Model 8 Universal AVO METER

Designed for Dependability

The Model 8 Universal Avo Meter is a high sensitivity multi-range a.c./d.c. electrical testing instrument providing thirty ranges of readings on a 5-inch hand calibrated scale. Range selection is effected by two rotary switches for a.c. and d.c. respectively.

The instrument has a sensitivity of 20,000 ohms per volt on d.c. voltage ranges and 1,000 ohms per volt on a.c. from the 100-volt range upwards, and meets the accuracy requirements of B.S.S.89/1954 for 5-inch scale length portable industrial instruments. It is robust, compact, and simple to operate, and is protected by an automatic cut-out against damage through inadvertent electrical overload.

### VOLTAGE

<table>
<thead>
<tr>
<th>D.C.</th>
<th>A.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.5V</td>
<td>2.5V</td>
</tr>
<tr>
<td>10V</td>
<td>10V</td>
</tr>
<tr>
<td>25V</td>
<td>25V</td>
</tr>
<tr>
<td>100V</td>
<td>100V</td>
</tr>
<tr>
<td>250V</td>
<td>250V</td>
</tr>
<tr>
<td>500V</td>
<td>500V</td>
</tr>
<tr>
<td>1,000V</td>
<td>1,000V</td>
</tr>
<tr>
<td>2,500V</td>
<td>2,500V</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CURRENT D.C.</th>
<th>A.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>50µA</td>
<td>100mA</td>
</tr>
<tr>
<td>250µA</td>
<td>1mA</td>
</tr>
<tr>
<td>1mA</td>
<td>2.5A</td>
</tr>
<tr>
<td>10mA</td>
<td>10A</td>
</tr>
<tr>
<td>100mA</td>
<td>—</td>
</tr>
<tr>
<td>1A</td>
<td>—</td>
</tr>
<tr>
<td>10A</td>
<td>—</td>
</tr>
</tbody>
</table>

### RESISTANCE

<table>
<thead>
<tr>
<th>D.C.</th>
<th>A.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0—20MΩ</td>
<td>—</td>
</tr>
<tr>
<td>0—200MΩ</td>
<td>—</td>
</tr>
<tr>
<td>0—2,000MΩ</td>
<td>—</td>
</tr>
</tbody>
</table>

### DECIBELS

-15dB to +15dB

Various external accessories are available for extending the above ranges of measurement. Leather carrying cases are also available if required.

Dimensions: 8½" x 7½" x 4½". Weight: 6½ lb.

Write for fully descriptive folder or for complete catalogue of AVO Instruments.

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Kit of new parts, comprising chassis, mains and output transformers, valves, etc. (F11, 9504, 7845) and all components. With full instructions for making high gain amplifier with separate base and screen controls, sensitive sound back, etc. Truly mains operated.

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a.s.d.

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P.V.C. Bright colours. Five 250', code only

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COMPARE OUR PRICES

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MW 33/74
£33.15.0

VALUE!
4 watt AMPLIFIERS
Excellent amplifier with high gain preamp stage, 100W output stage, automatic gain control, complete with Sin.

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Quality Prices or Quotes for items not listed, particularly rare valves.

TECHNICAL TRADING CO.

January, 1964

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TECHNICAL TRADING CO.

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and leather with
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Revolutionary INTERNAL
FERRITE AERIAL makes
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Powerful, superb tone and clarity
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Completely portable, only 6 x 3 x 1½. Two-tone
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and s.w. Extra. Contact us
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ULTRA-MODERN CASE, use
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"Thank you for the SAN
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superior than expected."

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HV PROBE. HV-336 measures up to 30,000V D.C.
£2.19.6 Kit

RF SIGNAL GENERATOR. Model RF-1U. Up to 100 Mcts fundamental, 200 Mcts harmonics. Up to 100 mV output on all bands
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MULTIMETER. Model MM-1U. Ranges: 0-1.5 v, to 1,500 v, A.C. and D.C.; 150µA to 15A D.C.; 0.02% to 20µUA 4½in. 50Ω meter.
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"OXFORD" LUXURY TRANSISTOR DUAL WAVEBAND RECEIVER. The ideal domestic, car or personal portable receiver. 10 Semi-conductors. Solid leather case. Send for full details.
Incl. P.T. £14.18.0 Kit

6 TRANSISTOR PORTABLE. Model UXR-I. Prealigned I.F. transformers, Printed circuit, 7in. x 4in. high flux speaker. Real hide case. Very easy to build.
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7 TRANSISTOR PORTABLE. Model RSW-I. Two short, trawler and medium wave bands.
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- You get professional appearance and performance with every model.

**HI-FI AMPLIFIERS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>18W STEREO AMPLIFIER, Model S-99</td>
<td>Ganged controls. Stereo/Mono gram, radio and tape recorder inputs. P/B selection.</td>
<td>£27.19.6 Kit.</td>
</tr>
<tr>
<td>6W DE-LUXE STEREO AMPLIFIER, Model S-33</td>
<td>Inexpensive stereo/mono amplifier with high sensitivity. Suitable for use with Decca Deram cartridge.</td>
<td>£13.7.6 Kit.</td>
</tr>
<tr>
<td>SW HI-FI MONO AMPLIFIER, Model MA-5</td>
<td>A low priced amplifier based on the S-33. Printed circuit construction makes it easy to build.</td>
<td>£10.19.6 Kit.</td>
</tr>
<tr>
<td>HI-FI SINGLE CHANNEL AMPLIFIER, Model MA-12</td>
<td>Ideal for use with Models USC-1 and UMC-1. 0.1 THD at 10 W. Wide freq. range.</td>
<td>£11.18.0 Kit.</td>
</tr>
</tbody>
</table>

**NEW MODELS**

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUBLIC ADDRESS AMPLIFIER, PA-1</td>
<td>For vocal and instrumental groups, guisiers, etc. 50 W rms, 100 W pk output, 4 inputs, 2 loudspeakers. Send for full details.</td>
<td>£74.00 Assembled £54.15.0 Kit.</td>
</tr>
<tr>
<td>COMMUNICATIONS TYPE RECEIVER RG-1</td>
<td>A high performance low cost receiver for the discriminating listener. Freq. cov. 600 kc/s-1.5 Mc/s and 1.7 Mc/s to 32 Mc/s. Send for details. £53.00 Assembled.</td>
<td>£39.16.0 Kit.</td>
</tr>
<tr>
<td>SELF SUPPORTING AERIAL TOWER KIT, Model HT-1</td>
<td>Ideal for Amateur Radio or TV reception, etc. Strong steel construction, height 32 ft. tapered square section 3ft. x 3ft. at base. Kit £29.15.0 Oxide Painted. £35.15.0 Galvanised. Accessories available. Send for details.</td>
<td>£29.15.0 Kit.</td>
</tr>
</tbody>
</table>

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Full details of model(s)__________________________

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ADDRESS ________________________________

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BUILD YOUR SHORT WAVE LISTENING STATION WITH CODAR-KITS.

CR 66 COMMUNICATIONS RECEIVER

THE FINEST SUPERHET KIT EVER OFFERED

🌟 Frequency Range
$40 \text{ Kc/s}$ to $30 \text{ Mc/s}$ in four Bandswitched ranges.

Electrical Bandspread. Coil Unit wired ready and I.F. Transformers factory aligned, no test equipment required. Temperature compensated trimmers. Regenerative I.F. stage for maximum gain and B.F.O. Panel aerial trimmer, separate speaker switch, 3 watts output for external 2-3 ohm speaker. Separate cathode follower for tape recording etc. Valve line-up—ECC81, EBF89, ECC81, EL84, EZ80, EM84 (Optional extra). For 200-250 volt A.C. Cabinet size $16 \times 6 \times 9$ in. Complete Kit with 17-page Instruction Manual Carriage $6\text{f}$. Tuning indicator parts with EM84, 1716. H.P. TERMS AVAILABLE ON REQUEST.

OUTSTANDING SUCCESS AT THE RADIO COMMUNICATIONS EXHIBITION

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P.R. 30 R.F. PRESELECTOR ★

Frequency range 1.5-30 Mc/s. Substantially improves the performance of any superhet receiver.

G4HZ writes . . . I am delighted with it, it improves my Eddystone 640 in all respects. The difference with the Preselector is fantastic, a weak signal on 15 metres about 52 changed to SB. On the I.F. Bands, unwanted noise and mush is cut out. G3RJA writes . . . The results in conjunction with my Eddystone 888 are amazing. Signals are twice as strong with much higher signal/noise ratio. A first-class product well worth the money. The P.R.30 uses EF183 Frame Grid R.F. Amplifier and provides up to 20 dB gain. Features include vernier tuning, gain control, selector switch for either dipole or end fed antenna. External power supplies (obtainable from Rm). Smart styling in grey and black. Complete, ready for use, with all plugs, cables. Now available in two models.

P.R.30 for external power supplies 180-250 volts H.T., 6.3 volts $3\text{ amp.}$ L.T. (obtainable from receiver). £4.17.6 Carr. 316.

P.R.30X self powered with internal power supply for 200-250 volt A.C. Will provide 200 volts up to 25 W. and 6.3 volts 1 amp. for other accessories. £7.2.0 Carr. 316.

THE NEW CR 45 MAINS T.R.F. SHORT WAVE RECEIVER

World-wide short wave reception, North-South America, India, Russia, Far East, Australia, amateurs, shipping, etc.

★ Separate electrical bandspread.
★ Three slow motion vernier drives.
★ Low loss polystyrene plug-in coils, factory aligned.
★ Dials calibrated in frequencies and degrees.
★ Power output 3 watts for 2/3 ohm speaker.
★ Valve line-up: ECC81/EL84/EZ80.
★ Front Panel Silver and Black, control knobs Grey.
★ Provision for panel phone jack.


CR 45 Cabinet Silver Grey $12 \times 51 \times 7$ in. with sliding door for easy coil changing and detachable louvred rear panel. Instruction Manual only 41- post free. Extra coils 49f each.

THE MINI-CLIPPER

36/6

★ Miniature I valve short wave receiver.
★ Low loss polystyrene plug-in coils, factory aligned.
★ Air spaced ball bearing condensers.
★ Provision to add two-transistor amplifier.
★ Battery lasts months.

Can be built in one evening, ready to switch on, to bring the fascination of Short Wave listening at very low cost. Complete MINI-CLIPPER CODAR-KIT, valve, and one coil 25-75 metres, Instruction Manual 4 pages, 37/8, carr. 216. Extra Coils 49f each. Electronic Bandspread available. Instruction Manual only 2f, post free.

THE SUPER CLIPPER

88/6

★ Peak Performance short wave battery receiver.
★ Large precision dial, dual slow motion drives.
★ Bandspread on all Bands.
★ High gain valve/transistor hybrid circuit.
★ Mullard transistor amplifiers pre-assembled and tested.
★ Low loss polystyrene plug-in coils, factory aligned.
★ Batteries last months.

Easy to assemble, this famous Short Wave Receiver brings a new world of listening pleasure to your finger tips. Complete SUPER-CLIPPER CODAR-KIT, valve, transistors, 2 Coils 20-60, 55-180 metres, Instruction Manual 7 pages, 88/6, carr. 216. Front Panel Silver Grey, 10 x 7 in. 6f extra if required. Extra Coils 49f each.

CODAR-KITS are famous for PEAK PERFORMANCE, EASY TO FOLLOW INSTRUCTIONS, CLEAR PICTORIAL DIAGRAMS. Some of the Top Quality names who supply material for CODAR-KITS . . . MULLARD, BRIMAR, JACKSON, DENCOR, ELECTRONIQUES, THORN, A.E.I. etc. etc. . . . only the best is good enough for the high CODAR standards which make complete success certain. 6d. in stamps brings illustrated leaflets.
Mullard 3-Valve Pre-amplifier TONE CONTROL UNIT

Designed mainly for Mullard Range of Amplifiers, also suitable for any Amplifiers requiring Input up to 300V. Incorporates Input Channels, including for Tape and Magnetic Pickups. Separate Bass and Treble controls. High pass filter 20 to 100 c/s, low pass filter 5-5Kc/s. Totally enclosed in case size 11" x 4" x 4".

