The **MINISCOPE**

The **TUDOR** 4-valve battery portable
BRAND NEW AM/FM (V.H.F.) RADIOGRAM CHASSIS AT £13.13.0 (Carriage Paid)

ALL C. ONLY. Chassis size 16 x 7,5 x 51n, high. New manufacture. Dial 14 x 51n, in 2 colours predominantly gold.


Valves: E805, E805, E805, EPB0, M.F., M.F. CHASSIS.

Speaker and Cabinet to fit chassis (table model): 47/6 (post 2/6).

E.60. ELIPTICAL SPEAKER. 20-, to purchasers of this chassis.

£7.10.0. OVERSPRINT model. £3 down and 4 monthly payments of £2 and 1 of £13.0. 


THE "CANTATA" 6-TRANSISTOR AND DIODE PORTABLE COMPLETE KIT FOR ONLY £7.19.6


BUILD YOUR OWN RECORD PLAYER Price £12 carr. paid

FULLY BUILT 2 VALVE AMPLIFIER

B.S.R. 4-sp. autochanger. case 17 x 15 x 51n. Assembled in 8 mins. Simple cabinet for tape recorder with plain board only £8 carr. paid. Attractive colour finishes. 

with or with 3 valve 15+ extra


6 TRANSISTOR STEREO AMPLIFIERS. 2 ECL82—2 x 21 watts, 12 x 8 x 61n. piano keys, 75, post paid.


CABINET £15. Room dipole 12/6. Feeder 6d. 4v.

PUSH-PULL AMPLIFIER £5.50

(CJ Carr.)


Front panel normally screwed to chassis may be removed and used as "flying panel." Stereo version 2 x 4 w. same price.

THIS SUPERB SET FOR £10


SUPERIOR GRAMOPHONE AMPLIFIER

Valves: U851, UF30 and UL94. Main trans. 250-310 A.C. Covered baffle 11 x 8 x 7in. (Inc. speaker) £1. 1 x 7in. 18 x 5in. speaker, 3 front controls bass, treble, on/off (vol. 0), (post 4/-) either type. Reimex cabinet with lifting handle and lid (detachable) 14in. or 12 x 8 x 5in. £15+.

GRAMOPHONE AMPLIFIER. With 5in. SPEAKER. Baffle 12 x 6in. ECL82 and Rectifier. Tone and Volume. On/off switch. Two knobs. Ready to play. Useful for stereo. £7/4- (post 4/-).

TEST LEAD KIT. Leads, Prods. Terminals. Clips, in case, 10/- post paid.

TAPE TOP QUALITY HORNED. 51n—£85/80, 15/-/1200 ft. 17/6. 1200 ft. 17/6. £9.50. 12/6 all plus 1/6 post 2/- for 2.

SPECIAL OFFER


COLLARO STUDIO TAPE TRANSCHRIPTOR. 3 MOTORS, 3 SPEED, 11, 31 and 71 1/2. P.S. Push buttons £10.17.6 (10/- carr.) incl. spool.

3-VALVE AMPLIFIER (Inc. RECT.)


BATTERY ELIMINATOR

For 4 Low Consumption Valves 69 range. 90v. 15mA and 1.4v. 125mA. 45/- (25/- post). 90-24v. 4. A.C. Also for 200mA, 1.4v. and 50v. 10mA at same price.

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CHASSIS BATTERY RADIO


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* VALVES *

The most comprehensive competitive valve list in the country

10% DISCOUNT
Special offer to Purchasers of any SIX VALVES marked in black (i.e., 12/9 in.
doesn’t). Post 1 valve, 6d., 2-11, 1/-.

NEW LOW PRICE GUARANTEED 3 MONTHS
FREE TRANSIT INSURANCE. All valves are new or fully guaranteed ex-Government or ex-Export stock. Satisfaction or Money back Guarantee on Goods if returned unused within 14 days.

Tubes

Most Mullard, Mazda, Cosgrove, EMI.
Scope, Brimar, Ferranti Types.
Practically in our own Factory

Guaranteed

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6 Months $3.00
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Highest Quality — Compare our Prices

Special temporary offer. Due to the Buoy Special Purchase we are offering MW 31/7 Tubes at the unreasonable price of 15% 30/- 82/-. P.P. 12/6. The above are guaranteed for 6 months.

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"Vonkki" 4 Track Sound, 3 Speed Transcription Deck, Superior reproduction, Strengthened framework, Inexpensive. Cannot be equalled on market value at half. Our special price 28/-.


Three-Speed Record Players.

Latest Turntable, together with light-weight Marant Galaxie dual crystal set turntable pick-up. Ideal for childrens radio. (12 only). £3.10.0. Carr. 5/-.

Portable Record Players. Take all sizes Records, all speeds, amplifier, microphone, Garrard, new "Jenkins" trans. In two-tone cases. All absolutely new, £9.15.0. Carr. 15/-.

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P.M. Speakers. 3 ohm, top makes, performance guaranteed. £1.15.0. 3/6. 7 x 4½. 11/-.

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Table Models, Famous Makes. Absolutely Complete. These sets are undoubtedly in value due to huge purchase of direct from source. They are tested and guaranteed to be in working order. Carr. etc., 15/-.

£2.19.0 15/- £4.19.0

Transistor Portables. 6 + M.T. High Lightweight, approx. 10 lbs., slightly larger than pocket set, but much greater volume. Better quality complete, battery operated, unusually sensible worth £11. Our price only £7.15.0.

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5 Code different colours, 4/-; Connecting flex. Price as above.

Transistors. Red spot 3/- ea. Yellow spot 6/- ea. Yellow spot 3/- ea. Germanium diodes 9d. ea. 8/- doz. From 3-50/- in 10 sets. Mixed packets of 25-30/- Joel. The best and cheapest was to buy.

4½ watt AMPLIFIERS. Further delivery of these excellent units to hand complete with l.f.s. amplifier, 8059 output, and 8059 rectifier. Easily converted into high gain unit, complete with good quality. £15. Speaker in attractive two tone bakelite case easily converted for guitar, record players. £15. Carr. 8/-.

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10 Volt. Blowers, ex-Govt., 15/.

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Famous makes complete with PUFS, POBS valves. 30/- to 1/-.

Fantastic value 15/-.

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Get 15. G.E.C. High Power, Contact coupled, manufactured to match Transistor with Piff-Pull input 4 Output Transformers. Knock out price 28/-.

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"Garrard" Similair. Very latest compact Autohugers, Just released. Amazing value, £2.15.0. Also available, Garrard Model 229, £8.17.5. P.P. 4/-.

100 Resistors 6/-

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Miniature Ceramic Condensers 3 pF to 6,000 pF. List Value over £9.

Ivory/Gold knobs 1½ Diameter, half price 1/-, 5 for 6/-: 1½ 3/- for 6/-.

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September, 1962

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The displacement caused by the new Tangential fan is quite amazing, but what more amazing is the almost complete absence of noise. The J.B. Air-Conditioner on a window ledge near an open window, and you can have either of bad air, or input of clean, new air, depending upon which way you turn it.

In addition to a fan for moving the air, there is also a carbon absorber and control switch, wired such that the output may be varied. The total building cost of this air-conditioner is £17.10.0, but is offered at a specially low price during the summer months, this price namely £18.10.0, plus 5/- carriage and insurance. The case is very nicely finished in hammered enamel, and when assembled, the unit is indistinguishable from those selling at £12 and more.

Don't miss this special summer offer.

Adjustable Thermostat

Suitable for Industrial or domestic purposes, such as controlling furnace heating or dehumidifier etc. Can also be used as a flame-stabiliser for any appliance. Made by Sunvic these are approximately 17 1/2 long and adjustable over a range 0 to 2000 F. The contacts are sealed at 15 amp., 200 volts, and the adjustment spindle, which comes to the top, can be fitted with a flexible drive for remote control or a polisher knob for local control. Listed at 64/- or 4/- each. These are offered at only 19/6 plus 2/6 postage and insurance.

Introducing the J.B. Range of Transistors

Try these, you will be very pleased—

J.B1. All wave mixer

J.B2. I.F. Amplifier (replaces CCO etc.) . . . 6/6

J.B4. A.F. Driver (replaces C01D etc.) . . . 4/-

J.B5. Output matched pair (replaces C071 etc.) . . . 13/-

Special offer set of 6 matched for superhet . . . . 95/-

Transistor Components

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

“A jolly fine set but deserving a better case.”

This is a comment on which many constructors have voiced or and therefore we now offer a De Luxe version of the Pocket Companion, which uses a solid case, complete with gold lettering and personalization. Price £27.10.0. The most up-to-date Superhet portable of its type, it uses a transistor in conjunction with Philet transistors and Mullard output transistors. Complete building costs with plastic case £35.15.0, or with solid case £37.15.0.

If you have already built and want to change your case, then return the plastic case with a postal order for £1 or if you wish to retain the plastic case then send 2/6, plus 1/6 post and ins. for the hide case only.

AGENTS WANTED TO BUILD OUR COMPANION PORTABLES. SEND S.A.E. FOR FULL DETAILS.

ROMANTICA 7

Cheaper than you can possibly make it, we offer a completely made-up transistor Pocket Superhet. Uses all first rate, matched transistor pairs and is complete with leather case (replaces 0044 etc.) filters and power capacitors, 535-1065 kc/s., sensitivity 340 mV, carbon output 150 mw., ferrite slab aerial. Size approximately 5 x 9 x 14 in. Price £8.19.6. Post and Ins. 3/-.

Cabinet & Pick-up

Cabinet battery rectifier player, size approx. 9 x 11 x 6 in., allows for 7 x tin., speaker and amplifier. Nicely covered two tone. Must have cost at least £13, but we offer it new and perfect. Most popular for 45 or 78 records. Price 9/6, plus 2/6 post and insurance.

Cosmocord Pick-up

As illustrated with cartridge and headrest. Ready to use and new and perfect. Suitable for either 45 or 78 records. Price 10/-, plus 2/- post and insurance.

CLOSED CIRCUIT TV

If you feel like taking a day out we invite you to our studio for a free visit and will demonstrate 450 and 525 systems, as well as under water and other types of installations. We have a range of sets for sale or loan, and will be glad to discuss with you various points which you may have. You will be interested to note that a transistorised camera for working directly into a domestic TV receiver can now be purchased for little more than the cost of a good photo camera.

The 'Good Companion' Mk.11 using Transistors

In the 'de-luxe' cabinet illustrated it costs £10.10.6 to build—but why not? Some these pages: you will find nothing to compare with its specification. It uses transistors instead of F. transformers, has variable feedback as well as all the usual features. A.V.C., Pull-in output, Ferrite Aerial, Slow Motion Tuning etc., etc., and is a very powerful Medium & Long wave set. All conservatively rated at 750 mw. Each component used is a famous name part. Prices are £2 3/6, 3/4, 3/- and unused and unused and unused and unused.

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

Yaxley Switches

All new and unused and in first class condition

1 pole, 2 way 1/4; 1 pole, 3 way 5/6

1 pole, 7 way 5/6; 1 pole, 8 way 5/6

1 pole, 11 way 5/6; 1 pole, 12 way 5/6

2 pole, 5 way 5/6; 2 pole, 6 way 5/6

2 pole, 10 way 5/6; 2 pole, 12 way 5/6

3 pole, 6 way 5/6; 3 pole, 12 way 5/6

4 pole, 4 way 5/6; 4 pole, 5 way 5/6

4 pole, 3 way 5/6; 4 pole, 6 way 5/6

5 pole, 6 way 5/6; 5 pole, 11 way 5/6

6 pole, 4 way 5/6; 6 pole, 5 way 11/6

12 pole, 5 way 11/6; 12 pole, 7 way 3/6

4 pole, 8 way 7/-; 4 pole, 9 way 2/6

12 pole, 5 way 11/6; 12 pole, 7 way 3/6

6 pole, 6 way, shorting 3/-

Stocks of most types

Special prices for quantities.

Philco Record Player Cabinet

Two-tone, covered with high grade enamel, fitted with rubber feet. The trim is particularly nice being made of walnut with a high gloss finish. Size approximately 14 in. wide, 8 in. deep, 15 in. high. Nicely covered. We have this special record player or tape deck cabinet. For only £24.5/-; it is a better quality unit than some other similar record player or tape deck etc. Can be got for as little as £12 each, our special ship price 35/- each, carriage and insurance 6/6.

“Coolerstat”

Worries in reverse to normal—for switching fans, freezers, air conditioning etc. Price from £3/- and up. Philips Pullin Company. Nominal 600 watts. One of the best A.S.C. instructs, at least £3 each, our special ship price 65/- each, carriage and insurance 3/6.

Power Unit

A useful source of D.C. for experimenting, using instruments, electroplating, electrolytic batteries etc. This power unit can be used in a few hours and due to the availability of the rectifiers at such a very low price, we can supply the complete kit of parts with A.S.C. instructions, fitted into any box for 8/- 6d. Plus 1/- post and insurance.

Building A 'Scope?

3in. oscilloscope tube. American made type No. 3PF7, 6.3 v. 50 ma. ampl. or fluorescent deflection, brand new and guaranteed. Complete circuit diagram of scope, 15/- each, plus 2/- post and insurance.

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MULTI-METER BARGAINS!

MODEL 200H (illus. on right), 20,000 ohms per volt, 20 ranges comprising A.C. volts, 5 ranges up to 1,000 D.C. volts, 6 ranges up to 2.5 kv., C.C. current, 3 ranges up to 26 ohms, resistance, 2 ranges up to 6 meg., capacity 2 ranges up to 0.1 decibels — 20 to 22. Scale cornerwise to the equivalent of 4 in. movement is a pocket size instrument measuring 3½ x 3½ x 1½ in. Complete with test probes, battery and operating instructions, price £6.19.6, post free.

MODEL EPIOK. Similar in size and appearance to 200H except that this is 10,000 ohms per volt and maximum D.C. volts 1,200 instead of 2.5 kv., also no capacity range. Price £5.19.6. Post free.

ALL METERS BRAND NEW AND FULLY GUARANTEED

MODEL TP55. (Illus. on left). 20,000 ohms per volt, D.C. volts, 5 ranges up to 1,000 A.C. volts, 5 ranges up to 1,000 resistance, 2 ranges up to 10 meg., capacity 2 ranges up to 0.1 decibels — 20 to 22. One switch control really beautifully made precision instrument, size only 3½ x 3½ x 1½ in., price only £5.19.6 Post free.

MODEL TP10. Similar in size and appearance to TP55, but sensitivity 2,000 ohms per volt, price £3.19.6 Post free.

MODEL U1. A robust instrument of 1,000 ohms per volt sensitivity. A.C./D.C. volts up to 500, A.C. current up to 500mA., A.C. resistance up to 20000 ohms, size 5½ x 3½ x 2½ in., complete with test probes, single switch control, large easily read scale, price only £2.19.6 Post free.

Making An Extension Speaker?

The cabinet illustrated, although intended for T.V., makes ideal extension speaker only £6.75. Net. front. Size 16 x 16 x 14 in. deep. Can be cut through middle to make two stereo cabinets. Bargain at only £6.19.6 plus ½ post.

Parcel of Electric Switches and Switch Plugs

All bakelite cases, suitable for normal house wiring. Parcel comprises 6 oblong 1 way 5 amp, 4 oblong 2 way 5 amp, 2 amp 3 pin switch socket. Value easily £5.00, yours for 10/6 plus ½ post.

Parcel of Mica Condensers

50 all very useful values. Total list price over £5 and yours for 5/- plus ½ post.

Lens system for direct TV Infrared Binoculars

See in the dark for night hunting etc. You get 3 complete optical systems (could be used for T.V., camera and 2 screens, stereo - part of the Tabby equipment. Unused, believed in good order, but no guarantee at this silly price of £3-15.6, plus ½ post.

TRANSLATOR SET CABINETS

Very modern cream cabinet, size 51 x 3 x 11 in. with chrome handle, tuning knob and scale. Price 7/6, plus ½ post and packing.

Special quotations for quantities.

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A New Six Transistor luxury portable with the new "SLIM LINE" look. To build well, with printed circuit chassis for reliability and simplicity in construction. May be used as Car Radio, with full MEDIUM wave coverage.

The "CRUSADER"

Our new four transistor plus diode portable with big sale quality!

- Full Medium Wave coverage.
- Completely self-contained.


NEW IMPORT! Large quantity shipments enable us to offer keenest meter value yet! 300 ohms volt-ohm-milliammeter. (Similar to Model 2001 originally advertised)

Range: A.C. Voltages: 10, 50, 100, 500, and 1000 volts (10,000 ohms per volt). D.C. Voltages: 0-2, 0-5, 0-25, 0-50, 0-125, 0-250, and 0-500 volts. D.C. Currents: 0-50 micro-ampere, 0-2.5, 0-250 micro-ampere. Resistance: 0-5, 0-4, 000 ohms and 0-4, 000 ohms at centre scale. Capacitance: 10 pf to 0.001 pf, 0.01 pf to 0.1 pf, 0.1 pf to 1.0 pf, Decibel: -30 to -22 dB.

A fully guaranteed pocket size meter (actual size: 3" x 3" x 1") knife edge pointer, log quality supplied complete with test probes and full instructions. ONLY £5.5.0 POST FREE.

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MINIATURE COMPONENTS?

Soldering is easier with the

NEW 15 WATT
SOLON

electric soldering iron

- Ideal for transistorised and printed circuitry.
- In in. diam. bit in + in. diam. stem will reach normally inaccessible connections and components.
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MULLARD "5-10" MAIN AMPLIFIER

For use with the MULLARD 2-valve pre-amplifier which, under the highest power output conditions, 12 watts is obtained. We supply SPECIFIED COMPONENTS and NEW MULLARD VALES, including TRANSFORMERS and choice of the latest Ultra-Lineary PARTRIDGE or the PARMEKO Output Transformer.

COMPLETE KIT OF PARTS £10.0.0
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Alternatively we supply

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Employing two EP8 valves, and designed to operate with the MULLARD MAIN AMPLIFIERS, but also perfectly suitable for other makes.

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Supplied strictly to MULLARD'S SPECIFICATION and incorporating:

- Input for Crystal Pick-ups, and variable reluctance magnetic types.
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The popular and very successful "510" Incorporating Control Unit providing up to 10 watts quality reproduction. Only-Specified Components and new MULLARD VALES are supplied including PARMEKO MAINS TRANSFORMERS and choice of the latest: PARTRIDGE or PARMEKO Ultra-Linear Output Transformers.

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THE IDEAL AMPLIFIER FOR A SMALL QUALITY INSTALLATION PROVIDING EXCELLENT REPRODUCTION OF UP TO 4 WATTS OUTPUT.

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STERN'S INTER-COMM BABY ALARM

A small versatile Unit employing the new MULLARD EC68 valve and enabling conversation up to extreme distances. Operates from A.C. mains or 9-volt battery. Available for CASH £1.8.2

KIT OF PARTS £6.17.6 ASSEMBLED AND TESTED £8.8.0
Consists of a MASTER UNIT, also only 8 x 51 x 6in. and ONE EXTENSION (a second extension is also available to any time). The Master Unit incorporates switching and power supply and with the chassis completely isolated from the mains is operated in a safe manner.

A BULK PURCHASE OF MARCONIPHONIC TAPE RECORDING EQUIPMENT ENABLES US TO OFFER THE MODEL MTR/I PORTABLE TAPE RECORDER FOR £26.0.0

STERN'S TRANSISTOR BATTERY OPERATED INTERCOM

Model MTR/I, one microphone input matched for moving coil or Ribbon Mike. £11.10.0 extra.

STERN'S INTER-COMM BATTERY ALARM

Self powered with Cathode follower output, incorporates two Inputs for MICROPHONES, One for CRYSTAL PICK-UP and a fourth for RADIO or TAPES Complete Kit of Parts £10.0.0

TERMS: Deposit £2 and 12 months at 15/6.

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Thelohmic amplifier.

STERNS INTER-COMM BATTERY ALARM

Self powered with Cathode follower output, incorporates two Inputs for MICROPHONES, One for CRYSTAL PICK-UP and a fourth for RADIO or TAPES Complete Kit of Parts £10.0.0

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Thelohmic amplifier.

STERNS INTER-COMM BATTERY ALARM

Self powered with Cathode follower output, incorporates two Inputs for MICROPHONES, One for CRYSTAL PICK-UP and a fourth for RADIO or TAPES Complete Kit of Parts £10.0.0

TERMS: Deposit £2 and 12 months at 15/6.

