shunt condenser usable. It is a good rule of thumb to use a shunt-capacity of about 1% of the value of the reservoir condenser used, but not exceeding 0·1μF.

The second measure is to assign the rectifier a proper place on the chassis in relation to other circuits. The power rectifier should always be as far away from all R.F. and I.F. circuits as possible, and the latter should be adequately screened, for this and other reasons. A mains transformer with a shield between primary and secondary is very helpful. In high-voltage circuits, where shunt-condensers across the rectifiers may be impossible, because maximum values tolerable on account of the low values used for the reservoir condenser are useless to shunt R.F., it may be necessary to use a good transformer with a screen and build the whole rectifier circuit into a screening can. But such severe cases should be extremely rare.

Neighbouring Receivers

It must be added on this topic that the author has several times been called upon to repair a receiver suffering from "severe hum", and finally cured the fault by shunting the rectifiers in a radio belonging to a completely different family, in some cases several floors removed in the same house. Careful work with a portable direction-finding receiver was necessary to locate the offender, and such work is really the job of GPO interference-tracing vans. It is here mentioned merely as an example of the surprising range of re-radiated signals with modulation hum, under "favourable" conditions. One can cause considerable annoyance



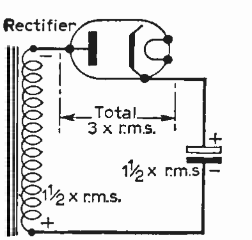


Fig. 4 (above)—Curing modulation hum in older mains installations sometimes requires more than just a shunt-condenser.

Fig. 5 (left)—The relation between r.m.s. input and peak inverse voltage (PIV) ratings.

to one's neighbours with an unsuitable rectifier circuit, as well as impair the performance of one's own equipment. Notorious offenders are A.C./D.C. sets drawing H.T. through a rectifier connected direct to the mains, as this arrangement offers easy entry and exit of R.F. signals over the mains. Sets using a transformer are far better, and in many cases the R.F. losses of the mains transformer are high enough to remove all trace of modulation hum even without rectifier-shunt condensers.

It is virtually impossible ever to make an A.C./D.C. set run free of modulation hum without a shunt-condenser, which then takes a familiar simple form of a 0·1μF condenser straight across the mains input to the set. Whilst this measure virtually cures modulation hum in the set concerned, it is sometimes less effective in older domestic mains installations using long runs of wire without conduit, which function as efficient aerials. In such cases, the addition of the items in Fig. 4 may help.

Peak Inverse Voltage and A.C. Input Rating

The *peak inverse voltage* of a rectifier is the maximum voltage it can withstand in the non-conducting direction (i.e., with anode negative and cathode positive) without breakdown. The *A.C. input rating* is the maximum permissible r.m.s. voltage output of the transformer winding feeding the rectifier and smoothing circuits. Sometimes the one and sometimes the other is quoted in the characteristics for a rectifier, and there exists a definite relation between the two.

Considering the simple conventional half-wave rectifier circuit of Fig. 5, it is clear that the reservoir condenser charges up until it reaches a D.C. voltage equal to the *peak* of the applied A.C. voltage. Now this peak is roughly one-and-a-half times the r.m.s. value for the mains sine wave (exactly, peak=1·414 r.m.s.).

Inverse Voltage Stress

On the subsequent half-cycle, in which the rectifier is blocked because the transformer voltage has reversed, the peak condenser voltage and the negative peak transformer voltage (another one-and-a-half r.m.s.) act additively in series across the rectifier in the non-conducting ("inverse") direction. Thus, the total inverse voltage stress on the rectifier is *three times* the A.C. r.m.s. voltage output of the transformer.

Thus for a 350V r.m.s. A.C. transformer winding, the rectifiers must be rated for "350V A.C. input", or for "1000V peak inverse voltage", both statements amounting to the same thing. It is this factor which limits the use of metal rectifiers at the higher voltages. In principle, sufficient elements of metal rectifiers may be connected in series to withstand the inverse voltage, but this becomes prohibitively expensive if high-current operation is desired. In such cases one finds valves more economical.

Valves

At normal H.T. current ratings of 50mA to 100mA it is at present relatively uneconomical to

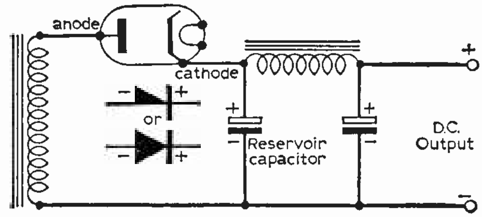


Fig. 6a—Basic half-wave rectifier circuit.

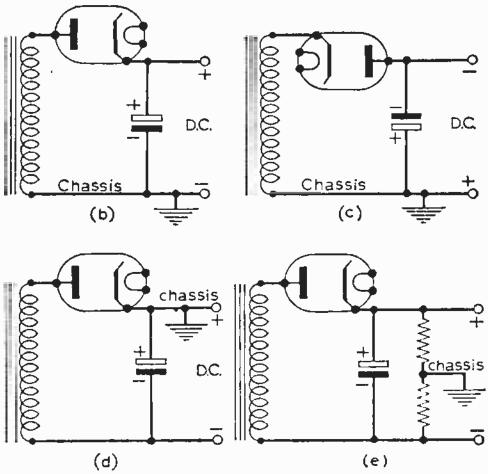


Fig. 6b—Positive-output half-wave rectifier circuit: c and d—negative-output half-wave rectifier circuits, e—obtaining positive and negative outputs simultaneously in a half-wave circuit.

construct metal rectifier elements for A.C. input voltages exceeding at the very most 500V (peak inverse voltage 1,500), though series piles of elements for low-current EHT rectifiers are relatively cheap and common, even up to A.C. inputs of many thousands of volts. The modern developments in silicon power-diodes capable of carrying currents up to some amps in the larger types have a present peak inverse voltage limit of about 1000, so that maximum A.C. inputs of about 350V are permissible. There is nothing except the price, to prevent the use of two or more such diodes in series (to increase the voltage rating in direct proportion), but a valve would almost always be more economical in such cases. The silicon diodes need a heat sink in the form of a metal plate to which they are bolted, and if several such diodes are connected in series, the heat sinks will be at different potentials, and must be adequately insulated. This can introduce problems outweighing the disadvantages of a valve rectifier in the particular application envisaged.

Combination of Rectifier Types

The author is of the opinion that the "valve rectifier versus metal rectifier" controversy is largely futile. The truth is that the scope open to the constructor has been enriched by the availabilty of both types of rectifier. There are a number of applications where the ideal solution of a problem involves the use of a mixed circuit, using both valve and metal rectifiers, as will become apparent in the course of this article. However, as a general principle, valves score on their high inverse voltage rating, but are clumsy and require heater voltage, and generate appreciably more heat. Metal rectifiers of copper oxide, selenium or silicon types score on high current ratings, but have limited inverse voltage rating. As a result, modern circuit practice has justifiably relegated valves to the higher voltage circuits.

When connecting metal rectifiers in series to increase the voltage rating, only identical types may be used in each series connection, as the series-connection of different types with different inverse resistances cannot enable the desired equal sharing of voltage to be realised. To allow for tolerances, it is not advisable to run a pair of series connected rectifiers to a voltage higher than 1½ times the rating of a single rectifier of the same type.

Conventional Half-wave Rectifier Circuits

The rectifier diodes in all the following circuits of conventional type have been drawn in the form of valves. They are of course equally applicable to the use of metal rectifiers or silicon diodes, bearing in mind the remarks in the previous paragraph.

Fig. 6a gives details of the simplest conventional rectifier circuit, the "half-wave" circuit, together with the most common equivalent symbols for valves and other types of rectifier. It is very important that the constructor familiarise himself with the accepted circuit symbols and representation of polarity of rectifiers because connection of a rectifier with wrong polarity in a circuit can lead to serious consequences. It is conventional to make the thin line of a metal rectifier symbol correspond to the valve-cathode, and this corresponds to the terminal marked "+" or "red" or "cathode" in a metal rectifier. The "triangle" or "arrow" of the metal rectifier symbol corresponds to the valve anode.

Chassis Connections

According to which side of the D.C. output of the half-wave circuit of Fig. 6a is connected to chassis (earthed), we can get a negative or a positive output voltage with respect to chassis, as shown in Figs. 6b and 6c. The "positive" form of Fig. 6b is used for H.T. supplies in A.C./D.C. sets, where the transformer winding of the diagram is actually replaced directly by the mains. Fig. 6b is used as it stands, with input from a mains transformer secondary winding of the desired voltage, in H.T. supplies for the simpler forms of A.C. mains radios, amplifiers, etc, where the current drain is not high enough to warrant the expense of the more efficient full-wave circuit. The "negative" version of Fig. 6c is often used, to provide the input D.C. voltage to a negative grid-bias voltage-bleeder chain in such circumstances which require higher grid bias voltages than are easily obtainable by the use of cathode resistors for the valves, or other conventional methods. An independent grid-bias supply of this type also has the advantage of greater stability and of fundamental independence from the anode currents flowing in the valve circuits being biased.

The half-wave rectifier circuit of Figs. 6 a to e derives its name from its simple function. When the transformer winding voltage is of the same polarity as the ultimate output D.C. voltage, i.e. on alternate half cycles of the A.C. waveform, the rectifier conducts to charge the smoothing condensers. On the other half cycles, the rectifier is blocked, and the inverse voltage, discussed in the previous paragraph, is operative across the rectifier.

(To be continued)

BOOKS REVIEWED

ELEMENTS OF ELECTRONIC CIRCUITS—by J. M. Peters. 94 pages. Published by Iliffe Electrical Publications Limited. Price 21s.

THE most complex-looking electronic circuit is usually capable of being reduced to a number of recognisable elements. If the function of all such circuit elements is thoroughly understood, then the operation and function of the whole complex circuit can generally be deduced without much difficulty.

Hitherto the only information available on many such basic circuit elements has been scattered among diverse publications, embracing collectively practically the whole field of electronic technology. Now, for the greater convenience of students, engineers and the more general reader alike, in this book are gathered together clear descriptions of the operation of the more widely used basic circuits employing valves. The emphasis is on physical explanations and mathematics are kept to the minimum. Detailed waveform and circuit diagrams accompany each description, but it is felt that the use of inferior letters (letters below the line of the others) and figures in circuit references, such as R_a, I_a and the confusing mixture of roman and italic type tends to spoil the otherwise concise text.

Subjects covered include: time constants and differentiation, clamping or D.C. restoration, amplitude limiting, multivibrators, electronic markers, gates and coincidence circuits, delay circuits, performance of mathematical functions.

This publication forms a valuable source of reference for both amateur and professional.

PROBLEMS IN RADIO ENGINEERING—by E. T. A. Rapson. 170 pages. Published by Sir Isaac Pitman and Sons Limited. Price 15s.

THIS book sets out, in a comprehensible form, typical problems that the National Certificate student in radio communication is likely to meet in his examinations. The questions are drawn from past examination papers of the City and Guilds of London Institute in Radio Communication, the Institute of Electrical Engineers in Electrical Communications, and the University of London in Telegraphy and Telephony. All students of radio engineering, no matter for which examinations they are preparing, will find this book invaluable.

There are forty-nine chapters covering every aspect of radio communications fully and no attempt has been made to cram too many subjects into one chapter, so that " series resonance ", for example, has one complete chapter devoted to it and is not included in the chapter concerning " series circuits ". Each set of problems is preceded by a number of formulae with which it is imperative that the student be acquainted, in order that he be able to answer the question fully.

All the answers are listed in one chapter at the end of the book.

This is the eighth edition of this book, bringing it right in line with all recent advances made in the field of radio communications.

THE ELECTRONIC MUSICAL INSTRUMENTS MANUAL—by Alan Douglas. 301 pages. Published by Sir Isaac Pitman and Sons Limited. Price 37s. 6d.

THIS is the fourth edition of a useful book which was first published in 1949. It deals very fully with the many note generators, vibrato generators and tone formant circuits which are now employed, and it may safely be said that there is no electronic musical instrument at present on the market which does not employ at least one of the many circuits which are illustrated. The latter part of the book is devoted to a brief description of the major circuitry of some of the commercial instruments now on the market, and this includes the Gulbransen transistorised organ, probably the most up-to-date instrument to appear in this very large market. Although much thought has obviously gone into the preparation of this Manual it is clear that much of the data has been taken straight from manufacturers service manuals etc., and as a result the experimenter will find that many of the circuits leave out certain essential data, such as condenser and resistor values, so that experimental work on these circuits cannot easily be carried out. It is also felt that there is a wide gap in the information covering key switching, which we think is at times more important than generator or tone formant circuitry. However, for the student there is much to be found in this particular volume which we do not think can be found in any other publication, even on the American market, and it should help many who are interested in either finding out how a modern electronic organ functions, or in trying to design one for their own use.

RADIO AND TELEVISION RETAILERS' HANDBOOK—by F. X. Carus. 216 pages. Published by George Newnes Limited. Price 35s.

THIS is believed to be the first work of its kind, devoted to the business and managerial aspects of radio and television retailing.

After reviewing the growth of the Radio Trade and assessing its future prospects, the author discusses the problems associated with the setting-up of a retail business. The merits of the various trading arrangements, i.e. sole trader, limited company and partnerships are analysed in detail.

Four chapters are devoted to the selection and training of staff, selling techniques, window displays, advertising and similar subjects.

Emphasis is given to the " after sales " aspect of retailing in a very informative chapter on the service section. In addition to the practical matters concerning the layout and organisation of an efficient servicing department, sound advice is offered on servicing philosophy.

The book-work involved in the retail business is well covered, together with other responsibilities of management such as work study, staff comfort, sales analysis and market research.

The last two chapters of the book provide an authoritative exposition of the Law as affecting retailers.

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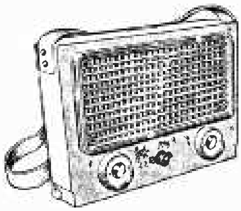

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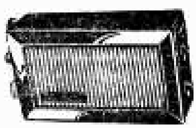

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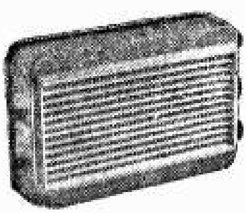

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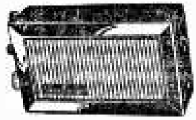

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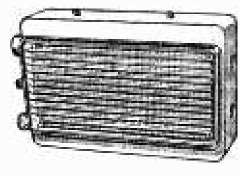

350 Mw Mullard push-pull output Transistors. Powerful magnet 3in. high grade speaker. Push-pull transformers. This is a top performing receiver. Nearly 30 stations listed in one evening including Luxembourg loud and clear. A pleasure to listen to. **FERRITE ROD AERIAL.** All parts sold separately, including pale blue gleaming polystyrene case with duo-diffusion grilles in red. Uses 9 volt battery. Sockets for car aerial.

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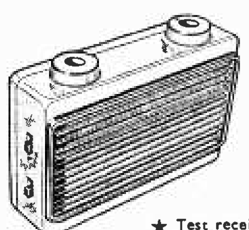

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A 4-valve Signal Tracer

THIS INSTRUMENT WILL ALSO PROVIDE A SIGNAL FOR TESTING AUDIO AMPLIFIERS

By V. E. HOLLEY

THIS versatile piece of equipment is a worthwhile addition to any bench. It will trace a signal through all the stages of a radio receiver from the grid of the first valve onwards and will itself provide a signal of good quality for testing audio amplifiers or loudspeakers; it can also be used as a general purpose bench amplifier and when not in use for any of these purposes, will serve as a portable local station receiver for the workshop or the house.

Signal Production

The first stage, which employs a high gain R.F. pentode, EF91, is concerned entirely with the provision of a signal, the source of which may be any radio transmission which is readily receivable at consistent strength. In the area in which the prototype is used, the Light programme on 200kc/s is the only one which meets this requirement and it was accordingly selected. As will be seen from Fig. 1, a ferrite rod aerial with long-wave coil, tuned by a fixed capacitor of 330pF, collects the signal and presents it to the grid of V1, the anode load of which is the 4·7k resistor, R2. The amplified signal passes through the capacitor C4 to a miniature jack socket J1, and thence through C5 to the following stage. Decoupling is provided by resistor R1 and capacitor C2, while bias is obtained in the usual manner by means of a by-passed cathode resistor.

R.F. Tracing

Signals to be traced are fed in at J1, where insertion of a plug applies them to the grid of V2 and breaks the connection between this point and the first stage. It was found that the miniature socket used in the prototype had sufficient capacity to pass on a small portion of V1 output despite the disconnection, and the switch S1 had to be fitted to silence it. The valve V2, another R.F. pentode, accepts and amplifies signals of any radio frequency and the tracing range is limited only by the characteristics of the choke Ch1, which loads the anode circuit. This is an "all-wave" component which, in the prototype, has a range of from 0·2Mc/s to 60Mc/s.

Demodulation

Diode D1 accepts for demodulation the signals appearing at V2 anode. Resistors R8 and VR2 form the load proper, and R7 completes the D.C. continuity of the circuit. Capacitors C9 and C11 remove the now unwanted radio frequencies and

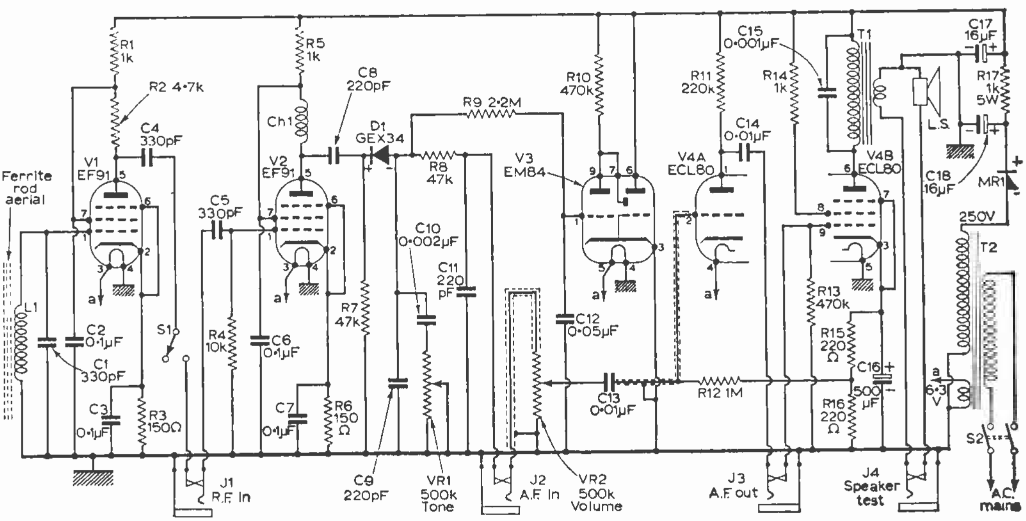


Fig. 1—The circuit of the instrument.

LIST OF COMPONENTS

Resistors (½W unless otherwise stated)

R1	1k	R11	220k
R2	4·7k	R12	1M
R3	150Ω	R13	470k
R4	10k	R14	1k
R5	1k	R15	220Ω
R6	150Ω	R16	220Ω
R7	47k	R17	1k, 5W
R8	47k		
R9	2·2M	VR1	500k
R10	470k	VR2	500k with D.P. mains switch

Capacitors:

C1	330pF mica	C10	0·002μF 250VW
C2	0·1μF 350VW	C11	220pF
C3	0·1μF 350VW	C12	0·05μF 350VW
C4	330pF	C13	0·01μF 350VW
C5	330pF	C14	0·01μF 350VW
C6	0·1μF 350VW	C15	0·001μF 350VW
C7	0·1μF 350VW	C16	500μF 15VW elec.
C8	220pF mica	C17	16μF 350VW elec.
C9	220pF mica	C18	16μF 350VW elec.

Diode: GEX34 or similar

Valves:
- V1 EF91, B7G base
- V2 EF91, B7G base and can
- V3 EM84, B9A base
- V4 ECL80, B9A base

Transformers:
- Mains 250V half-wave, 50mA, 6·3V 1·5A
- Output 60 : 1 30mA primary

Rectifier: Contact-cooled, 250V, 50mA

Miscellaneous:
- RF Choke—all wave, 0·2 to 60Mc/s
- 4 miniature jack sockets
- 2 miniature jack plugs

the audio output is passed on for amplification via C13. It will be noticed that a simple top cut tone control (C10/VR1) is connected to the diode circuit; this relates entirely to the receiver service and was added to reduce television whistle which is apt to be troublesome on 200kc/s.