KIT ASSEMBLED £10.00. (Carr. & Ins. 5/6)

Mullard "5-10" MAIN AMPLIFIER

For use with Mullard 2 or 3 valve pre-amplifiers with an undistorted power output of up to 10 watts is obtained. SPECIFIED COMPONENTS and MULLARD VALVES including PARTRIDGE MAINS TRANSFORMER are chosen and all the circuitry checked before Partridge Output Transformers. Simple and compact, the unit will be found in every home and at 2-1/2 Post Free.

COMPLETE KIT £12.00. (Carr. & Ins. 8/6)

Mullard "5-10" MAIN AMPLIFIER

THE MULLARD 5-10C AMPLIFIER

The popular complete "S-10" incorporating Passive Control Unit providing up to 10 watts high quality reproduction with Input of 600 mV. Specified components and new MULLARD VALVES, includes PARTRIDGE MAINS TRANSFORMER and choice of PARTRIDGE or PARMEKO Output Transformers. Surplus availability from Partridge. TUNING-UP EXTRA. Instruction book and detailed price list (free with kit) available separately at 2-1/2 Post Free.

COMPLETE KIT £16.00. (Carr. & Ins. 76/0)

Mullard 3-Valve Pre-amplifier TONE CONTROL UNIT

(a) THE KIT OF PARTS to build both the "5-10" Amplifier and the Pre-Amplifier...... £21.10.0

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(c) The PARTRIDGE OUTPUT TRANSFORMER £1.60 extra.

Mullard 3-Valve Pre-amplifier TONE CONTROL UNIT

PRICE

£15.15.0

£21.10.0

£19.10.0

£25.10.0

MULLARD 2-VALVE PRE-AMPLIFIER TRANSFORMER

Employing two E86 valves and designed to operate with the Mullard AMPLIFIERS but also perfectly suitable for other makes with input in 260 mV to 260 mV.

EQUILISATION for the latest R.I.A.A. characterisation.

INPUTS for Crystal Pick-ups and variable reluctance magnet types.

INPUT (a) Direct from High Imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier.

Sensitve Microphone Channel. Wide range BASS and TREBLE Controls.

KIT £6.6.0. ASSEMBLED and TESTED £9.10.0. (Carr. & Ins. 5/-)

Price reductions for full specification.

THE "TUDOR" STEREO AMPLIFIER

PRICE

£15.0.0

A self-contained Shelf-mounting Amplifier designed to provide high quality stereophonic and monophonic reproduction. Each channel provides a rated output of 6 watts and for monophonic operation approx. 12 watts is produced. Separate BASS and TREBLE Controls. The Cabinet is finished in Black Cralke. Size 14 x 8 x 31/2.

HI-FI STEREO HEADPHONES

PRICE

£9.10.0


STEREO STETHOSCOPE HEADSETS

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For the connoisseur who requires perfection. Each Earphone consists of a 23" Dynamic Loudspeaker with a full frequency range, fitted with large rubber Ear Pads for added comfort to keep out noise and to maintain an excellent bass response. The resistance-junction box with change-over switch provides simple transfer from Phones to Stethoscopes. Specifications: Frequency Range: 25-15,000 c.p.s. Input Impedance: 80 ohms. Power rating: 1 watt. Weight: 13 oz.

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PRICE

£10/6 P. & P.

SPECIAL PURCHASE! THE SHURE MODEL M30

Professional Dynamic Cartridge with Diamond Stylus, the Shure Dynetic Moving Magnet System combines the most faithful and distortion-free reproduction with complete reliability. Specifications: Diamond Stylus 0.7 thou. Load Imp. 7000 ohms. Output SmV Range 20-15,000 ohms. 3 DB. Stylus pressure 3-4 grams. PRICE £12 Gns.

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SEE FOLLOWING PAGE FOR ADDRESSES AND DETAILS OF OTHER STERN-CLYNE PRODUCTS

Great Britain's Greatest Electronic Hobbies Organisation
PRACTICAL WIRELESS
January, 1964

STERN-CLYNE

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THE 'HIGHWAYMAN'
OUR QUALITY CAR RADIO
TO BUILD YOURSELF AT
A NEW LOW PRICE

Look at these features:
★ Attractive styling. ★ Push-
button operation. ★ Three latest
models: high, low and sensitivity. ★ Printed circuit
(new type). 7 x 4 in. High flux p.p. speaker and sub-woofer. ★ Medium and
Long waves. ★ Push button for filter control. ★ Extremely low
battery consumption (less than 1 amp). ★ Easy to fit any make car.
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Special inclusive price of ONLY £7.19.6 Plus 5/- P. & P.
All parts available separately. Individually priced parts list and comprehensive
instruction booklet available on request. (Deducted from cost if complete parcel purchased later.)

THE 'AIR KING'
Our highly successful six-transistor
unit, with the 'SPEAKERS IN A LINE'
look. To build yourself. Printed
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allows any amateur to construct his
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weld! A.C. and L.O.D. wave
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★ 500 milliwatt output to high flux
30-channel stereo. ★ 35-channel stereo. 30m.
★ Six selected MULLARD TRANSISTORS
in latest supersensitive circuit plus per-
quartz diode. ★ Self-assembly complete size only 9 x 3
x 6.5 in. ★ Attractive three-tone cabinet, black, dark grey
and silver grey with gilt control knobs and all gilt fittings.
★ Coax. socket for car aerial. ★ Brand new guaranteed com-
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ONLY £7.19.6 Plus 5/- P. & P.
Full assembly details and individually
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TRANSISTORISED SOUND MIXER
Mixing 4 channels from high im-
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results. Inputs for high impedance
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Tape equaliser. 9 volt battery opera-
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PRICE 59/- P. & P. Complete with PP3 9v
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One of the finest general
communication receivers ever
available at this price.
Covers: 0-500kHz—16Mc/s,
5.44Mc—14.5Mc/s, 1.6Mc—
4.8Mc, 10.5Mc—30Mc/s.
Illuminated slide rule dial,
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8 valve plus Repeater super-
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B.F.O. control Q-mixer.
Controls: Function Switch, Audio Gain, SELECT-Q mixer,
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Switch, A.E. Switch, Main Tuning, Bandspread Tuning and Head-
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Grey crackle finish. 220/240
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Fitted with instructions and
circuit diagram supplied. Send S.A.E.
PRICE 40 Gns. Carr. &
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SEND STAMP FOR COPY OF OUR INTERESTING LITTLE BOOKLET "What Is High Fidelity!" and Suggestions List of
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SEE PRECEDING PAGE FOR
OTHER STERN-CLYNE PRODUCTS

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Introducing our new read-
built transistorised car radio
for ONLY 94 Gns. P. & P.
including 7 x 4" speaker fitted,
fixing brackets, fuses, unit, all nuts and bolts with
full instructions. H.P. Terms: £12 19.6
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Pocket Features: ★ Handsomely Styled. ★ Mollard Valves and
Transistors. ★ Push Buttons. ★ 11 watt Output. Large and
Radio Luxembourg (and many other foreign stations) 12 volt
Positive earth Only (applied to 90% of the cars on the road).
Dimensions: 7 x 2 x 2.7 depth.

Multi-trial extra. Complete con-}
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Why be bothered with a notepad? Take
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Simple to operate, a unique 4-way push-
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Pick-able microphone ensures complete ease of handling.
Fast and adjustable speed through the life of Batteries and the
volume and tone from the 2nd internal
speaker is outstanding. All accessories
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equipped with ¥1000 Microphone.
PRICE 12 Gns. 4/-
Spare 2" empty spools, 1/-; Spare 2" Paks. 6/-.

STEREO TAPE DECK
WITH BUILT IN
PRE-AMPLIFIER
A professional addition to your Hi-Fi sys-

tem consisting of two basic Units, the Tape
Deck and Pre-amplifier, which employs 7 Transis-
tors and 4 Valves. The Unit with record and playback: 1
transistor or 1 track mono at
either 78 r.p.m. or 33 1/2 r.p.m. both speeds being fully equalised.
Features: Track system: 1 track
2 channel stereo or monaural record and playback. Independent
single channel recording on either channel while playback on other
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equipment. Low loss: 100%. Low noise: 0.05%. Low hum: 0.05%. Low stray:
0.05%. Low hum: 0.05%. Low stray:
0.05%. Low stray:
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PRICE 42
Gns.
Carr.
Fig. 10/-

THE HE40 4-BAND COMMUNICATION RECEIVER
Completely built and ready to go
High sensitivity.
Superhet receiver type. 550 Mc/s—1,500 Mc/s (with Q-
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fitted. All of which come with grey crackle finish and
handy front panel, with chrome and satin chrome
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those amateur and short wave lovers.
Send S.A.E. for leaflet.

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Fig. 19/6
Amplifier. The AM INTRODUCTION source. PARTRIDGE Offers hi-recording pick-ups and radio switch. Oscillator circuit Incorporating ferro- Power transformer enclosed latest model. A.C. 52-1600 Kc. LF 145-370 Kc 100mV output mains 26/20/0 A.C. Valve line-up: 6981, 6FQ8, 6K6, 6481, ECC83. Multiplex output provided. Pre-amplifier--designed for use with the Tudor Stereo Power Amplifier with inputs for most types of Pickups. Direct play from Tape-Heads and ample sensitivity for either Crystal or Moving Coil Microphone. Distortion 0.1%. Tape output 100mV from 10K. ohm 250 m, Tuner 100 m. Valve line-up: 2E88B, 4-ECC83. Power Amplifier--14 watts per Channel, sensitivity 1 volt r.m.s. For 14 watts output, frequency response 0.500 - 20 c.p.s.—20 Kc. Speaker Impedance 4, 8 or 16 ohms, surplus power available for Tape Pre-Amp. mains supply 105/250 v. A.C. Valve line-up: 3-ECC81. 4-BL84. 1-12AT7.

GREAT NEWS!
We have pleasure in giving advance details of the NEW STERN DOUBLE FEATURE PRE-AMPLIFIER AND Jl0 POWER AMPLIFIER
A new conception in the field of audio engineering by Stern-Clyde development engineers. The most up-to-date circuitry is used in the Double Feature Pre-amplifier. It has matched inputs for microphone, crystal or magnetic pickup. Push-up and radio tuner are included in the KIT. The Kit offers full facilities for tape recording and high fidelity replay.
This unique feature means that should you wish to include tape in your hi-fi system at a later date all that is required is a suitable tape deck. Offer ample reproduction from all sources of your cost. Available shortly.

BRIEF SPECIFICATIONS:
110 POWER AMPLIFIER
Incorporates the latest triode pentode 8CL86 valves in push-pull. PARTTRIDGE ultra linear output transformer. PARTTRIDGE main transformers and smoothing chokes. Power supply available for tuner output impedance 3-7,5-15.ohms.

PRICE: KIT OF PARTS
11 Gns. Carriage Ready built
14 Gns. Include Insurance 7/6.

DOUBLE FEATURE PRE-AMPLIFIER
Inputs for microphone, crystal or magnetic pickup, tuner unit. Push-button switching for 3 tape speeds equalised. Tape erase bias oscillator circuit. Incorporating low frequency transformer. Function switches: separate base, treble and volume control, level control and latest EM4 mode of level indicator. The pre-amplifier is totally enclosed in a steel case, finish in silver hammer and an attractive perspex front panel carefully designed to blend in with modern wood finishers and equipment.

PRICE: KIT OF PARTS
£17 Carriage and Insurance 7/6.