(Plus £7.6.2 & Ins.)

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(Plus £7.6.2 & Ins.)

Thelohmic amplifier.
THE "STP-1" STEREO TAPE PREAMPLIFIER

- BRENNELL Mk. V TAPE DECK
- Incorporates Single 4-Track Mini-Flux Tape Heads
- PUSH-PULL OSCILLATOR CIRCUIT
- IMPROVED EQUALISATION
- PERRINOCUBE OSCILLATOR TRANSFORMER
- SENSITIVE METER FOR SIGNAL LEVEL
- SEPARATE GAIN CONTROLS IN EACH CHANNEL
- MULLARDS 12AS5 INCORPORATED

THE "STP-1" PREAMPLIFIER is offered WITH TAPE DECKS AS FOLLOWS:
- BRENNELL Mk. V 4-Track Model....$415.0
- COLLARO "STUDIO" 4-Track Model......$450.0

COMBINED PRICE SCHEDULE

THE MULLARD "10+10" STEREO AMPLIFIER

Designed to operate with COLLARO "STUDIO" TAPE DECK incorporating the best 1-Track Reuter Tape Heads.

OVERALL SIZE: CASE 13 x 5in.
FRONT PANEL (Choice of Black or Winter 14 x 3in.)

**Price:** £28.0.0
Including separate Power Supply Unit.
Deposit £5.12.0, 12 months at £2.1.0

The MULLARD "10+10" STEREO AMPLIFIER (described below) with the "STP-1" PREAMPLIFIER and one of the Tape Decks provides a COMPLETE STEREOGRAPHIC INSTALLATION. We offer the "10 + 10", the "STP-1" and the AM/fm Stereo Control Unit. 

- BRENNELL Mk. V DECK...
Deposit £17.8.0, 12 months at £2.7.9
- As above with COLLARO "STUDIO" DECK...
Deposit £12.12.0, 12 months at £2.1.0.

Please enclose S.A.E. with all enquiries.

The "TWIN-THREE" STEREO AMPLIFIER

OFFERED ASSEMBLED and TESTED for:

- £7.15.0 (Carr. & Ins., 7½ extra).
- Based on a recent design by MULLARD LTD. The "TWIN-THREE" is ideally suited for use in PORTABLE RECORD PLAYERS.
- £15.0.0 (H.P., £2.10.0 & 12 mths. at 18/4.

SUITABLE RECORD PLAYERS ARE AVAILABLE.

**Price:** £8.14.0

"The Tudor" AM/FM TUNING UNIT

A SELF-Powered HIGH-FIDELITY TUNER OF OUTSTANDING DESIGN.

**Price Only:** £19.19.0
Deposit £9.15.0, 12 months at £1.6.0.

Provides full coverage of the VHF-FM band (87-108 Mcs) and also the Long and Medium wavebands. Incorporates Multiplex outlet socket for synchronously, 'on', and separate controls for tuning the AM and FM bands. Operates perfectly with the STERN-MULLARD AMPLIFIERS and contains matching PORTABLE CASE in Black, Gold or White. Also operates equally well with any Amplifier requiring input of 100 to 400 milli-Volts.

"Hi-Fi" LOUDSPEAKERS WE HAVE IN STOCK A COMPLETE RANGE BY GOODMANS--WHARFEDALE--WB.

ILLUSTRATED AND PRICE LISTS AVAILABLE ON REQUEST.
BUILD A HIGH QUALITY TAPE RECORDER LIKE THIS FOR £35.00

FOR THIS WE SUPPLY
* Complete Kit of Parts to Build the HPTRS Tape Amplifier.
* The New Collaro “Studio” Tape Deck.
* Roll/Reel/Cassette 10 x 10 ft. P.M.
* ACOS Crystal Microphone and 1,000ft. Spool E.M.I. Tape.

ALTERNATIVELY WE SUPPLY THE COMPLETELY ASSEMBLED and GUARANTEED TAPE RECORDER FOR .....

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

ADD “HI-FI” TAPE RECORDING TO YOUR EXISTING AUDIO INSTALLATION WITH GARRARD 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 full speed treble equalisation by the latest FEROXCUBE POT CORE INDUCER, FOR COLLARO-TRUVOX-BRENELL WEARITE Tape Decks, has GILSEN Output Transformer, incorporates separate Power Supply Unit. KIT OF PARTS £13.13.0

ASSEMBLED £17.00 Deposit £2.15.0, 12 months at £1.14.11.

SPECIAL “COMBINED ORDER” PRICES
For Constructors with their own cabinet—WE OFFER—
(a) COMPLETE KIT to build the HPTRS Amplifier, with the HPTRS TAPE DECK Deposit £5.4.0, 12 monthly payments of £1.13.8.
(b) As above but, with the HPTRS supplied ASSEMBLED and TESTED Deposit £5.19.0, 12 monthly payments of £1.17.7.
(c) COMPLETE KIT to build the HPTRS AMPLIFIER with the BRENELL Mk. V TAPE DECK Deposit £5.8.0, 12 monthly payments of £1.16.7.
(d) As above but with HPTRS supplied ASSEMBLED and TESTED Deposit £5.9.0, 12 monthly payments of £1.16.9.
(e) THE ASSEMBLED AND TESTED H_PTRS AMPLIFIER with the WEARITE MODEL 4A DECK, incorporates WEARITE Head Lift final Power Amplifier £6.0.0 Deposit £12.12.0, 12 monthly payments of £1.0.6.
(Carriage and Insurance on each above 10/- extra.)

THE MODEL HFG/2R PORTABLE TAPE RECORDER
(Printed Price £33.0.0)

FOR ONLY 22 Gns.
Deposit: £4.14.0. 12 months at £1.13.9
Incorporates Twin Track Heads and Four Track Heeads and Four Track Head and Track Switch for Mono/4oStereo operation.
Deposit: £6.17.0. 12 months at £1.13.11.
Complete Twin Track Mono Recorder-Preamp Unit. £4.17.0. 12 months at £1.13.11.
Complete Four Track Mono Recorder-Preamp Unit. £6.17.0. 12 months at £1.13.11.
Complete Four Track Mono Recorder-Preamp Unit incorporating outlets for Stereo reproduction. £5.17.0. 12 months at £1.13.7.

THE GARRARD SERIES 80 TAPE EQUIPMENT

MODEL D82
Incorporating Twin Track Heads. £26.5.0
Deposit: £4.17.0. 12 months at £1.13.7.

MODEL D84
Incorporating Mono Track Heads. £29.8.0
Deposit: £4.17.0. 12 months at £1.13.7.

MODEL PD82
Incorporating Twin Track Heads. £42.0.0
Deposit: £4.17.0. 12 months at £1.13.7.

MODEL PD84
Incorporating Mono Track Heads. £46.0.0
Deposit: £4.17.0. 12 months at £1.13.7.

THE JEMCO MODEL MT-955 MULTIMETER

A truly efficient Motor for the amateur or professional man, having features found normally in more expensive meters. Ranges, D.C. volts 0-10-50-200-1,000 A.C. current 10mA to 100mA, 10 amp. Resistance 4 Ranges up to 20 meg. Price, including Full Test Lead Kit £12.19.6 p.d.

SPECIAL OFFER!
WE HAVE A LIMITED QUANTITY OF HMV Model 544 STEREO AMPLIFIERS and OFFER THEM FOR £18.18.0 12 months at £1.15.7.
List Price £27.6.0

A complete Stereo Amplifier incorporating All-Complementary Circuitry and has power available for Radio Tuners.
ERSIN MULTICORE SOLDERs

for a first class joint every time

ERSIN Multicore contains 5 cores of extra-active, non-corrosive Ersin Flux. Prevents oxidation and cleans surface oxides.

SIZE 1 CARTON 5/-

HANDYMAN'S CARTON Suitable for 200 average joints. 6d.

HOME CONSTRUCTORS 2/6 PACK

In addition to the well-known Home Constructors Pack (containing 16 fl. of 18 w.g. 60/40 alloy) a similar pack is now available containing 35fl. of 22 w.g. 60/40 alloy especially suitable for printed circuits.

WHEREVER PRECISION SOLDERING IS ESSENTIAL, MANUFACTURERS, ENGINES AND HANDYMAN Rely on MULTICORE. THERES A MULTICORE SOLDER JUST MADE for the job you have in hand. Here are some of them.

SABATV TYPE 1 ALLOY

A specially formulated alloy to reduce the wear of soldering iron bits. Contains 5 cores of non-corrosive Ersin Flux and is ideal for all soldering purposes.

SIZE 1 CARTON 5/-

Available in three specifications.

BIB WIRE STRIPPER AND CUTTER

Strips insulation without nicking wire. Cuts wire cleanly, splits extruding flex. 3½ each.

MULTICORE SOLDERs LTD.,

MULTICORE WORKS, HEMEL HEMPSTEAD, HERTS. ( Boxmoor 5858)
L. SUPER 5 TRANSISTOR POCKET RADIO INCORPORATING PRINTED CIRCUIT & MINI-FARADAY. No tubes or parts required. 4½ x 3½ x 1½ in. Output 200 M.W. at first quality transistors. High flux moving coil speaker. M/L internal high gain ferrite aerial. £10.50, f. & p. 25s. Circuit diagram 1½ in. free with parts.

2. TRANSISTORISED POCKET RADIO with printed circuit, mini-caps, high gain ferrite aerial. No aerial or earth required. To build yourself for completely personal listening. 4½ x 3½ x 1½ in. Low volume in favourable areas. Only 21s., f. & p. 5½s. All parts available separately.

3. A.C./D.C. POCKET MULTI-METER KIT. 2½½ in. moving coil meter, scaled in A.C./D.C. 0.500, 1.000, 0.250, 0.500, milliamperes 0-10, 0-100. Ohms ranges 0-10, 0-100, 0-1000, 0-10000. £5 10s. P. & P. 5½s. Wiring diagram 1½ in. free with parts.

4. SIGNAL GENERATORS. Cash £7.5.0, or 30/- deposit and 6 monthly payments of 21/6. Coverage 1½ kHz to 81 Mc/s. Case 10 x 6 x 4 in. Size of (a) 6½ x 2½ in. 2 valves and rectifier. A.C. input 230-250 v. Internal modulation 400 c.p.s. to a depth of 30 per cent. Modulated or unmodulated R.F. output continuously variable 100 millivolts. C.W. mod. switch. Variable A.F. output. Magic eye output indicator. Accuracy ± 2 per cent.

5. SIGNAL GENERATORS. Cash £5.5.0, or 2½½s deposit and 5 monthly payments of 25. Coverage 1½ kHz to 81 Mc/s. Case 10 x 6 x 4½ in. Size of (a) 6½ x 2½ in. 2 valves and rectifier. A.C. input 230-250 v. Internal modulation 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. Accuracy ± 2 per cent.

6. STAAR 45. 9½, BATTERY RECORD PLAYER complete with turntable and deck. A complete portable record player. Head protected by a dome with a brush which cleans the stylus as it runs into playing position. 45 r.p.m. Radio control switch governed motor, attractive two tone grey finish. £2.14.8. f. & p. 5½s.

7. CARRYING CASE for STAAR 45 or COMPLETE KIT beautifully styled in two tone with record compartment. Especially designed to take player and amplifier. Just screw in and connect up. All parts available separately. Cases only 2½½s. P. & P. 4½s. Complete kit £6 10½s. P. & P. 5½s.


10. R.S.R. MONARCH A.M. WITH FULL-F I.F. HEAD. 4-speed, plays 10 records, 12½ in., 10 in., 7½ in., 7 in. at 33, 45 or 78 r.p.m. Interchangeable anvils, una and 12 in. records on the same speed. Han magnet position: colour brown. Dimensions: 17½ x 10½ in. Space between base and stand 4½ in. Fitted with Full-F I.F. turnover crystal head. £19.16.6. P. & P. 3½s.

11. PUSH FULL OUTPUT STAGE including those with input and output transformers to match £4½, £3½½ in. with the POCKET RADIO. Kit of parts, including transistors. £10.50. P. & P. 3½s. Wiring diagram 1½ in. free with parts.

12. 9½½, PUSH PULL 4 VALVE AMPLIFIER plus METAL RECTIFIER. A.C. mains 500-250 v. Size 10½ x 6½ x 3 in. 5 valves. For use with all makes and types of output and output. Negative feed back. Two inputs, input and output, and controls for balance. Separate controls for Ban and Telec output. Response flat from 40 cycles to 10,000. 0.15 in. deep depth of 30 per cent, modulated or unmodulated R.F. output continuously variable 100 millivolts. C.W. mod. switch. Variable A.F. output. Magic eye output indicator. Accuracy ± 2 per cent.


15. 2½½, HIGH STREET BOX, LONDON, W.3. ALL ENQUIRIES S.A.E.

GLASS NOT DESPATCHED OUTSIDE U.K.
HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES
Two input sockets with associated controls allow mixing of "mike" and gram, as in A10. High sensitivity includes 5 valves, ECC83, ECC83S, EL4, EL24, 5Y3. High Quality sectionally wound output transformers. Forbidding carrying burrs with attractive two-tone 001/20 chrome finish, size 14 x 15 x 8 fin., high, and circuit. Total cost if purchased individually approximately $40. Performance equal to units in the 280-300 class. S.A.B. for leaflet.

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER
A complete set of parts for constructing of a stereo-phonic amplifier giving 5 watts high-quality output on each channel (total) of 10 watts. Sensitivity is 50 millivolts, suitable for all crystal valves. Gauged in many styles. Control gives equal variation of "low" and "cut." Provision is made for use as standard (monaural) 5-watt amplifier. Valve line-up ECC83S, 6DJ8, 6L6GC, 6A8G, 6SN7, etc. Output for 250-watt speakers. Point-to-Point wiring diagrams and Instructions supplied. Send S.A.B. for illustrated leaflet detailing Ready-to-Cabinet Assemblies. Speakers, Microphones, etc., with cash and credit available.

R.S.C. BATTERY CHARGING EQUIPMENT
All for A.C. Mains 200-250v., 50c's Guaranteed 12 months.

BATTERY CHARGER KITS
Consist of Finished Receiver, well ventilated steel case, Fuses, Fuse-holders, Grommets, Fuses, and circuit. Case. 30c's extra. 6v. or 12v. 1amp.... $4.9. As single, with small case, and ready for use with 6-volt or 12-volt metal cased fuses. 49c's. Ammeter and variable charge rate selection. 59c's. Use with stowed blue glass fuses. 69c's. Ammeter and variable charge rate selection. 69c's. For use with small case, and ready for use with mains and output leads. Terms: Deposit $1.00 and 5/10 months payments $1.62 or 10 live at an outlet, $10.00, at an outlet, 122c. "Lift" of mains and output leads. Double Only Fused Car. 49c $9.

R.S.C. MAINS TRANSFORMERS (Guaranteed)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>SPECIFICATIONS</th>
<th>PRICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>FULLY SHROUDED</td>
<td>425-450v., 200mA, 6V, 4a, C.T. 6.3v.</td>
<td>59c</td>
</tr>
<tr>
<td>FULLY SHROUDED</td>
<td>450-450v., 500mA, 6V, 4a, C.T. 6.3v.</td>
<td>69c</td>
</tr>
<tr>
<td>FULLY SHROUDED</td>
<td>500-550v., 1A, 12V, 4a, C.T. 6.3v.</td>
<td>59c</td>
</tr>
<tr>
<td>MIDWATT BATTERY</td>
<td>550-600v., 4a, C.T. 6.3v.</td>
<td>69c</td>
</tr>
<tr>
<td>SMALL PENETRATION</td>
<td>50000 to 300</td>
<td>49c</td>
</tr>
<tr>
<td>SMALL PENETRATION</td>
<td>78000 to 300</td>
<td>49c</td>
</tr>
<tr>
<td>COMMON PENETRATION</td>
<td>7000 to 300</td>
<td>59c</td>
</tr>
<tr>
<td>10000 to 300</td>
<td>59c</td>
<td></td>
</tr>
<tr>
<td>PULL PULL 7.5 watts, EL34, or 6V6</td>
<td>1.99</td>
<td></td>
</tr>
<tr>
<td>PULL PULL 12 watts, 6L6, or 612</td>
<td>2.99</td>
<td></td>
</tr>
<tr>
<td>PULL PULL 18 watts, 6A8, or 614</td>
<td>2.99</td>
<td></td>
</tr>
<tr>
<td>PULL PULL 25 watts, Mullard 500 Ultra</td>
<td>2.99</td>
<td></td>
</tr>
<tr>
<td>PULL PULL 30 watts, Mullard 500 Ultra</td>
<td>2.99</td>
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</tbody>
</table>

MIDWATT MAINS (Primaries 200-250v.)

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>SPECIFICATIONS</th>
<th>PRICES</th>
</tr>
</thead>
<tbody>
<tr>
<td>50v. 60mA, 6A, 6v, 2a</td>
<td>$11.9</td>
<td></td>
</tr>
<tr>
<td>25v. 80mA, 6A, 6v, 2a</td>
<td>$12.11</td>
<td></td>
</tr>
</tbody>
</table>

Both above sizes $24.99 x 2 pieces.

HI-FI CRYSTAL PICK-UP HEADS

BRADICOM RECORDING HEADS
(150 Impedance, Playback 25/4. Low Impedance 19/6.

PI-PACK ARMS. Complete with latest Aco's/5.

MICROPHONES.
(4) Standard, low impedance.

GUITARS, PLAYING RECORDS; MUSICAL INSTRUMENTS including STRING GANS, GUITARS, etc.

AMPLIFIER. Valve line-up ECC83S, 6DJ8, 6L6GC, 6A8G, 6SN7, etc. Output for 250-watt speakers. Point-to-Point wiring diagrams and Instructions supplied. Send S.A.B. for illustrated leaflet detailing Ready-to-Cabinet Assemblies. Speakers, Microphones, etc., with cash and credit available.

COLARO JUNIOR 4-speed Single Foun-<ref>www.americanradiohistory.com</ref>
SENSATIONAL STEREO OFFER

A complete set of parts to construct a good quality stereo amplifier with an undistorted output of 50 v. at 2 ohms. Input of 200 - 500 v. including pair matched 6N. Full instructions for point to point wiring diagrams supplied. Stereo Pick-Up Head 1/8" extra with above only.

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

A highly sensitive Push-Pull high output unit with suit-combined pre-amplifier.

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ONLY 4 Gns. carr. 5/-

OU.TPUT SOCKET PROVIDES L.T. and building cost suitable Type TWEETERS. hi-

wiring diagrams.

Type X15 or 30 A.C. approx. 250 v.

R.S.C. MICROPHONE v.


R.S.C. 45-WATT HIGH-GAIN AMPLIFIER

A highly-sensitive 4-stage quality amplifier for the home, small club, etc. Output is required for full output so that it is suitable for use with the latest high fidelity equipment and all types of pick-ups and practically all "mikes". Separate Bass and Treble Control heads are provided. These give full long-playing record equalisation. Hum level is negligible being 30 db. down 15 db. of Negative feedback is used. H.T. or 300 V. 25 m. and L.T. or 6.3 v. A.C. is available for the supply of a Radio Feeder Unit or Transformer at attractive prices. (with hands punched) This advice is given for all pick-ups.
SENSATIONAL NEW 1962 DESIGNS — BY CONCORD
LOW PRICES ★ PICTORIAL STEP-BY-STEP PLANS ★ EASY AS A.B.C.

THE NEW “LISBON” TRANSISTOR SET
This is a pocket 2-stage transistor set not much larger than a matchbox.
Excellent short wave reception covering all medium waves, works off a toy 1 or 3 volt battery costing only 15p.
Easy to build and an excellent introduction to transistor circuitry. Everything can be supplied right down to the last nut and bolt (C.O.D. in extra).

SIMPLE PICTORIAL STEP-BY-STEP PLANS FOR ONLY 19/6, plus post and packing 1/-.
Parts and separately, priced lists 1/-. 

OUR NEW 4-STAGE “MINUETTE” 39/6
Build this newly-revised “MINUETTE” 4-Stage transistor set in your workshop. It’s ready drilled ULTRA-MODERN CASE only 6 x 8 x 3 in. U.S. uses three transistors and diode and SELF-CONTAINED LOUD SPEAKER. Very sensitive, ideal for office, bedroom, etc. Months and months sensitive, ideal for office. bedroom.