Visual Tracing

In addition to the audio frequencies, there appears across the diode load a negative D.C. voltage proportional to the strength of the signal at V2 anode. This is used to control a tuning indicator valve V3, so that unmodulated or frequency modulated signals which, of course, produce no sound output, may be traced visually. Resistor R9 isolates the indicator grid from audio frequencies and capacitor C12 removes any which may reach this point.

Audio Tracing

Socket J2, which is included in the diode circuit, is the A.F. tracing input. Insertion of a plug transfers VR2 from the diode to the test lead.

Audio and Output Stages

A triode-pentode valve ECL80, is employed here. The triode section is arranged as a resistance-coupled amplifier with an anode load of 220k and included in its output circuit is the socket J3. Insertion of a plug here provides an audio output which, controlled by VR2, can be made large enough to load any normal output stage.

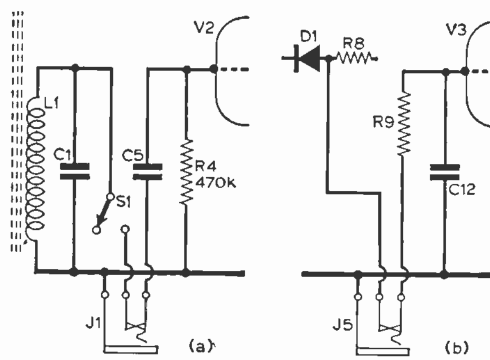
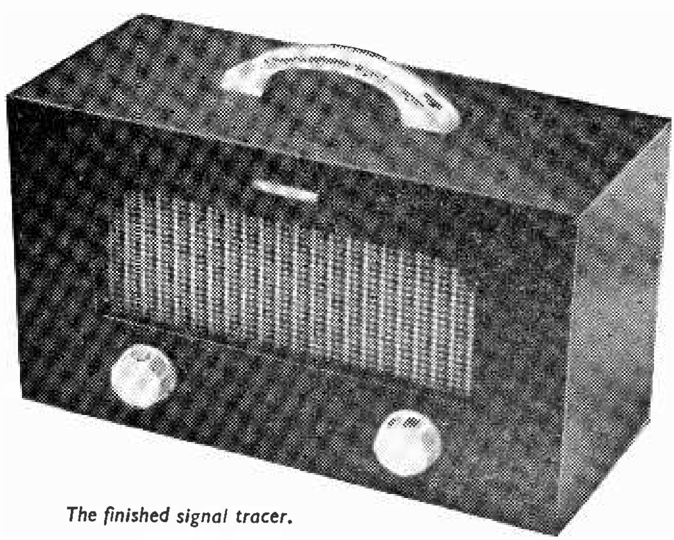


Fig. 2a—A modification of the circuit, omitting V1; b—An additional input to the grid of V3.

The two sections of the ECL80 share a common cathode but require different bias voltages; the triode grid resistor R12, is therefore returned to a tapping on the cathode resistor instead of to chassis. For satisfactory operation, this cathode network must be by-passed by a really large capacitance and C16 has accordingly been given a value of 500μF. The optimum load of the pentode section of V4 is 11,000Ω, and the output transformer should have a ratio of 60 : 1 to suit a 3Ω speaker. Suitable transformers are readily available. The primary windings of these com-



The finished signal tracer.

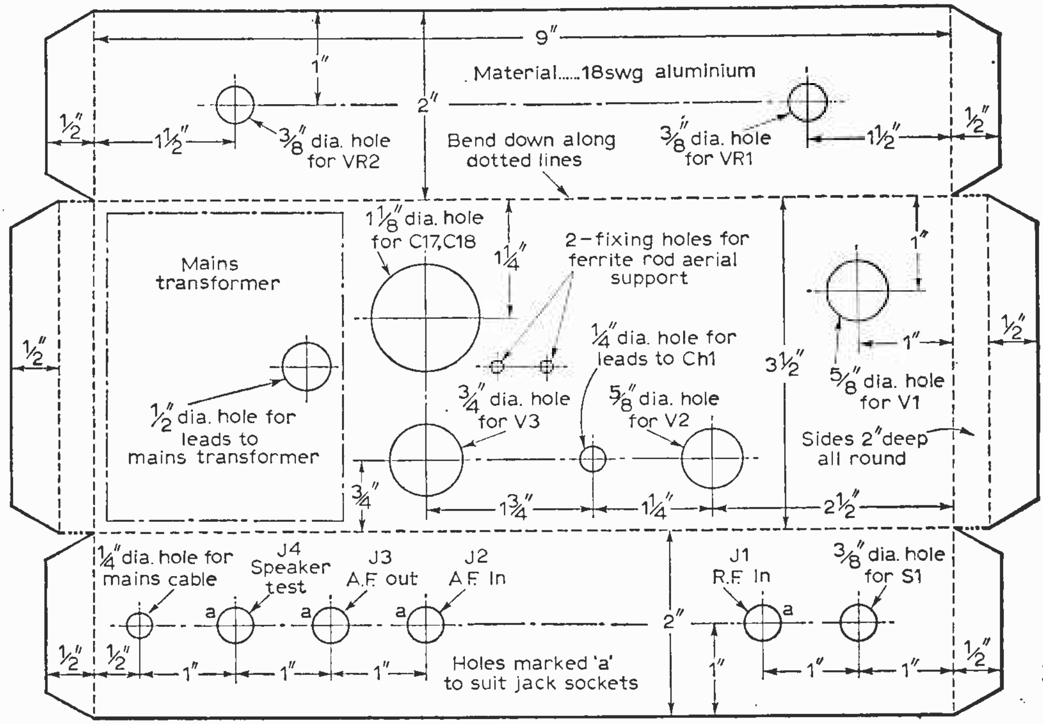
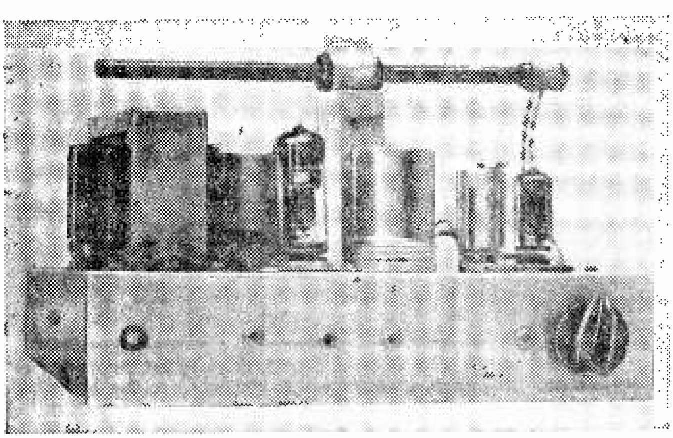


Fig. 3—The drilling dimensions of the chassis.

ponents usually have sufficient resistance to produce a noticeable voltage drop at the valve anode and resistor R14 is included in the screen supply so that the voltage here will not exceed that at the anode. Connected across the transformer primary is the capacitor C15, which corrects the response at the higher audio frequencies. The output from the transformer secondary is fed to a loudspeaker via a jack socket, J4. Insertion of a jack here provides a low impedance audio output for testing loudspeakers.

Power Supply

The total H.T. requirement is 45mA at 250V and a supply of 1·2A at 6·3V is needed for the valve heaters. This is provided by a half-wave mains transformer and a contact-cooled metal rectifier, MR1. Smoothing is by resistor, R17 in conjunction with the electrolytic capacitors C17 and C18. The value of the resistor may need adjustment to provide the correct H.T. line voltage of 200, depending on the output of the transformer-rectifier combination employed.



The unit without its cabinet.

Modifications

If the tracer is to be used in an area of good signal strength, V1 may be omitted, the ferrite aerial being connected through socket J1 to the grid of V2 as shown in Fig. 2(a). In this case, R4 will need to be increased to avoid excessive damping of the tuned circuit and R17 must also be increased to take account of the reduced current requirement.

(To be continued)

How Transistors Work

By B. N. Rolfe

(Continued from page 38 of the May issue)

A BASIC NON-MATHEMATICAL EXPLANATION

LAST month we learnt more about the semi-conducting process: how the two "*p*" and "*n*" types of semi-conducting materials are produced by the addition of "impurities", how the two types are integrated to form either a simple diode rectifier or three-element transistor and, most important, we discovered that minority-carriers quickly increase in number if the semi-conducting device is allowed to rise in temperature.

Normally, the collector current increases with increase in base current, but, due to minority carriers, the collector current will also rise with increase of temperature of the junction. Previous articles in this series revealed how the operating temperature of a transistor is stabilised from the circuit aspect, and this article will start with a few more notes on the operating limits of transistors.

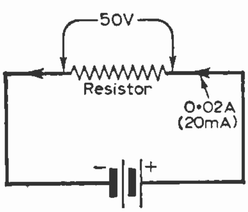


Fig. 23—The power dissipation in a resistor in watts is equal to the voltage multiplied by the current in amperes.

Collector Dissipation

Dissipation in the context considered is the "power" that a device can safely withstand. Power is usually rated in watts. Take an ordinary resistive circuit across which is a potential of 50V and through which a current of 0·02A (e.g., 20mA) is flowing—see Fig. 23. The product of the voltage and the current in amperes gives the power dissipation in watts. Thus, in Fig. 23, the power dissipation is 50 times 0·02, which works out at 1W.

An ordinary thermionic valve has an anode dissipation value which is calculated in the same way as with a resistor. In Fig. 24 is shown a simple valve circuit with 100V on the anode and, again, 0·02A of current (called anode current). The product of the two works out in this example to 2W.

The maximum dissipation of a resistor is, of course, determined by its physical size and, if wire-wound, the diameter of the resistance wire used coupled with the heat withstanding property of the former on which the wire is wound. Power dissipation produces heat, and in a resistor this is caused by the resistance that the wire or couductor possesses to the flow of electric current.

Anode Heating

In a thermionic valve, the electrons from the cathode are accelerated to a very high speed by the positive anode, and since the electrons have mass, on striking the anode they liberate their kinetic energy and in that way cause the anode to become hot. The maximum anode dissipation of a valve is related to the maximum permissible values of cathode current and anode voltage, and, in turn, these ratings depend upon the size and physical construction of the valve.

From the foregoing, therefore, it will be appreciated that a transistor has a collector dissipation rating. This is usually denoted pc and is given by the product of the maximum collector voltage (Vc max) and the maximum collector current (Ic max). However, with a transistor, there is also another important factor—temperature. As indicated in previous articles in this series, the maximum junction temperature (which is often the same as the maximum storage temperature) is in the region of 75°C for most germanium transistors. This means that if the temperature of a transistor is allowed to rise above that value it may well cease to work as a transistor and change into an ordinary resistor. The same applies if a transistor is stored for any length of time at a temperature much above 75°C.

Thermal Resistance

It is thus necessary to introduce a temperature

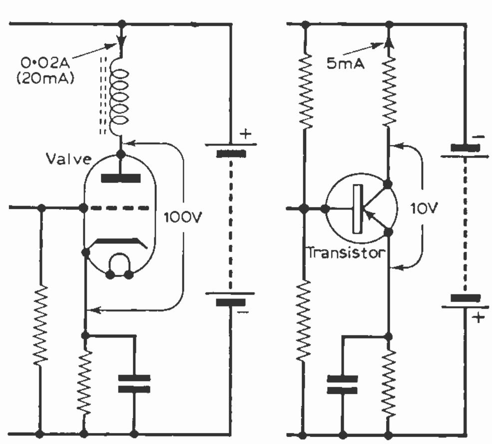


Fig. 24 (left)—A thermionic valve has an anode dissipation value equal to the anode voltage times the anode current.

Fig. 25 (right)—The collector dissipation of a transistor is given by (Ic x Vc).

factor into the equation dealing with maximum collector dissipation. This factor is called thermal resistance and is given on transistor data sheets in terms of °C/mW for small units.

A typical value is 0·33°C/mW. This relates the collector dissipation to the rise of temperature of the junction. It is not really as complicated as it sounds, as a simple example will show.

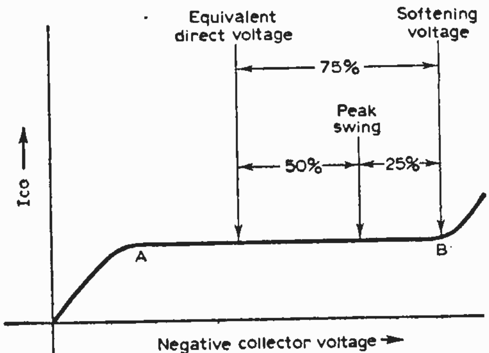


Fig. 26 (above)—Curve showing the voltage limits at the collector.

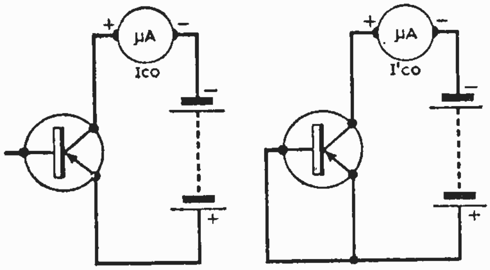


Fig. 27—With the base open-circuit, the collector current present is usually denoted Ico (a—left); and with the base connected to the emitter I'co (b—right).

As we are considering a rise in temperature from the ambient, there are four factors which have to be considered. These are (i) collector dissipation pc, (ii) junction temperature Tj, (iii) ambient temperature Ta and (iv) thermal resistance Rt. These are used in the following equation to permit the calculation of collector dissipation:

$$pc=(Tj-Ta)/Rt.$$

Suppose Tj=75°C, Ta=50°C, and Rt=0·33. Then, pc=(75−50)/0·33 which works out to a little under 76mW. This means that a transistor with a thermal resistance rating of 0·33 and a maximum junction temperature of 75°C working in an ambient temperature of 50°C has a permissible collector dissipation of 76mW.

Increased Dissipation

A small transistor would probably not require to operate with a collector dissipation in excess of 76mW, so all is well. However, larger transistors may be called upon to dissipate a power in excess of that allowed by the "free air" thermal resistance. This is possible by the use of a heat sink which consists of a good conductor of heat on which the transistor is mounted and which drains away the heat produced; is not to be confused with a heat shunt which is used primarily for by-passing the heat from a soldering iron away from a transistor during soldering.

In effect, a heat sink keeps the junction temperature below that which would have been reached under free-air conditions for a given collector dissipation. Thus, a transistor with a free-air thermal resistance rating of, say, 0·4°C/mW may well have its rating modified to 0·3°C/mW by the use of a suitable heat sink.

For example, a transistor with a thermal resistance in free air of 0·4°C/mW, with a maximum junction temperature of 75°C and working in an ambient temperature of 50°C would have a collector dissipation of about 62mW. However, by the use of a heat sink (thereby reducing the thermal resistance, say, to 0·3°C/mW) the same transistor could have a collector dissipation of about 83mW—a useful increase.

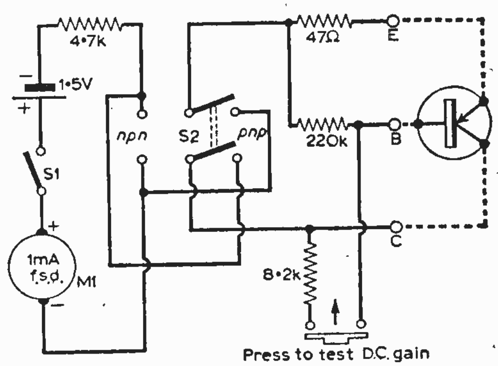


Fig. 28—A circuit of a simple transistor and semi-conductor diode comparator.

After finding the permissible collector dissipation, we can then put voltage and current values in the collector circuit, as shown in Fig. 25. Let us suppose that we found that the collector dissipation was 50mW. Then, the circuit elements would have to be arranged so that the product of the voltage and current did not exceed that value. This would be satisfied by 10V and 5mA.

The maximum voltage, however, is somewhat related to signal swing at the collector, whereas the maximum current has its limit in terms of permissible collector dissipation. For example, it is possible to operate a transistor at a very low voltage and draw from it relatively high currents.

Maximum Collector Voltage

The converse is not possible (e.g., a very low current and relatively high voltage) as already intimated. Without going into too much theory, we can see why this is the case by referring to the curve in Fig. 26.

It will be recalled that the base-emitter junction is biased by the power source in the reverse direction (e.g., negative at the collector and

(Continued on page 165)

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JUNE 1962

The P.W. TROUBADOUR

BLUEPRINT 3

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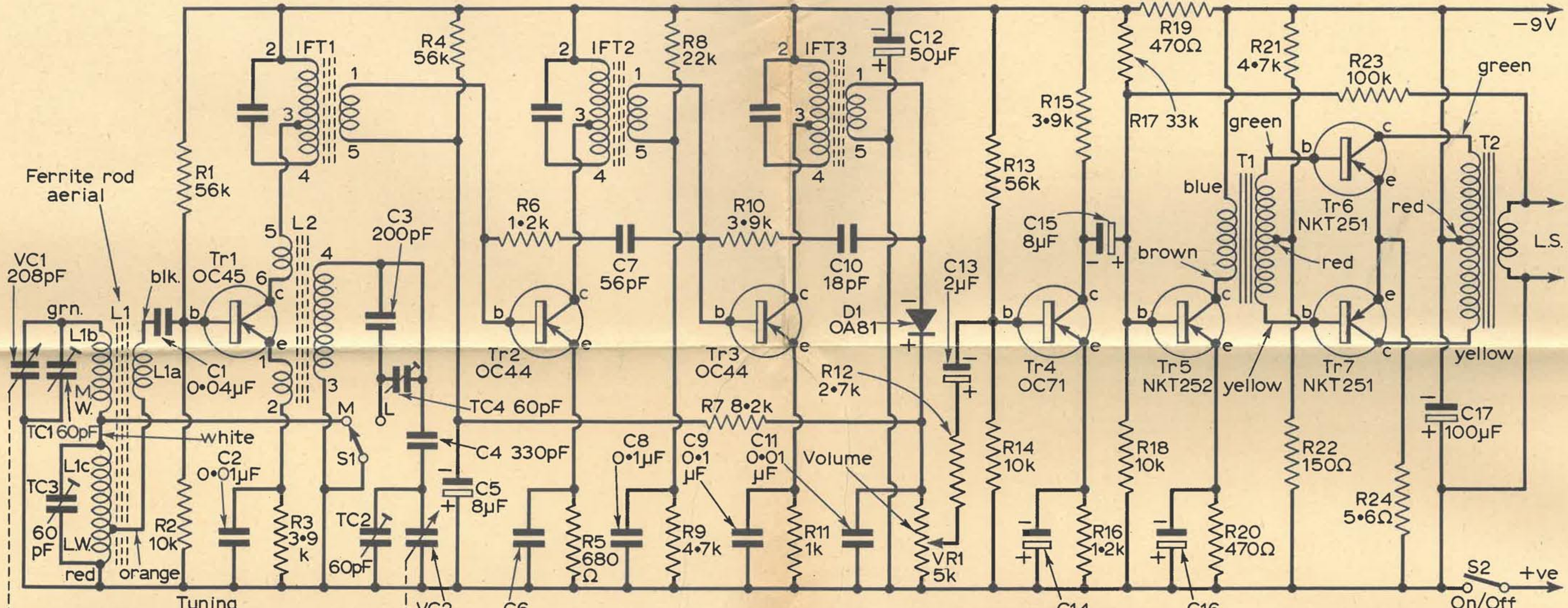


Fig. 1 — The circuit diagram.