READY BUILT
£21 Gns.

PRICES: if both above units are bought together.
KIT OF PARTS
£27.10.0 Carriage
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P R A I S E  f o r  t h e
W H A R F E D A L E
S U P E R  1 0 / R S / D D

The following letter is typical of many received praising the performance of the new Wharfedale Super 10/RS/DD, both of which have a remarkably wide and smooth response as the response curve indicates.

16 Grant House, Albion Avenue, LONDON, S.W.8.

Dear Mr. Briggs,

I feel I must write to you to say how pleased I am with my converted W10 Speaker (now a Super 10/RS/DD) which I received safely on Saturday.

The treble response is a delight to hear and even my poor quality records sound better, no doubt due to the absence of peaks in the middle and upper register. My pressure unit tweeter has now been dispensed with as it certainly cannot compete with the treble in your unit.

Being lucky enough to live within good range of Wrotham, I was able to put it through tests with various transmissions including the Proms, and we all have been most impressed—the bass improvement is also exceptionally good.
Yours sincerely,
Geo. H. Hunter.

Impedance 10/15 ohms only. Lin. dia. centre pole. Flux density 16,000 oersteds. Max. input 10 watts rms or 20 watts peak. Frequency range 30-20,000 c/s. Aluminium voice coil. Roll surround and double diaphragm. Axial response curve. Mic. distance 12 in. Input 4 v. at 1,000 c/s.

PRICES: SUPER 10/RS/DD £10.18.8 including P.T. GOLDEN 10/RS/DD £7.17.5 including P.T. Descriptive Leaflet on request

W H A R F E D A L E  W I L D C H A R T O N  Y O R K S H I R E

G r a m s : ' W h a r f d e l ' I d l e  B r a d f o r d
P h o n e : I d l e  1 2 3 5 / 6

H A R V E R S O N

O U R  L A T E S T  B U L K  P R O M O T I O N !

BRAND NEW A.C. MAINS 6 VALVE SUPERHET RADIO RECEIVERS

Housed in beautifully styled cabinets offering terrific performance and very high quality reproduction. Built-in ferrite aerial for reception of all your favourite programmes. Fully guaranteed.

MODEL 56 (as illus.). Covers Medium, Long and Short waves. Size 8in. w. x 3in. d. x 4½h. PRICE ONLY £7.17.6. P. & P. 5/6.

MODEL 30. Similar circuitry to above but covers Medium wave only. Size 7½in. w. x 3½in. d. x 4½h. PRICE ONLY £4.14.6. P. & P. 5/6. Either of the above can be modified for use with AM-FM unit.

3-VALVE AUDIO AMPLIFIER. MODEL HAA

Designed for Hi-Fi reproduction of records A.C. Mains operation. Ready built on plated heavy gauge metal chassis. 7½in. w. x 4 in. d. x 4½h. Incorporates 10/RS, EL4, E90, valves. heavy duty double wound mains transformer and output transformer matched for 3 ohm speaker, separate Bass, Treble and volume controls. Negative feedback circuit. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls.

The HAA has been specially designed for us and our quantity order enables us to offer them complete with knobs, valves, etc. wired and tested for only £4.50 P. & P. 4½.

SPECIAL OFFER! MARCONI QUARTZ CRYSTALS TYPES ZHB

Glass encapsulated, 2 wire lead out. Size 1½ in. high x 1½ in. dia. Following frequencies (kHz) only available:

1370. 14,000. 14,300. 14,500. 14,600. 14,700. 15,000. 15,500. 16,000. 17,500. 18,000. 18,500. 19,000. 20,000.

PRICE 45c. each; P. & P. 1½. 2 or more Post Free.

4-SPEED PLAYER UNIT BARGAINS SINGLE PLAYERS T/12 £1.15. Car. 2½d.

AUTO CHANGERS


SPECIAL TRANSISTOR AMPLIFIERS ALL BRAND NEW

GET 15 (Matched Pair) £2-4/6

OC71 6/6

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Set of Mullard & transistors, OC44, OC45, OC101 matched pair, £2-2½.

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R.P. 100. P.XA100 6/6

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Set of Mullard & transistors, OC44 and OC45.


1—PXA102 Oec. £10

OC41 matched pair £2-2½.

TELEFUNKEN HI-FI STEREO AMPLIFIER


STEREO AMPLIFIER

Incorporating 2 ECC83s and 1 E802, heavy duty, double wound mains transformer. Output 4 watts per channel. Full tone and volume controls. Absolutely complete.

TRIPOD £8-25. £15. (ECC83L & EL84.)

B A R G A I N  P R I C E £5-6. P. & P. 5/-
10/14 WATT HI-FI AMPLIFIER

A stylishly finished musical amplifier with an output of 14 watts from 2 EL86's in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and piano allow reverb and announcements to follow each other. Fully specified folded plate output transformer to match EL86's to speaker and 2 independent treble and bass controls and separate bass and treble controls are provided from side lift and rot. Valve line-up: 3 EL84, ECC83, EF86 and 12AT7, single ended, purely class A. 1/4" phone jack. All parts sold separately.

BRAND NEW 3 OHM LOUDSPEAKERS

Amplifier carrying cases.

BRAND NEW

Superior cabinet to take 4 x 1/4 speaker, with motor board, will accept speaker, RRI14 or RAI 14/6. $5.00. Speaker 1/4 x 1/4 and 10 in. 6/16, Furutech."
Brand new individually checked and guaranteed

**VALVES**

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| AR/P1 | 6/- | £1.15 | 5/8 | £1.75 | 4/- | £1.00 |
| AR/P1F | 6/- | £1.15 | 5/8 | £1.75 | 4/- | £1.00 |
| AR/P2 | 5/- | £1.25 | 4/- | £1.00 | 5/8 | £1.75 |
| AR/P4 | 4/- | £1.00 | 5/8 | £1.75 | 4/- | £1.00 |
| AT/P | 5/- | £1.25 | 4/- | £1.00 | 5/8 | £1.75 |
| AT/P1 | 6/- | £1.15 | 5/8 | £1.75 | 4/- | £1.00 |
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| AT/P2 | 6/- | £1.15 | 5/8 | £1.75 | 4/- | £1.00 |
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| AT/R4 | 7/- | £1.45 | 5/8 | £1.75 | 4/- | £1.00 |
| B1/6 | 7/- | £1.45 | 5/8 | £1.75 | 4/- | £1.00 |
| B1/6 | 10/- | £2.25 | 5/8 | £1.75 | 4/- | £1.00 |
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| R1/25 | 7/- | £1.25 | 5/8 | £1.75 | 4/- | £1.00 |
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| R1/53 | 10/- | £2.25 | 5/8 | £1.75 | 4/- | £1.00 |
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| R1/54 | 3/- | £0.65 | 5/8 | £1.75 | 4/- | £1.00 |
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| R1/23 | 7/- | £1.25 | 5/8 | £1.75 | 4/- | £1.00 |
| R1/23 | 10/- | £2.25 | 5/8 | £1.75 | 4/- | £1.00 |
| R1/54 | 3/- | £0.65 | 5/8 | £1.75 | 4/- | £1.00 |
| R1/54 | 5/- | £1.00 | 5/8 | £1.75 | 4/- | £1.00 |
| R1/23 | 7/- | £1.25 | 5/8 | £1.75 | 4/- | £1.00 |
| R1/23 | 10/- | £2.25 | 5/8 | £1.75 | 4/- | £1.00 |
| R1/54 | 3/- | £0.65 | 5/8 | £1.75 | 4/- | £1.00 |
| R1/54 | 5/- | £1.00 | 5/8 | £1.75 | 4/- | £1.00 |
| R1/23 | 7/- | £1.25 | 5/8 | £1.75 | 4/- | £1.00 |
| R1/23 | 10/- | £2.25 | 5/8 | £1.75 | 4/- | £1.00 |
| R1/54 | 3/- | £0.65 | 5/8 | £1.75 | 4/- | £1.00 |
| R1/54 | 5/- | £1.00 | 5/8 | £1.75 | 4/- | £1.00 |

**MARCONI COMMUNICATION RECEIVERS, CR.150.** Frequency coverage 50 Mc/s in 5 bands. Two I.Fs, 1st 1,600 kc and 2nd 150 kc. RF amplifier and mixer with separate grid circuit prov. over 40 dB up to 30 Mc/s and 20-40 dB from 30-60 Mc/s. Self checking facility with calibration meter. Standardization of supply and temperature compensation. Electrical and mechanical balancing for wide tuning. 8 meter tuning. Bandpass from 100 c/s to 10 kc/s in 3 stages. Acoustic filter associated with 100 c/s Bandpass position for CW reception. Facilities for diversity reception. In as new condition guaranteed with original mains power supply unit £70 or without power supply unit £60. Carriage 30/- CR.150/2. Frequency coverage 1.5-22 Mc/s in 5 bands, all other features as in CR.150. Price £35. Carriage 30/-.

**P.C. RADIO's mains power supply unit for H.R.O. Retail price £10. Include 5% sales tax.

**H.R.O. Senior.**

**Table Model.**

In excellent, fully checked, and tested condition. Complete with patented coil and power pack £15.10.0. As above but rack mounted model £14.10.0.

**Individual high-frequency coils for above £1 each set or set of 9 £8. Either model, carriage £1.10.0.

**Full output power pack for H.R.O. 110/220 v. a.c. Brand new in original packing. 45/- P. & P. 4/-.

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798

**PRACTICAL WIRELESS**

January, 1964
THE R.S.C. BASS-MAJOR 30 WATT GUITAR AMPLIFIER

A MULTI-PURPOSE HIGH FIDELITY, HIGH OUTPUT UNIT FOR VOCAL AND INSTRUMENTALIST GROUPS

Eminently suitable for bass, lead or rhythm guitar and all other musical instruments

- Incorporating two 12", heavy-duty 25-watt high flux (7,000 lines) loudspeakers with 21". diameter cones. Designed for efficiency handling full output of amplifier at frequencies down to 25 c.p.s.
- Dual Tone in second speaker reproduces frequencies up to 17,000 c.p.s.
- Heavy-duty cabinet of convenient size 24 x 13 x 14in, has an exceptionally attractive covering in two contrasting tones of Vynair.
- For 200-250 v. to 30 c.p.s. A.C. mains operation.
- A separate footswitch incorporates two independent switches for simultaneous operation of up to four instrument pick-ups or microphones.
- Separate bass and treble controls providing more than adequate “Boost” or “Cut”...
- LEVEL frequency response throughout the audible range.
- SUPERIOR TO UNITS AT TWICE THE COST.

39½ Gns.

Send S.A.E. for leaflet.


R.S.C. JUNIOR GUITAR AMPLIFIER

6-watt high quality output, separate bass and treble “cut” and “boost” controls. Sensitive, long-life tetrode input, 6l6, loudspeaker. Handsonely made cabinet in 4 for textured veneer, finished in attractive and durable polyurethane. 200-250 A.C. mains operation. £819.6 payments of £1. Carr. 12½.

LINEAR TEMPODICTUM UNIT

Designed for introducing the Tremolo effect to any amplifier which is fitted with a reserve power supply point for instantaneous H.T. and 6 h.v. A.C. L.T. This unit offers to practically all ampliers of our manufacture, and to those of several other manufacturers. The unit plug into power supply point, and any input socket of amplifier. Controls are speed (frequency of Tremolo), and phase (time between two Tremolo effects). Volume and Switch. Three sockets are for two inputs and Foot Switch. ONLY 4 Gns.

R.S.C. SENIOR 15 watt Guitar Amplifier

For lead or rhythm guitar. High-fidelity push-pull output. Separate bass and treble “Boost” and “Cut” controls. Two independent socket inputs that two instruments or two mic. pick-ups can be used at the same time. Loudspeaker. Heavy-duty cabinet is well made and finished as Junior Model. Size approx. 18 x 9 x 8in.