- BUILD THIS EASY TO THE LAST BOLT AND NUT, PRE-DESIGNED COMPLETE KIT, including miniature speaker—everything—ONLY 39/6, plus 2/6 P. & P. (C.O.D. 2/- extra).

PARCEL POSTAGE FREE JANUARY TO JUNE INCLUSIVE.

CONCORD ELECTRONICS Dept. 14/6 210, Church Road, Hove, Sussex

THE NEW “VOLKSRADIO” ONLY 19/6
TAKE-OVER BID MAKES THIS FANTASTIC OFFER POSSIBLE—and the beautifully compact "STAR VOLKSRADIO"

measuring 4½ x 3 x 1½ in, receiver perfectly—in the Bedroom, Office, Garden—over all medium waves (incl. Luxembourg). Under 3½ L.L. running cost. ANYONE can assemble it in one or two hours using our simple A.I.D. plan. Complete set of parts ONLY 19/6, plus 2/6 P. & P. (C.O.D. 3/- extra). Parts can be bought separately.

Money Back Guarantee.

THE NEW “SAN REMO” 5 STAR 29/6

This All Transistor Speaker Radio—The “San Remo” 5 Star covers all medium waves including “Home”, “Light” etc. It is capable of hearing and lightweight—-shot easily into the Pocket or Handbag—more so than any 4½ x 3 x 1½ in. Works for Months off 88! Battery: ideal for holidays, Country, Bedroom, etc. Anyone can assemble it in an hour or two with our simple A.I.D. PLAN. Complete set of parts including miniature speaker—everything—ONLY 29/6, plus 2/6 P. & P. (C.O.D. 3/- extra) Parts can be bought separately.

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HAS TO BE HEARD TO BE BELIEVED
We will supply ALL components at a
total cost of only

YOU CAN'T GO WRONG!
Free advice bureau, second-to-none

Transistors: OC76 4/6, OC71 5/-,
Japanese Audio 2/6, G.E.C. S1 Black
Audio 3/-, 52, Blue driver 3/-, SB305 9/-,
OC170 10/-, OC77 12/6, 2N398 10/-,
SB240 7/6, OC42 3/6, XA701 6/-, GET 103
6/-, OA10 6/-, OA2 203 7/6, OA5 diode
5/-, OA2 202 7/6, Latest miniature diode
OA90 2/11, XCI41 power output as
OC16, only 10/-, XA116 4/-, general
purpose diodes 1/-, P.P. 4d. on each
transistor. All these are new.

OC28 19/6, OC35 19/6, OC77 19/6,
OC200 12/6, P.P. 6d, OC72 5/-, P.P. 3d.
OC44 5/6, OA47 V.H.F. or hi-speed
switching diode 3/6, QA86 4/-, 2N456
19/6, OC28 and OC29 19/6, C12E
transistors 4/-, SB345 6/6, SB346 7/6.

12-way Tag Board, with resistors and
condensers as follows, all 2m, watt
transistor type: two 10 meg., two 0.01,
one 3,9 M, 5.6 M, 3.3 M, 1.2 M, 2.2 M,
470 0, 470K. All for 2/-, P.P. 3d.

4 Transistor Amplifier, printed circuit
with circuit 2/-, P.P. 3d. Fars available,
but not plans.

Car Aerials. Adjustable angle tele-
scopic. 12in. closed, 36in. extended with
Co-ax plug. 17/6. Post paid.

Window Fixing, type for portable, 17/6,
post paid.

Miniature Mains Soldering Irons. Designed
for transistor kit work. 30 watt,
special light weight, handle
unscrews to cover bit so that iron
can be carried even when hot,
supplied with handsome pocket case in
grey leather cloth P.V.C. Spares always
available—ONLY 17/6. Post paid.

WANTED

Valves, transistors, miniature compo-
nents, all types of radio equipment,
any quantity, but must be new, cash
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Audio 3/-, 52, Blue driver 3/-, SB305 9/-,
OC170 10/-, OC77 12/6, 2N398 10/-,
SB240 7/6, OC42 3/6, XA701 6/-, GET 103
6/-, OA10 6/-, OA2 203 7/6, OA5 diode
5/-, OA2 202 7/6, Latest miniature diode
OA90 2/11, XCI41 power output as
OC16, only 10/-, XA116 4/-, general
purpose diodes 1/-, P.P. 4d. on each
transistor. All these are new.

OC28 19/6, OC35 19/6, OC77 19/6,
OC200 12/6, P.P. 6d, OC72 5/-, P.P. 3d.
OC44 5/6, OA47 V.H.F. or hi-speed
switching diode 3/6, QA86 4/-, 2N456
19/6, OC28 and OC29 19/6, C12E
transistors 4/-, SB345 6/6, SB346 7/6.

12-way Tag Board, with resistors and
condensers as follows, all 2m, watt
transistor type: two 10 meg., two 0.01,
one 3,9 M, 5.6 M, 3.3 M, 1.2 M, 2.2 M,
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4 Transistor Amplifier, printed circuit
with circuit 2/-, P.P. 3d. Fars available,
but not plans.

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Co-ax plug. 17/6. Post paid.

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Speakers, 35 ohm. 7 x 4 in.
extra or 3 1/2 in. round 1/6 extra.

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ARDELTE Transistor Transmitter Type C3000, 7½", Push Pull to 3 cans for 250 cc., etc., 1 x 1 in.
Type D304, 1 7/8 : ICT, Push Pull Driver for 250 cc., etc., 1 x 1 in.
Type D503, 11/8: 1 Output to 3 cans for 250 cc., etc., 1 x 1 in.
Type D507, 1 7/8: 1 Output to 3 cans for 250 cc., etc., 1 x 1 in.
Type D508, 1 7/8: 1 Driver Transmitter. Type D505, 1 7/8: 1 Driver Transmitter, Type D503, 1 7/8: 1 ARDELTE Transistor Controls Type VN465, 5W with switch, dial, 6 in., 8 in., 5W Condenser, Black Transistor, 5, 5W.

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Long and Medium Wave Aerial—RAZUW. On 8 in. rod. 7/10in. diameter. 2000ft.
Sterling Coaxial. Car Aerial Coils: Oscillator Coils 9/0, 7/0. Medium wave coil. For 1800v tuning. 9/0 and 7/0 Transistors—P6060, 480 K.P., 15/3 in. dia. By 6H. 8 in. 3K, 3K and 1F, Transistors—P6050, 15/3 in. dia. for fixed diode detectors. 8 in. 3K, 3K, 6 in. Speaker Cores. Driver Transformer—LP70, 4d, each. 1 x 1 in. Waves. Wave Switch. Printed Circuit—PCA1, Size 8 x 8 in. Ready drilled and printed with component positions. 6 in. Volume Control. 7 x 3 1/2 in. 30 ohm speaker. 30 in. Round 35 ohm speaker. 10 in. Fixed Resistors. 40 x 4 in. 15 Fixed Condensers. 38 x 4 in. Fixed Capacitors. 38 x 4 in. Fixed Transformers. 46 x 4 in. 15 Fixed Resistors. 46 x 4 in. 15 Fixed Condensers. 46 x 4 in. 15 Fixed Transformers. 46 x 4 in. 15 Fixed Resistors. 46 x 4 in. 15 Fixed Condensers. 46 x 4 in. 15 Fixed Transformers.

Printed Circuit Battery Portable Kit
Medium and long wave. Powerful 7 x 6 in. High Fuzz Speaker. T.C.C. Printed Circuit and condensers. Components of finest quality Location with assembly instructions. Printed Ferrite Aerial Coils. Bezel covered attachment case chassis. Size 12m. 16 x 6 x 3 in. 1/2 in. Medium and long wave transformers used 12 in., 8 x 3 in., a.m. transformers used 12 in., 8 x 3 in., a.m. transformer used 12 in., 8 x 3 in., a.m. transformer used 12 in., 8 x 3 in., a.m. transformer used 12 in., 8 x 3 in., a.m. transformer used 12 in., 8 x 3 in., a.m. transformer used 12 in., 8 x 3 in., a.m. transformer used 12 in., 8 x 3 in., a.m. transformer used 12 in., 8 x 3 in., a.m. transformer used 12 in., 8 x 3 in., a.m. transformer used 12 in., 8 x 3 in., No Instructions, 9 (free with kit)
AMATEUR TRANSMITTER. Model DX-40U. Self-contained. 80-10 m. Power input 75 w. C.W., 60 w. peak. C.C. phone. Output 40 w. to aerial. Provision for V.F.O. £32.10.0

AMATEUR TRANSMITTER. Model DX-100U Covers all amateur bands, 160-10 m. 150 w. D.C. input. Self contained with power supply. Modulator, V.F.O. £71.10.0

Audio Signal Generator. Model AG-9U. 10 clr-100 kcs, switch selected. Distortion less than 0.1%. 10 v. sine wave output metered in volts and db's. £19.19.6

Valve Voltmeter. Model V-7A. Measures volts to 1,500 (D.C. and R.P.S.) and 4,000 pk to pk. Res. 0.1G-1,000 MΩ. D.C. input impeded. 11 MΩ. With test prods, leads and standardising battery. £13.0.0

R.F. Signal Generator. Model RF-1U. Gives accurate source of R.F. up to 100 Mc's on headmasts and 200 Mc's on harmonics. Up to 100 mv output on all bands. £11.18.0

Single Sideband Adaptor, Model SB-10U. May be used with most A.M. transmitters. Less than 3W R.F. input power required for 10W output. Operation on 80, 40, 20, 15 and 10m bands on USB, LSB or DSB £37.6.0


Hi-Fi A.M./F.M. TUNER. Tuning range: FM: 88-108 Mc/s. AM: 15-500, 200-550, 900-2,000 m. Tuning heart £6.5.6 incl. P.T.) and I.F. amplifier £19.8.0 sold separately. Printed circuit board. £14.3.0

Shortwave Transistor Portable. Model RSW-I. Two short bands, trawler and medium £11.6.0

6-W Transistor Portable. Model UX-1. Prefagalined I.F. transformers, printed circuit, 7 x 4 in. high flux speaker. Ideal hide case. £16.0.0

Tape Recording/Playback Amplifier Stereo (TA-5S). £23.6.0 Monaural (TA-M). £18.2.6

Stereo Control Unit USCI-I. Luxury model with press-button inputs to suit a y pick-up or tuner and most tapeheads. Output 1.3 v. R.M.S. channel. Printed circuit construction. £18.18.6

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Money Saving "PACKAGED DEALS" of Complete Stereo Equipment from £44.9.0


"COTSWOLD" Hi-Fi Speaker System. Acoustically designed enclosure "in the white" 26 x 23 x 15in. 12in. bass speaker with 2in. speech coil, elliptical middle speaker. Pressure unit covers the full i.rq. range of 30-20,000 c/s, complete with cross over unit, level control, etc. £21.19.0

Audio & Do-It-Yourself accessories also available.

Assembled models also available—prices on request. Deferred terms available over £10. Free delivery U.K.

Prices will be approximately 5% greater after 20th August.
The possibilities of introducing commercial sound broadcasting in this country have long been evident but until the Pilkington Committee reported, no decision could be given. The Committee reported in June and recommended that a service of local sound broadcasting should be introduced by the BBC and that commercial sound broadcasting (broadcasting financed from advertisement revenue) should not be introduced. The reasons for the Committee's decision were similar to those given for their recommendation that there should be a radical overhaul of the commercial television broadcasting services. They were that, when programmes are financed from revenue derived from the sale of advertisement time, then the planners of the programmes always, consciously or unconsciously, arrange the programmes to attract as much advertisement revenue as possible. The programmes, the Committee stated, must necessarily decline in standards and it therefore considered that local sound broadcasting should be provided by the BBC and financed from licence revenue. It had been argued that a commercial network would be able to provide the public with "what it wanted" rather than "what set of programme controllers thought it wanted". However, the Committee pointed out the fallacies in this argument; public taste would gradually be debased—unless the opportunity is available to listen to or view programmes of a high standard, such programmes can never be appreciated or enjoyed by the majority of the general public. The aim should be to improve public taste gradually yet provide programmes which are of high entertainment value.

In the White Paper published by the Government after the Pilkington report, it was stated that there has been little evidence of any general public demand for local sound broadcasting, and the Government would study public reaction before making a decision.

We are inclined to think that the lack of demand for a system of local sound broadcasting is due to the lack of public knowledge of the subject; no doubt demand will increase when the public realises the potentialities of such a service. We should be interested in hear readers' views.

MORE BLUEPRINTS

With the next issue, dated October, we are beginning another series of free double-sided blueprints. On one side of the blueprint in next month's issue, will be the first of a series of designs for a comprehensive hi-fi system. This part will consist of the main amplifier and power supply sections of the chain. The main amplifier will have a maximum output in excess of 20W with very low distortion.

On the other side of the October blueprint will be a design for a simple signal generator covering 150 kc/s to 30 Mc/s, modulated or unmodulated. Provision will also be included for use of the internal audio oscillator for test purposes. Although the signal generator uses a simple circuit, is inexpensive, and is easy to build with the large clear diagrams included on the blueprint, all amateur constructors will find it a valuable addition to their range of test equipment.

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The Editor will be pleased to consider articles of a practical nature. Such articles should be written on one side of the paper only, and should contain the name and address of the sender. Whilst the Editor does not hold himself responsible for manuscripts every effort will be made to return them if a stamped and addressed envelope is enclosed. All correspondence intended for the Editor should be addressed to The Editor, PRACTICAL WIRELESS, George Newnes, Ltd., Tower House, Southampton Street, London, W.C.2.

COPYRIGHT to the whole in the United Kingdom and the Republic of Ireland in the designs of wireless apparatus and to our efforts to keep readers in touch with the latest developments, we give no warranty that apparatus described in our columns is not the subject of letters patent.

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The following statement shows the approximate number of Broadcast Receiving Licences in force at the end of May, 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.

<table>
<thead>
<tr>
<th>Region</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>London</td>
<td>642,217</td>
</tr>
<tr>
<td>Home Counties</td>
<td>593,774</td>
</tr>
<tr>
<td>Midland</td>
<td>426,009</td>
</tr>
<tr>
<td>North Eastern</td>
<td>457,538</td>
</tr>
<tr>
<td>North Western</td>
<td>366,750</td>
</tr>
<tr>
<td>South Western</td>
<td>300,081</td>
</tr>
<tr>
<td>Wales and Border Counties</td>
<td>202,893</td>
</tr>
<tr>
<td>Total England and Wales</td>
<td>3,071,375</td>
</tr>
<tr>
<td>Scotland</td>
<td>424,798</td>
</tr>
<tr>
<td>Northern Ireland</td>
<td>107,557</td>
</tr>
<tr>
<td>Grand Total</td>
<td>3,508,208</td>
</tr>
</tbody>
</table>

Sound at Wimbledon

For over 30 years the sound amplification and distribution for the Wimbledon Lawn Tennis Championships has been the responsibility of the Public Address Department of Standard Telephones and Cables Limited.

STC equipment feeds all sound, except commentaries, from the Centre Courts Nos. 1, 2 and 3 to the BBC and into the Wimbledon distribution system. It feeds a ring of monitoring loudspeakers from which the electric scoreboards are operated; it provides facilities for car-park calling, turnstile control, emergency police control, and an over-riding call system under the control of Col. A. D. C. Macaulay, the secretary of the All England Lawn Tennis Club.

An elaborate telephone system is also installed by STC to link each umpire with the chief umpire and the referee’s room, and also to link the pay boxes and turnstiles.

Fuel cell battery power for GEMINI two-man Spacecraft

The fuel cell, one of the most promising new ways of making electricity, will be put to operational use for the first time in the next phase of the United States’ manned spaceflight programme.

Under contract to McDonnell Aircraft Corporation, U.S. General Electric will develop a fuel cell battery, the most advanced of its type yet produced, to supply primary power for the two-man Gemini spacecraft.

In the Gemini vehicle, fuel cells will for the first time take the place of conventional batteries or mechanical power units as the primary electrical power source in space.

Two STC engineers of the Public Address (Hire) Department, making final adjustments to the amplifier equipment before the start of play at the Wimbledon Lawn Tennis Championships.
The fuel cell system was chosen for Gemini because its weight will be significantly less than that of a combination of conventional batteries and solar cells which could also be used in space flight.

The Gemini fuel cell battery will deliver a peak load of almost two kilowatts of D.C., providing primary power for all equipment aboard the spacecraft, including control, artificial environment, communication and instrumentation apparatus.

In addition to its electrical output, it will have a by-product in the form of pure, potable water, accumulating at the rate of one pint per kilowatt-hour of operation. This water can be used, without treatment, to augment the supply stored aboard the spacecraft for drinking, cooling or other life-supporting purposes.

The system is based on General Electric's ion-exchange membrane fuel cell, which produced electricity through the chemical reaction of oxygen and hydrogen. A fuel cell battery is composed of many of the sandwich-like cells connected in series to form building blocks that can in turn be connected in series or parallel to meet specific power requirements. Each cell is separated into two sections by the membrane, a sheet of tough plastic.

In operation, hydrogen gas is fed to one side of the membrane and oxygen to the other. Electrons from the hydrogen atoms are picked up by a thin metallic electrode in contact with the membrane surface, while the remaining hydrogen ions pass through the membrane. The electrons flow into an electrical circuit, providing power, and then return to the other side of the membrane, where they recombine with the ions and join with the oxygen atoms in the formation of water.

Radio for Mobil Tanker

THE "Mobil Endurance", a tanker built for the Mobil Shipping Co. Ltd., has been fitted with radio equipment by Associated Electrical Industries Ltd. The "Mobil Endurance", which has now completed her acceptance trials, is the third of five vessels to be built for Mobil at Gothenburg. All five ships will finally be fitted with AEI marine apparatus. The radio installation, on the "Mobil Endurance" will include a 600W W.T./R.T. transmitter, a 28 channel international channel transceiver and an AEI "Escort 601" Chartplan radar.

Satellite Communication System

Almost all of the equipment at the British Post Office Satellite Communication Ground Station at Goonhilly Downs, Cornwall, planned for the initial experimental projects Relay and Telstar, is of British design and manufacture.

The predominating feature of the facilities which have been provided is an 85ft diameter steerable aerial. The aerial is in the form of a paraboloidal dish with full automatic steerability over the hemisphere above the horizontal plane on the basis of predicted orbital data, and manual control for resetting purposes.

The steering of the aerial in azimuth and elevation is by means of closed-loop servo type motors. The angular positions of the azimuth and elevation shafts are indicated by digital shaft-angle encoders.

Not the least important of the equipment at Goonhilly, the design authorities for which are the Space Communications Branch and the Research Branch of the Post Office Engineering Department, is the variety of cables which form the vital interconnections between the aerial and the control building, as well as those on the equipment on the aerial itself. The former cable runs in troughs above ground level.

British Insulated Callender's Cables Limited have supplied no less than 20 miles of cable, comprising all of the coaxial cable (31,000yd) which runs from the azimuth and elevation position encoders back to the control building—a distance of about a quarter of a mile—and some 5000yd of the multicore PVC SWA PVC sheathed 250/440 and 660/1100V control cabling between the aerial and the control building.

The Mullard research laboratories at Salfords, Surrey, was visited recently by representatives of the Press. At these up-to-date laboratories, much experimental work is carried out on colour television, transistors, computers, and many other aspects of the electronics industry.
MEDIUM WAVE POCKET SUPERHET

by J. G. THOMPSON

AN ECONOMICAL PORTABLE RECEIVER

The circuit of this receiver is shown in Fig. 1, and has the advantage that the battery drain is quite small. The full superhet circuit provides very good sensitivity, and the single-ended push-pull output stage is particularly economical. Current consumption, at low volume, is only about 8mA. At average listening volume, this rises to about 12mA to 14mA or so. The usual small type of 9V battery thus has a long working life.

Coverage

The receiver tunes medium waves only, as this simplifies the first stage, but it is possible to add long waves later, without disturbing other parts of the set.

If possible, it is recommended that an OC44 is used for Tr1, with OC45's for Tr2 and Tr3, and an OC71 for Tr4. However, other transistors of similar type were found to work satisfactorily in these stages. For the output stage, a maker's matched pair of OC72 transistors (2 x OC72) should be fitted. Resistors R18, R19, R20 and R21 should also be of 5% tolerance, while all others can be of 10% tolerance. Correct working conditions will then be assured, without any need to experiment, or change resistor values.