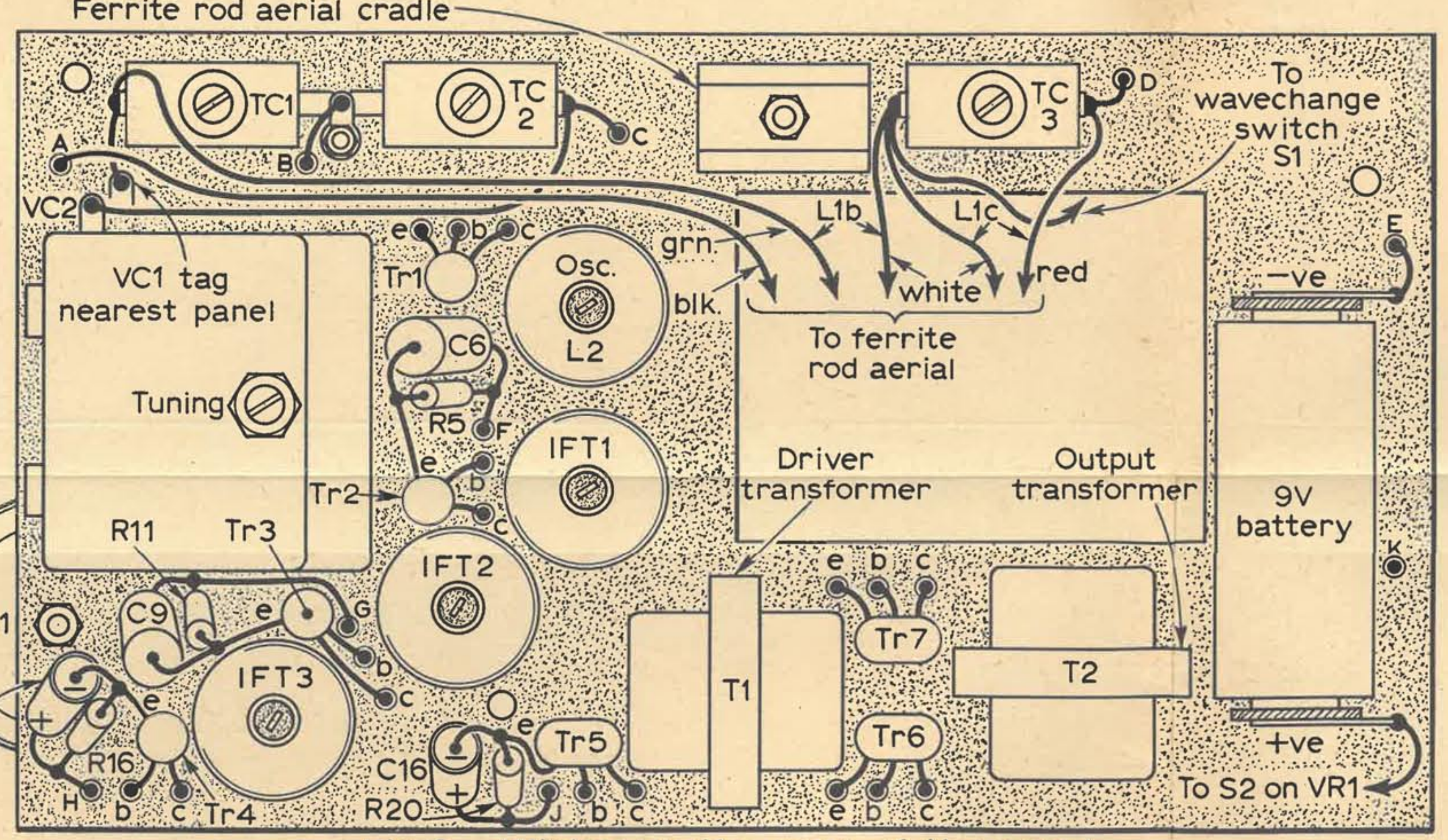


Fig. 2 — Wiring on the rear of the panel.

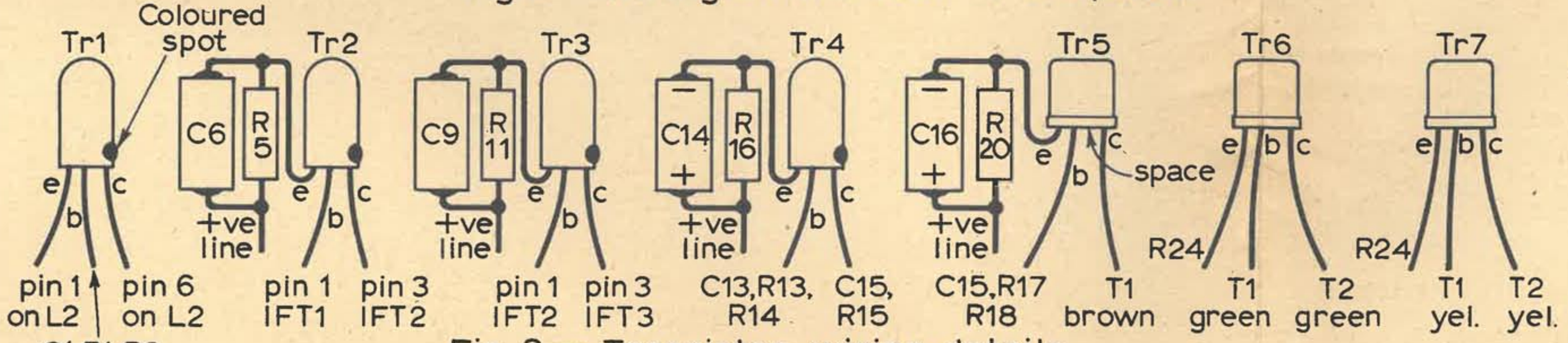


Fig. 3 — Transistor wiring details.

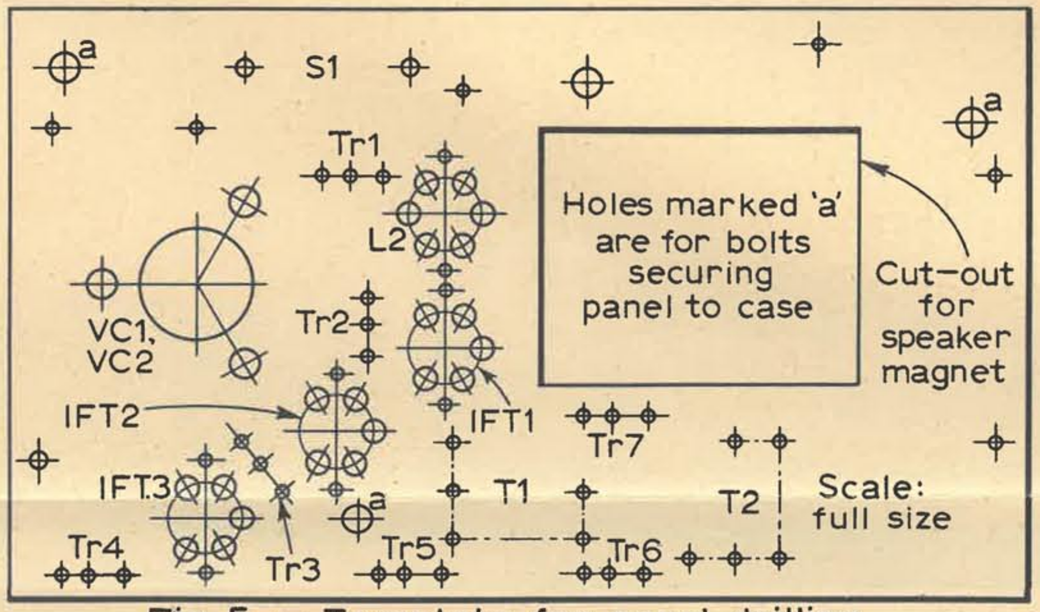


Fig. 5 — Template for panel drilling.

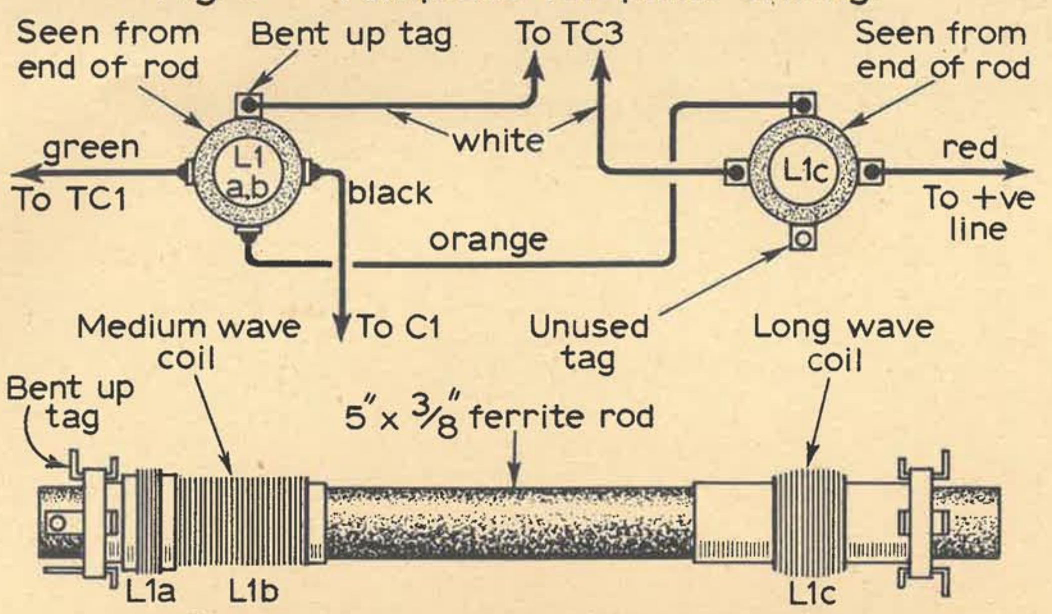


Fig. 6 — Ferrite rod aerial connections.

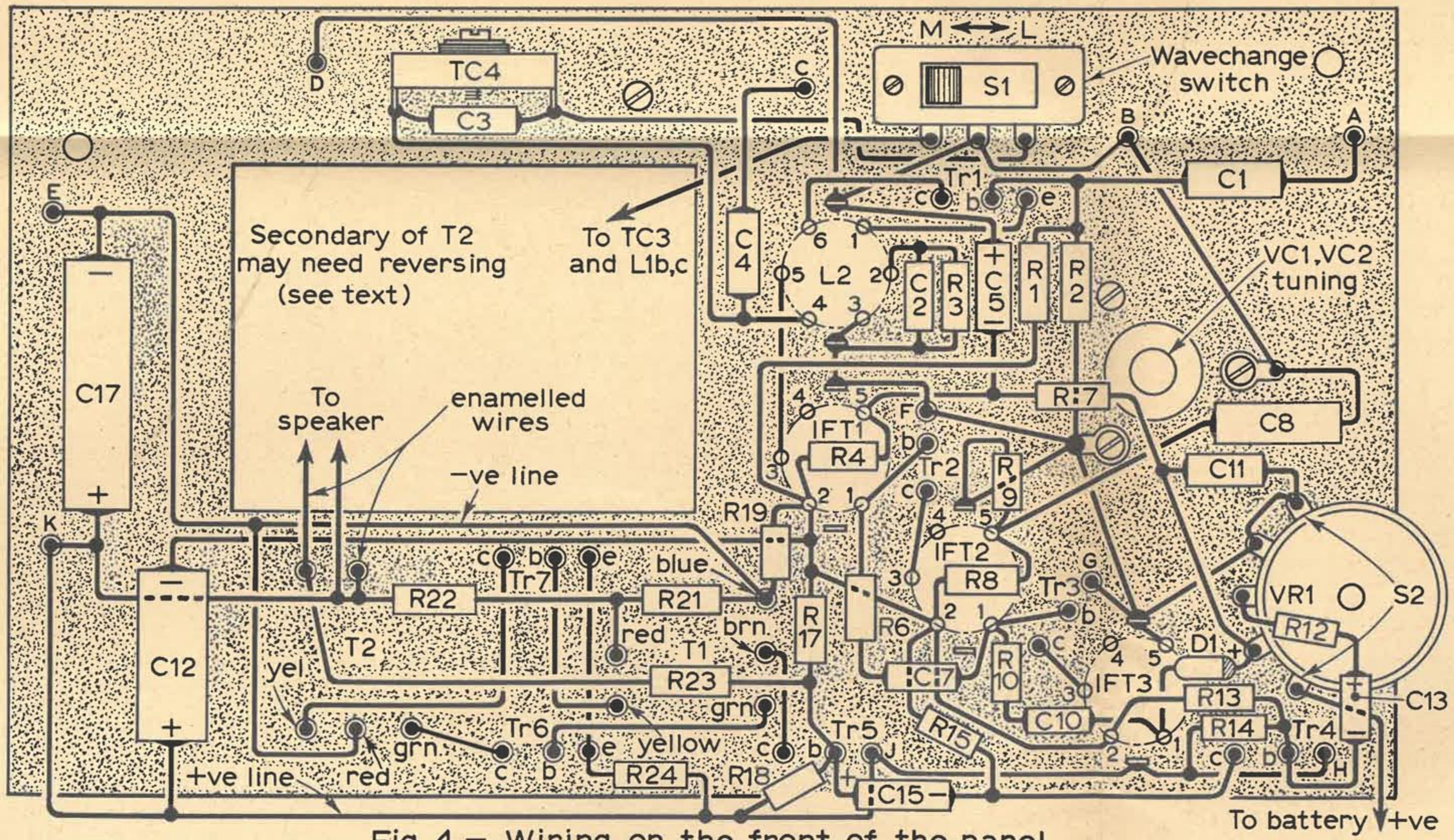


Fig. 4 — Wiring on the front of the panel.

COMPONENTS LIST

Resistors:
(All ¼W, 10% unless otherwise stated.)

R1	56k	R13	56k
R2	10k	R14	10k
R3	3·9k	R15	3·9k
R4	56k	R16	1·2k
R5	680Ω	R17	33k
R6	1·2k	R18	10k
R7	8·2k	R19	470Ω
R8	22k	R20	470Ω
R9	4·7k	R21	4·7k
R10	3·9k	R22	150Ω
R11	1k	R23	100k
R12	2·7k	R24	5·6Ω

VR1 5k pot. with switch (S2)

Capacitors:

C1	0·04μF 150VW
C2	0·01μF 150VW
C3	200pF
C4	330pF
C5	8μF 6VW
C6	0·1μF 150VW
C7	56pF 2%
C8	0·1μF 150VW
C9	0·1μF 150VW
C10	18pF 2%
C11	0·01μF 150VW
C12	50μF 12VW elec.
C13	2μF 6VW elec.
C14	30μF 9VW elec.
C15	8μF 6VW elec.
C16	30μF 9VW elec.
C17	100μF 12VW elec.

VC1/VC2 208/176pF two gang tuning condenser with screen between sections, (Jackson 00 type)

TC1, TC2, TC3, TC4 60pF miniature trimmers

Coils (Osmor):
L1 Ferrite rod aerial type FR1 (with cradle and strap)
L2 Oscillator coil—PW/01

Transformers (Osmor):
IFT1 PW/2
IFT2 PW/2
IFT3 PW/3
T1 Driver transformer—PW/DT
T2 Output transformer—PW/OT

Transistors:
Tr1 OC45, Tr2 OC44, Tr3 OC44, Tr4 OC71 (Mullard)
Tr5 NKT252, Tr6 and Tr7, matched pair of NKT251 (Newmarket)

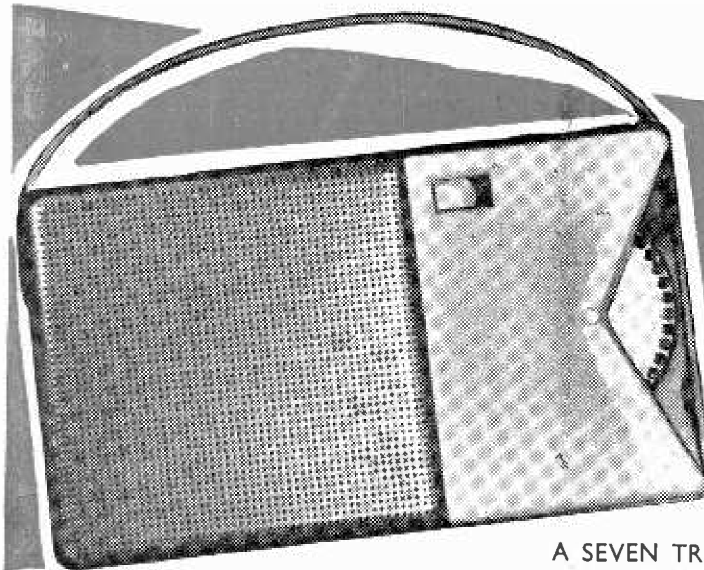
Diode (Mullard):
OA81

Battery:
9V Ever-Ready

Chassis:
Paxolin, about 5⅜in. x 3¼in. x 1/16in.

Wavechange Switch (S1):
Single-pole, two-way, miniature slide type

Miscellaneous:
Plastic cabinet and loudspeaker (Osmor), battery clips, 26s.w.g. tinned copper wire, 1mm sleeving, etc.



The Troub

A SEVEN TRANSISTOR, DUAL-WAVE, SUPERHET RECEIVER

THIS receiver uses seven transistors in a superhet circuit, and will be found to give very good results indeed, with ample volume in even unfavourable circumstances. It tunes both medium and long waves and fits in a ready-made cabinet which is approximately $5\frac{3}{4}$in. x $3\frac{3}{8}$in. x 2in. (external dimensions). It is thus very compact and portable, and is capable of a really good output from the internal speaker.

Circuit

The circuit is shown in Fig. 1 on Blueprint 3, and is very satisfactory for this type of set. VC1 and VC2 constitute the twin-gang tuning condenser, and TC1 and TC2 are for trimming the aerial and oscillator circuits on the M.W. band. TC3 and TC4 permit trimming and padding on the L.W. band. These adjustments are not particularly difficult, and will be dealt with next month. After two stages of intermediate frequency amplification, diode D1 acts as detector, and provides some measure of automatic volume control bias for Tr2, via R7.

Tr4 is a high gain, low noise audio amplifier, and should employ a genuine OC71 or comparable transistor; Tr5 is the driver, the output stage using a matched pair of NKT251 transistors. These permit high volume output when wanted, yet have a low resting current under "no signal" conditions. or when volume is lower. This is important, for long life from a miniature battery. As plenty of gain is available, it is possible to provide negative feedback, via R23, including Tr5, Tr6 and Tr7, and both audio transformers; quality of reproduction is therefore good.

BLUEPRINT 3

If other transistors are to hand, and it is wished to try these, satisfactory results should generally be possible, with comparable types. In general, the values of R14, R18 and R22 might then need changing, to obtain proper working conditions.

Paxolin Panel

The receiver is constructed on a piece of $\frac{1}{16}$in. thick paxolin $5\frac{5}{8}$in. x $3\frac{1}{4}$in. The correct positions for all holes are shown in Fig. 5, and if this is followed it will allow parts to be mounted easily. Small holes, for leads, can be made with a $\frac{1}{16}$in. drill. For the oscillator coil and IFT pins, $\frac{1}{8}$in. holes will do well, and these will also suit the three 6B.A. securing bolts. A hole nearly $\frac{3}{8}$in. in diameter is required for the tuning condenser, and three $\frac{3}{16}$in. or similar holes for the 4B.A. bolts holding this item.

After drilling, check that parts will fit, and that the holes for the three 6B.A. securing bolts agree with the matching holes in the cabinet front. A small round file may be used to elongate or enlarge any holes which have been inaccurately drilled.

The opening for the loudspeaker magnet is made by drilling a few holes close together each side, so that a small saw may be used. After cutting out the piece, level up the edges with a flat file.

The whole work of preparing the panel should prove to be quite straightforward. Rough edges and holes are cleaned up, and the panel is dusted off. No further drilling or similar preparation will be needed, though if any holes have been missed it is possible to make these later, taking great care not to damage parts already fitted.