Only 18 Gns. Carr. 9½.

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LARGE REEXINE COVERED SPEAKER. Heavy boardroom construction. Very attractive two tone covering of Rexine and Vynair. Size 48 x 21 x 16in. cut for 15in. or 18in. speaker or for two 12½ 11½ in. speakers and 9 monthly payments of £5½. Size 30 x 15 x 15in. cut for 15in. or 18in. speaker 18½ gns. Or Deposit £3-7-6 and 9 monthly payments of £3-7-6.


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FANE EXTRA HEAVY LOUDSPEAKER 15½ in. 15-ohm, 135 watts. 3½m. diameter. Total Flux 375,000 lines. High sensitivity. ONLY 25½ gns. Or Deposit £5½ and 9 monthly payments of £5½.

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R.S.C. B20 BASS GUITAR AMPLIFIER

A highly efficient unit. Incorporating a massive 15in. high flux loudspeaker specially constructed to withstand heavier load conditions. Rating 25 watts. Individual bass and treble controls give ample “boost” and “cut” facilities. Output transformers are separately controlled. All model bass and treble controls are arranged in a recess on top of the cabinet. Cabinet is of substantial construction and attractively finished in two contrasting tones of Rexine and Vynair. Size approx. 24 x 21 x 15in. Operation from 200-250 v. to 30 c.p.s. A.C. mains. £29½ Gns. Or Deposit £3-3-0 and 12 monthly payments of £6-6½.


R.S.C. BABY ALARM or INTER-COMM. KIT. Complete set of parts with diagrams, etc. housed in two polished walnut finished cabinets of pleasant design. High sensitivity. For 250 v. to 400 v. A.C. mains. Fully isolated. Controllable at both units. An intercom of this class would normally cost £20-50. Only 9½ Gns. or assembly ready for use £8 3½.

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PRACTICAL WIRELESS

January, 1964

799

949/3

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H.C. SUPPLY KIT. 12 v. 1.a. consisting of 13 x 1.5w. bulbs, 2 x 100w. mains transformers, F.W. Bridge Rectifier, 2 fuseholders and fuses, chassis and feet. Suitable for JUNIOR th. and circuit. For 200-250 v. A.C. mains. Suitable for Junior or Senior front-three available at 29½/11.

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HI-FI 18-WATT AMPLIFIERS

Brand New Complete £719.9 Carr. 12½.

Pull output. Latest high efficiency design. Suitable for 3 or 15 ohm speaker. Guaranteed tested and in perfect working order.

HIGH PURCHASE OF BRAND NEW 24, 30 amp. GIANT SENIORITY RECEIPT each

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PUSH-PULL ULTRA LINEAR "BUILT-IN" TONE PRE-AMP STAGES
Two input sockets with associated controls allow mixing of "mike" and gram, as in A1. High sensitivity. Includes 5 vacuum tubes: E120, ECC83, EL84, E801. High Quality sensitive wound output tube designed for Ultra Linear operation and reliable small components of modern manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "LIFT" and "CUT." Frequency response 350-4,000 c.p.s. Six sensitive feedback loops. Hum level less than 0.0001.

MAIN FEATURES:
- High sensitivity, low distortion
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- Includes five vacuum tubes
- BASS and TREBLE controls

SPECIAL SENSORS
- Ultra-sensitive input stages
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RSC. STEREO/TEN HIGH QUALITY AMPLIFIER
A complete set of parts for the construction of a stereo phonograph amplifier giving 5 watts high quality output on each channel (total 10 watts). Suitability to 50 milliamps. Suitable for all (and crystal) speakers. Ganged Base and Treble Controls give equal balance of "Hi" and "Cut." Provision is made for use as straight Amplifier and for Tape Recording. Complete set of parts supplied. Full construction details and parts list 25c. Cab. 49c.

RSC. BATTERY CHARGING EQUIPMENT
Guaranteed 12 months
For all A.C. Mains 200-250 v., 50 c/s.

SPECIAL FEATURES:
- Fitted Type C.B. type charging rate selector
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FULLY SHIELDED continued
425-450-500 WATT AMPLIFIER
Midget Battery Pentode 6L6.
Output transformers: 8 ohm.
Small Matteo 5000. 10000.
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Matched to 10000.
Push Pull 15-20 watts to match 6VR or FLA 4-8 to 150.
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19-1/2" x 17-1/2" x 9-1/4".
Wooden.

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Consisting of type A11, 250-300 v., 50 c/s.
Fitted for mains or 12 volt charging.

MIDGET MAINS 200-250 v., 50 c/s.
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Both above size 24 x 24 x 24.

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M.A.T.'s
(MICRO-ALLOY TRANSISTORS)
Give extremely high power gains at all levels of collector current and voltages and from A.E.P. to 100 M.W. Greatly improve performance of any circuit.

MAT 160 High gain low level .............. 7/6
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MAT 171 Extra high gain, medium and high level ............. 8/6

ADT, 140 for V.H.F. and U.H.F.
Only 1\(\frac{1}{2}\) in. high x 1\(\frac{1}{2}\) in. dia. Made by the unique alloy-diffused process and specially suitable for P.M., V.H.F., U.H.F. and D.H.F. frequencies. Has typical alpha cut-off of 400 M.S. with power gains of 50dB at 100 M.W. and 80dB at 200 M.W. 15/-

TWO OUTSTANDING AF AMPLIFIERS

SINCLAIR TR5
COMBINED PRE-AMP AND HALF-WATT POWER AMPLIFIER

Will produce a perfectly clean half watt of audio power even from very low output sources such as low-impedance tape heads, pick-ups and microphones. Ready built with instructions and unconditionally guaranteed.

CIRCUIT—6 matched transistors and temperature compensating diodes in a transformerless complementary symmetry configuration.

POWER OUTPUT—100 mW undistorted into 15 ohms.
SENSITIVITY—0·5 mV.
FREQUENCY RESPONSE—50 c/s to 20 Kc/s ± 3db.
POWER GAIN—90 dB (1,000,000 times).

9V. battery or power supply.

59/6

SINCLAIR MICRO AMPLIFIER
40dB GAIN at 1 Mc/s OUTPERFORMS AMPLIFIERS 20 TIMES LARGER

This fantastically powerful amplifier is smaller than a 3d. piece. With a frequency response from 30 to 80,000 c/s ± 1 db and power gain of 40dB (1,000,000 times) it can be used as a sub-miniature hi-fi amplifier at an output level of 1 db for any earpiece or even a loudspeaker.

5/6

THE SMALLEST AND MOST EFFICIENT YET
SINCLAIR MICRO-INJECTOR
FOR FAULT FINDING AND SERVICING

Using two MICRO-ALLOY TRANSISTORS, the Sinclair Micro-Injector is a precision sub-miniature instrument which generates and injects a test signal into any part of a receiver or amplifier at any frequency from 1 Kc/s to 20 Mc/s. By this means, the position of any fault can be rapidly found.

This Micro-Injector is powered by a standard 6d. battery which will last for about 5 months. Size is 1\(\frac{1}{2}\) in. x 1\(\frac{1}{2}\) in. x 1\(\frac{1}{2}\) in., excluding the 1\(\frac{1}{2}\) in. probe. Assembly is extremely simple and will take even a beginner only half an hour. With illustrated building and operating instructions.

Total cost including all parts, MAT Transistors, printed circuit board, plating, and case in royal blue with gold trim.

27/6

SINCLAIR radionics LTD. 69 HISTON RD. CAMBRIDGE
SINCLAIR ‘SLIMLINE’

THE SET YOU WILL NEVER WANT TO BE WITHOUT

BUILD ONE FOR YOURSELF

Give one for Xmas!

THE MOST FANTASTIC TRANSISTOR PERFORMANCE YET—GIVES YOU EUROPE IN THE PALM OF YOUR HAND

UNIQUE CIRCUITRY!

The secret of the Slimline’s performance is in its unique circuit. This circuit, specially developed by Sinclair Radionics Ltd., makes full use of our incredible Micro-Alloy Transistors (MATs), and because of its ingenious design the quality of reproduction is outstandingly good with selectivity and sensitivity of an incredibly high order.

BUILD IT IN A COUPLE OF HOURS

The parts necessary to build this wonderful set comprise printed circuit board, sub-miniature components, including MAT Transistors, case in royal blue and gold, featherweight high quality ear-piece etc. Full instructions with every order.

49/6

IDEAL AS A RADIO JACK

No matter what your experience with radio, the Sinclair Slimline is unique in its ability to give you reception in a way that no other set can. Its power and selectivity are truly phenomenal when you remember that this completely self-contained receiver is smaller than a packet of twenty cigarettes. It can be your companion everywhere, even letting you listen in car or train. Building is fascinatingly easy even if you have never built a set before in your life. If you are going to build and give one for Christmas, you had better order two—for once you have experienced making and listening to the Slimline, you won’t want to be without one either.

“BEATS MY SEVEN-TRANSISTOR SET”

Thousands of Slimline sets have been built and countless users have written expressing their enthusiasm. They have been used hundreds of miles out to sea, in the air, and in remote parts of Europe. Used as we are in receiving such letters—

“A friend of mine bought a Slimline and has used it from here to Aden with great success, equaling the performance and at times beating my seven-transistor set.

I am going on draft in another week and I would like very much to take a Slimline with me so could you rush the order through as soon as possible.

Yours sincerely.
K.H.R., H.M.S. Dryad, Southaria.”

To SINCLAIR RADIONICS LTD., 69 HISTON RD., CAMBRIDGE

PLEASE RUSH

FOR WHICH I ENCLOSE

NAME............................
ADDRESS..........................

Block letters please
**BUILD YOUR OWN RECORD PLAYER**

4 Speed Autochanger or Single Player units supplied with Brand New Single Player sets 12 x 15 Sin. deluxe strong carrying handle, gilt finish clips and hinges. As used by Famous Make for 20sin. models. Ready cut out motor board 14 x 5in. Front baffle with 7 x 4in, high flux loudspeaker and 3 watt valve UK5. 1/2m. 2-3amp. amplifier really built on metal chassis 12 x 5 x 5in. Quality safety mains switches etc. volume and tone controls. Does not commit to fit each other perfectly. Special instructions enable assembly in 30 minutes, only 5 wires to join! 12-month guarantee available. Available separate or package deals as below.

**AUTOCHANGER KITS COMPLETE (as above)**
- B.S.R. Mono. ... £11.95 P.P.
- Garrard 7 ... £11.95 P.P.
- E.M.I. Mono ... £11.95 P.P.
- SINGLE PLAYER KITS Complete ... £5.95 P.P.
- E.M.I. Auto start/stop ... £11.95 P.P.
- E.M.I. Banjo ... £7.50 P.P.

**TRANSCRIPTION UNITS**
- Garrard 4HF ... £16.10 P.P.
- Philips A1016 ... £12.50 P.P.
- Philips A1017 ... £11.95 P.P.

**BARGAIN E.M.I. Auto change A1102**
- Stereo Mono ... £7.10 P.P.
- Replacement sapphire tips available from 5/6.

**BARGAIN SINGLE PLAYER KIT £20/100 + A.C.**
- (less cabinet) £5.15.0

With 5-stage Amplifier: 3-watt 2 valves, U.C.C. £17.00. High-class 5in. speaker; 4-speed E.M.I. Turntable, 18, 33, 45, 78, 2500p.s.m. Crystal Pick-up for £20.00. Records £1.15. 3/4in. Car out Mounting board 10 x 4in.

**ARDENTE TRANSFORMER TRANSFORMERS**

**READY BUILT, WIRED AND TESTED**
- A.C. only, 200-250 V. Valves EL14 and EK20. 3-dial quality transformer. Mullard transformer gives the best sound quality and volume. Separate engraved front panel with drift adjust. Quality main transformer. Stove enamelled chassis £42.15.0. Bargain Price £34.15.0 Details N.A.C.