Paxolin Panel

This should be made first, all important drilling being finished before mounting any parts. The panel is 5½in. x 3in. x ¼in. thick, this giving a little clearance all round in the specified cabinet. Drill three holes so that the panel can be secured in the case by short 6BA bolts. (A piece of thin card can be used as a template, piercing holes in it in the correct positions.)

Fig. 1—The circuit diagram.
The gang condenser fits in a fairly large clearance hole. Check that there is space for the battery, with at least 1/8in. to spare; then, drill holes for the three short 4B.A. bolts shown in Fig. 3. The pierced card will show exactly where to drill. If the screws project more than the thickness of the condenser plate, washers are needed under their heads.

Volume Control
Mount the volume control as in Fig. 2. One switch tag projects up through a hole, and the other tags are bent flat. Check that the set will fit in the case, and that the battery can be accommodated. The volume control slot in the case will need widening slightly, with a small file. It may also be necessary to enlarge the tuning condenser hole.

These parts are then removed, and the holes are drilled for the four screened coils. If the pins are pressed on the thin card template, this will show where to drill. Check that each coil fits easily, then place it on one side. If any holes are not quite correct they can be enlarged with a small round file.

Loudspeaker Mounting
The loudspeaker hole is about 1/16in. larger all round than the loudspeaker magnet. It can be made with a washer cutter, a fretsaw or other very small saw, or by drilling holes, and clearing up with a half-round file. Temporarily position the loudspeaker, mark the two speaker fixing holes (Fig. 3) and drill them.

After drilling holes for the driver transformer, correctly in the case, with battery. Note that the case tapers slightly towards the back; there should be a little clearance all round.

The loudspeaker is now removed until the set is wired. When finally mounted, it is held by two 6B.A. countersunk bolts, inserted from the front. The bolt near the rod mount has two nuts, one locking the loudspeaker, and the other giving

![Diagram](image)

**Fig. 2—The layout and wiring diagram of the rear of the receiver panel.**

The loudspeaker hole of one panel, with the wiring complete.

transistor lead holes can be positioned as in Figs. 2 and 3. A short 4B.A. bolt holds the rod mounting.

Clean up all holes, and mount the rod, gang condenser, speaker, driver transformer and screened coils, and check that the whole can fit readily in the case, with battery. Note that the case tapers slightly towards the back; there should be a little clearance all round.

The loudspeaker is now removed until the set is wired. When finally mounted, it is held by two 6B.A. countersunk bolts, inserted from the front. The bolt near the rod mount has two nuts, one locking the loudspeaker, and the other giving

The following diagram shows where to mount the rest of the components:

![Diagram](image)

**Fig. 2—The layout and wiring diagram of the rear of the receiver panel.**

The loudspeaker hole of one panel, with the wiring complete.

transistor lead holes can be positioned as in Figs. 2 and 3. A short 4B.A. bolt holds the rod mounting.

Clean up all holes, and mount the rod, gang condenser, speaker, driver transformer and screened coils, and check that the whole can fit

tops of the transistors Tr1 to Tr4 come about level with the tops of the screened coils; Tr5 and Tr6 are bent over as in Fig. 2. Be sure that the transistors are in their correct stages, and that the collector base and emitter leads all emerge as

Construction
All wiring is of 26s.w.g. tinned copper wire, insulated with 1mm sleeving. It will be helpful to use red sleeving throughout the positive side of the circuit, and black sleeving throughout the negative line, with yellow or some other colour for all other leads. Sleeving is also placed over all transistor leads, and the wire ends of all resistors and condensers. Sleeving on the transistor leads can be of such a length that the
shown by the letters c, b and e in Fig. 3.

The various points marked MC form the earth, or positive, side of the circuit, and are all joined. These include the can tags of the oscillator coil and I.F. transformers, and the metal frame of the gang condenser.

Control Wiring

Fig. 4 shows the tag side of the volume control.

Another view of the completed set, less its case.

In Figs. 1, 3 and 4, A is one end of the element, B the slider, and C is the other end of the element and one switch tag. The remaining switch tag passes through the hole in the panel (see Fig. 2). A short piece of thin red flex is soldered on here and fitted with a positive battery clip.

The trimmer TC1 has one tag inserted in a hole, so that it can be soldered to the tag held by the 4B.A. bolt, in Fig. 3. Trimmer TC2 is soldered directly to the 176pF tag of the gang condenser (VC2), a short lead returning to the condenser frame.

All leads and components are kept close against the panel. Leads and resistors should also be clear of the position which the speaker will occupy. Electrolytic condensers are wired with the polarity shown in Fig. 3. Other condensers, and all resistors, may be wired in either way round. The negative end of the diode must go to pin 1 of the third I.F. transformer.

C13 and R16 are wired in parallel. The wire end of R16 passes through a hole, to the MC tag in Fig. 3. The negative lead of C13 goes to the same hole as the emitter of Tr4, to which it is joined.

The negative end of C15 passes into the same hole as the collector of the one OC72, as in Fig. 2, these leads being joined, and also going to R19, R20 and R22 (Fig. 3).

It is best to leave all the transistor leads reasonably long, but prolonged heating with the soldering iron should be avoided.

The larger fixed condensers are mounted behind the panel, as in Fig. 2; C5, C7, C9 and C11 each have a lead passing directly down through the panel, and all are soldered to the MC or earth line. The top wires of these condensers

<table>
<thead>
<tr>
<th>COMPONENTS LIST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistors: (10% unless otherwise indicated):</td>
</tr>
<tr>
<td>R1  56k</td>
</tr>
<tr>
<td>R2  10k</td>
</tr>
<tr>
<td>R3  3.9k</td>
</tr>
<tr>
<td>R4  68k</td>
</tr>
<tr>
<td>R5  8.2k</td>
</tr>
<tr>
<td>R6  680Ω</td>
</tr>
<tr>
<td>R7  1.2k</td>
</tr>
<tr>
<td>R8  22k</td>
</tr>
<tr>
<td>VR1 5k miniature vol. control with switch</td>
</tr>
<tr>
<td>C1  0.04µF</td>
</tr>
<tr>
<td>C2  0.01µF</td>
</tr>
<tr>
<td>C3  250pF</td>
</tr>
<tr>
<td>C4  8µF</td>
</tr>
<tr>
<td>C5  0.25µF</td>
</tr>
<tr>
<td>VR1 5k miniature vol. control with switch</td>
</tr>
<tr>
<td>Transistors:</td>
</tr>
<tr>
<td>TC1 30pF trimmer</td>
</tr>
<tr>
<td>TC2 30pF trimmer</td>
</tr>
<tr>
<td>VC1/VC2 208/176pF gang with screen</td>
</tr>
<tr>
<td>Transistors:</td>
</tr>
<tr>
<td>OC44</td>
</tr>
<tr>
<td>OC45</td>
</tr>
<tr>
<td>OC45</td>
</tr>
<tr>
<td>Tr5 and Tr6 matched pair OC72’s</td>
</tr>
<tr>
<td>Diode: OA81</td>
</tr>
<tr>
<td>Other Parts:</td>
</tr>
<tr>
<td>Split secondary driver transformer</td>
</tr>
<tr>
<td>(Fortiphone L412)</td>
</tr>
<tr>
<td>M.W. Ferrite rod, oscillator coil, 1st, 2nd</td>
</tr>
<tr>
<td>and 3rd IFT’s (Osmor)</td>
</tr>
<tr>
<td>75Ω loudspeaker, 3/8 in. with plastic chassis (W.B.)</td>
</tr>
<tr>
<td>3/4 x 6 1/2 x 1 1/2 in. Pocket Superhet case</td>
</tr>
<tr>
<td>Paxolin, wire, sleeving, etc.</td>
</tr>
</tbody>
</table>
are bent over, and pass down through other small holes, as in Fig. 2, so that they can be connected as in Fig. 3.

C14 and C15 must have insulated sleeves, or be covered with insulated material. They are secured side by side with tape, and rest on the speaker magnet. C14 goes from the positive line to the negative line. C15 is wired from collector to loudspeaker, as in Fig. 2.

In Fig. 1, short pieces of thin coloured flex are soldered to the aerial winding tags, for identification. Both “earth” ends of the windings are joined, for the orange lead. These leads are then connected up as in Fig. 2. That is, orange to condenser frame, red to Ti and VC1, and black to C1, Fig. 3.

After checking the wiring, solder lengths of thin flex to the 75Ω loudspeaker. One lead goes to MC in Fig. 3, and the other passes back to the positive end of C15. Fix the loudspeaker as described, making sure that its tags do not bear upon leads or parts already fitted. The loudspeaker itself is of insulated material. The spacing between loudspeaker and panel should be so adjusted that the loudspeaker rests on the front of the inside of the cabinet. A pad of material, such as thin soft card, is cut to fit inside the speaker opening, and an aperture is cut to match the speaker cone. This avoids buzzing noises due to vibration between case and speaker frame.

Check that the receiver will fit readily in the case. The unwanted tags of the gang condenser are bent down, to leave more space for the battery. A piece of cardboard, bent as in Fig. 2 isolates the battery from other parts, and prevents contact between the battery and second L.F. transformer.

Testing and Adjusting

If possible, a meter should be included in one battery lead. This should read about 7mA when the set is switched on. If the meter shows a high current, switch off at once, disconnect the battery, and check the wiring for shorts or errors.

A strip of paxolin or similar material should now be filed so that it will engage with the coil and transformer cores, to be used as an adjusting tool.

If a signal generator is available, set it for 470kc/s, with modulation, and connect its output to the black lead in Fig. 2, including an isolating condenser in circuit. Put the receiver volume control at maximum, reducing the generator signal, if volume is too great. The three transformer cores are then adjusted for best results, which will also be the highest reading on the meter included in the battery circuit. All cores should have quite a sharp tuning peak.

Alignment on Stations

If no generator is available, tune in the local station, adding an external aerial a few feet long, if required. Then adjust the three transformer cores for best volume. They should be in a reasonable position, not screwed right in, or very far out.

Aerial and oscillator stage tuning can then be adjusted. TC1 and TC2 must be capable of reaching a low capacity. To begin, unscrew both trimmers, carefully separating the plates, if necessary. If a signal generator is available, adjust it to 350m, close the gang condenser, and rotate the oscillator coil core for best results. Then move the aerial winding on the rod, to obtain maximum volume. The generator is then set to 205m, the gang condenser is opened, and TC1 and TC2 are adjusted for best results.

If coverage is restricted on the low wavelength end of the band, this probably indicates that TC1 and TC2 need opening to a lower capacity. Repeat the trimming and inductance adjustments described a number of times, always adjusting the trimmers at a low wavelength, and the aerial and oscillator coil inductances at a high wavelength. Keep the receiver volume control at maximum, but choose (Continued on page 417)
INCREASING VOLTMETER RANGES

By G. A. W. Partridge

There are several types of high reading voltmeters on the market—the multimeter which caters for current and resistance measurement usually reads up to 1000V. But not all instruments have such high ranges. There are, however, quite simple ways of increasing the range of a voltmeter either permanently or temporarily.

The most well-known method is to use a resistance type of multiplier connected as shown in Fig. 1. In this case a 0-500V instrument is able to read from 0-1000V; by connecting a suitable multiplier known as a multiplier in series with it.

**Multipliers**

The following example will show how a multiplier is chosen. The voltmeter reads from say, 0 to 100V and it is desired to increase its range to 1000V. The sensitivity of the voltmeter is 10,000Ω/V.

The total resistance of the meter and the multiplier must be 1,000V × 10,000Ω/V which is 10,000,000Ω. Now the resistance of the meter alone is 100V × 10,000Ω/V which is 1,000,000Ω.

10,000,000 - 1,000,000 = 9,000,000Ω; the required resistance of the multiplier.

**Alternative Calculation**

Another way of calculating this resistance is first to find the current taken by the meter on its own, at full scale deflection, which is 100V.

\[
I = \frac{100}{1,000,000} = 100 \text{mA}
\]

The full scale deflection with the multiplier in circuit will be multiplied by 1000. The voltage across the multiplier will be 1000 - 100 = 900V. Its resistance will be:

\[
R = \frac{E}{I}; \quad \frac{900}{100} = \frac{1}{10,000}
\]

This case the instrument reading will have to be multiplied by 10 to give the correct voltage. The wattage of the multiplier is also important. It will be given by I.E, which is 1/10,000 × 900 = 0.09W. A 0.25W resistor will be ample here as it will not overheat.

Fig. 3—Converting a milliammeter for use as a voltmeter.

If alternating current is to be measured, the calculations must be based on the internal impedance, or ohms-per-volt rating of the instrument as an A.C. meter, not as a D.C. instrument. The multiplier must be non-inductive.

There are special types of instrument resistors on the market which are designed to remain at constant values for many years.

**Transformer Multiplier**

For temporary and less accurate A.C. work, a transformer can be used as a multiplier (Fig. 2). In this case it has a ratio of 220/110V. The voltmeter reads from 0 to 100 and the transformer doubles this scale. The ratio error has been overlooked, but a reliable transformer should be chosen in order to prevent erroneous readings.

A 0-1 milliammeter can also be used as a voltmeter provided a suitable multiplier is connected in series with it. Fig. 3 shows an instrument of this type arranged to measure up to 500V. The internal resistance of the meter is 50Ω. Therefore the voltage required for full scale deflection is:

\[
E = 1R; \quad = 1/1,000 \times 50; \quad 0.05V.
\]

(Continued on page 400)

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High-fidelity Main Amplifier

By J. Haskell

The increasing number of hi-fi enthusiasts who wish to start a hi-fi system from scratch will welcome this article about a hi-fi amplifier capable of providing up to 10W of good quality reproduction with negligible distortion, and good frequency response.

Circuit

The main amplifier is usually built separately and can be stored away from the control unit if desired. An obvious choice for the output section in an amplifier of good quality is a push-pull one. The output stage consists of two EL84's in push-pull, under normal or low-loading conditions as required. Distributed loading was considered but due to the lack of peak power handling this arrangement was discarded.

The normal loading condition for the output valves results in a distortion figure of about 0.3% at 10W over a power response of better than 30-15,000c/s within one decibel. This response is more than adequate for even the most critical of listeners, and only very expensive speaker systems can reproduce below 30c/s at the rated output. The frequency response is 10c/s to 20kc/s ± 1dB or better.

Low-loading

Under this loading, the distortion content at 10W is approximately 0.1% over the specified range, and is therefore more suitable for music and speech reproduction in the home than normal loading. The anode to anode load for EL84's, in normal and low-loading conditions is 8,000Ω and 6,000Ω respectively. The usual "grid stopper" resistors are included in the circuit to prevent any parasitic oscillations from taking place.

The Phase Inverter

The phase inverter circuit is designed around a high-gain double-triode valve type ECC83, the first section of which acts as a driver and the second section as the phase inverter proper. This type of circuit gives good reproduction and is quite popular, the only disadvantage being that the overall gain is slightly more than unity (1.8). Since the cathode resistors of the phase inverter are not by-passed, there is heavy negative feedback, giving good transient response and also...
helping towards the balance of the output stage.

The output transformer was a Partridge type P3667, which has an 8k primary winding tapped at 6k. The constructor may therefore try both loadings out on the output stage, bearing in mind that resistors R13 and R14 will have to be changed as well (220Ω for normal loading and (390Ω) for low-loading conditions).

Increased Feedback

The degree of negative feedback is about 20dB, and increasing it to 30dB resulted in no instability, giving a good feedback stability margin.

An interesting feature about the driver-section is the resistor R6 and condenser C2 in series from the anode of V1A to earth. This is to prevent parasitic oscillations (rarely present in triode valves) and to provide a time constant giving good stability in the lower registers of the frequency range.

Close tolerance resistors should be used for the anode and cathode loads of the phase inverter, as well as in the grid resistors and stoppers of the output valves. The two coupling condensers, C4, C5 should have no leakage since any D.C. on the output valve grids will result in distortion.

The Power Supply

(Fig. 1). Valve V5, used in the prototype, was a 5Y3, though an EZ81 may also be used. In this case, the rectifier winding will be 6/3V, at 1A. If additional current is not required for a radio tuner, 10mA for a pre-amplifier is available. An EZ80 may be used instead of the EZ81, and

![Fig. 2—The circuit of the power supply.](image)

a common heater winding can then be used for all the valves. It should be noted that on no account should more than 90mA be drawn from an EZ80. Two resistors must be included in the anode circuit of the rectifier; the values for the EZ81 are 190Ω per anode, and for the EZ80 216Ω per anode. Under normal loading conditions the amplifier requires about 80mA of H.T. current, and 60mA under low-loading.

Since a smoothing choke was not used, a large smoothing condenser was required to supply the extra voltage on peak drives of the output stage.

COMPONENTS LIST

<table>
<thead>
<tr>
<th>Resistors (all ½W unless otherwise stated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1  22k</td>
</tr>
<tr>
<td>R2  220k</td>
</tr>
<tr>
<td>R3  100k</td>
</tr>
<tr>
<td>R7  220k (may be increased to 1M for H.F. stability)</td>
</tr>
<tr>
<td>R8  47k ±2%</td>
</tr>
<tr>
<td>R9  2-7k</td>
</tr>
<tr>
<td>R10 47k ±2%</td>
</tr>
<tr>
<td>R13  8k</td>
</tr>
<tr>
<td>R15 220k</td>
</tr>
<tr>
<td>R16 220k</td>
</tr>
<tr>
<td>R17 47Ω</td>
</tr>
<tr>
<td>VR1 100 w.w. potentiometer</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C9 50µF 450V elec.</td>
</tr>
<tr>
<td>C2 680pF</td>
</tr>
<tr>
<td>C3 0.05µF 600V/20 for low leakage types</td>
</tr>
<tr>
<td>C4 0.05µF 600V</td>
</tr>
<tr>
<td>C5 0.05µF</td>
</tr>
<tr>
<td>C6 50µF elec.</td>
</tr>
<tr>
<td>C7 50µF elec.</td>
</tr>
<tr>
<td>C8 220pF ±2% (for 3-75Ω speaker)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Valves:</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1 ECC83</td>
</tr>
<tr>
<td>V2 EL84</td>
</tr>
<tr>
<td>V3 EL84</td>
</tr>
<tr>
<td>V4 5Y3</td>
</tr>
</tbody>
</table>

Mains transformer

Primary: 200-220-240V
Secondaries: 300-0-300V, 60 or 80mA (see text)
3-15-0-3-15V, 2A
Winding to suit heater of V5

Output transformer: Partridge P3667

Chassis:
12in. x 9in. x 2½in. approximately.
Pilot lamp, wire, solder, bolts, sockets, etc.

The possible change in line voltage is only 0.5%. Adequate decoupling of the stage is also assured.

Feedback

The values of R5 and R20 govern the degree of voltage fed back, and the values used in the prototype were 560Ω and 180Ω respectively, giving about 20dB of feedback. Constructors who wish to increase the feedback may do so by decreasing the value of R20 slightly. Resistors R8 and R10 should be good quality components of ±2% tolerance. Lack of balance here or in the output stage itself will result in unnecessarily high second harmonic distortion, owing to incomplete cancelation of the distorted anti-phase wave forms. A condenser in parallel with the feedback loop resistor promotes a phase shift opposite to that of the output transformer at the high frequency resonance of this component, and thus prevents the feedback from becoming positive at this frequency. If the output transformer is different from the one specified, it may be necessary slightly to modify the value of this component. The optimum value is best found by trial and error. Best results
will be obtained if this amplifier is used in conjunction with the pre-amplifier designed by the author (June issue, 1961), as this was used with the prototype. The basic sensitivity is about 600mV and any high quality pre-amp capable of this output may be used.

**Assembly**

The components are first mounted on the group boards as shown in Fig. 3. When resistors R8 and R10, R15 and R18 are being soldered, a heat shunt should be used. Only one wire goes beneath the group boards, this is from C3 to R6 and is shown dotted in Fig. 3. When the group boards are assembled, they may be bolted into place with a spacer located between the board and the chassis, to allow for the wiring underneath.

All earth connections are soldered to the busbar, which may be held insulated from the chassis by means of two tags strips: this busbar should be earthed to chassis at the input socket only.

An output socket may be included if desired, and should be insulated from chassis if possible.

**Wiring**

The heater and power supply should be wired in first. Tightly twisted wires are used for all A.C. circuits, and this wiring should be kept away from signal circuits and positioned as close to the chassis as possible.

**Feedback**

For negative feedback to take place, the amplifier output secondary winding must be correctly phased in relation to the input. If in phase with the input, violent oscillations will take place, which may damage a high-grade speaker suspension; hence, it is best to use a low-grade speaker to secure the correct phase relation.