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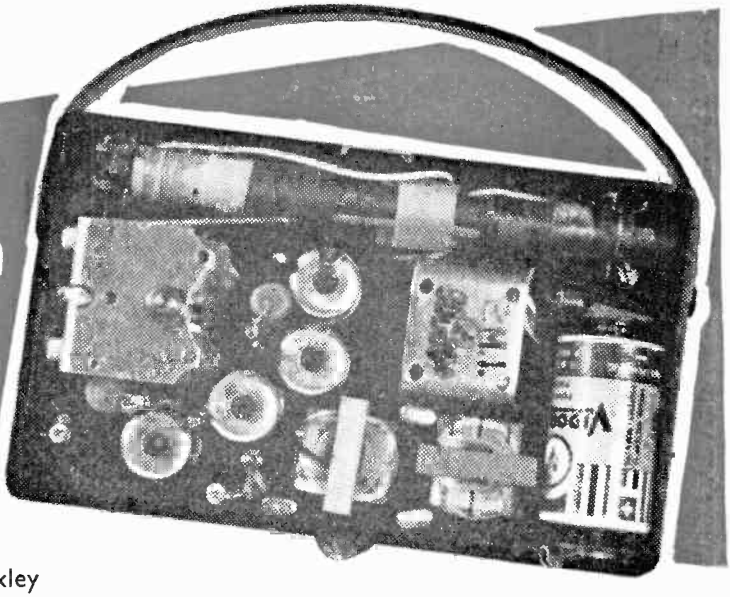
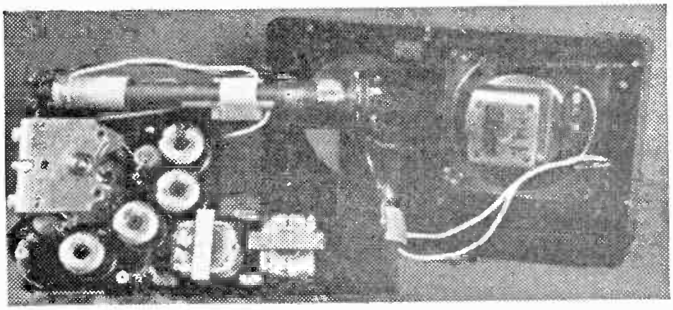
adour



By T. R. Huxley

Ferrite Aerial

When the ferrite rod has been fitted to the receiver, a little confusion may arise in wiring it correctly. This can be prevented by soldering colour coded leads to the various tags, in advance. Very thin coloured flex is satisfactory for this purpose, and can be obtained in the required colours. Alternatively the leads can be marked with pieces of coloured sleeving, or with temporary paper tags, or any other convenient system.



The chassis complete and connected to the loudspeaker, ready for mounting in its case.

Fig. 6 shows the aerial connections. Each winding is so placed on the rod that its tagged end is outwards, as in Fig. 6. The M.W. winding has one tag bent up, to identify the end of the tuned section. This is coded white, and goes to TC3 and the wavechange switch. The next tag (clockwise) is the beginning of the coupling winding, and goes to C1, being coded black. The orange tag is the end of this winding, and goes to the L.W. tap. The final tag on the M.W. portion goes to the tuning condenser VC1 and TC1, this lead being marked green.

With the L.W. section, the unused tag identifies the connections. Viewing the coil from its tagged end, the next tag clockwise also has a white lead, for TC3 and the wavechange switch. Next is the tapping, connected to the orange lead, as already mentioned. Finally, a red lead provides a connection for the "earthed" end of the L.W. winding.

After soldering about 6in. of thin flex to each tag, to agree with Fig. 6, the aerial is put aside, as it is not wired until last. The wires can then be cut down to suitable lengths, but left a trifle slack, so that the windings can be moved along the rod.

Fitting Components

The three intermediate frequency transformers are inserted as in Figs. 2 and 4, taking care to use the *blue spot transformer* for IFT3. The oscillator coil will fit in either of two positions, but one position is wrong, and a coloured spot identifies pins 1 and 6. This spot must therefore be towards the ferrite rod. Bend the can tags out slightly, to hold the IFT's and oscillator coil in position.

The tuning condenser is fitted as in Fig. 2, tags being placed under two bolts, as in Fig. 4. These three bolts must be very short, or have extra washers, to avoid shorting or damaging the condenser.

Insert the driver and output transformer leads so that they emerge as in Fig. 4. "Durofix" or a similar adhesive will hold these items to the panel. It may prove necessary to reverse the two output transformer secondary connections. This always arises in circuits with negative feedback.

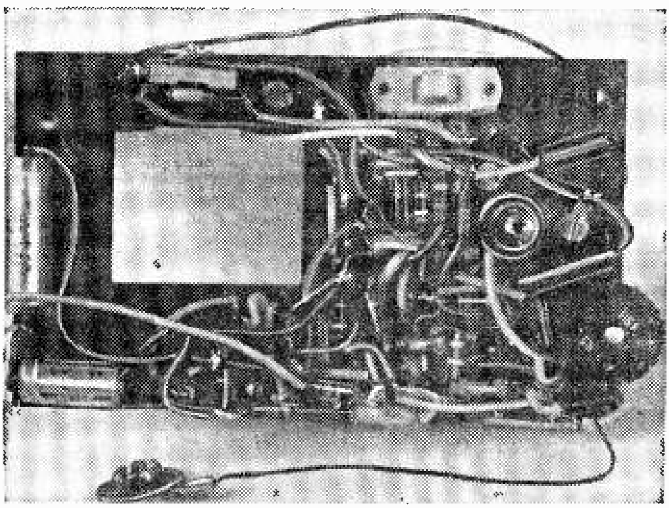
The volume control is held with an 8B.A. ½in. countersunk-headed bolt, the nut being near the tuning condenser (Fig. 2). The control tags are bent flat, so that leads may be soldered to them.

The slide switch is held by two 10B.A. ½in. countersunk-headed bolts. A tag is placed under one nut, and trimmers TC1 and TC2 are soldered to this, as in Fig. 2. A lead connects this tag to the tuning condenser frame (via hole B).

Trimmer TC3 has one tag inserted through a hole, this being wired to the positive line (via hole D). All three trimmers are kept close against the paxolin, to avoid obstructing the ferrite rod.

C17 is mounted by passing its appropriate ends through the holes. A short piece of thin flex, subsequently fitted with a battery clip, is soldered to the negative tag. The positive tag merely passes through the paxolin (hole K) to support the condenser.

All other small parts are generally held by their wire ends, and are added as wiring progresses.



A view of the front of the chassis when nearing completion.

Transistors

All the transistor holes are placed so that they are closely in line, for each transistor, with increased spacing between base and collector. This increased spacing agrees with the space between leads, for Tr5, Tr6 and Tr7. With transistors Tr1, Tr2, Tr3 and Tr4, a red spot identifies the collector leads.

Transistors Tr2, Tr3, Tr4 and Tr5 each have an emitter resistor, with a condenser in parallel. These components are placed near the transistors. All the transistors may thus be prepared as in Fig. 3; Tr1, Tr6 and Tr7 have all leads passing directly through the paxolin. About ½in. of 1mm sleeving is placed on the centre lead of each transistor, to space it from the paxolin, and avoid shorts.

Transistors Tr2, Tr3, Tr4 and Tr5 are all prepared in the same way. With Tr2, solder C6 and R5 closely together, cutting both leads of R5 short. Place insulation on the emitter and base leads of the transistor. Bring the emitter lead up, cut it to length, and solder it to the junction of C6 and R5, as in Fig. 3. Do not bend the emitter lead immediately at the bottom of the transistor. The two remaining transistor wires, and lead from C6 and R5, are then inserted through the appropriate holes.

Tr3, Tr4 and Tr5 are added in exactly the same manner. C14 and C16 are elctrolytics, and the positive ends must go to the positive line. If the 0·1μF condensers C6 and C9 have a band, or one end marked O.F., this denotes the outside foil connection, and it should preferably be wired to the positive line.

The few remaining leads in Fig. 2 may be added, and this completes this side of the panel, except for adding the aerial.

Remainder of Wiring

Fig. 4 shows the other side of the panel. All the can tags and earth points can be connected together first using 26s.w.g. tinned copper or similar wire, and 1mm sleeving. It is quite a good plan to use red sleeving for all "earth" (battery positive) wiring, and black for all negative line wiring, as this greatly simplifies checking. Another colour is used for other leads, if this system is followed. One yard each, of red, black and yellow sleeving will easily be more than enough.

The large capacity condensers are all electrolytics, and have positive and negative ends, which must be connected as shown. The cans of these condensers are negative. Other condensers, and all resistors, may be wired in either way round. Each resistor value should be carefully checked as it is inserted, because a mistake will upset the working of the set.

Insulation

No bare leads or joints must touch each other, or other parts. This includes the cans of electrolytic condensers, which can be wrapped with tape if necessary. This particularly applies to C15.

A careful check on work can be kept. if desired, by inking over each part on the diagrams, as it is added, and inking over each lead, as it is soldered. There should then be little chance of omitting anything.

Trimmer TC4 only requires initial adjustment on long waves, so it is placed as in Fig. 4, its leads and a touch of adhesive holding it in position.

Transistor Leads

Transistor leads should not be overheated while soldering. There is no need at all to cut these leads as short as possible. All parts and wiring on the right of the panel in Fig. 4 should be kept down to the level of the body of the wavechange switch, which will rest flush against the cabinet front. To the left of the panel, around the loudspeaker opening, the clearance is greater, for TC4, C12 and C17.

The secondary ends of the output transformer, marked "enamelled wires" in Fig. 4, should be left temporarily disconnected.

(To be continued)

Using your MULTIMETER

THE USE OF THE MULTIMETER IN RADIO CONSTRUCTION AND SERVICING

By G. J. King

(Continued from page 70 of the May issue)

THE D.C. or "static" operating condition of a valve or transistor circuit can speedily be determined simply by making a voltage measurement across the cathode or emitter resistor, as shown by Test 1 in Figs. 6(a) and 6(b). The fact that a voltage is recorded indicates conclusively that current is flowing in the resistor, and in the case of the valve this is the total cathode current due to the sum of the anode and screen currents—or the anode current alone in a triode. In a transistor, it is due to the current in the collector and base circuits.

Conditions

The value of the voltage is governed by two factors: one, the current in the resistor and, two, the value of the resistor. For example, a reading of 10V across a 1k resistor would reveal that the current was 10mA (from Ohm's law, where the current in amperes is equal to the voltage divided by the value of the resistor in ohms).

This measuring technique can be employed in almost any current-carrying circuit, and allows the current in the circuit to be assessed by measuring the voltage across an associated resistor without breaking the circuit. The alternative method, of course, is to break the circuit and insert a milliammeter, as shown by Test 2 in Figs 6(a) and 6(b).

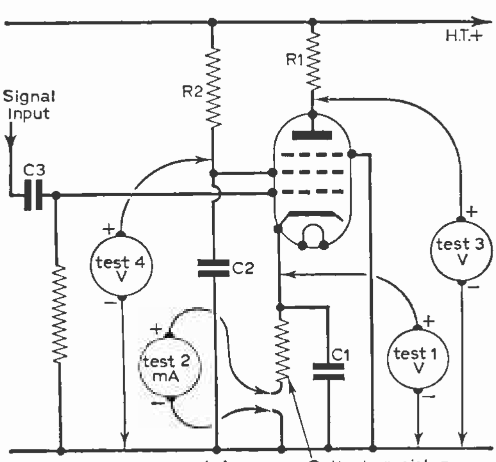


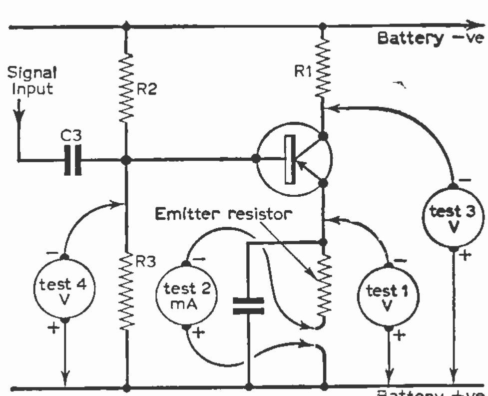
Fig. 6a (above)—Voltage and current tests in a valve circuit.
Fig. 6b (right)—Tests in a transistor circuit.

In some cases, Test 1 is not sufficiently accurate owing to the shunting effect of the voltmeter, as discussed in last month's article. However, in the cathode or emitter circuit, the resistor is of a relatively low value in comparison with the resistance of the meter, and there will thus be very little error indeed.

Expected Voltages

At this point the value of the voltage to be expected across the cathode or emitter resistor should be considered. In a valve circuit, the voltage may range from about 0·5 to 15 or more, depending on the type of circuit. The voltages are usually given in the service sheet or manual, and if there were a marked deviation between what they should be and what they actually measure, this would indicate fairly conclusively that there was trouble in the stage. A high reading would mean that the valve was passing more current than it should, while a low reading could indicate a low emission valve or an increase in value of a resistor in the screen or anode feed circuits.

In a transistorised circuit, the emitter voltage is usually little more than 1 and may be even less than that, depending on the stage and type of transistor concerned. This shows the importance of using a voltmeter with a full-scale deflection of 1V or 2·5V. A reading which is definitely above normal could indicate excess collector leakage current, since that current would flow in the emitter resistor. Lack of base current would cause a marked fall in the reading, while excessive base current would cause a rise in the reading.



Further Checks

It should be stressed, of course, that cathode and emitter readings, whilst indicating the presence or otherwise of a fault, do not show precisely where the fault lies. Other follow-up checks are necessary.

For example, if in the valve circuit, there were zero cathode voltage and C1 were not short-circuited, then a voltage measurement would be made at the anode, as shown by Test 3 in Fig. 6(a) and, if the reading were normal, it would be followed by a voltage check at the screen grid—Test 4. If there were no voltage at the anode—yet the H.T. line voltage were normal—R1 would be open-circuited. Similarly, R2 could be open-circuited if zero voltage were recorded at the screen grid. There is also another possibility here, and that is a short-circuit in the by-pass capacitor C2. With the set switched off, this can be checked by switching the multimeter to an "ohms" range.

Leaky Capacitors

In A.F. amplifier and output stages, the coupling capacitor sometimes leaks and makes the control grid slightly positive. This counteracts the bias produced by the voltage drop across the cathode resistor and, as a consequence, causes an increase in anode current, which is reflected as an increase in voltage across the cathode resistor.

A conclusive check if such trouble is suspected is to check the cathode voltage with C3 (Fig. 6a) disconnected from the control grid and then, while observing the voltmeter, reconnect the capacitor. Should this cause the cathode voltage to rise, the capacitor has too great a leakage and should be replaced.

In the transistorised circuit, follow-up checks are shown by Tests 3 and 4, at the collector and base respectively. The same reasoning as with the valve circuit applies here also. R1 is the collector load which, if open-circuited, would prevent any emitter current, while resistors R2 and R3 form the base-bias potential-divider. If R2 were open-circuited, there would be no base current and very little emitter current, while if R3 were open-circuited, the base current might rise above the normal value and cause on increase in emitter current.

Meter Loading

Service sheets and manuals give anode and screen voltages when taken with a certain meter of specified sensitivity. If a different type of meter or one with greater or lesser sensitivity were used, then the voltages would be bound to differ from those given in the manual. The amount of error would depend on the difference between the meters and the value of the resistance connected to the point where the measurement is made.

For example, R2 in Fig. 6(a) may be in the region of 220,000Ω, and if a meter with a sensitivity of, say, 2,000Ω/V were used on the 100V range, R2 would be shunted with 200,000Ω (the meter resistance). Thus the actual voltage read would be approximately half of that which is present with the meter disconnected. A meter with a greater sensitivity would read a greater voltage and a meter of lower sensitivity would read a smaller voltage.

However, if any meter is connected to the H.T. line, the reading should be almost the same as that given in the manual; say ±5%. This is because H.T. supplies have very low internal resistances and will deliver even the current required by a meter of quite low sensitivity without the voltage dropping. These factors tend to confuse the experimenter when comparing voltage readings with those given in manuals, and may well lead to incorrect diagnosis.

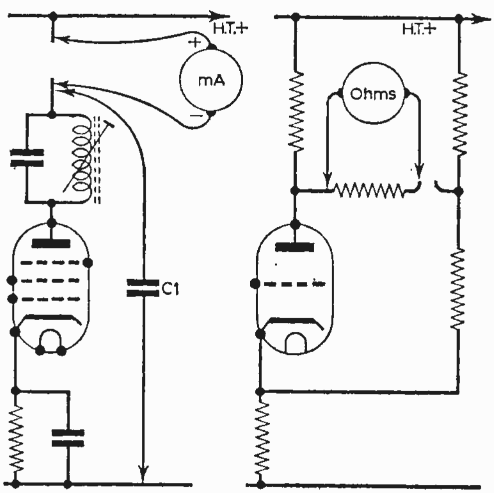


Fig. 7 (left)—When measuring current in an R.F. circuit, the milliammeter should be connected at the low-signal-potential side of the circuit, as shown. In certain cases—to avoid instability—a by-pass capacitor may be required, such as C1.

Fig. 8 (right)—Resistance measurements in complex networks should be made with one side of the resistor disconnected.

Current Measurements

It sometimes becomes necessary to measure anode and screen currents in R.F. or signal stages. The set should be switched off and the H.T. feed circuit should be broken at the low signal potential side so that a milliammeter may be inserted, as shown in Fig. 7. Care should be taken to ensure that the meter is connected the right way round (positive to H.T. positive input and negative to the actual circuit which is being fed), and that the correct current range is selected. To be on the safe side in the latter connection, a range higher than the expected current should be selected initially. The set should then be switched on.

As the valve warms up the meter deflection will rise, and eventually settle at a steady value. If a small deflection only is given on the selected range, the set should be switched off and the multimeter should be set to the next lower current range. The aim should be to obtain a deflection a little beyond the centre of the scale, where the most accurate readings can be taken.

In R.F. circuits, instability may result due to the meter leads. As this could cause an incorrect current reading, a small (0·1μF) by-pass capacitor should be connected between the negative side of the circuit and chassis, as shown by C1 in Fig. 7.

Ohmmeter Tests

Under no circumstances should an ohmmeter be connected to a component with the set connected to the power supply and switched on. In some cases it is possible to measure the value of a resistor or the insulation of a capacitor without removing the component from the circuit. For example, R1 and R2 of Fig. 6(a) could be checked *in situ*, as also could C2. C1 would require disconnecting because it is in parallel with the cathode resistor.

In complex networks it often happens that one component has shunted across it the resistance of one or more other components, thereby making a test *in situ* impossible. The same may apply to capacitors. Thus, if a check *in situ* gives a reading completely removed from that expected, the component should be isolated and the test performed again. It is necessary to disconnect only one side of the component under measurement, as shown in Fig. 8.

In transistor circuits, forward current in the transistor junctions may occur with the ohmmeter connected round one way, while a very small reverse current would then flow with the test leads reversed. This latter connection would give less error when performing measurements *in situ* in transistor sets.

Capacitor Checks

An ohmmeter can give a reasonable indication of the quality of a capacitor. For example, if the leads of the ohmmeter are connected across an electrolytic capacitor one way round, the capacitor will acquire a small charge from the ohmmeter battery. There will be a deflection on the meter which will quickly reduce almost to read "infinite resistance", as the capacitor charges. Now, if the test leads are reversed, the charge will flow out of the capacitor and there will be a tendency for it to re-charge in the opposite polarity. This will produce a definite kick on the pointer, thereby indicating that the component is, as least, still useful.

The lowest resistance range should be used on electrolytics, while higher ranges are more suitable for checking smaller paper units. By adopting the procedure detailed, even an 0·01μF capacitor should give a small kick on a high "ohms" range. If a permanent reading is obtained, then, of course, the component is useless.

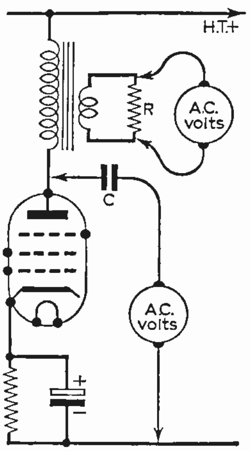


Fig. 9—Two methods of measuring A.C. (signal) output voltage. The capacitor C should have a value of 0·1μF.

Output and Power Measurements

The A.C. voltage ranges are also useful for checking A.F. signals and power—in addition to heater and A.C. power checks as detailed last month. By connecting the meter across the loudspeaker or, preferably, across a resistor used in place of the loudspeaker having a value equal to the impedance of the loudspeaker (R in Fig. 9), a small A.C. voltage will be recorded, the value of which varies with the sound signal.

The A.F. power across the load R is equal to the square of the voltage recorded divided by the value of the resistor R in ohms. Thus, if a reading of 2V A.C. is recorded on a peak and R is 4Ω, the power of the peak is 1W.