**"PERFORMS UNAFFECTED well"** (The Gramophone)

**MINIATURE PANEL METERS**

**PLASTIC RECORDING TAPE**

- Double Play 7in. rec. 2/4d.
- Spare Reels 3/4d.
- Long Play 7in. rec. 1,000ft. 2/6d.
- Standard 7in. rec. 1,000ft. 1/6d.
- 3/4in. rec. 1,000ft. 1/6d.
- Standard 3/4in. rec. 1,000ft. 6d.

**EASIEST Pairs** Tape Splicer 5/-.
7 Transistor superhet. 300 milliwatt output, 4-inch speaker. All components mounted on a single printed circuit board size 3½ x 4½ in. One complete panel for assembly. Plastic cabinet, with carry case, size 7 x 10 x 3½in. External socket for car aerial. Ferrite rod aerial. Price for the complete parcel including Transistor, Cabinet, Speaker, etc., and Full Construction Data: P. & P. 4/6.


Any parts supplied separately.

4 TRANSISTOR MINIATURE PULL-PULL AUDIO AMPLIFIER

PRINTED CIRCUIT, 6 in. x 12 in. x 1½ in. over transformers. Output for 3-inch speaker, suitable for microphone, record player, guitar and radio input, 5-12 volt battery required. Frequency range 150 c.p.s. to 30 Kc.p.s. Pushpull output single ended. Instruction sheet provided. Fully wired ready for use. Two types available, 2 watt output, ½ watt P.P. & P. 2/6.

THIS SUPERB SET FOR £9 (Carr. pd.)

6-transistor radio concealed in sponge oval. Four turntable, 5000-20000 tone accents. M.W. and L.W. ferite rod, precision for car aerial. 2-color scale. With PP9 battery giving 300 hours use. Wt. 1 lb. 4 oz. with carrying handle. 1½ x 7½ in. Small, neat at top. Brand new fully guaranteed, 3 inch buttons. Different models, 3½ in. x 2½ in.

5 WATT AMPLIFIER


SPECIAL REDUCTIONS ON GRAMOPHONE AMPLIFIERS

11 watt type. Save 4½s. With 5 inch speaker. 7½ in. x 6½ in. 200-240 v. A.C. 6L6 and Speaker, Tone and Volume, On/off switch. Two knobs. Ready to play. Useful for sound. 45½s., post 5s.


2½ watt type. Save 20s. 21½ watts. 6V6. 120-240 v. A.C. Control, volume phone and treble. On/off switch. 220-240 v. A.C. P.P. trans. 12½ in. x 9½ in. over valves. Suitable for microphone input and for Guitar. 15½s. post ½s.

STEREO CONVERTER UNIT


TOP QUALITY RECORDING TAPE (Guaranteed)

(1/4-in tape, six or more post free)

6 in. ... 600 ft. ... 10 sh. 6½ in. ... 1200 ft. 17½ sh.
6 in. ... 600 ft. ... 11½ sh. 7½ in. ... 1200 ft. 19 sh.
6 in. ... 900 ft. ... 12½ sh. 7½ in. ... 1800 ft. 20½ sh.
6 in. ... 1200 ft. ... 15½ sh. 8½ in. ... 2400 ft. 22½ sh.
6 in. ... 1800 ft. ... 19½ sh. 8½ in. ... 2400 ft. 25½ sh.

BATTERY ELIMINATOR

For use with Low Consumption Valves (19 range) 90v., 12V. and 12V.5A, 15 v. 15v., 12V., 200-240, 2A. 200-240, 2½A. 200-240, 2½A. 4½v. and 90v. 12½ in. mains. Each. Two separate units to replace existing batteries, 4 x 2½ x 2½ in. and 3 x 2½ x 1½ in.


HEATER TRANSFORMER

Mains input giving 6½s. 2 anns. 4½ in. x 2½ x 1½ in. (2½ in. over winding) 5½ in. Case 10½% for 12½ or 20½% for 20. 6½s. & 12½s. for 1 to 6, post free.
Measure of Success

One sometimes hears of enthusiasts who consistently build equipment without the aid of test gear. This is possible, of course, but what happens when a completed job fails to function satisfactorily or does not work at all? One can only poke about haphazardly hoping to stumble on a mechanical fault or abandon the project.

At all events, time and energy are wasted, often fruitlessly. Not only that, but this approach is to say the least a very untechnical one in a technical hobby!

Test gear is not only helpful in tracing breakdowns. Even assuming that all home-built equipment works, how much of it functions at optimum? How many receivers and amplifiers are there at this moment working at less than full efficiency?

All components, whether from the spares box or new from dealers, are subject to tolerances and variations in quality. The permutations possible in even simple equipment are considerable. Again, a "47k" resistor, for example, may be actually 47k or 470Ω due to wrong colour coding and components may be o/c or s/c or changed in value. These things do happen and if there is no means of checking when in doubt, the constructor may spend many frustrating hours looking for a constructional fault that does not exist. Without test gear he is working blind.

The acquisition of test gear need not be prohibitive, because for the average enthusiast a few basic items should suffice. And of these, an accurate multirange test meter is the obvious starting point. For those regularly building equipment it is an indispensable item and will provide facilities for overcoming many everyday snags and for solving mysteries of sub-standard performance.

It is, however, inadvertent to buy an inferior meter, for this type of false economy may only aggravate certain problems. Bearing in mind the need for an inexpensive and sensitive test meter we felt it would be a popular conclusion to our present series of blueprints to present an instrument of the calibre of the P.W. "Sixteen".

It will stand comparison with a good quality commercial product. A special plastics case is available, with the switch ranges and other lettering already printed on the front panel. The scale arcs are specially calibrated and printed ready for use. All the special components are available through usual sources.

We have thus overcome all the snags in building your own test meter—no tricky work in making up special shunts and multipliers, no calibration to work out and mark on the scale. In other words we are making available to the home constructor a multirange test meter which not only performs to commercial standards but looks professional, too!

With its sixteen a.c. and d.c. voltage, current, and resistance ranges, the P.W. "Sixteen" is a fine opportunity for those not having a test meter or wishing to replace an old one.

Our next issue dated February will be published on January 7th.
NEWS AT HOME AND ABROAD

Commonwealth Telephone Link Complete

On October 10th, the final part of the Commonwealth Telephone cable was layed off Hawaii and for the first time the Pacific Ocean was spanned by telephone cable. This occasion also marked the completion of the 14,000 mile Commonwealth link between Britain and Australia. With the trans-Atlantic cable between Britain and Canada—which has been in service since December 1961—and the new 3,000 mile microwave network which crosses Canada, London and Sydney operators will be able to dial right through to subscribers at each end of the link.

For telephone users in Australia and Britain, this link means a reliable method of communication over more than half the world’s circumference. A total of 80 two-way speech channels thus become available which, unlike previous radio links, will be free from fading and atmospheric conditions. As well as telephone conversations, the new cable will be used for teletypewriter traffic: each speech channel being capable of carrying 22 such circuits. Circuits will also be made available to commercial concerns, such as airlines and shipping companies.

In itself, the Pacific section of the link is the longest submarine telephone cable in the world: as a whole, the Commonwealth link is by far the biggest project of its kind ever attempted.

All of the cable used in the project—and there were 11,000 miles of it—was manufactured in Britain by Submarine Cables Limited and Standard Telephone and Cables Limited. This cable, which at one point in the Pacific section of the lay reaches a depth of over three miles, is little more than an inch in diameter.

The Atlantic and Pacific cable-laying operations have taken two and a half years to complete by the three British ships which had the task of making the lays. Terminal points of the Atlantic link are Oban in Scotland and Ham- den, Newfoundland. The Pacific cable joins Sydney, Australia with Vancouver, Canada, via Auckland (New Zealand) and Suva (Fiji).

New Communication Equipment for Police

Police forces throughout the U.K. are to be supplied with new radio communication equipment manufactured by Ultra Electronics Limited under a contract from the Home Office Communications Branch. Three separate types of equipment come under the contract and these are: a hand-held transceiver, a mobile transmitter/receiver for motor-cycles and a similar unit for other motor vehicles used by the police.

In the design of the motorcycle and car units, the manufacturers have employed circuit techniques which have resulted in economies in space and weight. The new pocket-sized transceiver is fully transistorised and takes its power from a nickel cadmium rechargeable battery which gives it an operating life of several hours.

ULTRASONIC CLEANING FOR GEAR

Ultrasonic cleaning equipment made by Mullard Equipment Limited, has replaced conventional methods of cleaning gearheads made at the Egham factory of O.T.M. Servo Mechanisms Limited. To ensure the efficient operation of these gearheads—which are used in servo systems of aircraft and guided missiles—it is essential for the gears and pinions to be thoroughly cleaned before they are assembled into the head.

Originally hand-washing in a solution of carbon tetrachloride was the cleaning process used, but this was found to take too long and the standard of cleanliness achieved was not satisfactory. The Mullard Ultrasonic equipment, however, successfully removed all particles of dirt bigger than two microns in diameter after a two minute cleaning period. This not only saves time but also increases considerably the life-expectancy of the gearheads because of the large percentage of dirt that can be removed by this process.

The Mullard equipment consists of an ultrasonic generator and a 1½ gallon stainless-steel tank, which holds the cleaning solution (a chlorinated hydrocarbon) into which the gears are placed for the cleaning operation.
HI-FI IN THE ARABIAN GULF

EQUIPMENT made and tested by the British manufacturers prior to its delivery, has been installed in the club recently built for the staff of the Bahrain Petroleum Company Limited in the Arabian Gulf. The equipment, which has been supplied by A.E.I. Limited, provides a high-fidelity amplification system covering every part of the several acres of ground which the club occupies.

Six A.E.I. 30W power amplifiers provide amplification for microphone, tape recorder, radio broadcast or record player inputs.

Laboratory Extension

THE Research and Development department of Garrard Engineering Limited at Swindon, has recently undergone a major extension programme which has resulted in an enlarged laboratory with the number of engineers and scientists employed there increased to 70. By the end of the year at least 80 technicians will be engaged on the research, development and testing of Garrard-made products.

British Simulator Trains Canadian Mariners

A FULLY transistorised marine radar simulator manufactured in England by the Solartron Electronic Group Limited, has been installed in the Navigation Department of the College for Trade and Technical Training, St. John's, Newfoundland.

Canada. Here it will be used to train some of Canada's future mariners in the methods of handling all kinds of ships in congested coastal seas.

The simulator confronts the student mariner with situations typically met with in the more crowded shipping areas as displayed on a radar screen. He has all the controls and navigation aids that would be found on the bridge of a ship and his handling of the 'ship' under varied simulated conditions is reproduced on the screen. Other simulated ships can be brought into the field of his radar and the movements of these are constantly fed to a computer where they are compared with the movement of the student's 'ship'.

The instructor who decides how to deploy these simulated ships can also simulate coastlines and typical radar effects which are often present with sea-borne equipment.

Power Amplifiers Clear Birds from Runways

A COMMON hazard faced by pilots of aircraft is the presence of large numbers of birds on and around runways. At several of the major airports in Britain steps have been taken by the authorities to remove this hazard and thus make take-offs and landings safer.

The device which is used in dispersing the birds consists of loudspeakers and amplifying equipment installed in a van. These mobile units operate close to the airport runways and broadcast bird cries which are effective in removing certain species from the area.

The Sappho audio equipment employed in these vehicles, is made by Trix Electronics Limited. The latest order for such equipment received by Trix is for a unit for Speke airport, Liverpool.

A mobile bird-dispersion unit, fitted with Sappho audio equipment, in position near an airport runway.