**Output Stage Balance**

The output stage is next balanced and is a very simple procedure. The balance control VRI should be slotted with a file for screwdriver adjustment only. Before switching on, check for an H.T. short with the meter. After switching on, if positive feedback occurs, then switch off immediately and reverse the anode connections on the output transformer primary. After about three seconds the set should have warmed up and a very slight hum only should be present (the hum level is approximately 80dB below full output).

A D.C. voltmeter is next connected across the anodes of the EL84's and the balance control VRI is adjusted until no reading is obtained (ignore random fluctuations). The valves are now balanced from the D.C. aspect, which is usually the same for signal input. If a balance cannot be obtained, the valves should be switched over and the procedure carried out again: if a balance is still not obtained, then the valves should be checked for emission. Usually a balance is easily obtained.
Transistor Sets Again

CONSIDERABLE publicity has been given recently in a certain section of the daily press, to a suggestion made in a letter on the “killing” of interference from transistor portables. A reader suggested that the annoyance from these sets could be removed by using a radiating device—which readers will remember was first suggested on this page a long time ago, and I mentioned the fact that it was not known at the time what the reaction of the Post Office authorities would be on the use of such “jamming apparatus”. We subsequently published a quotation from the Wireless Telegraphy Act which pointed out that it was an offence to use any apparatus which could cause interference with other apparatus and that therefore such jamming equipment would be considered to be illegal. The references to the interference device quoted in the opening paragraph of these notes has brought apparently shoals of letters in which such terms as “knighthood” and even “canonisation” have been suggested as suitable rewards for the student whose letter first drew attention to the idea. It is, of course, not an “invention”, but merely an application of a known device, which is, in fact, being used illegally if its purpose is to jam another receiver, and most readers will know that even a simple super-regenerative set, if it does not have a buffer input stage, can cause interference over a wide area even under the most correct operating conditions. The estimate of £20 for constructing one of these “jammer” seems rather excessive.

Remote Controls

Hard on the heels of my notes about remote controls (August issue) a reader reminds me of a demonstration given many years ago of a magnetic induction form of control which seems to have disappeared with time—although it would appear to have some useful possibilities. The demonstration consisted of a dance where, if one looked in at the door during the demonstration one would have seen dozens of couples waltzing round the hall in dead silence—yet all in perfect step. The secret was that they were all wearing a form of hearing aid earpiece inserted in the ear, and they carried a small unit which picked up sound from a loop running round the floor of the hall. Fed to this was the output from a record player, and the signal was inductively coupled to their pick-up device. It would seem that there are many very suitable uses for this type of coupling, not only inside buildings, but also out of doors. I will leave my readers to think of some of the most intriguing of these.

Electronic Games

I have now received a large number of letters on the above subject and some of these make most interesting reading. The one I like best is that describing a “Bingo machine” built by a reader in Kent, and when I have had time to study all of these, I will try and see if the Editor can afford the space to publish details of one or more. Some very ingenious ideas seem to have been applied, and so far expense seems to have been saved by utilising standing equipment which can be obtained very cheaply. I felt sure that our readers would overcome difficulties such as “expense” by making do, and this now does seem to be the case.

One reader suggested the simple plan of having ordinary on-off switches, either toggle or simple bell type, by means of which two people could play against each other, and he pointed out that these switches may be obtained with a bias in some cases so that their operation consists merely of pushing them against the bias, which will operate a desired circuit, and then on releasing them they will return to their original setting. This does offer some scope, but in most cases this arrangement could only be used with what I might call “electrical” circuits, rather than electronic. That is to say, battery and lights with switches in circuit could be employed, and by this means the “game” would be reduced to its most simple form, but this is not the type of device I had in mind in my first remarks on this subject. I was visualising the arrangement where a form of “electronic brain” was employed, whereby after one player operating a button or switch recorded information in the complete equipment analysing the results of his “move” and automatically made an answer to that move and thus enabled one person to “play” the machine. And, of course, such a machine could be so constructed that it could not lose but would always win or draw.
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A SURVEY OF PRINCIPLES OF PRACTICAL IMPORTANCE, AND USES OF SUCH CIRCUITS

(Continued from page 308 of the August issue)

LAST month's article finished with an explanation of the advantage of the cascade voltage doubler circuit over the conventional voltage doubler circuit.

Fig. 21 gives an example of a combined H.T./EHT supply on these principles. A further advantage of this circuit is shown in Fig. 22, where the same circuit but of inverse polarity is added to the same transformer winding, in the same method of circuit development as the previous treatment of the other basic circuits. The result here is an output at four times the voltage output of a simple half-wave circuit, so that this circuit is called the "Cascade Quadruplicator." These types of circuit are called "Cascades" on account of their cumulative method of working. Thus the first rectifier and condenser, MR1 and C1, function as a normal simple half-wave circuit, charging up C1 to the peak. On the half cycle of opposite polarity, where MR1 is now blocked, polarities are such that the charged C1 and the reversed transformer winding voltage act in series addition as voltage drive for the second rectifier and condenser MR2, C2 also operating in simple half-wave circuit, thus clearly leading to a doubled voltage output. The operation of C3/MR4 and MR4/C4 follows similar lines.

Progressive Cascading

In principle, the charge voltage on C2 and the transformer voltage can be made to act in series across a further rectifier on the next half cycle, and so on up to any number of cascaded stages. Thus a D.C. output voltage of any desired multiple of the output of a simple half-wave circuit is possible with rectifier cascade-multipliers, without the need for any transformers. But such circuits are of little use to the constructor, because rectifiers and condensers of the large voltage ratings required are not commercially available.

It may be mentioned, however, that the rectifiers may be replaced by spark-gaps of graded separation, trimmed so that breakdown just occurs at the half-cycles corresponding to the maximum voltage, exactly where a normal rectifier would be required to conduct in such a circuit. This is an interesting example of the use of spark gaps in substitution for rectifiers, which has actually been used in historical equipment for high-voltage supply for atomic research. Generators with spark-gap cascades have been built with an output of well over a million volts, using a transformer winding input of some thousands of volts.

This completes the survey of those rectifier circuits considered to be of practical use to the experimenter. Many other interesting types, such
as three-phase and polyphase equipment, grid-controlled rectifiers, etc., are not considered to be of practical importance for the general experimenter.

**Peaking and Smoothing**

All rectifier circuits work into an output load through which the D.C. output current flows. In basic principle, this output load consists of a resistive element (the actual useful load) and a capacitive element (the "smoothing") in parallel, as shown in Fig. 23. Fig. 24 shows the more conventional smoothing, where the capacitive element is split at the "hot" end into two, and a choke or resistor inserted. This enhances the characteristic that the A.C. component of the output (hum ripple) goes preferably through the capacitive element to earth, whilst the true D.C. component goes through the resistive element (real load) to earth, which is the familiar purpose of smoothing—namely to remove as much as possible of the remaining A.C. component of the output.

Now, the capacitive element of the circuit of Fig. 23, as long as it is not charged to the final voltage, represents a short-circuit as soon as the transformer winding voltage has reached a part of the half cycle of the conduction-polarity where the voltage has risen above that to which the condenser is at the moment charged and charge current will then flow into the condenser to increase its voltage. It is thus perfectly obvious that this process goes on until the condenser has charged up to the peak voltage of the A.C. wave, which is about 1.5 times the r.m.s. value for the mains sine wave. This property of rectifier circuits is known as (capacitive) peaking, and raises the peak inverse voltage rating required for the rectifier, as explained earlier in this article. Even if no physical condenser is present, the circuit stray capacities, even if very small, are inevitably fully sufficient to give full peaking on open-circuit output, so that no reduction in inverse voltage rating of the rectifiers is permissible even if no physical smoothing condensers are used, as in common accumulator charging circuits.

**Load Characteristics**

The remarks regarding full peaking made in the previous section apply to open-circuit output, i.e.,

The case when the resistive component of the output load is of infinitely large resistance. As soon as a finite resistive component is connected, i.e. an actual pure D.C. output current is drawn, this will draw charge away from the smoothing condensers. Thus, in actual practice, the final operating output voltage will be somewhat less than the full peak voltage, according to the balance struck between the load current passing out of the condensers and the rectifier current passing into them on the appropriate portions of the A.C. cycle. Zero output D.C. load results in full peaking, as explained above, and as the output D.C. load current increases the voltage will fall below the peak, the decrease being normally linear with rise of current in most circuits, which means that Ohm's Law is obeyed to the extent that a definite corresponding internal impedance may be ascribed to the circuit. This internal impedance lies in the region of about 1k to 2k for normal conventional full-wave H.T. rectifier circuits. so that a decrease of 1V to 2V may be expected in the output voltage for each rise of about 1mA of output current drawn. The actual exact figures in a particular case will depend greatly on the smoothing capacity values, rectifiers, resistances of transformer windings, etc. A good power supply should have as small a change of voltage with load current as possible, i.e. as low an internal impedance as possible.

**Condenser Values**

Large values of smoothing capacities reduce the internal impedance, in that they keep the output voltage high at greater load currents, but this is at the expense of large surges of current through the rectifier at the A.C. cycle peaks, which exceed the surge-current rating of the rectifier for smoothing capacities larger than a critical value for a given circuit. Thus the use of too large a smoothing capacity can cause overheating and flashover in the rectifier. Most rectifiers, and especially the new silicon rectifiers, can tolerate higher peak currents than normal valve rectifiers. This is a great advantage of these devices, and allows the use of much larger
smoothing capacities, which is very useful in half-wave circuits requiring the extra smoothing effect. It is extremely difficult to determine the maximum tolerable smoothing capacity on theoretical lines if one is about to try out a new rectifier circuit of one's own design, but fortunately it is a simple matter to measure the peak rectifier current in an experimental circuit if one possesses an oscilloscope and an A.C. voltmeter. Fig. 25 shows the arrangement for such a measurement, as typically applied to a conventional full-wave H.T. rectifier circuit. The normal load which the circuit is intended to feed is connected, and the small measuring resistor of about $\Omega$ (the resistance $R$) of which must be known accurately) is connected as shown. It does not disturb the function of the circuit appreciably, serving merely to monitor the rectifier current.

The oscilloscope input is now connected to A, and the trace adjusted to suitable height and the timebase to display a convenient number of cycles. The waveform will not be a sine wave, but will display the regular current surges through the rectifiers. Without altering any settings of the oscilloscope controls, the oscilloscope input is now switched to B, and R2 adjusted until the mains sine wave display has exactly the same peak to peak amplitude as the peak to peak amplitude of the rectifier current display. If V is the reading of the A.C. voltmeter, then the peak rectifier current is given by

$$I_{\text{peak}} = \frac{V}{R} \times \frac{3R^2}{R1 + R2} \text{ Amps} \quad (\text{Resistances in Ohms})$$

$$V \text{ in Volts r.m.s.}$$

The data list should then be consulted to check whether the measured peak current is within the *surge-current* rating of the rectifier in use. If not, then the smoothing capacity must be reduced, the load current reduced, a different rectifier type used, or a surge limiting resistor or choke inserted (Fig. 26), or any suitable combination of such measures. If one were very careful in the design of circuits, then initial surge currents through the rectifiers as the condensers charge up from zero upon initially switching on would also be studied.

**Surge Limiters**

If the initial surges are found to exceed the rating of the rectifiers, then the same measures as indicated above can be used, though the best measure in this case would be the use of surge-limiting resistors or chokes. There is in principle a choice of three positions for such components, as illustrated in Figs. 26 a, b, c. Fig. 26a is normally used if resistors are used, whereas Fig. 26b is common if a choke is used, whereas Fig. 26c is seldom found.

There is not a great deal to choose between the three arrangements, the particular preferences being largely a matter of convention. Fig. 26b represents the familiar choke-input smoothing circuit, which has the characteristics of a very rapid initial fall of output voltage away from the full peak at low output currents, but thereafter a far slower fall of output voltage with output current in the region of the operating value of output current (assuming proper choice of component values). The result is that such a smoothing circuit gives a smaller output voltage at a given load than the conventional smoothing circuit of Fig. 24, but the effective internal impedance is lower, i.e. the regulation is better.

**High Ratings**

It should be mentioned that the use of television booster diodes as power rectifiers, in addition to advantages already discussed, has the further advantage of high surge-current rating. This is because these diodes are specially designed for pulse-operation in television line-output circuits, and therefore are fitted with excellent high-emission cathodes. Thus the PY81 is rated at a peak surge current of half an amp. so that with a 400V r.m.s. transformer winding giving a peak voltage of 600V forward, the surge-limiting resistance would only need to be at the very most about 1000$\Omega$. The

(Continued on page 438)
A HOME-MADE HI-FI OUTPUT TRANSFORMER

THE USE OF A TERTIARY FEEDBACK WINDING ARRANGEMENT SIMPLIFIES THE CONSTRUCTION OF THIS TRANSFORMER AND REDUCES THE COST.

PRICES of quality output transformers are still high enough to deter the experimenter who has economy in mind, particularly when the cost has to be doubled for stereo. Substitutes bring distinct risks of trouble with published designs, a fact which emphasises the importance of considering transformer and amplifier circuit side by side. Despite this cautionary remark, the transformer to be described will be found to be stable in several circuits and will provide the basis for some interesting, inexpensive experiments.

Sections

The number of winding sections is small and their arrangement simple enough for home workshop methods and yet the transformer does not lend itself to factory production, possibly because it requires a centre-partitioned bobbin and a "stop-and-start" procedure unsuitable for automatic machinery. Therefore, despite its advantages of small size, simplicity, cheapness and high-quality performance, it is not likely to appear in the shops.

The achievement of stability in an amplifier having overall feedback generally demands a complex sectionalised winding arrangement in the output transformer. A successful alternative for the small amplifiers which, in stereo pairs, can supply a total of about 10W output, is to operate the output stage safely within class "A" conditions so that small and simple transformers can be used. Another method is to apply heavy negative feedback over the output stage to clean up distortion at its principal source, thereby reducing somewhat the risks of instability with the voice-coil loop.

Separate Feedback Winding

A further arrangement is the provision of a tertiary (third) winding to supply a Fig. 2 (right)—A push-pull output transformer with tertiary windings (T).

Fig. 3 (below)—Each anode winding is confined to one side of the partition and divided into two sections separated by the secondary. The secondary and tertiary are wound across the full width of the former.

AA Tertiary, one layer, full width;
BC Primary, inner section, one side of the partition;
DE Secondary, full width;
FG Primary, outer section, one side of the partition;
H Tertiary, one layer, full width;
JK As BC;
Tap secondary tap;
LM As FG.
feedback voltage that suffers none of the distortions to which voice-coil connections are prone. It becomes possible to apply very heavy feedback without the sectioning normally required. This is the basis of this transformer. To obtain the greatest versatility, the windings are so arranged and insulated that the leads, which are all brought out instead of being internally connected, provide a choice not only of turns ratio but also of output stage conditions and feedback circuits.

Fig. 1 shows in the simplest forms (a) the conventional feedback circuit and (b) the tertiary arrangement. A very simple tertiary winding would seem to be possible by wrapping the very few necessary turns around the outside of any transformer winding. This can be tried and the transformer may be found to behave reasonably well, but the feedback will be out of balance and some distortion is certain. A virtual replica of the anode signal can be obtained when the tertiary is divided into two single-layer sections in series, one on the inside of the bobbin and the other on the outside. It is also preferable, and easily arranged, to have a balanced primary having the winding for each valve of a push-pull pair kept to its own side of a partitioned bobbin. This not only gives excellent push-pull conditions but balances the D.C. supply and the resistive component of the A.F. load.

**Tertiary Sections**

The arrangement adopted has both primary windings divided into two sections, each pair on its own side of the partition with the secondary as a single section wound across the full width and tapped for alternative loudspeaker impedances. The tertiary sections comprise only

![Fig. 4](image-url)  
*Fig. 4—The circuit of a two-stage push-pull amplifier.*
twelve turns each, spaced across the full width. The arrangement of the sections is shown schematically in Fig. 2, with colour identification that will be used throughout this article and the one which follows. Fig. 3 will give some idea of the actual positions of the sections.

No rigid specification for core dimensions and quality will be given because of the difficulty of obtaining laminations of any particular size and grade in the shops. Instead, some guidance will be offered to enable the constructor to use the best he has or can obtain and to adjust the windings to suit. A feature of the transformer is that it is tolerant in this respect, and good results can be achieved with cores rather smaller than might be needed with others. High frequency response is good and there seems to be little to gain by dividing the windings into the many sections found in the usual high quality job. Nevertheless, for the very finest quality, a generous stack of good quality laminations should be provided. In a 10W amplifier very fine bass down to 30c/s is possible with a 1½in. stack; a 2in. stack gives excellent results in a stereo amplifier giving about 6W per channel.

**Pre-amp**

The amplifier should have sufficient gain to overcome the attenuation of heavy feedback, and the necessary amplification must be achieved with the minimum of A.C. coupled stages. Two stages coupled by one R.C. network is safe enough, and the tertiary transformer can be made to work quite well in a three-stage amplifier. The phase shift with three stages can be kept well within the stability margin if one is direct-coupled. With more than three stages an amplifier is likely to be unstable with any transformer if all are within the feedback loop. A safe and satisfactory method for small domestic amplifiers is to use a two-stage main amplifier and to feed it from a pre-amplifier having its own local feedback. The object of the main loop is to clean up the distortion that is generated chiefly in the output stage and there is no point in using voice-coil or tertiary feedback for earlier stages where simple local loops can be more effective and stable.

In Fig. 4, a triode “see-saw” phase-splitter and amplifier stage feeds the output pentodes. The tertiary winding, earthed one end, supplies feedback to V1 via R1 and provides a path for the cathode current.

(To be continued)

**INCREASING VOLTMETER RANGES**

(Continued from page 388)

The multiplier must take $500 - 0.05 = 499.95V$. Its resistance will therefore be:

$$R = \frac{E}{I} = \frac{499.95}{1/1.000} = 499,950\Omega.$$  

Such a multiplier can most conveniently be made by connecting 470,000, 22,000, 7,000, 820, 100 and 30Ω resistors in series. Taps can be arranged for 250, 100 and 10V or other such ranges, calculated in the same way.

The multiplier in circuit at 500V is 499,950Ω, at 250V is 249,950Ω, at 100V is 99,950Ω, and at 10V is 9.950Ω.

**The Voltage Divider**

Valve voltmeters and oscillographs have a different multiplier system. Fig. 4 illustrates the arrangement. R is known as a divider. The valve voltmeter is connected to a small portion of R and therefore measures only a fraction of the voltage under test. R is usually made up of several high resistances connected in series giving a total value of about 20M. It is essential to have R as high as possible in order to maintain the sensitivity of the valve voltmeter.

In Fig. 4 the total value of R is 20M. Therefore on 1,000V it will pass:

$$I = \frac{1,000}{20,000,000} = 1/20,000\text{A} = 0.05\text{mA}$$  

The valve voltmeter reads one volt at full scale deflection. Therefore the resistance between b and c will be:

$$R = \frac{1}{1/20,000} = 20,000\Omega.$$  

The resistance between a and b will, of course, be the difference between 20,000,000 and 20,000 = 19,980,000Ω. Tappings can also be arranged between the various components of R to give, say 500, and 250V ranges. In Fig. 4 the resistors are as follows: b to c = 20,000Ω, b to 250V tap = 4,980,000Ω, 250 to 500V tap = 5,000,000Ω, and 500 to 1000V tap = 10,000,000Ω.
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LAST month we dealt with record and replay equalisation and discovered how a reasonably flat overall frequency response can be obtained by applying controlled treble lift on record and bass boost on replay. This month we shall be considering the various programme sources and signals used by the home recordist.

Recording from the Radio

The radio is undoubtedly the most used source of programme material exploited by the amateur but, unfortunately, full advantage is not always taken of this medium and consequently the quality of reproduction may be sadly lacking.

The easiest way of getting a radio recording is to site the microphone in front of the loudspeaker and record in the usual manner. Although the results so obtained are acceptable to some, this is a very poor method of recording technically and far better results are possible by the use of other methods. With the loudspeaker/microphone method, three basic distortions are introduced to the recorder, and these are: (i) the inherent distortion in the output stage of the receiver (even the best sets produce some distortion in the output stage); (ii) the distortion and coloration produced by the loudspeaker itself and by its baffle or enclosure; and (iii) the distortion, reverberation and coloration reflection reflected from the room.