A greater deflection is possible by connecting the meter between the anode of the output valve and chassis, via a capacitor (C in Fig. 9). A peak reading of about 50V A.C. is possible, depending on the power of the output stage. It is difficult to measure power output by this method, however, but it is useful as an output meter when making adjustments to the receiver's alignment. ■

The P.W. Everest Tuner

(Continued from page 119)

Bifilar-Winding Connections

As before, the ends of the coils are shortened to about ¾in., bared for ⅛in. and tinned with solder—the ends of the enamelled wire will have to be scraped lightly. Five connecting wires are required for this transformer as shown in Fig. 10, and the coil wires should be connected as shown. Note that the two outer wires of the bifilar winding are connected together to form the secondary centre-tap connection. If there is any doubt as to which two to connect together, check that when two are joined, the two coils of the bifilar winding are effectively in series. The 10pF and 50pF condensers may now be soldered in position and the screening can placed over the coil. The meter may be used to check for continuity of the windings and for lack of short circuits to the can.

Although complete winding details have been given for the I.F. transformers, commercial transformers may be purchased and used in their place if desired. For IFT1 and IFT2, standard 10.7Mc/s F.M. I.F. transformers may be used, and for IFT3, a standard 10.7Mc/s Foster-Seeley discriminator transformer. Coils L1, L2 and L3 are easy to make and substitution of other coils is not to be recommended.

Underchassis Screens

Next, the underchassis screens may be cut out, drilled, and bent to shape—note that the one in Fig. 11 differs slightly from that indicated on the Blueprint. The alteration has been made to give increased screening between the oscillator circuit and the R.F. stage.

All required components may now be bolted to the chassis, taking care to include soldering tags under fixing bolts where indicated in the wiring diagram (Fig. 2) on the Blueprint. Wiring should follow the Blueprint wherever possible since the layout has been carefully designed for maximum efficiency.

(To be continued)

Short-wave Listeners' Log

IT is very easy indeed to set up a short-wave listening station, and much interest can be obtained from one. Simple equipment serves quite well, when used in such a way as to give best results.

The receiver is naturally essential. A receiver tuning all bands from about 14 to 170m (21 to 1·8Mc/s) will prove to be very satisfactory, though a more restricted coverage will also bring in many interesting transmissions. For home construction, simple 1, 2 and 3-valvers are capable of astonishing range, and are easily built, or an ordinary domestic set, with S.W. bands, may be utilised. There are, of course, specially sensitive and selective receivers designed for such purposes, and termed "communications" receivers, but many S.W. listeners commence activity with small sets.

For general listening, an all-band aerial will be needed, and it can be any of the types previously described here. Many S.W. listeners spend a lot of operating time on a particular band, such as the long distance 14Mc/s and 21Mc/s bands. In such cases, it is a good plan to have a second aerial, designed for optimum results on the chosen band. This might be a dipole, made as previously described. A 2-way switch will allow selection of either aerial.

Provision for using either phones or speaker may be required, especially with a fairly small receiver, or to avoid disturbing other persons. The normal receiver speaker can be silenced by having an on/off switch in one lead from the output transformer to the speaker speech coil. With battery sets, high impedance phones can be connected across the transformer primary. A switch giving easy choice of phones or speaker is handy. With mains sets, the phones must be isolated by a coupling transformer, or 750VW condensers. Weak transmissions can give ample phone volume, while being almost inaudible with a speaker. It may be convenient to fit a jack with extra contacts, so that plugging in the phones automatically silences the speaker.

A log book of results will be useful. This can include wavelength or frequency of stations heard, time, signal strength, aerials used, and other information. If 300 is divided by any wavelength in metres, this will give the frequency in Mc/s. Each S.W. band has a period of maximum coverage of various parts of the world, as previously described.

Some S.W. listeners collect QSL cards. These are acknowledgements of reception reports, obtained from transmitting stations. Some listeners have "SWL" cards printed for this purpose. These have spaces to fill in frequency, time, signal strength, type of receiver and aerial, etc. They can be filled up from information noted in the station log book.

Some means of checking frequency is often useful. This can be a signal generator, crystal frequency standard, absorption meter, or similar device. A simple wavemeter, of moderate accuracy, is very handy indeed for locating the various bands on home-built receivers. More elaborate equipment, such as a crystal marker, will allow frequencies to be read off with great accuracy. Some other test gear and similar equipment will probably be added from time to time.

Quite a number of S.W. listeners read Morse, to increase the scope of operation, and with a view to having their own transmitting licence one day. But even without a knowledge of Morse, there will always be stations of interest audible, on some bands, at any hour.

How to make A.C. AMMETERS

(Continued from page 121)

A piece of relatively thin paper should now be cut to the correct size and shape, and glued carefully over the existing scale. The author has found the type of rubber-plastic solution used for gluing lino or Formica sheeting on to plywood to be the most ideal glue for this purpose. It allows a neat uniform film to be applied, which is not easily possible with other adhesives. Scales glued on with cellulose glues, especially when of paper, as here, tend to have uneven bumps which could contact the pointer, and at least spoil the appearance. This trouble is not experienced with rubber solution. A few streaks should be squeezed out of the tube on to the middle of the new paper scalepiece, which is lying on a sheet of paper. These streaks are then smudged into a thin even film with the finger, taking good care to overlap over all edges on to the surrounding sheet of paper. No film of glue is applied to the metal meter scaleplate. The paper piece is then carefully positioned on to the scale plate, another new sheet of paper laid over the top, and fixture ensured by means of pressure from the fingers.

The choice of paper used for this new glued-on scale should have been such that the original scale is *just* still legible through the glued-on paper. The author finds normal typing paper in every way satisfactory for this purpose. As soon as the glue has dried fully, the scale 0 to 10 may be marked on, using the corresponding reference points determined above, on the still faintly visible original scale. The scale-arc should then also be traced through. For all this marking, a good blue-black ink, or preferably Indian ink, should be used. The contrast is then so great that the faint scale showing through the paper is virtually invisible.

The scaleplate should then be replaced on the meter, taking great care not to damage the pointer. The casing should be closed by replacing the grub-screws, and the calibration is finished.

This method of providing a meter with a new scale, here just described in detail, is used by the author whenever he needs to carry out such work—which is in fact with practically every meter he uses, as the original scale on a surplus meter is seldom usable as it stands.

FAULTS IN VHF/F.M. RECEIVERS

7—SERVICING

By G. J. King

(Continued from page 62 of the May issue)

PREVIOUS articles in this series have dealt with the installation of receivers, VHF tuners, combined receivers (both valve and transistorised), circuit techniques, and general faults relating to the circuits described. In this, concluding, article we shall be looking at some fairly common troubles which occur in both F.M.-only and A.M./F.M. models, but which are often persistent and difficult to cure.

One such trouble is station drift and, although relatively common, particularly in the older models, its cause is not usually fully understood. The symptom is well known; although a station may be accurately tuned when the set is first switched on, the tuning point drifts as the set warms up. On F.M., detuning causes distortion accompanied by impaired A.M. limiting.

Ratio Detector

Most sets feature the popular ratio detector, the circuit of which is given in Fig. 17. This gives an audio output across the *impedance* of C1 (which is the A.F. load) of a frequency equal to the *rate of change* of the signal frequency and of an amplitude proportional to the frequency *deviation* of the signal.

This happens because of phase changes associated with the tuned circuits of the ratio detector transformer resulting from a change of frequency. There are many good books describing the effect in great detail for those who are interested.

Most F.M. detectors have two diodes like the ratio detector, and are thus "balanced" so far as the signal is concerned.

This causes the response at the detector to be rather like that in Fig. 18(b). Response A results from one half of the circuit, while response B results from the other half.

If the circuit is balanced, the nominal I.F. carrier will occur accurately in the centre between the two responses, as shown by *fc*. Now, when the signal is frequency-modulated, each deviation from the resting frequency (*fc*) will give an audio output. Maximum modulation in BBC transmissions is equal to a frequency deviation of ±75kc/s. This means that, on loud music, the signal may deviate from *fc* by ±75kc/s.

This will be all right on the curve shown, as the signal will not deviate outside the limits of the points marked "X". This part of the combined curve is straight (linear), which means that there will be very little distortion and extremely good audio quality should be obtained.

Tuning Drift

What happens when the tuning drifts? This is shown in Fig. 18(c) over a drift of about 50kc/s on the same curve. The range of maximum modulation (between points "X") is still within the linear part of the curve, so the reproduction should be hardly impaired.

However, trouble starts when the drift is sufficient to cause peaks of modulation to reach the curved (non-linear) portions of the response, and this would happen should the carrier point *fc* shift by about 75kc/s on the curve in Fig. 18(c).

In practice, one would not expect the local oscillator to cause such a big drift, but drift does occur, nevertheless. In the illustrations, we have assumed that the bandwidth of the detector is ±200kc/s. This is an ideal value, but is rarely found in commercial receivers for various reasons. To achieve such a passband, the response of the I.F. channel would have to be something like that in Fig. 18(a). Most commercial sets can be aligned to give a response of that kind, but only at the expense of gain.

Most sets are aligned with a passband of about 100kc/s. This is reasonable from the aspect of quality of reproduction, but does not always provide sufficient tolerance for oscillator drift. Some sets handled by the author had bandwidths of

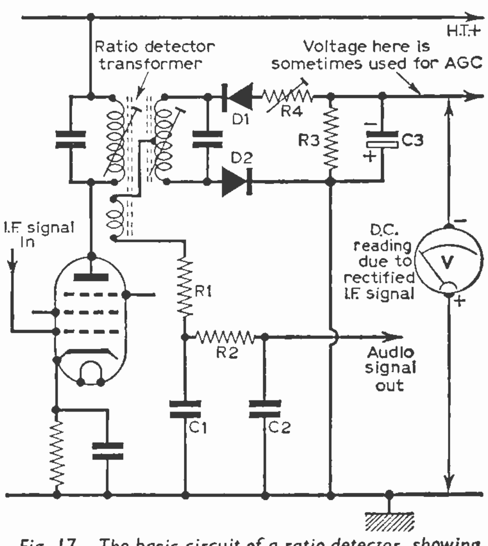


Fig. 17—The basic circuit of a ratio detector, showing the load across which a direct voltage is developed due to the I.F. signals being rectified by the series-connected diodes. C1 is the A.F. load, R1 a current-limiting resistor, and R2 and C2 the de-emphasis network. The pre-set resistor R4 facilitates a balance adjustment for optimum A.M. limiting.

only about 50kc/s and some also had a very distorted I.F. response curve.

Limited Response

The overall I.F. response curve on a set with a ±100kc/s bandwidth is shown in Fig. 19(a). This is quite a good curve since it has a fairly flat top and, provided the ratio detector were correctly balanced, the detector response would be something like the curve in Fig. 19(b). This would handle full modulation over the linear part of the curve as long as the undeviated carrier were kept fairly close to the centre of the linear part (at point *fc*). A small deviation from this centre, however, would cause the signal to enter the curved part of the response and result in severe distortion. A drift of only 50kc/s would cause the signal to traverse between the points marked "X" on the curve.

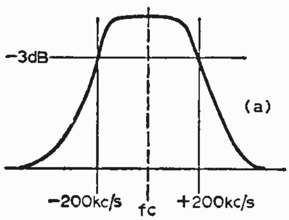


Fig. 18—VHF/F.M. receiver characteristics:
(a)—the ideal response curve for an I.F. amplifier,
(b)—the ideal response curve for a ratio detector,
(c)—the effect of tuning drift on curve (b).

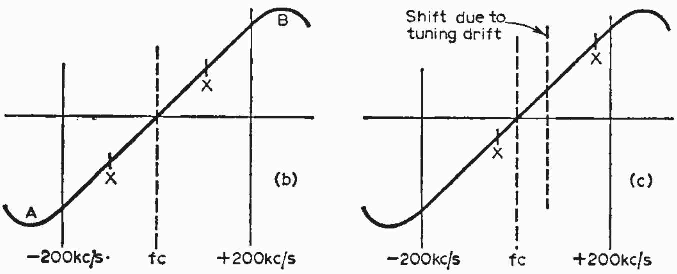
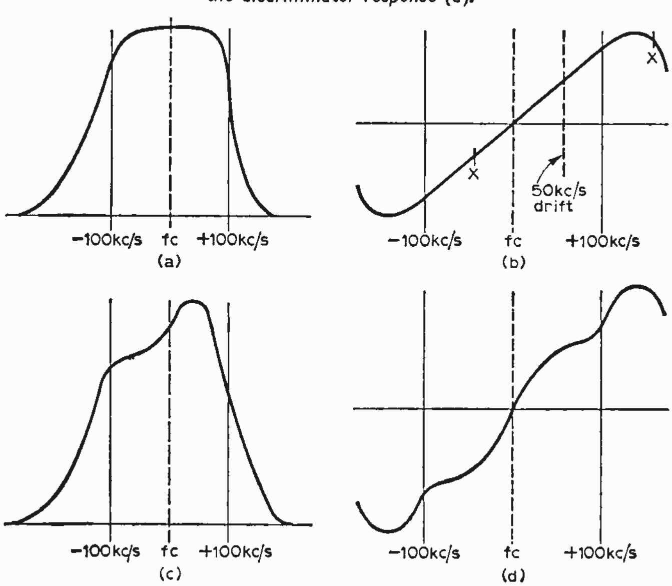


Fig. 19 (below)—With a narrow I.F. bandwidth (a), and a linear discriminator response (b) of only 100kc/s, tuning drift would cause distortion when the signal frequency excursions reached the curved parts of the discriminator characteristic—as at X—X.
An asymmetrical I.F. response (c) would give rise to lack of linearity in the discriminator response (d).



Clearly, then, the more limited the overall response, the more critical becomes the tuning, and the more oscillator drift is magnified. On a set with a bandwidth less than 100kc/s, it is virtually impossible to maintain accurate tuning for any length of time without automatic correction (AFC).

Distorted Response

A distorted response, which is also limited in bandwidth, makes results even worse, as revealed by the curves in (c) and (d) of Fig. 19. In Fig. 19 (c) the top of the I.F. response is far from flat, and this is reflected into the ratio detector response as severe non-linearity between the two responses. At a certain critical tuning point it may be possible to cause a signal with low-level modulation to ride over a reasonably linear portion of the response with not too much distortion, but a small drift from the critical point or an increase in modulation level would result in extremely poor quality.

Unlike A.M., F.M. produces multiple sidebands which extend up to about six times the modulation frequency. Thus, if the modulation frequency is, say, 16kc/s, then the sidebands would extend up to about 96kc/s. A fairly wide pass-band is necessary, therefore, simply from the sideband angle — to avoid attenuation of the higher audio frequencies.

Older Sets

With the advent of VHF/F.M., much of the country was in the fringe of the service areas and sets with the highest possible gain were needed. As gain and bandwidth are not compatible, many early models were aligned for extra high gain and reduced bandwidth, and such adjustment resulted in the problems described in the foregoing text.

As VHF/F.M. became country-wide with the erection

(Continued on page 153)

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(Continued from page 150)

of main stations and translators, and as the figure of merit of valves improved, so it has been possible on later receivers to provide sufficient gain coupled with adequate bandwidth. Thus, more recent models are considerably less prone to critical tuning and distortion than their "vintage" counterparts.

Nevertheless, there are many thousands of the older VHF/F.M. sets still in use, and a very large percentage of these can be brought into line with the new models by nothing more elaborate than careful realignment.

Simple Alignment Check

Many experimenters and service technicians immediately concentrate attention on the oscillator stability of the VHF tuner on a set which suffers badly from tuning drift. This is a good point but rarely the cause of the trouble (or effect). All VHF oscillators drift as they warm up. Much has been done to reduce the effect by the use of positive and negative temperature coefficient capacitors arranged in critical proportion in the oscillator tuned circuits. But drift still occurs in a small way, and it is unlikely whether improvement could be achieved by changing the positions or coefficients of the capacitors. The designers

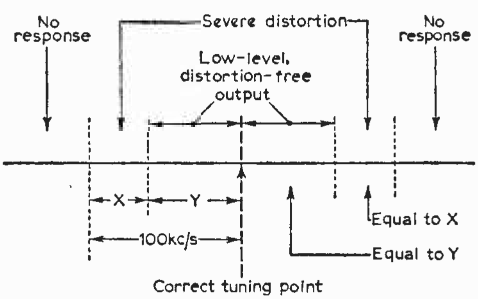


Fig. 20—Judging the alignment of a F.M. set by tuning through a station—see text.

spent a lot of time in the first place to reduce drift by these means, so unskilled tampering with the oscillator circuits of the tuner would probably make matters even worse. In nearly all cases the trouble is the inability of the I.F. passband to cater for "reasonable" drift.

A rough assessment of the bandwidth and alignment of an F.M. set can be secured by tuning the set over a station while observing certain factors. Detuning either side of a transmission will result in bad distortion, as we have already seen, but if the distortion occurs the same distance away from the station either side of the correct tuning point it can be assumed that the ratio detector response is reasonably symmetrical.

On low-level modulation, a distortion-free but reduced output should be obtainable either side of the correct tuning point — just before the areas of heavy distortion (due to the signal riding up and down only one half of the linear detector response) as shown in Fig. 20. The distances from the correct tuning point to the points of no response either side should be equal, and the distance between the correct tuning point and the

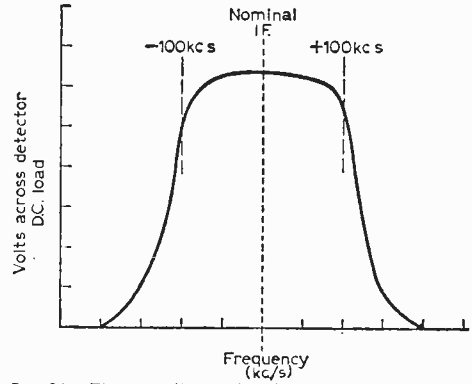


Fig. 21—The overall pass-band of the receiver can be plotted by measuring the D.C. load voltage at the ratio detector against the input infrequency.

point of no response one side should equal at least 100kc/s for good quality and freedom from excessive drift effects.

Use of a Signal Generator and Voltmeter

As it is rather difficult to measure frequency on the scale of an ordinary VHF/F.M. set a better way is to plot the overall passband on graph paper by measuring the voltage across the D.C. load of the ratio detector at various spot frequencies within the I.F. passband—see Fig. 21. The voltmeter is connected across the load as shown in Fig. 17, and an unmodulated signal at the nominal I.F. is injected into the mixer grid. The signal input should be adjusted to give about 10V on the meter (more is likely to overload the set and bring in any other A.M. limiters that may be in circuit), and the frequency should be adjusted in steps of about 10kc/s either side of the nominal I.F.

A curve such as that shown in Fig. 21 would be ideal. Usually, however, it is either narrower or asymmetrical, indicating that realignment is necessary. In this event the set should be completely realigned in accordance with the service sheet or manual. The best idea, of course, is to use an oscilloscope and wobbulator so as to obtain a display of the response on the screen of the CRT. The cores of the I.F. transformers may then be adjusted, while observing the response, to secure the required passband and symmetry. Such alignment procedures have been dealt with in past pages of this magazine. ■

Club News

REPORTS OF CURRENT ACTIVITIES

AMATEUR RADIO MOBILE SOCIETY
Hon. Sec.: G3FPK, 79 Murchison Road, London, E.10.

Sunday, June 24th, has been slected for this year's International Mobile Rally and A.R.M.S. annual general meeting, which will once more be held at Barford St. John. The largest gathering of mobile hams during April was at the North Midlands Mobile Rally held on April 29th.

Future Events:
May 6th—South Eastern Counties Mobile Rally.
June 17th—Longleat Mobile Rally.

BARNSLEY AND DISTRICT AMATEUR RADIO CLUB
Hon. Sec.: P. Carbutt, G2AFV, 19 Warner Road, Barnsley, Yorkshire.

On April 13th members heard a talk, given by J. Walker, on workshop practice, and on the 27th of the same month, W. Lee gave a lecture on VFO/CO mixers.

Future Event:
May 11th—Transistors in a station, by J. Ward.

BRADFORD RADIO SOCIETY
Hon. Sec.: M. T. G. Powell, G3NNO, Gledhow Avenue, Roundhay, Leeds 8.

A sale of spare equipment was held on April 10th and on April 25th the arrangements for the field day were discussed.

Future Event:
May 8th—A visit to an automatic telephone exchange.

EXETER AMATEUR RADIO SOCIETY
Hon. Sec.: S. Line, 46 Roseland Crescent, Heavitree, Exeter, Devon.

At the meeting on March 6th, members of the society challenged amateurs from the Torquay club in a general knowledge quiz. The meeting which was well attended, proved an enjoyable evening, with Torquay ending up the victors by a narrow margin.

FLINTSHIRE RADIO SOCIETY
Hon. Sec.: H. T. Jones, GW3NQP, "Bedwyn", Queens Walk, Rhyl.