Laser Drills Holes in wire

IN a technical paper presented at the National Electronics Conference held recently in Chicago, U.S.A., Dr. Danilo V. Missio of the Raytheon Company of Massachusetts, revealed that he and his fellow research workers had successfully used accurately controlled flashes of laser light to bore holes through tin wire only two-thousandths of an inch in diameter. The holes themselves were less than five microns (two ten-thousandths of an inch) in diameter, and this was the first report of holes of such small magnitude being drilled using a beam of laser light, although previous work had indicated that it was possible.

RADIO EQUIPMENT FOR AIRLINERS

EVER since 1949, Central African Airways have specified Marconi aeronautical radio equipment for their aircraft. Now the Marconi Company Limited have received an order from C.A.A. to equip their new B.A.C. One-Eleven aircraft with the Sixty Series of airborne radio units.

Under this order, each aircraft will have dual v.h.f. communications systems, a single v.h.f. navigation system and dual automatic direction finding systems.
THE PRACTICAL WIRELESS

“Sixteen” Multirange METER

The Blueprint given away free with this issue provides all the circuit and wiring diagrams for this instrument.

16 switched ranges; nine for voltage measurements, four current ranges, and three resistance ranges.

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Current</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2.5V d.c.</td>
<td>0-50µA</td>
<td>0-2,000Ω</td>
</tr>
<tr>
<td>0-25V</td>
<td>0-2.5mA</td>
<td>0-200kΩ</td>
</tr>
<tr>
<td>0-50V</td>
<td>0-50mA</td>
<td>0-20MΩ</td>
</tr>
<tr>
<td>0-250V</td>
<td>0-250mA</td>
<td></td>
</tr>
</tbody>
</table>

Meter sensitivity: 20,000Ω/V on d.c. ranges; 1,000Ω/V on a.c. ranges.

Basic movement: 40µA f.s.d. moving coil. With universal shunt full scale deflection current is 50µA.

Physical details: Black plastic case, 3½in. x 3½in. x 1½in. 3in. scale window; two scales printed black on white.

Controls: 12-position range switch; slide action a.c. volts—d.c./ohms switch; ohms zero adjustment potentiometer; meter zero.

External Connections: Two sockets to suit 4mm test lead plugs.

W hen properly assembled, with the specified components used throughout, the P.W. Sixteen will meet most of the requirements of the average radio constructor for voltage, current and resistance measurement. The special arrangements that have been made with various manufacturers ensure that not only will the finished multimeter have an excellent electrical performance but that it will also have a neat, professional external appearance.

The multimeter is built around a highly accurate and sensitive moving coil movement. The universal shunt used in conjunction with this movement brings the overall d.c. sensitivity to 20,000 ohms per volt. Two clearly printed scales are provided on the meter face. Uppermost is the ohms scale which is calibrated (right to left) from zero to 2kΩ. The second scale is used for the d.c. and a.c. ranges and is in fact a double scale.

This scale is divided linearly into 50 small divisions, with main calibration points at every tenth division. These points are marked 50, 100, 150, 200 and 250 on the upper edge, and 100, 200, 300, 400 and 500 on the lower edge of the scale. A quick glance at the setting of the range switch is all that is necessary to establish which particular calibration is to be read.

THE COMPONENTS

It is emphasised straight away that with an instrument of this nature, no liberties can be taken as far as the components are concerned. Close adherence to the details given in the components list on the blueprint is essential if the calibration accuracy and general performance of the final instrument is to be up to standard.

The following notes amplify the information in the components list and should be read with particular care before arranging to purchase the various parts. In this connection it should also be made clear that all components are obtainable through usual retail sources and that the manufacturers named here do not, as a general rule, supply direct to individuals.

The instrument case is supplied with the meter movement built in. With the meter case is supplied a specially selected swamp resistor (R17); note that meter movements and swamp resistors are not interchangeable. This point also applies to the meter rectifier (MR1), which comes complete with its own associated shunt resistor (R19). All these components are supplied as a kit by Taylor Electrical Instruments Ltd.

The slide type changeover switch (S2) has been listed as an Arco-electric type T225; however, mention should also be made of an alternative Aerial pressings type RA 2133/PVC. This particular switch has p.v.c. insulation which is impervious to moisture.

The range switch (S1) is an N.S.F. type, and can be obtained by quoting its reference “PW16”.

The various multiplier and shunt resistors are generally of non-standard values and it will
certainly prove convenient to obtain these as a complete kit as manufactured and supplied by The Radio Resistor Co.

**BUILDING THE METER**

Having obtained all necessary parts and materials, it is good policy to examine carefully Fig. 2 and Fig. 3 on the blueprint and so familiarise oneself with the arrangement to be adopted. The task of construction is not unduly complicated but the restricted space necessitates a methodical approach. The wiring-up should not be rushed, but a high standard of workmanship aimed at as belittles a piece of test equipment.

A small instrument type iron is essential. Good soldered connections are vital. A badly-made, high-resistance joint may have serious effect upon the accuracy of the meter. Overheating of components must be guarded against.

Remove the two 4BA screws from back of instrument case and lift off the top panel. Inside will be found the meter rectifier, two resistors (R17, R19) and two sockets, with solder tags, locking nuts and plastic pillars.

Do not remove the protective cap fitted to the rear of the meter movement, as particles of dirt or dust could easily fall into the movement while assembly work is in progress.

Fit the two input sockets to the front panel; place a solder tag beneath each locking nut and then screw on the plastic pillar.

Mount the a.c./d.c. switch (S2) and secure to the front panel by means of two screws.

Remove the knob from the potentiometer (VR1) and place this component in position securing with the ring nut supplied (a pair of line nosed pliers can be used for this purpose). Fit the knob by pressing lightly into the hole, rotate until the slot engages and then press right down to lock it.

Screw the solder tags "A" and "B" in position (Fig. 2). If a double tag is not available, use two single tags for tag "B".

Solder R19 across uppermost pair of tags on S2, then solder the meter rectifier to these same tags. The centre lead on the rectifier is soldered to tag "A".

Special care is required during this soldering operation, because excessive heat will (1) affect the calibration of the rectifier and (2) melt the p.v.c. switch plate and cause intermittent contact.

The range switch S1 should next be dealt with. All the wiring shown in Fig. 3 must be performed before the switch is installed. It is suggested that each switch tag be dealt with in turn, proceeding in a clockwise direction and starting with tag 1. See Fig. 3. The high stability resistors must be handled with care. If the thin protective coating suffers damage, the resistance value can be seriously affected. Grip by the wire leads only.

Ensure that all resistors have at least 3in. of wire at each end, this is to avoid overheating when soldering—which might result in damage or change of value. Space all resistors at least 3in. away from each other, and also from any other switch tags. Careful positioning of R1 and R6 is particularly important as these resistors carry 500V.

It may be an advantage to fit a plastic protective sleeve to the following resistors in order to prevent them coming into contact with other components of a different potential: R3, R7 and R18.

See that all flying leads are of adequate length, check by referring to Fig. 2. Use 7/36 p.v.c. covered wire for the battery leads; these should be suitably colour coded, and should extend 6in. from the edge of the switch wafer.

All other wiring can be in 22 or 24s.w.g. tinned copper, p.v.c. covered.

Carefully check over the wiring of S1, then fit this switch in position, ensuring that the orientation and the rotor setting agrees with that shown in Fig. 2 and Fig. 3. Secure the switch with the nut, then fit knob, aligning the pointer with the 25V position engraved on the front panel.

The remaining wiring should now be completed as per Fig. 2. Handle the wirewound meter swamp resistor R17 with care to avoid open-circuiting the winding. R5 and R16 should preferably be sleeved.

Thread a 2½in. length of 6mm plastic sleeving over the four battery leads and push this down as far as possible into the centre of the switch. This sleeving will prevent chaffing of the leads by the switch spindle or rotors.

Place the instrument case body close against the left hand side of the panel, and solder the four battery leads to the connection points on the back of the battery compartment. The uppermost pair of connection points are for B2 (15V), the lower pair for B1 (15V). The right hand connection points are positive (+).

Close the two sections of the case, carefully dressing the battery leads so that they do not foul anywhere, and secure by replacing the two 4BA screws.

To install the batteries, remove the small panel at the rear of the instrument case. Looking into the battery compartment, the positive contacts are those to the left hand side.

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**Christmas 1963**

The editor, staff and contributors join in wishing all readers a Happy Xmas and a successful New Year
A wide range
I.F. OSCILLATOR

by P. CAIRNS

A good-quality instrument for the amateur experimenter.

This article describes a simple and cheaply made sine wave oscillator covering audio and ultrasonic frequencies. This unit, when correctly built and calibrated, can be extremely useful, having many practical and experimental applications, and should prove of use to both the amateur and professional engineer. The frequency stability is extremely good, being better than ±2% for changes in h.t. of ±20%, and changes in heater voltage of ±5%. The wave shape is also of good sine waveform, though very slight distortion was noticeable at the extreme h.f. end of the tuning ranges.

Circuit Description

The complete oscillator circuit is shown in Fig. 1. This covers the frequency range 35c/s to 70kc/s in six overlapping ranges. The oscillator is the double triode VI with the necessary resistance-capacitance phase shift network required to maintain oscillation. The output stage, V2, gives both high and low impedance outputs.

The frequency of oscillation is determined by the resistance-capacitance network R1-R6, R7-R12, and VC1. Feedback is fed from V1b anode to V1a via C6, the amount of feedback being controlled by VR1. This pre-set control also has a marked effect on waveform. The frequency range with the variable capacitor shown and a given set of resistors is less than 4:1. Thus six resistor ranges were necessary to cover the required band of frequencies, S1 being the range selector switch.

The oscillator output is taken from the cathode of V1b via C8 and VR2 to the triode amplifier V2. This has two outputs which are selected by S2, position 1 being the high impedance output, V2 working as an amplifier. Position 2 gives the low impedance output with V2 working as a cathode follower. In either position the output not in use is bypassed to earth via C10 or C11, these being the output coupling capacitors in the alternative position. Position 3 is "off", with the output point earthed. The amplitude of the output waveform is controlled in both cases by VR2. With VR2 at maximum, the output voltage in the high impedance position is approximately 25 peak, and in the low impedance position, approximately 2.5 peak.

Fig. 1: The circuit of the oscillator.
Construction

The layout of the majority of the circuit components is not critical, and a suggested scheme is shown in Fig. 2. Care should be taken with the resistors R1 to R12 on S1, these being mounted directly on to S1, the resistor end wires being cut as short as is practicable. S1 should also be a good quality switch, ceramic if possible. This is to avoid leakage on the l.f. ranges as the 10M resistors (range 1) may approach the insulation value of a poor quality switch.

Good insulation is also preferable on the twin gang capacitor VC1 for similar reasons, this being mounted away from, and insulated from, the chassis. The V1a section of the circuit should be kept to its own part of the chassis and wired with reasonably heavy gauge wire.

To reduce any possibility of mains hum, the heaters can be wired with screened wire. Screened wire may also be used on the VR2 output lead. An important point regarding the resistors R1 to R12 should be made. As these resistors are of non-standard values, the correct values may be obtained by measuring the nearest preferred value for a high or low component as suggested in the components list. These resistors should be within 5% and preferably 2% of the stated values and of each other. This latter point is most important as any great discrepancy between resistor pairs on the same range can result in poor tracking, variations in amplitude, and possibly dead spots in the tuning range.

Values

Should difficulty be met with in obtaining the correct value, two resistors may be used in series; e.g., R2, R8, are 2-42M each, and these could be made up from a 2-2M and a 220k in series. The resistor pairs, R1-R7, R2-R8, etc., should be matched on an ohmmeter if possible before connecting them into circuit.

No power unit has been incorporated as the oscillator will work from any 250-350V power pack without affecting the frequency calibration, the h.t. current drain being only 6mA.