The first kind of distortion is present always and cannot be reduced or eliminated; (ii) is, again, always present and depends much on the loudspeaker and enclosure employed by the receiver; (iii) however, can be varied to some extent by playing with the spacing between the loudspeaker and microphone and by cutting out excessive reverberation by covering the channel between the loudspeaker and microphone with a heavy cloth.

The loudspeaker/microphone channel is virtually an electro-acoustic transducer, in which there are two distortions to contend with: the "electro" distortion and the acoustical distortion, as already described.

Eliminating the Acoustics

It is rather pointless to use the A.F. signal produced by the set to operate a loudspeaker, and for this loudspeaker to cause the diaphragm of a microphone to vibrate in sympathy, and then to use the signal produced by the microphone for recording (see Fig. 25). By far the best idea is to utilise the A.F. produced by the set as the recording signal (Fig. 26).

This, then, presents several problems: the best way of extracting the A.F., etc. The obvious arrangement is to disconnect the loudspeaker and apply the two loudspeaker wires to the input of the recorder. This, although obvious, is a bad thing to do for several reasons. One is that as soon as the loudspeaker is disconnected from the set, the output stage is operating without a load. This immediately introduces quite a lot of extra distortion, but not only that, it also causes the A.F. voltage to rise to dangerous peaks at the anode of the output valve and across the primary of the output transformer. Before very long either the valve would flash over or the primary of the transformer would short-circuit or break down.

(Continued from page 315 of the August issue)

If this method of feeding is to be used, then it is essential for either the loudspeaker to remain connected or a resistive load to be used instead. The resistive load should have a value equal to the impedance of the loudspeaker, which, in most ordinary valve-type receivers, is of the order of 3Ω. With transistor receivers, the impedance may be entirely different and in some cases the loudspeaker speech coil may be centre-tapped, in which case special precautions will have to be taken to prevent damage to the output transistors.
Where possible, it is best to operate without the loudspeaker for, apart from the disturbances created by a watt or so of audio during a recording exercise, the varying impedance with frequency of the loudspeaker can detract from the quality of the recording and, in certain cases, upset the equalisation. When a resistor is used instead, it should be able to handle the full output power of the set or amplifier hook-up. As $\frac{3}{2}$ resistors are rather difficult to come by, a length of resistance wire (available almost anywhere) wound round the body of a ceramic high-value resistor, and terminated at the lead-out wires, is adequately suitable for this application.

Voltage and Matching

Next things to consider are the signal voltage required at the input of the recorder to give full modulation without overload, and the impedance matching between the output of the set and the input of the recorder.

Voltage Considerations

Tape recorders usually have two (or more) inputs, one for microphone and the other for radio. The microphone input is usually more sensitive than the radio input. This is because the voltage at the output of a microphone is much below that available from a radio set. Typical levels for full modulation are: microphone 1mV and radio 100/150mV. Sometimes there is a second radio input suitable for low-level signals direct from the diode detector, but this will be considered later.

The question, then, is what sort of voltage is present at the loudspeaker leads of an average radio set? This depends very much on the impedance of the loudspeaker circuit and the output of the set. The voltage is easily found, however, for any set, by using the simple expression \( E = v \times R \), where \( E \) is the r.m.s. output voltage, \( v \) the watts output and \( R \) the impedance of the loudspeaker or load resistor in ohms.

A typical set, for example, might be giving, say 3W across 3Ω. Three times three is nine, and the square-root of nine is three. Thus, it follows that, at full output, 3V r.m.s. exist across the loudspeaker load. This is well above the input voltage required on most recorders, so the signal is either turned down at the set (set's volume control) or at the recorder—but this can cause trouble. For example, say the radio is turned up to nearly full output, using a resistive load instead of a loudspeaker, so that 3V peak are applied to the recorder. This will mean that the record level control will have to be turned well back to avoid over-modulation as indicated on the modulation depth indicator. Indeed, under such conditions the record level control will only be a fraction on.

Now, although the modulation or record level indicator will be showing that overloading is not apparently taking place, the recording will almost certainly be very poor indeed. The main reason for this is not so much a question of matching, but one of overloading in the first stage. The recording level control is usually connected after the first valve, so the first valve is receiving a full 3V of A.F. It cannot handle that, of course, and distortion will occur, the distortion being controlled, in terms of recording level, by the level control after the amplifier.

The Best Settings

The best way of setting up such a combination is, first to turn on the recording level control almost to maximum, then turn up the radio volume control for maximum record level as indicated. In that way the first stage of the recorder will always work well below the distortion level, but difficulty may be had in obtaining a sufficiently low setting of the receiver's volume control—a slight touch being sufficient to push the recording level indicator well over the limit. Also, if the receiver's loudspeaker is to be used as programme monitor, the low volume control setting will not give sufficient output, bearing in mind that only 0.001V or so is required to drive fully the recorder and that this corresponds to very little audio power across 3Ω.

Attenuation

Thus, an attenuator is a good thing to have between the set output and the tape recorder input. This will enable the set to be operated at near normal volume without overloading the first stage.

(Continued on page 418)
Servicing the P.W. POCKET SUPERHET RECEIVER

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by a quarter revolution, or less. Speech and music should be of pleasant quality, from low volume right up to ample volume for ordinary listening in an average room.

Battery Space

The unused tags of C1 and C2 should be bent in against the condenser. A round body battery such as the Vidormax T.6004, will fit more easily than a square battery. The IFT2 can safely be positioned a little more to the right, and larger battery clips can then be accommodated. Neither clip must touch the IFT can. To avoid this, a piece of thin card, about 2j, x 1 in, may be bent to isolate the battery from the IFT and C1 and C2.

If a trifle more space is needed the tuning condenser can be moved slightly higher by elongating the holes in the paxolin. This can be carried out with a small round file. The T.6004 battery should fit without need for this, unless the holes for the securing screws have been drilled a little inaccurately.

Waveband Coverage

This is about 200-525m on M.W. and 1100-1750m on L.W. A high minimum capacity in the trimmer C3 will prevent 200m from being reached. If so, the spacing between the trimmer plates needs increasing. This can be done by unscrewing the trimmer and bending up the plates with a knife, taking care not to break the insulation.

Stray minimum capacity should be as low as possible, so leads to C7 and C8, and the switch, should be clear of the condenser frame, or earthen wiring.

Trimming can be on 208m (Radio Luxembourg) with the audio gain control at maximum, the set being oriented to keep volume low. Failure to tune to a sufficiently low wavelength indicates that the trimmer is screwed down too much, or that stray capacity is too high.

It signals at about 525m cannot be reached, with the tuning condenser closed, this probably indicates that the oscillator coil core is not screwed into the coil far enough. Even half a turn on this...
core will considerably influence band coverage. If C8 is abnormally low in value, this will have the same result.

On the L.W. band, 1500m (Light Programme) should be found near the middle of the L.W. range. If not, C7 may be too low in value, or the oscillator coil core may not be screwed in far enough. If C7 is too low in capacity, wiring a 60pF trimmer in parallel with it will correct this. Adjust C4 near 1200m and the position of the L.W. winding on the rod near 1700m. Poor L.W. reception may be caused by wrong wiring to the L.W. winding tags, switch, or C7.

Complete failure of the oscillator stage to work, with a set just constructed, may arise from wrong oscillator coil positioning. There is electrical continuity between pins 1 and 2, between pins 3 and 4, and between pins 5 and 6. If this is not so, remove the coil, turn it as necessary, and replace it.

**Noisy Reception**

Receiver background noise should be very low. If high, a transistor may be responsible. Reputable transistors of named make will have passed a low noise test, but cheap or surplus transistors may be noisy. Noise from defective soldered joints may be found by examination, by moving suspected leads carefully with an insulated tool, or by checking each stage individually. It takes only a moment to “tin” the leads of resistors, etc., by applying the iron and cored solder. If this is always carried out, no joint should be defective.

**I.F. Oscillation**

Instability in the intermediate frequency amplifier may be heard as a whistle or similar noise. It may arise from wrong values for R7 and R11, or C10 and C13, which should be of 2% tolerance. Very long leads to Tr2 and Tr3 may contribute, and base and emitter wires should not be close together.

If the trouble ceases on tuning in a strong station, it is very slight. If it ceases only on detuning one or more I.F. transformer, check that wiring is short and direct. Increasing the values of C11, C12 and C14 may help. This is most easily done by adding other condensers in parallel, to a total of 0.1µF or 0.25µF.

**Current Drain**

A meter included in one battery lead should read approximately 8mA, with no programme tuned in, or with volume very low. Current consumption depends directly on volume, rising to about 15mA on peaks with average good volume. Maximum volume from a local station can give peaks of 25mA or higher.

Consumption up to and including Tr4 should be about 6mA. If the no-signal drain of the output stage, Tr5 and Tr6, is much over 2mA, R19 should be slightly reduced in value to correct this. R18, R19 and R20 should be of 5% tolerance, and these values are correct only for OC72's.

If consumption of the output pair is very low,
A view of the assembled receiver.

with no signal, and reproduction is distorted, R19 should be increased slightly in value. Alternative transistors will probably require some change to the value of R18 or R19, to obtain a suitable base voltage. With the OC72's, R20 may be 47Ω.

The driver and output transformers are for OC71 and OC72's and near equivalents. Resistor values shown permit economical working with full output.

Low Temperatures

Very low temperatures, such as may arise in winter in a vehicle or unheated room, may shift transistor characteristics, so that output is reduced and distorted. This is common to many such circuits, and is most likely when R18 and R19 chance to be of such a value as to make the output pair base voltage rather positive. The need for a new battery may be suspected. The trouble should cease when the set is run for some time in a heated room, or is otherwise allowed to reach a more normal temperature.

If this effect is unduly troublesome, R19 should be increased slightly in value to suit the actual output pair fitted. R19 should not be unnecessarily high in value as this will increase current consumption.

Distortion

This is most probably caused by wrong values for R18 or R19, as explained, or for R14, R15 and R17. The first three stages can be most simply checked by wiring phones across R15. Adequate volume with good quality should be obtained.

Transferring the phones to the driver transformer primary should give a very great increase in volume with good quality maintained. If not, suspect R14, R15 and R17, or Tr4. If quality is good here, but not from the speaker, suspect R18 or R19.

Resistor Coding

Errors in reading values are most likely with low values, such as 4.7Ω, 47Ω, and 470Ω. If values are in doubt, they should be checked with a meter.

The 5% tolerance resistors should have a gold band, and all other resistors should have a silver band to indicate 10% tolerance. Unmarked resistors (20%) should not be used.

Transistors

Leads will be of about the right length if the transistor tops are level with the tops of the I.F. transformers. Alternative transistors will be found to work satisfactorily, if of equivalent or near equivalent type.

If different transistors are incorporated, some changes in component values may be required. With Tr1 (OC44 specified) R2 might require changing, or a low value resistor may need adding between collector and pin 6. With different transistors for Tr2 and Tr3 (OC45's specified) it could occasionally be necessary to modify neutralising values, or base supply resistors.

Warning

This article has been published for the benefit of those readers who built the original P.W. design and the servicing information given here may not apply to later versions of the receiver although it may be found of assistance.
This article describes the construction of a compact test-set combining the functions of several separate units of conventional construction, and enabling a multitude of qualitative and quantitative measurements to be performed on wireless and amplifier circuits.

Introduction

Many keen experimenters must confine their activities to some odd corner of a room used for other purposes too, or possess only a workshop of very limited size. Experimental work, on the other hand, is considerably hampered if essential apparatus has to be stored away in inaccessible places, requiring considerable preliminary setting-up work prior to any working session. This trouble is particularly aggravated if such apparatus is bulky or consists of many separate units. It is thus highly desirable to have the essential measuring and test equipment in as compact and multipurpose a form as possible, so that it may be left permanently set up ready for immediate use, even under conditions of very limited space.

The "Experimenter's Power Pack" (already published in this magazine in the January 1962 to July 1962 issues inclusive) is aimed to meet experimental power-supply needs under the conditions just mentioned. This article describes a very compact test-set, measuring only 11½in. x 8in. x 7½in. deep, which embodies the full functions of (a) oscilloscope (b) signal tracer (c) audio test-oscillator (d) frequency-meter (e) valve-voltmeter (for A.C. and D.C.) (f) quantitative waveform analyser, and (g) resistance-inductance measuring bridge. It uses only seven valves and a miniature cathode-ray tube, and has a built-in moving-coil meter and all power-supplies also built-in.

Very considerable experimenting time has been devoted during design to obtaining a really stable and reliable circuit which should function well without any difficulties if the points discussed in the course of this series of articles are carefully observed.

Equipment for the Experimental Workshop

The following question has often been raised: "What basic equipment does the keen experimenter require if he really wants to be able to observe systematically what exactly is going on in his experimental circuits, rather than rely on more hit-and-miss methods?". The "Experimenter's Power Pack" and the "Miniscopes" of the present article are the answer which this magazine offers, in a practical way, to this vital question. In addition to these two items (apart from the obvious need for an adequate set of the usual hand-tools such as soldering-iron, screwdrivers, files, pliers, etc.) the following may also be recommended:

(a) A good multimeter which may be homemade, according to information already published in these pages, or any good commercial model from the wide selection of advertiser's offers.

(b) A small handy grid-dip meter covering those ranges of radio frequencies with which the experimenter intends to work. For general-purpose use, an instrument with a set of plug-in coils covering the range 100kc/s to 100Mc/s would be ideal. It is of advantage to see that this instrument is usable as R.F. and I.F. signal generator and absorption-wavemeter too (as most grid-dip meters will already be, or will be after simple modification). Capacities below 1,000pF and inductances in the milli-henry and micro-henry
ranges can then be measured with this instrument, as well as tuning-ranges of tuned circuits, etc., thus augmenting the functions of the Miniscope.

A useful third item here would be a small wobbulator for use in conjunction with the "Miniscope" for aligning tuned circuits, bandpass filters, etc. Provision is made on the Miniscope for connection of such a wobbulator, in conventional fashion.

A constructor possessing this list of equipment, and having acquired the necessary skill and knowledge in its practical use and possibilities, should be in a position to carry out almost any quantitative or qualitative observation on processes in normal experimental work, giving him a very clear picture of what is going on in his circuits at every stage.

Regarding the Miniscope in particular in this scheme of equipment, the parts-list may appear formidable, with 73 resistors and 43 condensers and a quantity of other material. But, remembering that this instrument combines the functions of about seven instruments which would otherwise have to be built and bought separately, and which are all essential, the price of these components is in fact astoundingly cheap for the benefits reaped.

**General Circuit Plan**

The Miniscope consists basically of four circuit-portions. The first is the combined H.T./EHT power-supply. The second is the Wide-Band Signal Amplifier (Y-amplifier), including valve-voltmeter functions in the input stage and a signal-tracer output stage. The third is the special time-base circuit, calibrated quantitatively for time and frequency measurements in the range from a few microseconds to about 25 milliseconds. The time-base-wave is available externally at a coaxial socket for feeding a wobbulator, or for general use as audio test signal. The fourth circuit portion comprises the additional elements and switching for a novel phase-bridge for L and C measurements.

A function-switch selects three operating positions. The first is entitled "tracer". In this position only, the Signal Amplifier (and associated valve-voltmeter) is operating. The amplifier signal may be heard on headphones connected to the output provided or on a miniature loudspeaker which is connected there, or else passed into an external separate power-amplifier. Of the three pilot lamps only the green one labelled "tracer" is lit.

If the applied signal is pure A.C., then the waveform appears on the CRT, but the meter needle does not move. If the applied signal is pure D.C., then the meter shows it, but the CRT shows only the undisturbed timebase trace. The advantage of this arrangement over the otherwise more conventional signal-amplifier passing the full D.C. component (D.C. amplifier) and giving D.C. indication by a corresponding bodily shift of the trace on the CRT screen is that the relative D.C. and A.C. sensitivities may be chosen independently to suit the relative D.C. and A.C. contents of the waveform being observed. Thus, for example, accurate observation of hum-ripple percentage on a power supply is immediately possible which requires two separate measurements with a conventional D.C. oscilloscope.

Furthermore, the arrangement here adopted allows the essential D.C. measurements yet does not require a full D.C. amplifier, which would normally be tricky to construct under amateur conditions. A straightforward, stable and reliable A.C. amplifier is thus used.

The main signal amplifier has a bandwidth, level to within the usual specifications of ±3dB, extending from 25c/s to 120kc/s, and will thus give accurate displays of pulsed waveforms even at the highest audio frequencies. A low-pass filter is built in between the CRT-feed stage and the tracer output stage to prevent frequencies higher than 15kc/s reaching the earphones/speaker output (as these could otherwise be rectified at the input
to a subsequent amplifier, causing grid-current blocking or distortion or creating various forms of instability. Thus, even if applied signals are of a frequency well above the highest audible, they are still displayed on the CRT, yet give no tracer output. The amplifier still shows appreciable (though much reduced) gain at 1Mc/s and will just resolve individual cycles of the carrier of medium-wave stations operating around this frequency on the CRT display. These will be seen by connecting a tuned circuit and good aerial to the input or the output of an R.F. signal-generator if local-station signal strength is not sufficient.

The third position of the function switch brings the L-C bridge into operation. The green pilot lamp "tracer" is now extinguished, the red "scope" lamp is still lit, and the third lamp, a green one labelled "bridge", is now also lit. The signal amplifier is operating, as is the CRT, but the sawtooth-sweep timebase is inoperative, the X-deflection now being by the mains 50c/s sine wave. A fixed R-C combination shifts this sine wave so that it is running 45° out of phase with the local mains. If now a sample of the in-phase mains wave is applied to the Y-amplifier (from the 6.3V heater line) the oblique-ellipse trace characteristic of two waves of equal frequency but constant phase-shift relative to each other is obtained on the screen.

But the in-phase wave is taken from the heater line, via an unknown condenser to be measured, on to a calibrated potentiometer, taking the Y-amplifier input from the potentiometer. This gives a phase-shift of an amount dependent upon the relative sizes of condenser and resistance, and a certain definite combination gives 45°, so that X and Y signals are then in phase again, both being 45° off the mains. This condition gives a clean diagonal line on the CRT. As the potentiometer is adjusted, therefore, the ellipse will close up to a narrow diagonal line at balance, and open up again beyond, and the potentiometer may be calibrated in capacity values correspondingly. This arrangement gives very clean, unambiguous balance readings. Ranges giving continuous coverage from 1.000pF to 30µF are incorporated in the Miniscope. Smaller capacities are better measured with a grid-dip meter and larger ones by a method described later in this article.

Inductances give a phase-shift in the opposite direction to condensers with the arrangement here described and thus augment the phase difference between X and Y signals. A good reference

---

Fig. 1 — The Y-amplifier circuit. The input is direct-coupled, and will tolerate a maximum D.C. component of 25V (of either polarity), or an A.C. signal of maximum amplitude 50V peak-to-peak. With the probe to be described at the end of this article, fifteen times these inputs are tolerable, and the calibrations on the D.C. level meter and on the calibrator are made to apply to conditions when using the probe. It is undesirable to use the Miniscope without the probe, unless the extra sensitivity is indispensable. Less waveform distortion of H.F. components of a signal is also obtained when using the probe.
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<th>COMPONENTS LIST</th>
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<td><strong>Resistors</strong></td>
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condition is then when the phase difference has been complemented to 90°, giving a vertical or horizontal ellipse instead of an oblique one, which can be adjusted to a **true circle** by suitable adjustment of the Y-amplifier gain. The potentiometer is thus calibrated for coils for the condition for having a trace in the form of a true circle on the CRT screen. A range of 1H to 20H is incorporated for chokes, transformers, etc. Smaller values arising in R.F. coils, etc., are better measured with a grid-dip meter.

A number of other useful measuring operations are possible in the "bridge" setting of the Miniscope, which will be discussed below in conjunction with the circuit details.

**The Signal Amplifier (Y-amplifier)**

Fig. 1 shows the theoretical circuit of this portion of the Miniscope circuitry. It employs three valves, using high-slope triodes throughout. The input stage, VI (pins 6, 7 and 8), is a Class-A cathode-follower with unity voltage gain but impedance step-down. The purpose of this arrangement as input stage is to meet several requirements. Firstly, it accepts very high input amplitudes without overloading, so that the input can be run "fully open"—i.e., without a gain control. The input is at high impedance (as it must be, otherwise the signal source would be loaded and its waveform possibly changed in nature) and any volume control connected there would shunt high frequencies considerably on account of its inevitable self-capacity. The wide bandwidth achieved here would then not have been possible. The cathode-follower input stage, however, transforms the impedance at its output down to a mere one or two hundred ohms and considerable shunt capacity is tolerable there without high-frequency loss—thus the gain-control appears in this position.