GW3JGA/T gave a talk on amateur colour television on March 26th, and on April 30th, members enjoyed a film show.

GUILDFORD AND DISTRICT RADIO SOCIETY
Hon. Sec.: J. Barker, G3PDX, 35 Banders Rise, Merrow, Guildford, Surrey.

At the meeting on March 23rd, E. Drackley gave a talk on aerial tuning units and aerial couplers.

The election of officers for 1962/3 was one of the items on the agenda of the annual general meeting which was held on April 12th.

HALIFAX AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: G. Sunter, 24 Booth Fold, Luddenden Foot, Halifax, Yorkshire.

Life on two metres was the subject of a talk given to members on May 8th, by G5YV.

Future Events:
May 22nd—Ragchew.
June 5th—Visit to Ferranti.

MEDWAY AMATEUR RECEIVING AND TRANSMITTING SOCIETY
Hon. Sec.: W. E. Nutton, G6NU, 42 Richmond Road, Gillingham, Kent.

Elliott's radio society has combined with the Medway society to hold a Hamfest and Mobile Rally at Rochester Airport. It is to be held on May 20th and will start at 2.30 p.m. There will be parking space for 300 mobiles. Admission will be by ticket and these may be obtained from the address given above or at the door.

NORTHERN HEIGHTS AMATEUR RADIO SOCIETY
Hon. Sec.: A. Robinson, G3MDW, Candy Cabin, Ogden, Halifax, Yorkshire.

Recently members have heard a talk, given by G3GJV, on his activities as a mobile amateur. On May 2nd members visited the Leeds and Bradford airport at Yeadon.

Future Events:
May 16th—Converters, by G3OGV.
May 30th—Visit to the Holme Moss television station.

PETERBOROUGH RADIO SOCIETY
Hon. Sec.: D. Byrne, G3KPO, Jersey House, Eye, Peterborough, Northamptonshire.

At the invitation of the Telephone Manager of the Peterborough automatic telephone exchange, members toured the exchange at their March meeting. On April 6th members attended a lecture on short-wave communication receivers. 'Aerials' was the subject of the talk given at the meeting on May 4th.

PRESTON AMATEUR RADIO SOCIETY
Hon. Sec.: W. K. Beazley, 9 Thorngate, Penwortham, Preston, Lancashire.

Meetings are held on the second and fourth Tuesdays of each month. They are held at St. Paul's school in Preston, and commence at 7.30 p.m. All local licenced amateurs and SWL's are invited to any meeting.

Basic valve circuits was the title of the illustrated tape lecture given on April 10th.

RHONDDA VALLEY RADIO SOCIETY
Hon. Sec.: A. Chapman, Royal Hotel, Trealaw, Rhondda.

Despite the extremely cold weather and an outbreak of smallpox in the area, many members turned out for the society's annual dinner on March 1st, to make it a memorable occasion. The guest speaker was Mr. A. Williams, the zonal representative of the R.S.G.B. in Port Talbot.

ROYSTON AND DISTRICT RADIO CLUB
Hon. Sec.: H. E. Taynor, G3NAH, 103 Cross Lane, Royston, near Barnsley, Yorkshire.

On April 19th members heard about a modulator for a top-band transmitter, and on May 3rd a power supply for a transmitter or receiver was the subject for the meeting.

SOUTH MANCHESTER RADIO CLUB
Hon. Sec.: M. Barnsley, G3HZM, "Greenways", 11 Cemetery Road, Denton, Manchester, Lancashire.

The address of the club's new headquarters is; Fallowfield Bowling and Lawn Tennis Club, 81 Wellington Road, Fallowfield, Manchester 14.

The title of G3HZM's talk on April 6th was "Simple transmitters, methods of modulation". On April 13th, single sideband transmitting and receiving techniques were discussed in the lecture given by G3GRO. The club's transmitter was on the air at the meeting on May 4th.

SLADE RADIO SOCIETY
Hon. Sec.: C. N. Smart, 110 Woolmore Road, Erdington, Birmingham 23.

T. J. Hayward—G3HHD—gave a lecture on aerials at the meeting on April 6th, and on April 20th, an evening direction finding contest was held.

SPEN VALLEY AMATEUR RADIO SOCIETY
Hon. Sec.: N. Pride, 100 Raikes Lane, Birstall, near Leeds.

Railway signalling was the subject chosen for the meeting on April 11th and on 25th of that month, L. Stevenson talked about simple maths.

Future Event:
May 9th—More about counting, by Dr. N. H. Chamberlain.

TORBAY AMATEUR RADIO SOCIETY
Hon. Sec.: Mrs. G. Western, G3NQD, 118 Salisbury Avenue, Torquay, Devon.

At the society's annual dinner held on March 3rd, trophies were presented to the five winners in each class.

The annual general meeting was held in April.

Future Event:
May 12th—Discussion on preparation for N.F.D.

YORK AMATEUR RADIO SOCIETY
Hon. Sec.: N. Spivey, G3GWI, 80 Melton Avenue, Clifton, York.

At the AGM held on March 1st, G. F. Nottingham was elected chairman and N. Spivey was elected secretary and treasurer. The committee was also elected.

The club transmitter was the subject under discussion at the meeting on March 29th and on April 26th plans were laid for the N.F.D.

Trade News

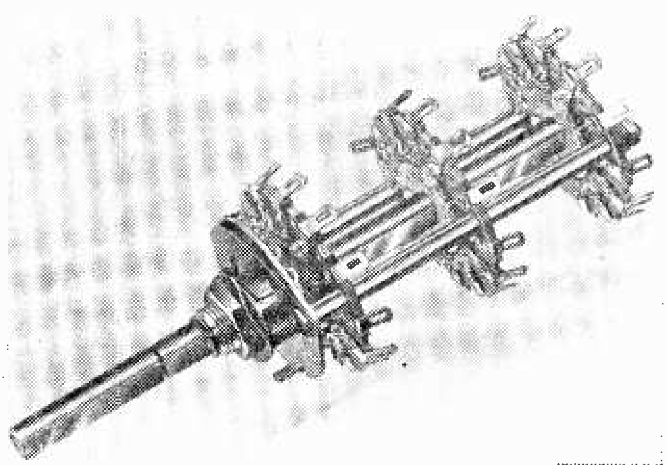
ROTARY SWITCH WITH ADJUSTABLE STOP

MADE available recently, by N.S.F. Limited, are a number of Oak rotary wafer switches, model JK. These switches incorporate a readily adjustable stop.

The switches can be supplied with one, two or three wafers, with one, two or four poles per wafer and giving 2 to 12, 2 to 7 or 2 to 4 positions, depending upon the number of poles. Shorting or non-shorting contacts are optional.

Indexing is in 30° steps and the detent mechanism is of positive single-ball type. One fixed and one adjustable stop are provided; the latter is adjustable to operate at any position between the second and eleventh and is omitted where 12-position switching is required.

N.S.F. Limited, 31-32, Alfred Place, London W.C.1.

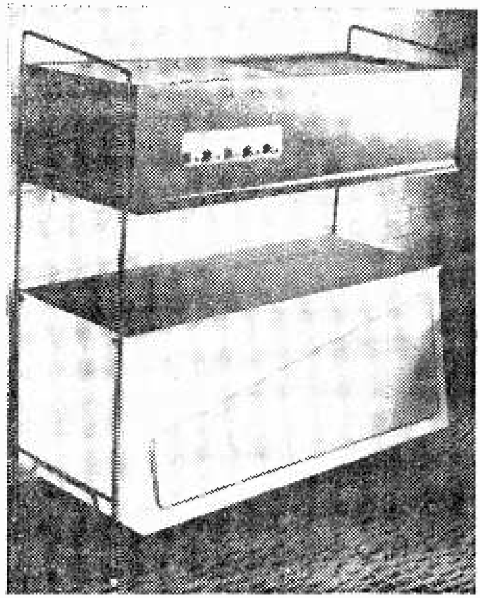


The model JK rotary switch from N.S.F. Limited.

HI-FI CABINETS

A RANGE of cabinets designed specifically for hi-fi equipment has recently been introduced by G.K. Developments. The range goes under the name of "Spacemaker".

The standard "Spacemaker" units will accommodate most makes of amplifiers or record players, and consists of two cabinets—one for equipment, the other, a speaker enclosure. The equipment cabinet measures 35½in. x 11in. x 16in. and is finished in sapele woodgrain with the facia and sides in black, gold and silver. The speaker enclosure is constructed throughout of ¾in. non-resonant material, and is of bass reflex design, fitted with internal filter, suitable for speakers up to 10in. (12in. version available). The top is veneered in sapele mahogany and the facia and sides in white, gold and silver.



Above—A newly designed hi-fi cabinet by G.K. Developments.

The "Spacemaker" units are made by *G.K. Developments (Sound Division), 18 Albany Road, London N.14.*

MULTIMETERS

THERE are two models of the Selectest multimeter, made by Salford Electrical Instruments Limited; the Super K and the Super 50.

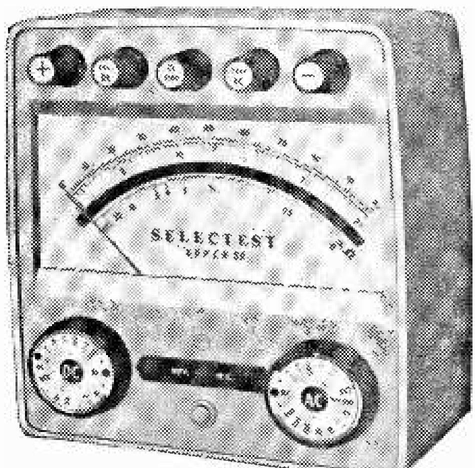
Most of the components in both models are mounted on a printed circuit board, enclosed in a strong, two-tone moulded case. The overall dimensions of this case are approximately 9¾in. x 7in. x 4¾in.

Three scales are provided, with a mirror inset and knife-edged pointer to eliminate parallax errors. On the Super K model, two scales, 0 to 75 with 75 divisions and 0 to 300 with 150 divisions are used for all current and voltage ranges, and the third, 0 to 1,000Ω covers all three ohm ranges. The Super 50's current and voltage scales are 0 to 100 with 100 divisions and 0 to 25 with 50 divisions.

The range required is selected by two rotary multi-position switches capable of continuous rotation in either direction.

The sensitivity of the Super K D.C. voltage ranges is 1,000Ω/V, and A.C. voltage ranges 500Ω/V. The sensitivity of the Super 50 D.C. voltage ranges is 20,000Ω/V, A.C. voltage ranges 2,000Ω/V, and 2·5V A.C. range 167Ω/V.

Salford Electrical Instruments Limited, Peel Works, Silk Street, Salford 3, Lancashire.



The Super 50 multirange instrument made by Salford Electrical Instruments Limited.

RANGE OF TAPE RECORDERS

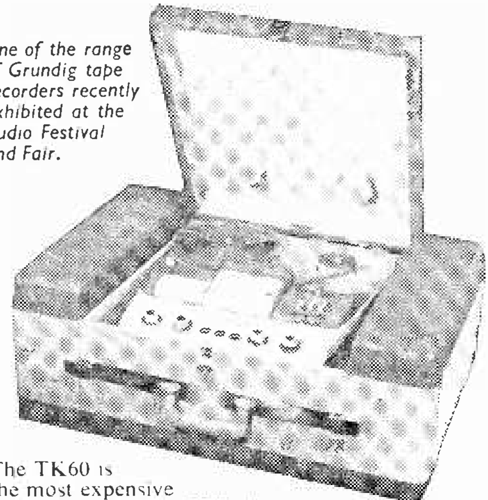
AT this year's International Audio Festival and Fair, Grundig (Great Britain) Limited exhibited their current range of tape recorders—the TK1, TK14, TK40 and TK60.

The TK40 is a four track model, incorporating every facility that the keen amateur enthusiast could possibly need — three speeds, facilities for superimposition, synchronised superimposition and the mixing of two inputs etc. It has a frequency response of 60-18,000c/s and costs 75 guineas.

The model TK1 has a speed of $3\frac{3}{4}$in./sec. and uses a 3in. spool. It weighs only 8lb and has a frequency response of 100 to 8,000c/s. The price of this model is 29 guineas.

The TK14 also runs at $3\frac{3}{4}$in./sec. but uses a $5\frac{3}{4}$in. spool. The frequency response is somewhat better than the TK1, being 60 to 12,000c/s. This machine costs 35 guineas.

One of the range of Grundig tape recorders recently exhibited at the Audio Festival and Fair.



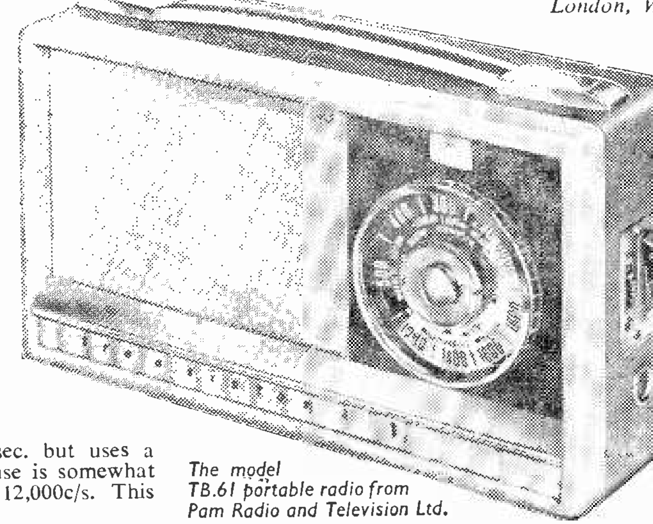
The TK60 is the most expensive of the range, costing 128 guineas. This model has two speeds; $3\frac{3}{4}$ or $7\frac{1}{2}$in./sec. The TK60 weighs 55lb. and has a frequency response of 50 to 15,000c/s.

Grundig (Great Britain) Limited, Newlands Park, Sydenham, London S.E.26.

PORTABLE RADIO

THE model TB.61, from Pam Radio and Television Ltd., is a new transistorised portable receiver. It includes six transistors and features printed circuit design. Primarily the receiver uses an internal ferrite rod aerial but provision has been made for its use with an external aerial. The set covers both medium and long wavebands and tuning is achieved by a slow-motion tuning dial.

The receiver is finished in tan and grey with a silver and black facia. It measures only $9\frac{1}{2}$in. x 5in. x 3in. and weighs $2\frac{1}{2}$lb. The price of the TB.61 is 15 guineas and it is manufactured by *Pam Radio and Television Ltd., 295 Regent Street, London, W.1.*



The model TB.61 portable radio from Pam Radio and Television Ltd.

A VERSATILE LOW-CURRENT VARIABLE H.T. SUPPLY

USING AN OUTPUT PENTODE AS GRID-CONTROLLED H.T. RECTIFIER, A WIDE RANGE OF VOLTAGE CONTROL CAN BE ACHIEVED IN A VERY SIMPLE CIRCUIT.

By D. A. Brandon

IN the course of experiments and constructional work, it repeatedly happens that a small one- or two-valve circuit has been built, which requires a small H.T. current of a few milliamps, at voltages between about 100 and 300. Unless the constructor has built, or purchased, a universal variable stabilised power unit (which will, of course, be the ultimate aim of most serious constructors) it is always a problem to meet such low-power H.T. needs. The output voltage of normal H.T. units is generally too high, so that various series-resistor voltage-droppers are used. These serve the purpose very well for rough adjustment of the final output voltage, but do not lend themselves well to providing continuous regulation, so that a particular desired voltage may be set exactly. If control down to very low voltages is desired, high-resistance variable resistors would be needed, whilst these must also be capable of carrying the maximum current. Consequently potentiometers of high wattage are required, which are expensive.

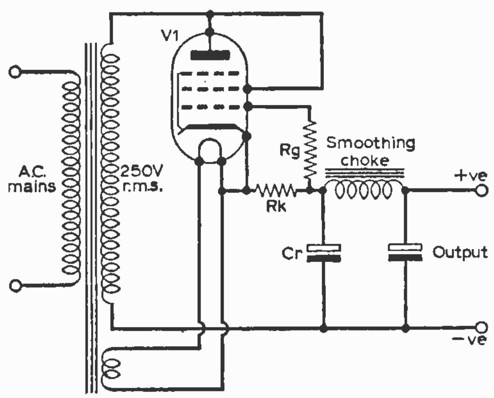


Fig. 1—Using the normal cathode bias and grid leak resistors with an output valve as rectifier.

Output Valve as Rectifier

It would thus be more economical to use an output-valve as the series resistor, controlled by means of its grid-bias voltage. The grid-bias potentiometer can be of normal carbon type, as negligible power is needed in the grid circuit. Now the ultimate benefit of this type of circuit is apparent when it is further realised that the *same valve* can be made to function as H.T. rectifier, and to supply its own control grid bias, as well as an automatic limiting bias to prevent excessive current if the output is short-circuited.

It is the subject of this article to discuss such a circuit, with special attention to the factors governing the choice of the most suitable type of output valve to use as "grid-controlled rectifier", and also to some other important practical factors to be observed.

Electrode Connections

It is, in principle, possible to strap all electrodes except the cathode together, for use as "anode", to make any valve whatsoever function as a rectifier diode, and in practice this will also work very well—up to a certain maximum voltage of operation, which is usually very low.

It is necessary to pay careful attention to peak voltages, especially inverse voltages (i.e., for the non-conducting direction, when the anode is negative to cathode), and also to the question of "what to do with the grid", when using an output valve as an H.T. rectifier. It is most certainly not permissible to strap the grid to the anode, even via a series-resistor of normal grid-leak value to limit grid current on positive half-cycles to a safe value, unless the operating voltage is to be very low (not exceeding about 50V r.m.s. applied A.C.). The smoothing condensers charge up to the peak of the applied A.C. on positive half-cycles (about 1·5 times the r.m.s. voltage), which thus constitutes the cathode voltage of the valve (see Fig. 1). On the peak of the negative half-cycles, where the valve does not conduct, the anode will be negative to chassis by about 1·5 times the r.m.s. A.C. voltage—i.e., negative to the cathode by a total of three times the r.m.s. A.C. voltage. If the grid were strapped to the anode, even via a large resistor, this large voltage difference would appear between grid and cathode. If a 250V r.m.s. transformer winding were used, the grid would thus go to a peak of about 750V negative to the

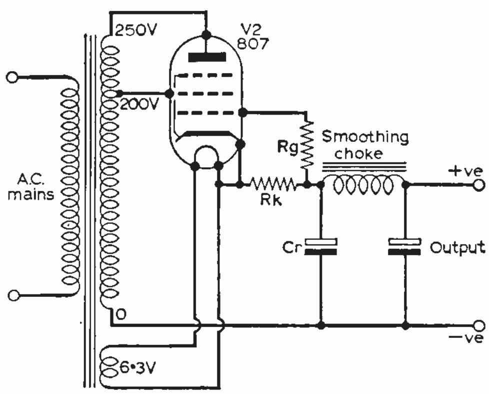


Fig. 2—Feeding the screen from a tap on the transformer instead of strapping it to the anode.

cathode, if it is strapped to the anode, which will certainly produce breakdown in any ordinary output valve.

Normal Cathode Resistor

This discussion shows that it is necessary to connect the grid to some point with a potential in the region of that of the cathode. Thus, the next most obvious thing to do is to use the normal cathode bias resistor Rk, and grid-leak Rg, for the valve, and connect these in exactly the same way relative to the valve as if it were used for its normal purpose as an output valve. This is shown also in Fig. 1. One advantage of doing this is already apparent, for if the output terminals in Fig. 1 are completely short-circuited, the valve is seen to have actually degenerated to the normal output-valve connection, apart from the minor difference that the loudspeaker transformer is

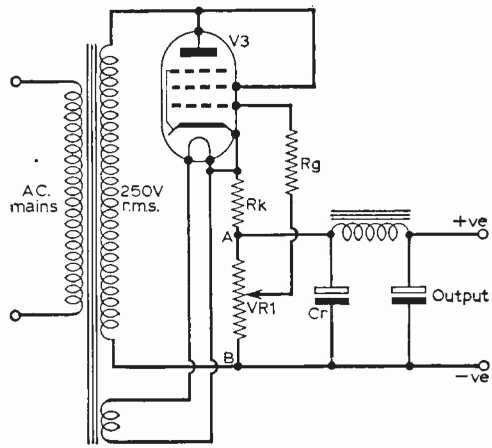


Fig. 3—A variable output circuit using an EL34.

missing in the anode circuit, and that A.C. instead of D.C. feed is used. The latter means that the full voltage is only present some of the time instead of all the time at the anode, so that the maximum current through the valve and into the short-circuit certainly cannot exceed the normal anode current of the valve. The circuit is thus necessarily short-circuit proof. Furthermore, initial surge-current into a discharged reservoir condenser Cr cannot ever exceed the normal H.T. current of the valve, for the same reasons. Thus the usual restrictions on the maximum size of reservoir condenser present for diode rectifiers are not required, and very large smoothing and reservoir condensers may be used, to give excellent smoothing if needed.