For those wishing to keep the size of the unit to a minimum, miniature all-glass type valves may be used without any change in circuit values.

Alignment and Use

Switch on and allow the unit to warm up, set both trimming condensers TC2, TC3 to maximum, S1 to position 3, S2 to position 1, and VR2 to minimum. A pair of headphones are connected to the output. An audio note should then be heard when VR2 is increased; if not, adjust the feedback control VR1 until the circuit just goes into oscillation. If the circuit is already oscillating, adjust VR1 in the opposite direction until oscillation is just occurring, at this point the best waveform is obtained. Too much feedback gives a distorted waveform. With the circuit just oscillating, swing VC1 through its entire tuning range. Should oscillation stop at this point, adjust the trimmers TC2, TC3, for better capacitance balance. With correct adjustment of TC2, TC3, the oscillator should work correctly over the entire range of VC1.

The other frequency ranges are then checked in a similar manner. Should any range not oscillate over the complete sweep of VC1, the resistor pairs on that particular range are not closely enough matched. This should not occur, however, if the tolerances quoted are used. Should difficulty be met with in maintaining oscillation over all ranges, the feedback may be increased by a very slight adjustment of VR1. It should be stressed, however, that the purest sine wave is obtained with VR1 at the lowest setting which maintains oscillation over the entire frequency range.

—continued on page 870
In last month's article the author referred to the tubes and crystals used in this tuner. There are several other components which warrant special attention.

**OTHER COMPONENTS**

Resistors generally should be of 10% tolerance, and R16 and R17 should be matched as accurately as possible. If the ratio detector is used, R22 and R23 should be similarly matched, and R20 and R21 should be 5% or better. Wattage ratings are given in the list of components.

The i.f. transformer should ideally have an acceptance band width of 250-300k/c/s. This is usually achieved by over-coupling, and if critically coupled transformers are used it may be necessary to fit damping resistors across their primaries. The manufacturer's instructions should be followed here.

The choke, L4, is made by close winding 50 or 60 turns of 30 gauge enamelled copper wire onto a 100kΩ resistor of about 5/32in. diameter. The value of the resistor is not critical.

**WIRING**

It is essential to observe v.h.f. technique here, reducing all connections to minimum length. Do not make any attempt at orderly layout; the short direct connection is the primary requirement and must take precedence.

If the specified types of components are used, it will be found possible to reduce connections to decoupling components to less than ½in. in length and this should be the aim.

A small iron of the instrument type is essential. Tinned copper wire of 20swg covered with sleeving can be used for the heaters, but 22 gauge is a more suitable size for the remainder of the wiring.

Decoupling resistors are conveniently fitted in a vertical position so that the h.t. line can be taken around to each stage in turn in the final stages of construction, well away from other components. It will not then be liable to carry r.f. currents from one stage to another.

The main smoothing resistor, R24, must be mounted in a position where its heat is easily dissipated. The top of the mains transformer is a good place but the choice is one of convenience provided it is above the chassis.

Complete wiring diagrams, showing all the connections, are given in Figs. 7 and 8. It should be noted that as the wiring has been opened out for clarity the positions of the components are only approximate, and many of the connections appear much longer than is permissible in construction.

The circuit diagram (Fig. 1) shows the grid of V2 connected to the cathode, this is, of course, incorrect and pins 1 and 6 should be taken directly to chassis, as indicated in Fig. 7.

It should also be mentioned here that V2 is an EC91—not an EF91 as stated in the components lists.

**TESTING**

When the wiring has been completed and checked against the circuit diagram, test with a meter between C30 and chassis to see that there are no shorts in the h.t. circuits. Power can then be applied and a further check made with the meter that the proper voltages are present at the valve electrodes. The h.t. line voltage should be between 220 and 250, and if it is not the value of R24 must be altered as necessary.

**ALIGNMENT OF I.F. AMPLIFIER**

If a signal generator is available, it is advisable first to align the i.f. amplifier to 10-2Mc/s. as follows:

Remove V2 and connect a high resistance d.c. voltmeter positive to chassis and negative to test point A. Inject an unmodulated 10-7Mc/s. signal at the grid of V5 and adjust both cores of IFT2 for maximum reading on the meter, reducing the output from the generator as the circuits come into line.

Transfer the generator to the grid of V4 and adjust IFT1 in the same way.

To align the discriminator, connect the voltmeter between test point B and chassis and detune the transformer secondary by withdrawing the bottom core so that it projects about 1/16in. from the can. Inject an amplitude modulated signal at the grid of V5 and adjust the primary core for maximum response, then adjust the bottom core for extinction of the response. Finally, set the secondary core to produce a very small negative reading and peak this reading by adjusting the primary core. Return the secondary core to zero.

**RATIO DETECTOR**

If the ratio detector has been used, connect the meter to test points D and E, observing polarity, and inject an unmodulated signal at the grid of V5. Adjust the top core of the transformer for maximum response. Connect the meter next between chassis and test point C and adjust the bottom core for zero output. This will affect the
top core which should be re-adjusted for maximum as already described.

The foregoing adjustments need not be made with the greatest accuracy since the final alignment must be done on a BBC transmission. With both types of detector transformer, it will be found that as the bottom core is traversed through the former, the meter reading will rise to a maximum, fall through zero to a reverse maximum, and then return to zero, after which further movement has no effect. The correct position for the core is at the zero between the two maxima.

**OSCILLATOR CIRCUIT**

To align the oscillator, replace V2 and connect an audio amplifier. Set the tuning switch to the highest frequency to be received. Commencing with the core of L3 almost fully withdrawn, enter it slowly into the former until the programme is heard. It will be found that as the inductance of L3 is increased, the programme strength will rise slowly and then fall suddenly to zero as the crystal relinquishes control. The proper position for the core is just before the point at which control is lost.

If the programme cannot be found, reduce the inductance of L2 and try again. If there is still difficulty it should be checked that the oscillator circuit is in order and covers the required range. Remove the highest frequency crystal and fit in its place a mica or ceramic capacitor of about 47pF. With the switch in the appropriate position it will then be possible, if the circuit is in order, to tune all three transmissions by manipulating the core of L3.

The i.f. amplifier and the detector transformer must now be aligned accurately to the crystal controlled signal in the manner described for alignment with a signal generator.

The tuning switch can next be set to each of the other two positions in turn and the programmes tuned in with the trimmers TC1 and TC2. Commence at minimum capacity and set the trimmers to a position just before that at which control is lost.

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**Fig. 7:** The main underchassis wiring diagram.

**Fig. 8:** The ratio detector wiring diagram.
H.F. PROBE

A more accurate method of adjustment, and one that may be found essential in poor reception areas, is to use a high frequency probe connected to a high resistance voltmeter, or a low range millimeter to detect resonance of the crystals. A suitable circuit for such a probe is given in Fig. 9, while Fig. 10 shows how it may be constructed on a strip of paxolin or other similar material. It may be applied to the grid of the mixer valve or to the cathode of V2. As the inductance or capacitance of the oscillator circuit is increased, the meter reading will rise slowly, falling abruptly to zero as control is lost. The diode used in the probe is not critical; a GEX34 or similar will serve.

![Fig. 9: A suitable circuit for an h.f. probe.](diagram)

To meter

Fig. 10: A suggested form of construction of the probe.

R.F. CIRCUITS

Connect the meter negative to test point A and positive to chassis. Adjust L1 for maximum on the lowest frequency transmission and the L2 similarly on the highest.

ALIGNMENT WITHOUT A GENERATOR

If the signal generator is not available, it is best to use pre-tuned i.f. and detector transformers. If this is not done, then one of the crystals must first be brought to resonance by the probe method when, provided a reasonable signal is available, it should be possible to align the i.f. and r.f. circuits as described.

OPERATION

The aerial required will depend on local reception conditions. A loft-mounted or outside dipole with reflector and low loss 75Ω coaxial down lead is recommended for fringe conditions; while in areas of good field strength satisfactory results may be had from an internal cabinet aerial. This may be made from a length of flat twin p.v.c. covered flex by parting the conductors at one end over a length of 30in. and extending them along the top of the cabinet to form a rudimentary dipole. The arms can be turned downwards 90 deg. if their whole length cannot be accommodated horizontally.

If something smaller is required, the arms of the dipole can be shortened and the deficiency made up with loading coils as shown in Fig. 11. No large scale experiments have been done on this by the author but promising results were obtained with metal foil glued to the inside of the cabinet, each arm being 15in. wide and 15in. long. The loading coils can be self supporting, consisting of 18 gauge tinned copper wire, four or five turns each and about half an inch in diameter. The inductance can be adjusted for optimum results by extending or compressing the coils.

In all cases, the aerial should be mounted perpendicular to the direction of transmission, and it is worth remembering that with a normal dipole the strength of the received signal varies almost directly with the height of the dipole above the ground. If the Foster-Seeley discriminator has been used, do not forget that a fairly large signal is required at V5 grid for efficient limiting.

VENTILATION

The cabinet in which the tuner is housed should permit free ventilation above and below the chassis.
Variable Capacitance Diodes

Theory and applications of this new semiconductor device

Variable capacitance diodes have a wide variety of uses both industrially and commercially, one of the more popular uses being that of remotely controlling the tuning of radio receivers. These devices are now becoming more readily available to the home constructor and experimenter, and this article provides a brief summary of their operation and shows the practical aspects of their use.

P-N JUNCTIONS

The normal junction diode consists of two pieces of germanium (or silicon) sandwiched together, one of which is 'n' type, the other 'p' type, Fig. 1(a) shows this diagrammatically. It will be noticed that the electrons in one side and the "holes", or absence of electrons, in the other side collect near the junction. This region, known as the "depletion layer", has a relatively high resistance compared with the rest of the diode, and in fact forms the dielectric of our capacitor; the two outer pieces forming the plates.

Fig. 1(b) shows the same diode with a reverse voltage applied across it. The "depletion layer" (the dielectric of our capacitor) has now increased in width, so the capacitance has been reduced.

The fact that capacitance decreases with an increase in voltage should be born in mind when using these devices, and a typical curve showing capacitance/voltage relationships is given in Fig. 2. The lower part of this curve is definitely not straight and is due to what is termed the "built in voltage". This can be overcome, if required, by biasing the diode on to a straighter part of its characteristic.

CHANGE OF CAPACITANCE

This change of capacitance with applied voltage is common to all types of germanium silicon diodes, and this, of course, includes point contact diodes and transistors. Before attempting to use these devices, it is wise to check the capacitance to ensure they have the capacitance range for the particular application. The test circuit shown in Fig. 3 is useful here. Two similar devices should be used to ensure that the bridge voltage does not produce
Fig. 2: A typical curve for a low capacitance variable capacitance diode.

An error, the bridge voltage should be kept as low as possible, and the peak inverse voltage of the diodes, obtainable from manufacturers data, should never be exceeded. The capacity reading on the bridge should be doubled for a single diode, as here we have two capacities in series.

In practice it will usually be found that the larger the junction the greater the capacitance, point contact diodes normally do not exceed about 10pF, on the other hand there are variable capacitance diodes which change from approximately 50pF to 250pF for a 25V change in applied voltage.

REMOTE CONTROL OF RECEIVERS

The circuit shown in Fig. 4 is for the remote operation of a radio receiver, with both the oscillator and r.f. stages remotely tuned. In the case of f.m. receivers it is usually unnecessary to tune the r.f. circuit, so one pair of diodes may be replaced by a trimming capacitor.

The volume control may be used remotely as shown together with the receiver on/off switch. All these interconnecting leads, and the control unit itself, should be adequately insulated, particularly so in the case of a.c./d.c. equipment.

In Fig. 5 we have a circuit which shows how the reactance valve in a switched tuned receiver may be replaced by capacitance diodes. The preset resistor which is used to bias the diode to the centre portion of its characteristic could at a later stage be replaced by two fixed resistors.