*(To be continued)*

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**Fig. 2**—The timebase circuit. This embodies an extremely linear sweep generator, with speed continuously variable from 12µsec/cm to 25m sec/cm on the CRT screen and also a powerful sync circuit, operating on the Y-signal on either polarity at will, or on the mains frequency. The sync amplifier acts as Buffer, preventing timebase signals entering the Y-circuits, as well as amplifying the sync signals, so that lock is rigid even at tiny Y-amplitudes on the CRT screen. Finally, the timebase screen-grid waveform is shaped in a special circuit, giving effective flyback-blanking, avoiding confusion in displays.
A COMPACT CONVERTER for short waves

(Continued from page 319 of the August issue)

The constructor following the instructions given in last month’s issue will have fixed the chassis to the front panel and mounted some of the larger components.

When this stage is reached, wiring can be begun using Figs. 4 and 5 for reference. (Avoid overheating the coil spills when soldering.) The small dimensions of the chassis permit short and mostly self-supporting wiring, which is a desirable feature in short-wave equipment. Note the location of the stand-off insulator used as an anchoring and take-off point for the coaxial outlet lead.

All fixed capacitors should be of very high quality and of modern miniature design, since leaky specimens are likely to cause poor operation. Ceramic valve bases were used in the prototype, but are perhaps not entirely essential.

Testing the Converter

If all wiring is correct S1/S2/S3 may be adjusted to position “2”, valves inserted and batteries connected at the appropriate points, polarity being carefully observed. Coaxial cable should then be connected to the aerial and earth sockets of the receiver with which the unit is to be used, after first transferring the aerial lead to the converter.

The receiver should then be switched on and tuned to a silent point on its dial around 1.5Mc/s (200m), the volume control being turned well up. The converter sensitivity control, VR1, should next be set to the H.T. end of its travel and VC3 set at approximately half capacity—with its moving vanes half enmeshed in the stationary ones. The converter can now be switched on and aligned.

If no signal generator is to hand the dial of the converter should be rotated until some hiss or a
signal is heard when the core of L3 should be manipulated in an attempt to strengthen the signal. The next step lies in trimming and padding the signal and oscillator circuits at the high and low frequency ends of the scale, taking care to allow only the minimum of capacity to be introduced via the trimmers. The oscillator should operate on the high side of the signal frequency, and normally the coil cores will be screwed in reasonably well.

No adjustments should be made to VC3 until alignment is complete, which might take a little time in the absence of a signal generator. The sensitivity control might need to be turned down as certain transmissions are received.

Faults

The above supposes “first time working”, which in practice might not result. When the converter is first switched on, silence might well result, and if this occurs, and voltage supplies, etc., are in order, as indicated by a suitable testmeter, the oscillator section of V2 should come under suspicion. All dry frequency changers quite often are more

(Continued on page 417)
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temperamental than their mains-powered contemporaries, but oscillator functioning can be checked by disconnecting R4 from the H.T. line and inserting at this point a meter switched to read 0-10mA. The current flow should then be noted, and the value should alter when spills 8 and 9 of L2 are momentarily short circuited. Should no change be detected the oscillator is not operating and no

frequency changing can occur. The remedy lies in checking that part of the circuit very carefully and reducing R4 to 10k or increasing the value of C3 to, say, 100pF.

When the oscillator is working, the above test should be made at several points on the tuning scale, for it is quite possible for it to cease functioning at a particular frequency. Should no signals be heard when oscillator operation is satisfactory, try removing V1 and temporarily connecting a lead from pin 6 on its base to pin 6 on V2 base. If signals now result, V1 or the associated circuitry is at fault and should be investigated.

Modifications

Where the output is considered insufficient or where the broadcast receiver used with it is of low sensitivity, improved converter efficiency would result from fitting a further valve of the type specified for V1 and using it as an intermediate amplifier. The principle is shown in Fig. 7 where V3 is the added valve. Coil L3 is removed from the frequency changer anode and a miniature 1-6Mc/s I.F. transformer fitted instead. The amplified output is taken from L3, which is transferred to V3 anode. Extra care must be taken in a circuit of this kind to ensure adequate rejection of signals in the 1-5Mc/s band and a wavetrap tuned to the frequency might become necessary at the aerial input.

Fig. 6—A circuit modification to increase output.

MEDIUM WAVE POCKET SUPERHET

(Continued from page 387)

weak signals, to keep volume down. Final adjustment should be at frequencies a little from the extreme ends of the bands, once it has been found that band coverage is satisfactory. It may be difficult to keep volume down to a level where the effect of adjustments can be easily heard, when aligning with broadcast stations. If so, rotate the whole receiver, to make use of the directional properties of the rod, to reduce volume. During alignment, volume should not be reduced with the receiver volume control, or an exact setting of trimmers and cores will be difficult to find.

Reproduction should be at adequate volume and of pleasing quality. Should results sound extremely distorted, it is probable that one secondary of the driver transformer has been wrongly wired, in error. If so, reverse leads to one secondary.

The tuning knob should rotate with a little clearance. If not, a washer may be needed under it. The set can be used flat, or standing, with the rod horizontal. Only in rare instances need the receiver be rotated for best signal pick up, as volume should easily be sufficient.

The new version of the P.W. Pocket Superhet case can be used for this receiver; the use of this case will facilitate construction since it is larger than the original.
Short-wave Listeners' Log

Unless conditions are very bad, listening on these bands will almost certainly furnish some Dx (long distance) stations, and 15m and 20m are often termed the "Dx bands". When conditions are good, signal strength from remote counties may be good enough for satisfactory reception with simple 2-valve and similar receivers.

SERVICING TAPE RECORDERS

(Continued from page 404)

of the recorder, whilst leaving a reasonable margin on the recording level control for low level signals.

Fig. 27 shows a very convenient arrangement, where the attenuator comprises R1 and R2. The single-pole, two-position switch allows the set's loudspeaker to be used as programme monitor when required, whilst in the "loudspeaker off" position, the output stage is automatically loaded by R3. This resistor, of course, should have a value equal to the impedance of the loudspeaker.

Values for R1 and R2 are well worth considering. From the impedance aspect, there is not too much to worry about by connecting 3Ω across a megohm or so of the radio input socket. On the face of it, there would appear to be a bad case of mismatching, but in practice this has remarkably little adverse effect. Overloading is the chief trouble. However, when an attenuator is employed, the impedance can be stepped up to the tape recorder input so that the match is more theoretically exact.

R1 and R2 simply form a potential-divider. That is, all the signal is applied across the two resistors in series and only a fraction of it is tapped off from across R2. Ignoring the loading effect of the recorder input circuits, then in proportion the voltage across R2 is equal to R2 divided by the sum of R1 and R2. For example, take R1 and R2 as 100k and 20k, then R2 would be 50 divided by 150, which is one-third. Meaning that one third of the full voltage from the set's output stage would be fed to the recorder.

In practice, the applied signal would be a little below one-third, since R2 would be shunted by the input impedance of the recorder which, in effect, would reduce the value of R2 in relation to R1, but this should not make a lot of difference in the majority of cases. Thus, the attenuator can be made any required value simply by working out suitable combinations of resistors, as explained above. The value of 100k and 50k may well be used in practice, and this would mean that the input of the recorder would see a resistance almost equal to 50k and 100k in parallel, which is approximately 33k.

The signal should be conveyed, via screened cable, the R2 side of which should be connected to the braid and earthed. But beware at this point, since the set may have a "live" chassis; that is, connected to one side of the mains supply to follow the now popular A.C./D.C. technique. This aspect of recording, however, will be discussed in next month's article.

(To be continued)
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<th>Type</th>
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<td>T.816</td>
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<td>£2.12.3 diecast</td>
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PRACTICAL WIRELESS September, 1962

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Noisy Volume Controls

HINTS FOR THE SERVICEMAN ON CURING A COMMON FAULT

By E. Dexter

(Continued from page 345 of the August issue)

The reader was introduced to three examples of correct and incorrect circuitry associated with volume controls in last month's article (Figs. 3, 4 and 5, pages 342 and 345).

Fig. 4 shows a volume control used in the same arrangement as Fig. 1, which is basically permissible, but the value is now made very high. If the grid leak of a valve is higher than half to one megohm, quite considerable D.C. voltages may be developed across it due to the electron-current reaching the grid of the valve by virtue of the electrons' energy of ejection from the cathode, even though the actual grid voltage may still be quite negative, and thus, theoretically, electron grid-current not to be expected. Thus no volume control track used directly in the grid leak position of a valve should have a total resistance exceeding about 500k. If a greater resistance is, for any reason, desired, then another blocking condenser or separate grid leak, as in Fig. 4b, should be used. Otherwise the volume control is likely to become noisy very quickly.

Fig. 5 gives a typical example from transistor circuitry. It is common practice in modern high-gain transistorised amplifiers to insert the volume control not right at the input to the first stage but between the first and second stages, so that signal-to-noise ratio is improved with reduction of volume (this feature is good practice in all high-gain amplifiers, valve or
transistor, yet carries the danger of running the input unprotected from overload at the first stage.

Now a transistor, in contrast to the grid-circuit of a valve, always draws current at its input, with a D.C. component also in addition to the A.C. signal component. Thus the transistorised version of Fig. 1 is fundamentally incorrect in a transistor amplifier. The subsequent transistor will always draw D.C. through a volume control track if all or part of this were used as the direct-coupled input resistance to the stage. Thus, if a volume control is used between two transistor stages, a blocking condenser must be used on both sides of it. For a volume control between two valve stages we saw that a blocking condenser on the input side generally suffices, provided that the resistance of the volume control is not too high. Fig. 5b shows the correct arrangement for a volume control between two transistor stages.

**Input Terminals for Amplifiers**

The arrangement of Fig. 6 is often used for the input to the first stage of an amplifier. This is quite satisfactory as long as pure A.C. signals are applied as inputs. As soon as the signals contain a D.C. component, noisiness is likely. The arrangement of Fig. 7 would prevent the D.C. component shifting the operating point of the input stage, and thus prevent distortion under such circumstances. But, as the discussion in this article should have made clear, it will not remove noisiness in the presence of a D.C. component in the input signal. The arrangement of Fig. 8 will, however, remove this trouble, too. Thus Fig. 8 is considered to be the ideal arrangement for the input to an amplifier if the volume control is to be situated there. This circuit pattern applies equally to valves and transistors.

**Time Constants**

Consider Fig. 9. Here we have a transistorised amplifier input circuit, following the scheme of Fig. 8 and with typical component values given. Suppose now we feed this amplifier from a signal source containing a D.C. component and having an internal resistance of 2M—for the purposes of illustrating the following argument with an intentionally severe example. The input electrolytic C3, of 50 µF, will now need to charge up to its final resting potential difference through a total resistance of 2M. This represents a time constant of 100 seconds. Charging will not be complete until three to five times this time. Thus it will take about five minutes. All this time D.C. will be flowing in the volume control track. The symptoms are thus that, upon switching on, the volume control will be extremely noisy, becoming gradually less and less so, until after some five minutes it will be quiet. This procedure will repeat itself every time the apparatus is switched on after a rest!

This point is trivial for valve circuits where capacities of coupling condensers are so small that time-constants are normally smaller than the filament-warming-up times of the valves. But for transistors, where large capacities are common, the point must be watched.

However, an arrangement such as Fig. 9 is undesirable anyway on account of its large signal attenuation (unless this is deliberately wanted). Furthermore, C3 is an electrolytic operating in a low-current, high-impedance circuit—or with a high-impedance-to-capacity ratio. Under such circumstances electrolytes have been known to function as electrolytic rectifiers, giving severe signal distortion. Thus, if a high-impedance source is to feed a low-impedance transistor input circuit, it is desirable to interpose a cathode-follower, an emitter-follower, or a transformer.

**Intermittent Faults in Coupling Condensers**

The author has had receivers in for repair where intermittent, or permanent, crackling (of low rumbling pitch) appeared alone or in conjunction with volume control crackling of the usual relatively high pitch. This type of fault is indicative of intermittent or randomly-variable leakage in a coupling condenser. The variability of this fault—i.e., its A.C. component—is shunted by the capacity of the coupling-condenser, removing higher harmonics; hence the low pitch.
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September, 1962
**POWER DISTRIBUTION UNIT**

The latest addition to the range of distribution boards made by Lexor Electronics Ltd., is the 'Dis-board' portable unit.

This unit is available in 2-, 4- and 6-way groups of 5, 13 or 15A sockets. The finish can be either in brown or ivory and the sockets may be switched or unswitched.

There is a wide variety of extension cables and plugs which can increase the usefulness of any particular unit. The 'Dis-board' is connected to the mains outlet by a length of heavy-duty flexible cable.

List prices range from £3 9s. 6d. to £5 19s. 0d. and all standard combinations (and the available combinations and types now exceed 300) are available from stock.

The manufacturers are Lexor Electronics Ltd., 25 Allesley Old Road, Coventry, Warwickshire.

---

**TRANSISTOR PORTABLE**

A new six-transistor pocket portable receiver has been introduced onto the market recently by Pam (Radio and Television) Ltd. The printed circuit gives a maximum output of 45mW through a 2in. loudspeaker. This set will tune over the medium wave band and also provides the Light programme on long waves.

The dimensions of the receiver are 4in. x 2½in. x 1in. and the grey polystyrene cabinet has a facia of white and gold. A socket is provided in the cabinet for a 10Ω impedance ear-piece.

The power for the set is supplied by three 1·5V cells, giving a total of 4·5V. The price of the set is 10½ guineas and an optional carrying case is available at 7s. 6d. extra. Pam Radio and Television Ltd., 295 Regent Street, London, W.1.

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**STABILISED POWER SUPPLY**

This Heathkit power supply kit—model MSP-1—has been developed by Daystrom Ltd.

The stabilised D.C. output is variable over a range from 200 to 410V, by a control mounted on the front panel. Separate transformers are used for H.T. and L.T. supplies and Mains H.T. supplies are indicated by two neon lamps. A 3-position off/stand-by/on switch enables the D.C. outputs to be switched off while leaving the heater supplies connected. The unit also features an unstabilised 6·3V A.C. centre-tapped output at 4·5A.

Two models are available, one with meters and one without. In the former model, the meters are 3in. moving coil instruments; a voltmeter reading 0-400V, and a milliammeter reading 0-25mA.

The unit is of all steel construction and the cabinet is louvred to ensure adequate ventilation. The dimensions of the cabinet are 13in. x 8½in. x 9½in. The kit is made by Daystrom Ltd., Gloucester.
thene used is completely inert and will not affect protective coatings on either metal or glass cased components. Tests indicate that these clips do not limit transistor heat dissipation and can be used over a range of ambient temperatures from $-55^\circ$C to $+70^\circ$C.

Type B is formed from beryllium copper, hardened by heat treatment. One clip covers both 5 and 6mm diameter transistor units.

The Plessey Co. Ltd., Ilford, Essex.

IMPROVED MULTIMETER

A n improved version of the Taylor 20,000Ω/V pocket size multimeter (model 127A) has been recently announced.

A feature of the new model is the facility for measurement of high D.C. The instrument now has a special “millivolt” socket and a range of “plug-in” miniature shunts is now available for readings of 0.1, 5 and 10A D.C. These shunts are designed to locate directly into the millivolt sockets incorporated in the Model 127A, thus forming a compact unit for measurement of high D.C. current.

A new type of ohms adjust control is now fitted which ensures greater stability and an improved type of A.C./D.C. selector switch is also incorporated.

The instrument is made by Taylor Electrical Instruments Limited, Montrose Avenue, Slough, Buckinghamshire.

COMMUNICATIONS RECEIVER

T HE model CR 66 is a new communications receiver kit from the Codar Radio Company.

The CR 66 covers a frequency range from 540kc/s to 30Mc/s in four ranges. The separate main tuning is calibrated in frequencies and the bandspread is calibrated in degrees. The circuit includes a regenerative I.F. stage for maximum gain and BFO for C.W. reception.

The size of the cabinet is 16in. x 6\frac{1}{2}in. x 8\frac{3}{4}in. and the front panel is finished in silver and black. An output socket is provided for tape recorders etc. and also one for an external speaker.

The total cost of parts, less the cabinet, is £16 10s. and the cabinet costs £1 15s.

The kit is made by the Codar Radio Company, Colebrook Road, Southwick, Sussex.
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Post: W. A. BENSON (W.W.), 136 Rainworth Road, Liverpool 15, S.E.P. 6532.

OTHER THAN TRANSISTORS.
In last month's article a description of the circuit was followed by details of the construction of the chassis. Now the constructor may proceed to the next stage, which is wiring.

![Diagram](https://www.americanradiohistory.com)

**Fig. 4—The complete wiring diagram.**

- Valve mounting platform shown laid flat to clarify wiring
- Mains transformer
- Transformer earthing connections to chassis
- Output transformer
- Tags marked 'MC' denote earthing connections to chassis
The chassis of the receiver can be wired up independently of the remainder of the circuit. Wiring is simple but the valveholders are best attended to first. In the layout and wiring diagram (Fig. 4), the valve platform is shown pressed out flat so that the underside connections may be seen clearly. Use of modern miniature capacitors and resistors is desirable in order to prevent undue congestion and the electrolytic decoupling capacitor, C8, should be a miniature type.

Testing

The usual tests and checks for faults in the wiring, etc. are made with a testmeter prior to switching on, particular care being taken to ensure that the mains wiring is correct. A three-pin plug should be fitted to the end of the mains lead in the correct sense and a pair of attractive control knobs fitted to the receiver. If all is in order, the receiver may be switched on and an aerial (a few feet of wire will do) connected. It should then be possible to tune in various transmissions by operating VC1 and VR1 judiciously, care being taken not to let the receiver oscillate. The precise setting of TC1 will depend upon the aerial in use, location, etc. but the best position can soon be found by experiment, the smallest capacitance possible probably giving the most satisfactory results over the band. The value of C7 can also be altered experimentally; for example, if reproduction tends to be shrill, the value may be increased to 5,000pF or more as required.

Housing the Receiver

All the woodwork dimensions required are shown in Fig. 5. The sides are glued to the inside of the panel and are held securely by metal “L” brackets; wooden reinforcement blocks will also serve just as well. Quadrant (lin.) is glued to the top of the panel and sides to form a frame mitred at the front corners. Similarly, quadrant is fitted to the inside edges of the loudspeaker aperture.

Fig. 5—The method of construction used by the author in making a suitable cabinet for the receiver.

A view of the interior of the completed set.

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PRECISION COMBINATION VOLTMETER/AMMETER FOR A.C. AND D.C.

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1-VALVE SHORT-WAVE RADIO

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P. & P. 7/-

The "REVILO"

This transistor receiver uses high quality
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and tested to give the best possible
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An inexpensive little set, with built-in ferrite rod
aerial transmits in medium waves at wonderful
volume. Light case, size only 10 x 3 x 3 in. Puts
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**Circuit**

It will be seen that the circuit (Fig. 1) is a completely conventional 4-valve superhet covering full medium wave and sufficient of the long wave to tune the Light programme, at good strength, anywhere in the country.

The actual lay-out has been very carefully arranged to achieve a neat and compact design and from the group-board wiring diagrams (Figs. 2 and 3) it will be seen that practically all the small components can be mounted on to two group-boards which can be completely assembled and wired up before fitting to the chassis.

The original prototype had the chassis and front panel made in one from a single piece of aluminium, but this had several disadvantages and it will be found much easier to make these as two separate items as shown in Figs. 4 and 5.

**Wiring the Group-boards**

Before assembling any components on to the chassis, it will be best to wire and mount the smaller components on the two group-boards; the exact position of these and the method of wiring up at the back of the boards will be seen quite...
clearly in Figs. 2 and 3. It is recommended that one end of the board is marked in some way, as it is quite easy to be confused when constantly turning it round for wiring up.

As these group-boards have to be bolted to the main chassis, remember to leave the two relevant components off until the boards have been mounted, to enable the screws to pass through the holes. It is also important to note that an insulated back-plate is placed between the back of the board and the chassis.