Anode and Screen

This has taken care of the grid. It remains to consider the voltage stresses on anode and screen. If these electrodes are strapped together, as is normally permissible in this circuit, and as is shown in Fig. 1, the peak inverse voltage impressed on these, relative to the cathode, is three times the r.m.s. transformer voltage, for reasons explained above. It may safely be assumed that the peak inverse voltage rating is at least as large as the peak positive normal operating voltage at these electrodes. Thus the problem of choice of output valve resolves to finding one of suitably high peak anode and screen voltage rating. The use of line-output valves from television circuitry is immediately suggested, as these are built for very high transient anode voltages occuring in a line timebase output stage. Thus one would consider, for

(Continued on page 165)

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500 pF Stamp Trimmers, only 9d. each.

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F.T.R. II. Tape Recorder Kit. Sub-assembled, finished in one hour. Size: 6 x 8¼ x 2¼in. Fully portable. 20 min. play. Send for illustrated leaflet. S.A.E. Kit cost £6.19.6. P.P. 3/6.

B7G Valve Holders, with can 9d. P.P. 3d., less can 6d. P.P. 3d.

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(Continued from page 162)

example, using a PL36 here. This is rated at 7000V transient peak anode voltage, which is ample under all circumstances for our present purposes, but the screen rating is only 250V peak, which is too low for safety. A further disadvantage is the 23V heater voltage, which is not easily available. A normal output valve of the 6V6-type, or an EL84, has a normal 6·3V heater, but maximum anode and screen voltage ratings of about 300. This would not safely allow a transformer input voltage of more than about 100V r.m.s. to be used in Fig. 1 if breakdown were to be avoided.

Test Circuit

The writer, for purposes of a practical test, has however, set up the circuit of Fig. 1 with a 6V6, using a transformer A.C. voltage as high as 350V r.m.s. This arrangement was left operating for many hours and did not break down, nor showed the slightest tendency to do so, although the peak inverse anode voltage must have been nearly 1000V under these conditions, at least three times as high as the normal rating of a 6V6. The fact that this circuit worked for a long period without breakdown should not be taken as recommendation for its copying by experimenters, but rather as an indication of the quality of modern components. The writer remains doubtful of the reliability of a 6V6 in this circuit for really long-term operation. We must look further for a really suitable valve. The 807, with a peak anode rating of 600V, screen 300V, is easily obtainable on the surplus market for a few shillings, and in view of the results mentioned already for a 6V6, is almost certain to provide long-term reliability in the circuit of Fig. 1. The writer would thus safely recommend the use of an 807 for an r.m.s. A.C. voltage up to 250 at the transformer (the 6V6, of lower rating, was tested at 350V r.m.s.). It might be advisable to feed the screen from a tap at about 200V on the transformer, instead of strapping to the anode, as shown in Fig. 2.

(To be continued)

How Transistors Work

(Continued from page 139)

positive at the base—see Fig. 25). This, then, gives the curve of Fig. 26 which, for a circuit in the common base mode, is really a representation of the leakage current (Ico).

This leakage current rises to a constant value with increase in negative collector voltage from point A to point B. Point B is sometimes called the "softening voltage" (rather the same as the turn-over voltage of a semi-conductor diode biased for reverse conduction). When point B is reached, Ico starts to rise rapidly. The *peak* voltage swing of the collector is usually limited to a value which is about 25% below the softening voltage, while the *maximum* equivalent direct voltage of the collector is usually considered as being about 75% below the softening voltage, as shown on the curve.

When a transistor is arranged in the common emitter mode, then the factors as described above still apply, but the whole curve is scaled down, since, under this condition, the softening voltage occurs at a value below that for common base operation. The curve then shows leakage current with the base open-circuited, usually denoted I'co—see Fig. 27.

Tester for Comparative Checks

From the foregoing it will be understood that both Ico and I'co increase in value with increase in temperature. Either when a transistor is too warm or in some way defective the value of Ico or I'co rises considerably and in severe cases could result in a reversed conduction approaching the value of forward conduction. It is then that a transistor ceases to operate as such.

The D.C. gain of a transistor is really a measure of the ratio of Ico and collector current when base current is flowing. In Fig. 28 is given a simple circuit which facilitates ratio measurements of this kind on both *npn* and *pnp* transistors. With a transistor connected correctly to the terminals indicated, and with S2 in the appropriate position, a very small reading will be recorded on M1 when S1 is closed. This is effectively the leakage current between emitter and collector with the base open (e.g., Ico). On a good transistor the reading should not exceed 0·1mA (100μA), but should normally be less than this.

This reading will be influenced by the air temperature around the transistor, as already explained, and the temperature sensitivity can vividly be demonstrated simply by bringing the heat from a soldering iron towards the component under test (avoid too much heat!).

Transistors are also light sensitive, which is one of the reasons why they are painted black or sealed in a light-proof container. If there is any leakage of light through the case Ico will change with room illumination.

Indication of D.C. Gain

Now, when the button marked "press to test D.C. gain" is depressed, the base circuit is closed through the 8·2k resistor which goes back to the battery at the appropriate polarity. The meter reading will then rise up to the region of 0·6mA at least; and it is this *change* in current which gives an indication of the D.C. gain. The greater the change, the greater the gain.

Clearly, then, the tester can be used to select transistors from a bunch and will, at least, allow comparative checks and show whether a unit is serviceable or not. It can also be used to select matched pairs of transistors for push-pull output stages. It is fairly fool-proof as the battery voltage almost prevents burning out transistors.

The circuit can also be used to test semiconductor diodes. The diode is simply connected between the "E" and "C" terminals and the reverse and forward conduction ratio can be assessed by switching S2 from one position to the other. With a good diode, the current change should not be less than about 0·6mA.

(To be continued)

Letters to the Editor

The Editor does not necessarily agree with the opinions expressed by his correspondents.

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying commercial or surplus equipment. We cannot supply alternative details for receivers described in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. If a postal reply is required a stamped and addressed envelope must be enclosed with the coupon from page iii of the cover.

P.W. MINUETTE

SIR,—I have just constructed the P.W. Minuette, which was described in the January and February issues of PRACTICAL WIRELESS, and I am very pleased with the results. Among dozens of other stations it receives Luxembourg loud and clear.

I have omitted the telescopic aerial and used a 5½in. ferrite slab instead. I have also fitted a personal earpiece socket.

The tuning condenser I have used is a solid dielectric type and I have found that a 100k reaction control works well instead of the 50k potentiometer shown in the issue.—V. LOWE (Droylesden, Lancashire).

TELEVISION SOUND

SIR,—I know that much has already been said about the reception of television sound on short waves, but most reports mention signals picked up on the 80m band. One evening while listening on short waves, TV sound came in quite loud on 15m. The signal was definitely being emitted from the receiver downstairs, as my commercial superhet receiver picked up whichever channel was selected on the television.

I see that one reader suggests that the signals come from the A.F. stages of the TV receiver, but I doubt if this is the case, as reception of ITV sound was much weaker than BBC, no matter how high the volume of the television.—P. FOSTER (Denmead, Hampshire).

CORRESPONDENTS WANTED

SIR,—I have only recently taken up radio and electronics as a hobby and I would like to correspond with English radio amateurs wishing to exchange ideas, news and information on these subjects. I will answer all letters received.—AHMED AWAD ABOUL ENIEN (8 Ebn fernas Street, Fleming, Alexandria, United Arab Republic).

PURCHASING BY POST

SIR,—I often hear complaints about the service given by mail order firms—about slow service, wrong components sent, etc. But I wonder how often it is the fault of the purchaser and not the supplier that causes problems when ordering components by post.

I am sure that if people indicated precisely which articles are required, addressed the envelopes correctly and enclosed the exact cost of all, including the postage, many more of the public would realise that mail-order firms are a very convenient sales medium. By experience I have found that careful attention to the above three points will, in nearly all cases, ensure swift service, and if there is any delay—caused by heavy demands for a particular component, for example—patience or a polite reminder note will work wonders.—P. S. HARRISON (Guildford).

LOCAL STATION PICK-UP

SIR,—I have experienced a trouble which appears, from my chats with workmates, to be fairly common. The effect I refer to is the direct pick up of the local station on a tape-recorder, when this is set up to make recordings with an ordinary microphone—not with a radio jack. It appears to be due, in many instances, to the input valve of the recording amplifier "bottom bending" and I have improved this with a modification in the value of the cathode bias resistor. In other cases, this was ineffective and the only cure was to shorten the microphone lead, and to use coaxial cable in place of thin screened lead as fitted to the microphone. It would be interesting if other readers' cures for this trouble could be enumerated, as there appears to be a real fault with this type of apparatus, and there must be a single "cure-all" for all types of recorder.—R. FERGUSON (Barnet).

THE AMATEUR TRANSMITTER

SIR,—With reference to G. D. Thornton's remarks in the November issue. "Let would-be hams join the C.D." I agree, but, what about those who cannot, such as serving soldiers? Let's face it, the licensing regulations were written when Marconi was a boy and are still in force. With the GPO now clamping down on Radio Clubs, no person, who is not a licence holder, will be allowed to transmit, no wonder there are pirates and Ghost Clubs with no members. No wonder why, on 40m and 80m I have heard G's saying, "Sorry O.M. unmodulated S9 carrier". If a person could operate and study, the result would be no, or very few pirates. As the transmitter stands today, a child could operate one, and keep it TVI-proof (cost £50+£3 10s. for low pass filters—TVI-proof; I've done it). The manufacturer has taken the first step and produced a low cost, good Tx. Now let the GPO act. A simple test of ability to tune and erect aerials should give grace for 18 months to take the R.A.E..—E. J. BOOTH (Ex 9M2, DL2, now BRS15100), York.

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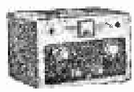
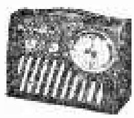
S.33

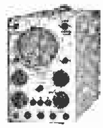
S.8b



DX-40



UXR-1



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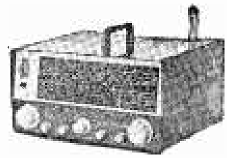

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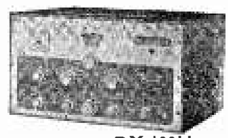

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NEONS in the Experimenter's Power Pack

A discussion of some factors of fundamental practical importance in the design of circuits using neon-tubes, leading to some simple but worthwhile further improvement to the "Experimenter's Power Pack" published in PRACTICAL WIRELESS, January 1962 etc.

By M. L. Michaelis

AFTER completing nearly 2,000 operating hours successfully, mostly non-stop for periods of over a week at a time, the author's prototype of the "Experimenter's Power Pack" was taken down for a routine inspection.

This inspection was carried out extremely thoroughly, as it was of great experimental interest to examine all effects of such prolonged non-stop usage. Thus not only were voltages and currents checked at every point of importance in the circuit, using a meter, but also all such points were tested for the slightest *A.C.-components* of voltages present, using an oscilloscope with a sensitive Y-deflection amplifier. This oscillographic investigation was primarily intended to test for possible deteriorations regarding hum-levels after such drastic long period usage. No drifts in this respect were found compared with the original values noted just after the original completion of the unit, but some other, most unexpected and mysterious effects were shown up on the oscilloscope, in that various A.C.-components of frequencies vastly different from the mains (anything from a few cycles per second, to many kc/s) were present, chiefly of good sawtooth waveform, often amplitude of frequency modulated at mains frequency or harmonics. These A.C.-components were present at the most varied points of the circuit, and their exact waveforms and frequencies depended greatly on the magnitude of loadings placed on the various outputs of the unit. They appeared and disappeared in an apparently haphazard manner, too, as the loadings at the ouputs were changed.

Levels

All amplitudes were, however, invariably very small, seldom amounting to more than about 1% or 2% of the actual D.C. voltages present at the points concerned. Thus they were invariably of the same order of magnitude as hum levels to be expected in simple unstabilised power supplies of conventional design which is the reason why these peculiar oscillations here had not manifest themselves earlier as interference in apparatus fed from the unit, but were noticed only during the routine inspection. Nevertheless, they represent a definite "fault" to be diagnosed and cured, particularly as this unit, being a fully stabilised power supply, has very low intrinsic hum-levels.

Initial checks after completion of the original construction also included oscillographic checks, and showed no such peculiar oscillations whatsoever in the final design at that time. These oscillations have thus definitely appeared some time during the long and continuous usage since.

Investigation

Being thoroughly puzzled as to the exact cause and method of cure for these oscillations, the author decided to extend what was originally supposed to be a routine check, in order to perform a detailed experimental investigation of these effects, with a view to understanding them and removing them. The cathode-ray oscilloscope and an electronic audio frequency meter proved invaluable tools for a successful conclusion of these experiments. Knowledge gained therefrom is considered to be of such fundamental practical importance that it has formed the basis of this article.

Some hours were spent in a *systematic* recording of all frequencies, waveforms and amplitudes observed at all important points, for systematic

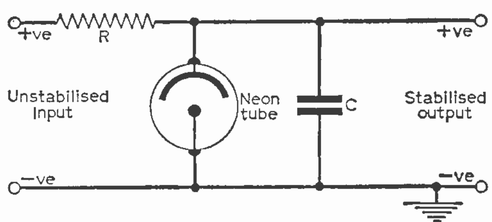

Fig. 1—Basic neon stabiliser circuit; a very steady voltage appears across C and the neon tube. This voltage is constant for large variations in the current drawn from the output. The neon is permanently struck and the current through it is always such that, when added to the output current, the correct voltage drop is given across R to keep the voltage across the neon (output voltage) constant.

variation of load-currents in steps at the outputs. With the tabulated results, circuit diagrams, valve data tables, etc. an interpretation was worked out and circuit modifications devised which thereupon ought to effect a full cure. Upon returning to the workshop and performing the small circuit-modifications devised, the cure was in fact immediate and complete. It was no longer possible to induce the slightest trace of low-amplitude oscillations under any circumstances within the normal ratings of the outputs.

Causes of the Instability

The causes of the peculiar instability were traced to be entirely due to the neon-tubes. Fig. 1 shows a conventional neon-stabiliser circuit, four of which appear in the 'Experimenter's Power Pack'. Fig. 2 shows a conventional neon-oscillator giving a saw-tooth waveform output. It is at once seen that there is *absolutely no outwardly visible difference* between the two circuits. Yet the one is supposed to oscillate, and the other to stabilise (i.e. suppress oscillation—etc.)—two contradictory functions from

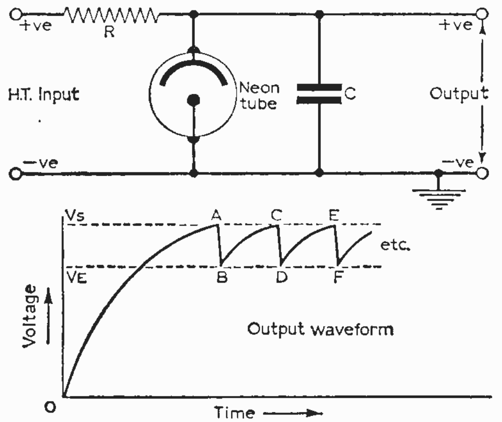

Fig. 2—Basic neon oscillator circuit with the output waveform. The circuit is apparently identical to Fig. 1, yet it is an oscillator with a sawtooth output instead of a stabiliser.

C charges through R until the striking voltage of the neon is reached at time A. The neon strikes, and C is rapidly discharged to the extinguishing voltage , which is reached at time B shortly after A. The neon is then extinguished, and C recharges slowly through R until at time C the striking voltage is reached once again. The cycle repeats CDEF, etc., and thus a saw-tooth waveform appears at the output.

apparently identical circuit arrangements. That the same circuit in fact does perform both functions is an experimentally proved fact, and thus it is obvious that the precise operating conditions of voltage and current must determine which of the two opposing functions the circuit will actually perform. There will be a region of operating points promoting oscillation, and a region of operating points promoting stabilisation. The border-line between the two regions may be more or less ill-defined, giving rise to erratic behaviour partially oscillating and partially stabilising, which was clearly the case with the author's power supply. The fact that the main function in his case was still pretty good stabilisation, with only very small amplitude oscillation of erratic character, shows that his operating points lay within the "stabilisation region", but not far enough from its boundary to secure absolute stability. It was necessary to obtain a clear understanding of the factors which determine whether an operating point lies within the "oscillation" range or the "stabilisation" range, and subsequently to modify values of resistors to secure operating points further within the "stabilisation" ranges.

Negative Resistance

This magazine is of a practical nature, and does not wish to burden its readers with matters of theory. Nevertheless, small theoretical points must be dealt with briefly if these are necessary for a proper appreciation of practical matters, and thus no apology is needed for the following brief discussion of negative resistance.

The concept of negative resistance can be looked at in two ways. A greater current flowing through such a resistance causes less voltage drop instead of more voltage drop across it, i.e. it obeys Ohms Law in reverse. To drive a larger current through a negative resistance we need to *reduce* the voltage. The other way of looking at it is to say that current passing through a negative resistance does not consume power, but *generates* power. Now it is obvious that such a peculiar thing as a negative resistance, were it to be connected into a circuit containing otherwise normal components, could not settle down to a particular voltage and current value, as its own requirements for a relation between the two defy all the normal rules of electricity. Consequently, the voltages and currents must oscillate up and down continuously, in a futile attempt to find a stable operating point. The result is simply an oscillator circuit.

If a net resulting negative resistance is present in any circuit whatsoever, i.e. a negative resistance component in excess of that necessary to compensate the total normal positive resistance present in the circuit, *then the circuit always oscillates*, without exception. The converse is also true: if a circuit oscillates in any form whatsoever, then net negative resistance must be present in it, without exception. Oscillation and negative resistance never occur separate from one another. Consequently, if a circuit is unstable, we must seek the causes of a negative-resistance component, which is certain to be present. On the other hand, if we wish to cause a circuit to oscillate, we must take steps to create sufficient negative resistance in it, i.e. create a portion in its characteristic where either decreasing the voltage causes the current to increase, or where increasing the current causes decrease of power consumption (increase of power generation).

Examples

The conventional valve-oscillator using some form of reaction coil is the most familiar example. Here the grid-circuit is caused to go negative in its net resistance value, for the following reasons. If current increases in the grid circuit, greatly amplified power is fed back into the grid circuit from the anode circuit, via the reaction coil, so that the net consumption of power in the grid circuit is reduced, representing the conditions of negative resistance. In other forms of valve oscillators or their transistor equivalents the power-feedback to create negative resistance is via internal or external valve capacities, etc. Similar, though more involved, forms of reasoning are applicable to the various multivibrator types, etc. used in timebase circuits. All these oscillators are of the "externally produced" negative resistance type, i.e. the characteristics of negative resistance are created by using external influences to modify an otherwise normal, stable, positive resistance circuit element. *(To be continued)*

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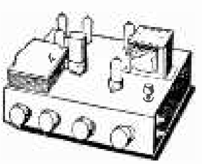

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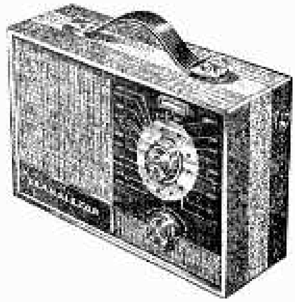


*A really remarkable **2-Band 6-Transistor Superhet Radio**—25,000 satisfied customers and still in huge demand.*

The Contessa is the professional looking set with the professional performance.