Mounting the Major Components

Having completed and fitted the tag-boards, the next step is the mounting of all the main components to the chassis taking particular note of the orientation of the valveholders. The I.F. Transformers have similar windings for primary and secondary and it is not important which way round they are fitted. Some constructors may prefer to leave the front panel with its associated controls and parts separate from the main chassis until later in the assembly, and it is suggested that a strip of insulation tape along the inside lower part of this front panel is a useful precaution as the clearance between it and the group-board tags is rather small.

It is advisable to leave the ferrite rod aerial to last as some alterations to it are necessary before fitting, and also it will eliminate the risk of breaking or damaging it during construction.

The two-gang tuning condenser is mounted from the front of the panel using three countersunk 4BA screws. (Ensure that these are cut down short enough to prevent them from projecting through and interfering with the movement of the vanes of the condenser.) The loudspeaker can also be mounted in a similar manner.

(Continued on page 437)
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Immediate Dispatch Service!
Best Value for Money!
All items advertised have been approved by our technical team of qualified engineers.

TUBULAR BAFFLE EXTENSION SPEAKER
Most adaptable of all speakers. Mounts vertically or horizontally, or sits on desk.

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P. & P. 7½.

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TWIN HEADPHONES

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**SET OF LUSTROUS CRYSTAL PLASTIC KNOBS, PUSH-ON TYPE, SUITABLE FOR ANY RADIO OR RADIOGRAM.**

**Dimensions:** Large 2½in., Small 1½in.

**LIST**

- 47/½ Three knobs, as illustrated, for direct drive tuning, with attractive red centre discs
- 46/½ As above, with cursor dial for slow-motion tuning
- 45 Tuning gear, diameter 2½in., lustre gilt finish, printed MW and LW stations and wavelengths in red and black

Above knobs, with smart gold lustre centres, extra per set.

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- 51B Case handiwork, red plastic, to suit 1½in. flexible handle, 4 BA x 1 in. fixing
- 51G Bracket as above, but brilliant gilt lustre finish pair
- 52C Speaker escutcheon grille, red plastic, 3in. x 3in.
- 52G Grille as above, but attractive gilt lustre finish
- 53C Post for case, black plastic, 1½in. x ½in.
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- 54 Tuning knob for above, only control, 200-500M and long wave
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September, 1962

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**TRANSISTORISED WIDE-RANGE SIGNAL GENERATOR 27**

220 kc/s to 220 Mc/s

**CHECK THESE FEATURES!**

- **COMPACT!** Only 6½ x 4¼
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  - **ment loft array, 8½/- Element. 30½/-, Wall mounting, 3 Element, 9½/-, Element 4½/-.

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7½/-, postage 6d.


Radio Valve Data, by "Wireless World", 6/-, postage 6d.

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**3-TRANSISTOR POCKET RADIO**

**with miniature loudspeaker**

No SOLDERING No DRILLING

3 transistors and 4 diodes. Full medium wave coverage. Size 4½ x 2¼ x 1¾. Full instructions provided.

47/- Battery 1/½ P. & P. 2/- extra

All parts sold separately

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and 2 diodes, in 3 stage reflex circuit. Size 4½ x 3½ x 1¼.

Battery 2/½. P. & P. 2½ extra.

57/-

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---

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**HOLE PUNCHES**

**Instant Type**

<table>
<thead>
<tr>
<th>diameter</th>
<th>#6 ea.</th>
</tr>
</thead>
<tbody>
<tr>
<td>⁵⁄₈</td>
<td>6</td>
</tr>
<tr>
<td>⁷⁄₈</td>
<td>6</td>
</tr>
<tr>
<td>¹⁰⁄₈</td>
<td>6</td>
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</table>

**Screw-up Type**

<table>
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</tr>
</thead>
<tbody>
<tr>
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<tr>
<td>¹⁰⁄₈</td>
<td>6</td>
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<td>¹³⁄₈</td>
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<tr>
<td>¹⁵⁄₈</td>
<td>6</td>
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<tr>
<td>¹⁷⁄₈</td>
<td>6</td>
</tr>
<tr>
<td>²⁰⁄₈</td>
<td>6</td>
</tr>
</tbody>
</table>

**Postage and packing 1/-**

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**Oliver & Randell Ltd**

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The chassis of the receiver viewed from above.

Some slight alterations will need to be carried out to the rod aerial before fitting. In the first place it will be found that there are low impedance coupling windings over the top of each of the two coils and these were removed completely. If it is desired to use this set with a car radio aerial in a car these windings may be left on and taken in parallel to a suitable socket for the car aerial. In the prototype it will be seen that the medium wave winding is connected to the upper two tags with a miniature 60pF trimmer soldered into position, and the long wave winding is connected to the lower tags and another 60pF trimmer positioned in parallel.

Components List

Resistors (All 1/2W 10%)

<table>
<thead>
<tr>
<th>R1</th>
<th>82k</th>
<th>R5</th>
<th>2.2M</th>
<th>R9</th>
<th>1M</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2</td>
<td>33k</td>
<td>R6</td>
<td>100k</td>
<td>R10</td>
<td>2.2M</td>
</tr>
<tr>
<td>R3</td>
<td>27k</td>
<td>R7</td>
<td>10M</td>
<td>R11</td>
<td>390Ω</td>
</tr>
<tr>
<td>R4</td>
<td>27k</td>
<td>R8</td>
<td>2.7M</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VR1</td>
<td>2M log. with D.P. switch</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Capacitors (All miniature components)

<table>
<thead>
<tr>
<th>C1</th>
<th>0.04µF 150V</th>
<th>C8</th>
<th>100pF mica</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2</td>
<td>0.04µF 150V</td>
<td>C9</td>
<td>0.04µF 150V</td>
</tr>
<tr>
<td>C3</td>
<td>100pF mica</td>
<td>C10</td>
<td>0.04µF 150V</td>
</tr>
<tr>
<td>C4</td>
<td>100pF mica</td>
<td>C11</td>
<td>0.04µF 150V</td>
</tr>
<tr>
<td>C5</td>
<td>500pF mica</td>
<td>C12</td>
<td>2µF 150V elec</td>
</tr>
<tr>
<td>C6</td>
<td>0.01µF 150V</td>
<td>C13</td>
<td>25µF 15V elec</td>
</tr>
<tr>
<td>C7</td>
<td>0.01µF 150V</td>
<td>C14</td>
<td>33pF mica</td>
</tr>
<tr>
<td>VCI, V2</td>
<td>500/500pF 2 gang tuning (Jackson type L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TC1, TC2</td>
<td>60pF miniature compression trimmers</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Valves

<table>
<thead>
<tr>
<th>V1</th>
<th>DK96</th>
</tr>
</thead>
<tbody>
<tr>
<td>V2</td>
<td>DF96</td>
</tr>
<tr>
<td>V3</td>
<td>DAF96</td>
</tr>
<tr>
<td>V4</td>
<td>DL96</td>
</tr>
</tbody>
</table>

Two Denko IFT.11 I.F. transformers (465kc/s)

Miniature output transformer

Oscillator coil (Weymouth radio type H03)

Switches

<table>
<thead>
<tr>
<th>S1</th>
<th>D.P. switch on VR1</th>
</tr>
</thead>
<tbody>
<tr>
<td>S2</td>
<td>D.P.D.T. slider switch</td>
</tr>
</tbody>
</table>

69V + 1.5V battery

Miniature 14-way and 5-way group-boards

Medium and long wave aerial (Repanco FS2)

2½-in 3Ω loudspeaker

Miscellaneous:

Valveholders; knobs; battery plug; nuts; bolts; etc.

(Continued from page 434)

Using 4BA. countersunk screws with nuts on the inside to make it secure. When all the parts have been fitted to the front panel it can be completed by covering with fine mesh expanded metal, or loudspeaker covering material, leaving a small aperture for the miniature wave-change switch. If it is intended to fit dials one can be mounted under the fixing nut for the volume control and the other one for the tuning indicator is best secured by using contact adhesive.

Most of the wiring is quite straightforward and obvious from a study of the diagrams. In order to simplify the wiring...
Sufficient length of lead should be left to allow both these coils to be moved along the ferrite rod for tuning to the best position. It should be noted that this aerial coil wire is Litz and it is essential when making soldered joints that every single strand is carefully cleaned and tinned otherwise performance may be affected. The ends can be carefully cleaned by placing on a firm surface and scraping gently with fine emery cloth, or another method is to heat the wire ends in a small flame and while still hot, plunge them into methylated spirit after which the ends can be wiped clean and then soldered.

(To be continued)

**Power Rectifier Circuits**

(Continued from page 397)

Resistance of the transformer winding is often an appreciable fraction of this value, and added to this there is already the internal resistance of the rectifier present. Thus surge limiters of at the most a few hundred ohms will be needed with a PY81, however large the smoothing capacitors may be made. Under the conditions of Fig. 19 where the smoothing capacitors are only $5\mu F$ each, no limiting resistor was deemed necessary. It is in fact good practice not to make the smoothing condensers too large in the power supply itself, providing the additional smoothing internally in each consumer circuit connected, in the form of a large series resistor and electrolytic condenser, as shown in Fig. 27. This provides decoupling and smoothing in one, and avoids unnecessarily large rectifier surge currents.

**Values**

Good power supply designs use surprisingly small values for the smoothing capacitors, often only a few microfarads, especially for the first capacitor (the "reservoir" condenser) connected directly to the rectifier. If insufficient smoothing is thereby achieved, then electronic stabilisation is resorted to, which gives far lower internal impedances and far greater smoothing than is achieved by haphazard increases of smoothing capacities, and far lower strain is imposed on the rectifiers. Several such circuit designs have been published in this magazine.

All circuits using large values of smoothing capacitors connected directly to a rectifier are to be considered basically as compromises in compact or cheap-to-construct apparatus, where it is not deemed desirable to waste too much space or attention on the power supply. Such circuits give very reasonable performance life if capacities not exceeding about $32\mu F$ are connected direct to the output of normal valve rectifiers, and not exceeding about $64\mu F$ for metal rectifiers, and not exceeding about $100\mu F$ for silicon power-rectifiers. However, these figures must be treated as mere, very rough guides. The higher the reservoir capacity, the greater the strain on the rectifier, and the more is its useful life likely to be shortened.

**Domestic Equipment**

In domestic radio sets and other equipment subject only to intermittent service with long periods of rest, the matter is far less critical than for laboratory apparatus intended for long-period non-stop experiments. Thus the author is at present conducting experiments with Geiger-counter monitors for atomic radiation, for which a large quantity of electronic equipment is in non-stop operation day and night for weeks on end. If insufficient attention would have been given to proper design of power supplies, for example, frequent breakdowns would have been inevitable, which would have caused the loss of valuable measurements, as well as the trouble and expense of such breakdowns. Even for television circuits a higher measure of care is required for power-supplies than for simple radio receivers, because higher voltages and currents are involved, more expensive equipment is in danger in case of breakdown, and the operating hours of television sets in most families are longer than those of radio sets.
SETTING A NEW STANDARD FOR DISCRIMINATING CONSTRUCTORS
HUNDREDS OF TESTIMONIALS PROVE THE EFFICIENCY OF OUR DESIGNS

THE SUPER SEVEN
EASILY THE BEST
(7 Transistors plus 2 Diodes)
★ 2 R.F. STAGES.
★ Mullard and Surface Barrier Transistors.
★ Coverage of Medium, Long Waves, Trawler Band
★ Use as domestic radio, car radio or fit with strap for carry-about.
★ No aerial required except for use as car radio.
★ 3-inch speaker but will drive a larger speaker.
★ 400 milliwatts output stage.

SIZE: 7½ x 5½ x 1½ in.
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THE EASY-BUILD-7
MED/L.W.

Case as Super Seven.
Simple construction for beginners. 7 transistors plus 2 diodes. Performance will amaze you. May be built for ONLY £5.19.6
P.P. 3½. Parts price list and building plans 2½.

THE EASY-BUILD-7
MED/L.W.

400 Mw Mullard push-pull output Transistors. Powerful magnet 3in. high grade speaker. Push-pull transformers. This is a top performing receiver. Many 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.

Total building cost £4.19.6 P.P. 3½. Size 6½ x 4½ x 1½ in.
"Agreeably surprised with Trawler Band reception. Luxembourg as loud as local. Your easy build diagram helped a lot ... my first attempt." H. S., Penzance, Cornwall (poor reception area).

PARTS PRICE LIST and EASY BUILD PLANS 1½.

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(MW/LW and TRAWLER BAND)
(5 Transistors, plus 2 Diodes)

Designed round supersensitive FERRITE ROD AERIAL and 3in. moving coil speaker. Attractive case in black with speaker grille in red. On test Home, Light, Radio Luxembourg and many Continental stations were received.

Total cost of all parts £2.19.6 P.P. 3½

EASY BUILD PLANS AND PARTS PRICE LIST 1½

THE MELODY SIX
★ Ferrite road aerial.
★ 6 new type transistors and top quality components. Attractive case in blue and red and carrying strap with gold trim.
★ 3in. Speaker.
★ M.W/L.W.

£3.19.6
P.P. 3½

Components price list and plans, 2½.

BEGINNERS
PUSH-PULL FIVE
(5 Transistors, plus Diode)
★ M/C Speaker, 2in.
★ Ferrite rod aerial.
★ Tuning condenser.
★ Volume/orcillator control.
★ Case with speaker grille in red.
★ Fully tunable over med/long waves.
★ Simple assembly diagrams.
★ 250 Milliwatts output stage.
★ Can be built for 59/6 P.P. 3½, or with 3in. speaker 68/6
★ PARTS PRICE LIST, etc. 2½.

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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.C.R. COMMUNICATIONS RECEIVER

SIR,—I wonder if any of your readers could advise me as to what is the correct L.F. of the P.C.R. communications receiver currently available. Also, I would like to know, the make and type of a suitable BFO coil for use with half a 6SN7 in this set.

I would also be very grateful if anyone could sell or loan me a copy of the original circuit for the R.F. unit No. 24.—A. WATT (67 Glenhurst Avenue, Bexley, Kent).

AMERICAN STATION

SIR,—In answer to a query made by Mr. T. Gerrard in the July issue, regarding an American station he heard on the 32m band, the station is one of the American Telephone and Telegraph Co. radio telephone services. These stations are not engaged in broadcasting but are used solely for international communication.

A station which may be of interest to Mr. Gerrard and other readers, is WRUL, New York, which broadcasts some excellent programmes and is, in fact, the only commercial S.W. station operating from the U.S.A. The times of transmissions are 15.00-23.00 GMT on week days; 18.30-23.00 GMT at weekends. The frequencies for Europe are 15,380kc/s (19m band) and 17,760kc/s (16m band).—R. PATRICK (Derby).

SIR,—The transmission identified by T. Gerrard (July issue) as coming from an American station, is in fact a single sideband transmission by a German station.

The message in English is as follows: "This is a test transmission by a single sideband system operated by the Overseas Service of the Deutsche-Post Francis Main Terminal. Please give identification signal on channel A for receiver adjustment."

The other message is in German. — R. R. DIAMOND (Stockport, Cheshire).

MEDIUM WAVE FADING

SIR,—I have been having trouble with a 12-year-old McMichael receiver. It has the habit of fading on medium waves after it has been switched on for about 10 minutes.

The only way I have found to rectify this, is by disconnecting the aerial lead-in and connecting it to earth! Could any reader explain this or suggest another way of curing the fault? — K. CLOUGH (Bolton).

THE P.W. TROUBADOUR

SIR,—I have just completed constructing the P.W. Troubadour, 7-transistor receiver (June and July issues) and am amazed at its performance. This pocket set gives better selectivity, sensitivity and none-fade reproduction than some expensive models owned by friends. Although it does work out expensive if the constructor has not any of the components in stock, this receiver must surely be worth double the complete kit price.—W. W. CLOUGH (Bexley, Kent).

TELEVISION BREAK-THROUGH

SIR,—There have been a number of letters in recent issues about the reception of long-distance stations on crystal receivers and I think there is no doubt that in the majority of cases this reception is not direct from the station concerned, but re-radiated from a neighbouring aerial. I experienced a very similar effect some time ago, when I heard music as a background on my simple set, and on trying to resolve it found it was the BBC television programme. I felt that this could not be direct pick-up on account of the frequency used and my distance from the nearest station, and this was confirmed a little later when the station disappeared instantly—that is, it did not fade out. A few nights later I noted that the station returned, again in a sudden manner rather than a gradual signal strength build up, and I knew the people downstairs had a TV and made a few inquiries, as a result of which we carry out some tests, and the programme did, in fact, come from their aerial, which was of the indoor type, and their contrast control had to be full up. There was obviously some H.F. instability which resulted in the signal being radiated in this manner. I hope this will be of interest to others.—E. GOWING (Portsmouth).

CORRESPONDENTS WANTED

SIR,—I am 22 years of age, and I am interested in radio servicing as a hobby. I would like to correspond with amateur enthusiasts of my age from any country. — D. L. KIRIWANDALA, P.O. Box 732, Colombo, Ceylon.

SIR,—I am 16 years of age and would like to correspond with amateurs of my age. I have been interested in S.W. for about a year now.—BUTCH BONE, c/o Daw Thein Wa’s, Bookland, P.O. Box 294, 385 Bogyoke Street, Rangoon, Burma.
BRADFORD RADIO SOCIETY
Hon. Sec.: M. T. G. Powell, G3NNO, 28 Gledhow Avenue, Roundhay, Leeds 6.
On June 26th a number of members visited a firm of engineers. The two meetings for July consisted of an informal evening on 10th and a talk by G3KV—"160m SSB"—on 24th.

DERBY AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: F. C. Ward, G1CVV, 5 Uplands Avenue, Littleover, Derby.
G3ERD/P operated from Harborough Rocks, Brasington on July 7th and 8th for the second R.S.G.B. Two-metre Field Day.
L. Ball gave a talk on July 11th and the meeting for 18th was taken up by the fourth direction finding league fixture.
A sale of members' surplus equipment was held on August 1st.
Future Events:
August 15th—Direction finding league fixture, No. 5.
August 22nd—Stereophonic demonstration.

MIDLAND AMATEUR RADIO SOCIETY
Hon. Sec.: A. B. Watt, G12DRG, 11 Holly Road, Handsworth, Birmingham 20.
On Tuesday, 17th July, members attended a lecture given by H. C. Smith. The title of his lecture was "Tape Recording", and it was given at the Birmingham and Midland Institute.
Future Event:
August 21st—"G2DAF receiver for SSB" by G3LLN.

MORECAMBE AMATEUR RADIO SOCIETY
Hon. Sec.: K. J. Singleton, G3NLN, 8 Westmoor Grove, Heysham, Morecambe, Lancashire.
Meetings of this society are held on the first Wednesday of each month at the Liberal Club, Balmoral Road, Morecambe, and start at 7.30 p.m. Any new members will be made welcome.

For the July meeting, a number of members visited the automatic telephone exchange in Lancaster. The meeting for August was devoted to a ragchew.

NORTHERN HEIGHTS AMATEUR RADIO SOCIETY
Hon. Sec.: A. Robinson, G3MDW, Candy Cabin, Ogden, Halifax, Yorkshire.
Recent club activities have included a display of members' equipment which was held on July 4th.
As the meeting on August 1st, the society played host to members of the Manchester Radio Society, who gave a D.F. demonstration. On August 4th, members operated a demonstration station at the Warley Club and Institute Charity Gala.

PURLEY AND DISTRICT RADIO CLUB
Hon. Sec.: E. R. Honeywood, G12KG, 105 Whyteleafe Road, Purley, Surrey.
A portable expedition was held on the evening of July 6th, at Walton Heath. Operation was on Two-metres and Top Band.
On July 20th, members heard an R.S.G.B. tape recorded lecture which was illustrated by slides.
Future Event:
August 17th—Film of National Field Day.

RADIO CLUB OF SCOTLAND
Hon. Sec.: A. Barnes, GM3LTB, 7 Southpart Terrace, Glasgow W.2.
This is a new radio club which held its inaugural meeting on June 1st this year. Meetings are held every Friday evening, and commence at 8 p.m. A welcome is extended to anyone who is interested in the hobby of amateur radio. All interests are catered for but suggestions are always welcome for expanding the programme. The first Friday in every month is especially for beginners.

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QUOTATIONS FOR YOUR CIRCUIT BY RETURN

PRACTICAL WIRELESS September, 1962

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A LL 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.

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.

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<th>Title</th>
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<td><strong>CRYSTAL SETS</strong></td>
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<td>Junior Crystal Set</td>
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