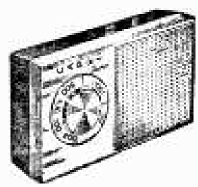
Study these brilliant features which cannot be found in any other Radio—

- **Waveband coverage of 530 kc/s to 1,620 kc/s and 160 kc/s to 270 kc/s.**
- **Assured reception of at least a dozen stations in daylight!**
- **Large clearly-calibrated station-named dial.**
- **Internal high-gain ferrite aerial.**
- **5 : 1 ratio slow motion tuning.**
- **Fitted with the latest 12,000-line high flux loudspeaker.**
- **Power of 410 milliwatts from the single-ended push-pull final stage.**
- **Specially designed aerial matching coil for use in a CAR.**
- **Only first-grade fully guaranteed matched transistors and diodes are used.**
- **Double tuned IF transformers for maximum gain and knife-edged selectivity.**
- **Fully drilled printed circuit panel marked with component numbers.**
- **The two-colour case measures 10 x 7¼ x 3½ in. and weighs approx. 4 lbs. when assembled.**
- **Battery lasts 4 months with normal usage.**
- **Book supplied with detailed assembly instructions, diagrams and circuitry.**
- **Anyone can build this set—everything supplied just a soldering iron required.**

Inclusive price for all associated components, cabinet and battery, complete in every detail, or our BUY AS YOU BUILD SCHEME, any parts sold separately. Send for comprehensive descriptive Manual and Parts List, 3/6 post free **£10.19.6** Plus 3/6 P. & Pkg.

You can hold Europe in the palm of your hand with—

THE "CAPRI"



A MINIATURE pocket transistor Radio that **REALLY** works, retaining the most attractive features of the famous "Contessa". SIX first-grade Mullard transistors and diode are employed in a highly sensitive superhet MW and preset LW circuit embodying the most modern design practice. A special 2½in. high gauss loudspeaker provides surprising volume and a personal earpiece socket is also available. An attractive two-tone plastic case is supplied in two colours. Ivory/Red or Ivory/Blue, the full constructional details being given with each set of parts. The total **MEASUREMENTS** of the "Capri" are 4¼ x 2¼ x 1¼in.

SEE AND HEAR A WORKING MODEL TODAY

Inclusive price for all associated components, case and constructional data, complete in every detail or on our BUY AS YOU BUILD SCHEME. ANY PARTS SOLD SEPARATELY. 9 v. battery 2/6 extra. **£7.10.0** plus 2/- P. & Pkg.

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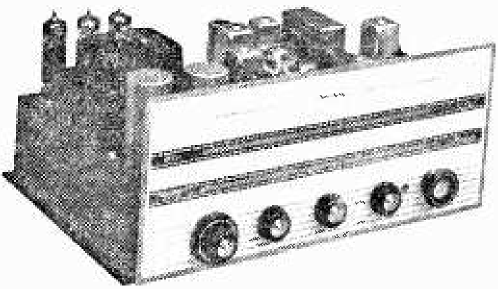

STEREO 12 MK.2 £44.15.0

8 watts push-pull output from each channel, 16 watts total. VHF, with automatic frequency control, medium and long bands. A hi-fi system on one compact chassis.

STEREO 55 *(Illustrated)* £33.15.0

A junior version of the Stereo 12 Mk. 2. 5 watts per channel. 10 watts total. VHF and medium bands. Inputs for tape, pick-ups and possible future stereo radio.

JUBILEE MK.2 £31.15.0

A mono chassis of 8 watts push-pull output and covering VHF, medium and long bands. Separate tone controls. A.F.C. Pick-up and tape inputs.

AF208 £23.15.0

An AM/FM mono chassis of 5 watts output covering VHF and medium bands. An inexpensive version of the Jubilee Mk.2.

An Armstrong chassis is more than just a radio-gram chassis. It is a carefully designed combination of tuner, control unit and amplifier in one compact unit which can be used as the basis of a complete high fidelity system. A system which can include tape recording and playback as well as radio and record reproduction.

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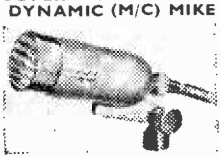
SUPER QUALITY HI-FI DYNAMIC (M/C) MIKE



with BUILT-IN TRANSFORMER
50 k. impedance

Suitable for hand or stand use. Complete with screened lead. OUTSTANDING VALUE MODEL M.D.180 **£4.15.0** Post Free

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HEAVY 9in. dome chromium base, chromium stand with screw top. Extends to approx. 6ft. Suitable for above mikes, etc. £2.15.0. Carr. 5/-

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2 v. 16 A.H., 7½ x 4 x 2 in., 5/- each. P. & P. 3/6.
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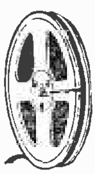

AMERICAN "CBS" TAPE

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5¾in.	L.P.	1,200ft.	(LP-12)	19/6
7in.	L.P.	1,800ft.	(LP-18)	28/6
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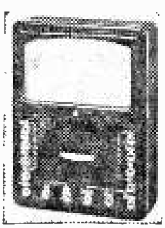
P. & P. 1/6 per order. (Orders over £3 post free). Many other types available including "Scotch," "EMI," "BASF," "Triton," "Synchrotape," etc. Send S.A.E. for our huge money-saving literature on Tapes and Accessories.

POCKET TEST METER MODEL TK.60

(4,000 O.P.V.) FOR ONLY **£4** POST FREE



A pocket size individual circuit tester with bakelite panel and metal cabinet. Complete with test leads batteries and ready to use.
Ranges: D.C. Volts: 10-50-250-1,000 v.
A.C. Volts: 10-50-250-1,000 v. (2,000 o.p.v.).
D.C. Current: 250µA/10 mA/250 mA.
Resistance: 0-10 K ohms/0-1 M ohms (by 3V internal battery).
Decibels: —20 to + 22db (0dB — 0.775v. —600 ohms).
Size: 4¾in. x 3¼in. x 1¾in.

Also available: **MODEL TK.50**
1,000 o.p.v. Ranges: D.C. mA: 1-250 mA, D.C. and A.C. Volts: 10-250-500-1,000 v. Ohms: 0-10K ohms 0-100K ohms. £3.7.6.

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Telefunken Stereo Hi-Fi Amplifier
Latest model S82 with balance control
ONLY **7 Gns.**

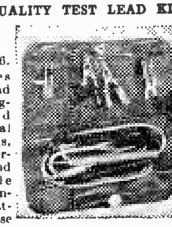
YES — ONLY **7 Gns.** Carr. 5/-

110/250 v. A.C. 5 watt undistorted output (10 watts nominal) size 12 x 9 x 2in., weight 9 lb. Complete with spec. and instructions.

12 VOLT D.C. AMPLIFIER
(Ardente). As new, 15 watt push-pull output mike and gram inputs, tapped output transformer. £9.19.6. Carr. 10/6. (Hand microphone for above 30/- extra.)

BEAM PROJECTION EXPONENTIAL HORN
19in. long, 12in. square flare. Complete with mounting bracket. Ideal for mobile use. Brand new. £6.10.0. Carr. 10/-.

SUPER QUALITY TEST LEAD KIT
No. 520
8/6
P. & P. 1/6.



Comprises leads and prods, English, and Continental type plugs, spade terminals and crocodile clips. Complete in attractive case

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10 gns. plus 13/6d P.P. & Ins.

NEW AUTO-CHANGE HI-FI RECORD PLAYER usual price £30,

to make up as follows: Beautiful cabinet in red and beige complete with push/pull Hi Fi amplifier. Dimensions 9" x 16" x 17". Mains Indicator, separate Bass/Treble controls, large speaker. Complete with motor board ready to accept Collaro Studio Auto Changer. £10. 0. 0d. plus £1. P.P. & Ins. Collaro Studio Auto Changer new and ready to fit. £7. 19. 6d. plus 7/6d. P.P. & Ins. All items may be purchased separately but if ordered together send

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TABLE RADIO cabinet in selected walnut veneers measuring 9" x 13" x 6". Cost manufacturer £2. Our price 15/- plus 2/6d. P.P. & Ins.
7-Transistor radio chassis to fit above cabinet complete with knobs and scale. 7-transistors, 2-diodes. Large ferrite aerial. Long and medium wave. 600 m.W. into 7" x 4½" L.S. £12. 0. 0d. plus P.P. & Ins. 10/-.
Each item sold separately but if bought together send £12. 12. 0d. only plus 12/6d. P.P. & Ins.

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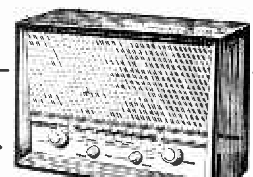

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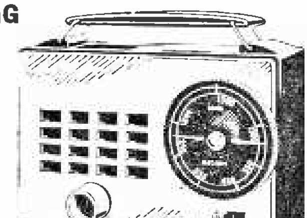
Printed Circuit —
Miniature earpiece
Completely portable
No Aerial or Earth is required



- ★ Size 4¾x3¼x1½in.
- ★ Output 200mW
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- ★ Push-pull output
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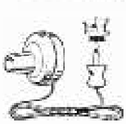

ONLY **59/6** 3/6 P. & P.

Complete with internal high-gain ferrox aerial and twin tone case in Red and Black. Med/Long wave. Earpiece has sub-min jack and socket with 3ft. fine cable. Almost invisible in use. All parts available separately. Circuit diagram 1/6—Free with parts.

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£2.19.6 P. & P. 2/-

PORTABLE SUPERHET **'REVEL 6'** *TRANSISTOR RADIO*

This two-wave band superhet receiver incorporates six first grade Mullard Transistors and one Diode; Printed circuit; Internal Ferrite rod aerial; develops 400mW push-pull output driving 8 x 3 speaker; M.W. and L.W.; operates on two 4.5 v. batteries. Although full portable (car aerial socket provided) this set has a performance superior to many mains radios of much greater size. Attractive two-tone cabinet—size 9½ x 6 x 3½in. Price includes full assembly and alignment instructions. All parts sold separately.

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6 Mullard transistors, 1 diode, internal ferrite rod aerial, 7 x 4 high quality speaker, printed circuit, 500mW push-pull output. MW and LW calibrated direct drive assembly. Highly polished handsome walnut cabinet. Inst. Book 2/6. Complete kit, inc. Battery. All parts sold separately.

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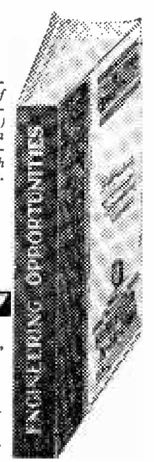

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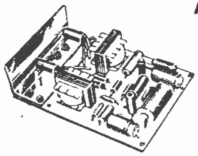
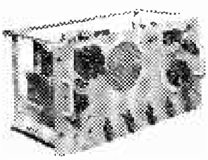


- 1 watt peak output.
- ±3db 70c/s to 12 kc/s.
- Output to 3 ohm speaker
- 9 volt operated.
- **Details on request.**

Built and Tested	Kit of Parts
69/6 OR	**62/6**
P.P. 1/6	P.P. 1/6

A printed circuit high gain amplifier size 4 x 2¾ x ¾in. using Mullard OC71/OC81D and 2-OC81 Transistors. Ideal for Intercomm., Record Player, Tuner Amplifier or any application requiring a quality and reliable amplifier.
Suitable 5in. speaker 15/-.

R208 COMMUNICATIONS RECEIVER "SPUTNIK SPECIAL"



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In Absolutely New Condition with Full Handbook in Steel Case.

£11.19.6
Carriage 15/-

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8. 4,000 ohm lightweight Headphones with leads. Very sensitive, **12/6,** P.P. 1/-.
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10. 8-Range All Transistor Signal Generator, 200 kc/s to 220 mc/s: RF, AF, IF, HF, etc., **£7.10.0,** P.P. 3/6.
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Components
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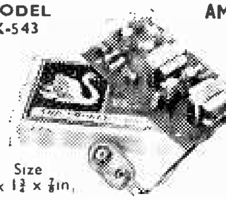
4 TRANSISTOR PUSH-PULL AUDIO AMPLIFIER

MODEL PK-543



Size 3 x 1¾ x ⅞in.

A ready built miniature 250mW push-pull amplifier incorporating input and output transformers, 4 transistors, 9 volt battery snap cord, speaker and volume connection leads. Ideal for use with record players, intercoms, hearing aids, tape recorders, etc. Complete with full instructions and circuit diagram.

PRICE 52/6 P.P. 1/6

SUITABLE 2½inch SPEAKER **16/6**

AVO-7

Famous Multi-meter. Reconditioned and fully guaranteed. Full A.C./D.C. voltage and current, resistance, dB, power, etc., etc. Supplied with Batteries, Leads and Instructions.

£11.10.0 Regd. Post 5/-.

CRYSTAL MICROPHONES

ACOS 39-1. Stick Microphone with screened cable and stand (list 5 gns.), **32/6,** P.P. 1/6.
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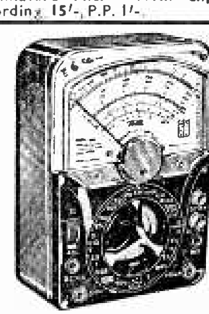
LAPEL. Miniature Mic. With clip. Ideal for recording, **15/-,** P.P. 1/-.

MODEL 500



30,000 ohms per volt multimeter.
8 Ranges D.C. volts to 1 kV.
7 Ranges A.C. volts to 1 kV.
5 Ranges D.C. current to 12 amps.
3 Range resistance to 60 meg.
Short circuit, Buzz test, Output meter, dB etc., etc. Size 6¼ x 4¼ x 2¼in. With Leads, Batteries and Instructions.

£8.19.6. P.P. 2/-.

Practical Wireless

BLUEPRINT SERVICE

ALL OF these blueprints are drawn full-size and although the issues containing descriptions of these sets are now out of print, constructional details are available free with each blueprint except for the PW Monophonic Electronic Organ and the PW Roadfarer.

The Index letters which precede the Blueprint Number indicate the periodical in which the description appeared. Thus PW refers to PRACTICAL WIRELESS; AW to *Amateur Wireless* and WM to *Wireless Magazine*.

Send (preferably) a postal order to cover the cost of the Blueprint (stamps over 6d. unacceptable) to PRACTICAL WIRELESS, Blueprint Dept., George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2.

Title	*Number*	*Price*
CRYSTAL SETS		
Junior Crystal Set	PW94	2/-
Dual-wave Crystal Diode	PW95	2/6
STRAIGHT SETS		
Battery Operated		
Modern One-valver	PW96	2/6
All-dry Three	PW97	3/6
Modern Two-valver	PW98	3/6
SUPERHETS		
A.C. Band-pass Three	PW99	4/-
A.C. Coronet-4	PW100	4/-
A.C./D.C. Coronet	PW101	4/-
The PW Pocket Superhet	—	5/-
MISCELLANEOUS		
The PW 3-speed Autogram	—	8/-
The PW Monophonic Electronic Organ *(No constructional details are available with this blueprint)*	—	8/-
The PW Roadfarer *(No constructional details are available with this blueprint)*	—	5/-
TELEVISION		
The PT Band III converter	—	1/6

SPECIAL NOTE

THE following blueprints include some pre-war designs and are kept in circulation for those constructors who wish to make use of old components which they may have in their spares box. *The majority of the components for these receivers are no longer stocked by retailers.*

Title	*Number*	*Price*
A.C. Fury Four	PW20	2/6
Experimenter's Short Wave	PW30a	2/6
Midget Short Wave Two	PW38a	2/6
Band-Spread Three (Battery)	PW68	2/6
Crystal Receiver	PW71	2/-
Signet Two (Battery)	PW76	2/6
Simple S.W. One-valver	PW88	2/6
Pyramid One-valver	PW93	2/6
BBC Special One-valver	AW387	2/6
A One-Valver for America	AW429	2/6
Short-Wave World Beater	AW436	3/6
Standard Four Valve S.W.	WM383	3/6
Enthusiast's Power Amplifier	WM387	3/6
Standard Four Valve	WM391	3/6
Listener's 5-Watt Amplifier	WM392	3/6

QUERY COUPON

This coupon is available until 7th June, 1962, and must accompany all queries in accordance with the notice on our "Letters to the Editor" page.

PRACTICAL WIRELESS, JUNE, 1962

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A new design 6-Transistor Printed Circuit Superhet for Medium and Long Waves. Uses all sub-miniature parts. Sub-min. Mullard Transistors. Quality speaker output, fitted earphone/record Sockets. Cabinets Red/White or Blue/White with Gold fittings.

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Size 4⅜ x 3 x 1¼in.

A Three Transistor Two Diode Personal Radio for Medium Waves and Amateur top band and shipping. Quality output on personal phone. Fitted air spaced tuner, vol. control. No aerial or earth. **Luxembourg guaranteed.**

69/6 P.P. 1/6.

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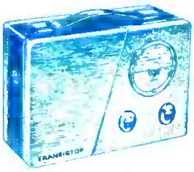

Medium and Long Wave Portable

8½ x 6½ x 3½in.

£6.19.6

P.P. 2/6

A 5-Transistor and Diode, Printed Circuit, Medium and Long Wave Portable. Features 5in. speaker, Car aerial socket, Mullard transistors and carded components. THE IDEAL PORTABLE.

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PW Minuette.
PW Tutor
PW Mini-amp.
PW Citizen.
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PW Shortwave 2.
PW Tuner

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6 TRANSISTOR MEDIUM AND LONG WAVE SUPERHET RADIO.

Unbeatable in performance and appearance.

Features the latest in design and performance, giving ease of station selection. Excellent Tone and Volume with amazing sensitivity and selectivity. Attractive two colour cabinets. Size 10 x 7½ x 3½in. Blue/White or Red/White. Fitted 5-inch speaker giving up to 425mW Push-Pull quality output. Full avc. fitted car aerial socket. 6-matched transistors, 2-diodes.

Total Cost £10.19.6 P.P. 3/6

GUARANTEED THE BEST OBTAINABLE

MODEL TH-L33

2,000 ohms per volt AC/DC. Size 5" x 3½" x 1½".

79/6

P.P. 1/6. with test leads, battery and instructions.

0/10/50/250/500/1000 volts D.C., 0/10/50/250/500/1000 volts A.C., 0/500µA/10/250mA., D.C. 3 ranges resistance 0/10K/100K/1 Meg. Capacity and dB ranges.

● BABY SITTER ●

ALL TRANSISTOR BABY OR INVALID ALARM

HOUSED IN ATTRACTIVE GOLD HAMMER FINISH PORTABLE CABINET. Battery operated, push-pull, 400MW output. Low impedance microphone enables unit to be used up to 200 yards. Output on quality speaker.

★ GUARANTEED for 12 MONTHS and 100% SAFE.

★ MICROPHONE is placed within 10ft. of baby; twin flex is taken to amplifier unit and placed in any room required. COMPLETELY BUILT & TESTED. P.P. 2/6. **£5.10.0**

★ **Used All Night, Every Night.** Battery Life 3 to 4 months.

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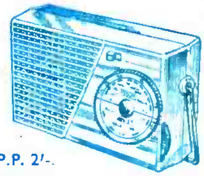


Size 5¼ x 3 x 1⅞in.

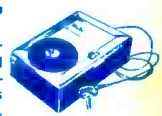
Red or Blue and Gold trim

£5.10.0 P.P. 2/-.

A Five Transistor Medium and Long Wave Printed Circuit Loudspeaker Radio, with Excellent Results including Luxembourg, guaranteed with full station separation. Supplied with Mullard Transistors and Carded Components. Fitted earphone/record socket.

Performance will amaze you.

"RANGER 2"



A Two Transistor Two Diode Personal Pocket Radio. Covering medium waves and top band. Supplied with battery and quality Personal 'Phone. No aerial or earth.

Size 4⅜ x 3 x 1¼in.

55/- P.P. 1/6.

"PW-6" SUPERHET RADIO

Medium and Long Wave Radio

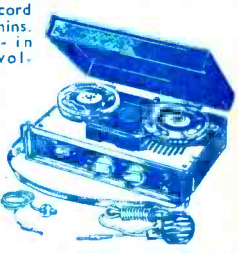
Size 5⅞ x 3⅜ x 2in.

£8.10.0 P.P. 2/-.

Modified version of previously advertised "PW" Superhet. Now with new style Two Tone Cabinet. 1st grade components and transistors. Printed circuit.

TRANSISTOR PORTABLE TAPE RECORDER

for home, office or travel



● Play/record up to 30 mins.
● Built-in speaker volume control batteries and play/record/rewind.
● Perfect speech recording.
● Sturdy case 6 x 8¼ x 2⅞in.

£11.19.6

Ready To Use **Fully Guaranteed**

Supplied complete with microphone, tape, batteries and personal phone.