A similar circuit may be used for frequency modulating an oscillator, in this case, however, we replace the a.f.c. voltage input by a modulating signal; this method is shown in Fig. 6. The audio oscillator is in most instances already built into the signal generator. The maximum frequency deviation will depend...
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<th>Gauss</th>
<th>Imped.</th>
<th>Price</th>
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**PARAMETRIC AMPLIFIER**

Another device which uses the variable capacitance effect of diodes is the "parametric amplifier". This is a very low noise type of amplifier and is now used fairly extensively for increasing the range of sensitive radio receivers, such as those used in radio telescopes.

Fig. 7 shows a simplified circuit and the device functions as follows. If we charge up a capacitor then pull the plates apart, the voltage across the capacitor will increase as shown by the familiar expression \( Q = C \times V \), i.e. "\( Q \)" is the quantity of electricity stored by the capacitor. So when we halve \( C \) (the capacity) the voltage across the capacitor must double. What we do in this circuit is to arrange that the capacity is reduced when the input signal reaches its positive or negative peak, and we do this by increasing the voltage across the diode at the right moment. This driving voltage is supplied by an oscillator running at twice the signal frequency in order that the peaks of the signal are "pumped" every half cycle.

There are many other applications for these diodes, such as voltage controlled oscillators, and filters, pocket-sized transistors, f.m. transmitters and d.c. to a.c. converters, in fact more and more uses are being continually found for them. In the future we can expect to see more sensitive devices with a greater capacitance range, and it is also to be hoped that the home constructor and experimenter will have a wider range from which to choose.

---

**THE "PRACTICAL WIRELESS" FILM SHOW**

The "Practical Wireless" Film Show which is held annually and to which readers of P.W. are invited, is to be held, as before, at Caxton Hall, Westminster. The date of the Show, which is arranged in collaboration with Mullard Limited, is the 31st January, 1964.

The programme will appeal to all readers of "Practical Wireless" and of especial interest will be the illustrated talk on colour, 625-line and u.h.f. television, which will form the first part of the programme. After a break for refreshments, the programme will continue with a film entitled "Ultrasonics".

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A Quality Transistor Amplifier

BY A. J. SHORT

A Compact, Three-Transistor Design

This little amplifier is suitable for use with domestic tape recording equipment or with hi-fi record playing equipment. It is preferable to conventional class B transistor amplifiers as it is so simple to make and gives a higher quality of sound reproduction.

Another feature of this amplifier is the extremely wide audio-frequency response, limited only by the characteristics of the output transformer. By using transistors having good high-frequency characteristics the response of the amplifier itself is virtually linear right up to the lower part of the radio-frequency spectrum. This results not only in absence of frequency distortion but also in extremely good transient response. The lack of coupling capacitors eliminates phase distortion. The automatic mismatching between stages resulting from the direct coupling gives a high degree of linearity of transistor characteristic.

Technical Description

This unusual circuit employs three directly-coupled transistors in the grounded emitter configuration. To achieve satisfactory d.c. levels the first and third transistors are of the usual npn type, while the middle one is an npn transistor.

Suitable working currents for the first and second transistors in the amplifier are determined by the judicious choice of collector resistors. The overall working currents in the amplifiers are set by adjustments of the base-bias resistor VR2 of the first stage, which is then stabilised from the average collector voltage of the output (or third) transistor.

Overall negative feedback compensates for the characteristics of the output transformer T1.

A thermistor in the base circuit of the first transistor overcompensates for temperature variations and, although this effect is partially offset by the d.c. feedback loop, the overall effect is to prevent use of the amplifier at unsuitable temperatures.

The Circuit Stage by Stage

The first stage is a high-gain, directly-coupled, grounded emitter a.f. amplifier. The base circuit of this stage is provided with separate a.c. and d.c. negative feedback circuits. The a.c. feedback consists of a fraction of the amplifier output signal developed across R2, via R3, from the loudspeaker speech coil. This voltage is then fed, via the volume control VR1 and C1, to the base of the first transistor Tr1. It will be seen that the feedback voltage appears effectively in series with the input signal, thereby increasing the impedance of the input circuit and reducing the effect of the curvature of the voltage/current characteristic of the first transistor. This, in turn, permits use of a lower value of R1 when the amplifier is used with "voltage" sources such as crystal pick-ups, allowing some reclamation of the loss of gain inherent with negative feedback.

The d.c. feedback circuit R6, C2, VR2 is a supplementary stabilising circuit to the overall temperature control of the thermistor R4. Having a relatively short time constant, about 2sec, it exerts prompt partial control of standing-current variations. The d.c. feedback voltage is developed due to the voltage drop produced by the output stage collector current through the resistance of the primary winding of the output transformer and the a.c. component is removed by the filter circuit R6, C2. The resultant voltage is used to provide the base bias of the first transistor. Increased output stage collector current, causing increased voltage drop across the transformer primary therefore reduces the bias to the first stage, resulting in amplified bias reduction to the output stage and overall stabilisation. Long-term overall amplifier dissipation is controlled by the thermistor R4, which takes into account not only local heating due to amplifier dissipation but also the effect of ambient temperature.
The second stage, directly coupled to the first, employs an npn transistor. Its bias is provided by the voltage drop in R7, due to the collector current of the first transistor, and its input impedance forms the collector load of the first stage. Signal currents in this stage are in phase with those of the first stage. This stage operates also in the grounded emitter configuration to obtain maximum gain.

The output stage employs a small power transistor Tr3 with extended high-frequency characteristics. By employing this transistor in class "A", directly coupled to the previous stage, a "hi-fi" output is obtained. The quality of reproduction is now limited only by the characteristics of the output transformer T1 and the loudspeaker. The characteristics of the output transformer are improved even further by the use of the negative feedback loop around the amplifier.

With a 12V supply and the amplifier set up so that the output stage is drawing 350mA, well over a watt of high-quality audio is obtained, more than adequate for domestic use in a normal size room.

**Construction**

The amplifier is best constructed in a small steel instrument case of the type specified, as one wall of the box can then be used to support the output transistor and at the same time act as a heat sink. The remainder of the circuit may then be assembled on a paxolin board mounted inside the case. Either tagboard or printed circuit construction may be employed as desired.

A simple printed circuit may be constructed by drawing the circuit on a piece of copper laminated board, obtainable from advertisers. The outline of the circuit is then carefully but firmly scored through with the point of a sharp penknife and then with the edge of the blade the unwanted portions of copper are carefully prised off. The printed circuit shown in the illustration was constructed in this way.

If tagboard construction is preferred, a sheet of paxolin should be drilled in the positions indicated on the printed circuit diagram and 6B.A. nuts and bolts, with soldering tags, inserted in these positions. The tags should then be wired as in the printed circuit diagram, after which the components may be inserted in position. The customary protection should be provided for transistors during soldering to prevent damage by heat. In particular the emitter and base wires of the power transistor should be firmly gripped.
by long-nosed pliers while flying leads are quickly soldered to their ends.

**Setting-up**

When construction is complete and all wiring checked the amplifier is ready for setting-up for use. For this purpose a 0-500mA meter will be required, together with a 12V low-consumption lamp.

Before connecting to the power supply ensure that the variable resistor VR2 is set to maximum resistance. If this is not done, damage to the transistors may result when the power supply is connected.

Check the polarity of the power supply and connect the amplifier to the power supply via a

![Image of a circuit diagram](image)

**Fig. 3: The wiring on the reverse of the mounting panel.**

A signal may now be applied to the amplifier and a trial run made, checking the current drawn from time to time and adjusting VR2 if necessary. It will be necessary to adjust VR2 further only if a change of supply voltage occurs or the amplifier is operated at a greatly different ambient temperature. As the amplifier is intended for domestic use, however, this is not likely to arise. Should it be desired to operate the amplifier over a wide ambient temperature range a permanent 0-500mA meter should be fitted. Should the amplifier be unstable when switched on it will be found to be due to the feedback connections to the loudspeaker speech coil being the wrong way round. Reversal of these connections should clear the fault.

Note that if the output transistor is bolted directly to the steel case the metal of the case will be "live" to the power supply negative. If this should not be desired the power transistor should be insulated from the steel case by use of the mica and plastic washers provided. A small dab of silicone grease between washers, case and transistor will improve thermal conductivity.

**COMPONENTS LIST**

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<td>R1 100kΩ (or to suit pick-up)</td>
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<td>R2 10kΩ</td>
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<tr>
<td>R3 1.5kΩ</td>
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<tr>
<td>R4 Thermistor CZI (Brimar)</td>
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<tr>
<td>All 1W carbon, except where otherwise stated</td>
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<td>VR1 500kΩ carbon potentiometer, log</td>
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<tr>
<td>VR2 1MΩ carbon preset potentiometer, linear</td>
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<td>C2 100µF electrolytic 12V</td>
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<td>Tr2 OC139, OCI40, 2N647, 2N649</td>
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<tr>
<td>Tr3 OC22</td>
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<tr>
<td>T1 Output transformer (Repanco TT12)</td>
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<tr>
<td>LS Loudspeaker 3Ω</td>
</tr>
<tr>
<td>FS1 Fuse 500mA</td>
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<tr>
<td>Steel instrument case 6in. x 4in. x 3in. (Tele-Radio Ltd.)</td>
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</table>

12V low-consumption bicycle headlamp bulb and the milliammeter. The bulb will protect the meter and the amplifier should a mistake have been made in wiring the amplifier. When connected and switched on, at this stage, the bulb should not light. If it does light there has been either a mistake in construction or the variable resistor VR2 has not been turned to maximum resistance. If the lamp does not light, short-circuit it or remove it completely from the circuit, reconnecting the supply, and commence gradually to decrease the resistance of VR2. Up to this point the amplifier has not been drawing any appreciable current from the supply and the milliammeter will have been reading "0". As VR2 is gradually decreased in value, however, a point will be reached where the amplifier suddenly begins to draw current. The transition will be quite abrupt and must be watched for. Carefully adjust VR2 until the milliammeter reads 350mA, allowing time after each adjustment for the d.c. stabilising circuit to settle down and take effect.

**HELP FOR HOME BUYERS**

When you are buying or selling property it is vitally important to know where you stand as far as the law is concerned. Ignorance or carelessness might cost you hundreds of pounds. There's sure to be a big welcome, then, for the new FREE LEGAL ADVICE SERVICE just announced by Newnes Property Advertiser and Holiday Guide. Every week, from now on, this paper will carry questions and answers on such topics as mortgages, insurance, surveying and general legal points. In addition any reader may have his own particular questions answered by a panel of experts simply by filling in a Query Coupon on the Legal Advice Page. Newnes Property Advertiser and Holiday Guide, which contains details of thousands of houses, flats, shops, business and holiday addresses, is on sale every Friday, price 4d.
A Variable POWER SUPPLY for Transistors

This unit provides a d.c. output adjustable from 0 to 26-7V in steps of 0-15V. Its maximum continuous current rating is 1-2A.

By R. Leyland

When powered from self-contained batteries, transistorised apparatus is fully portable but, on the other hand, a supply derived from the mains has very low running costs despite the higher initial expenditure on the power unit.

Dry batteries cannot supply large currents for long periods and are therefore inadequate when power output stages are to be worked, especially the class A type required for quality reproduction. For these it is necessary to employ either a car battery or a directly derived mains supply. The mains voltage is usually dependable and does not fall with the passage of time as in the case of batteries.

The power unit to be described (the circuit is shown in Fig. 1) provides up to 24V, which is probably as high a voltage as could be required with transistors—at least with types so far available. It has a maximum continuous current rating of 1-2A (at 14V). The rectifiers can deliver up to 1-5A but cannot do so for more than half an hour without reaching ambient temperatures too high for such a current rating, whereas at 1-2A the power unit can work continuously, reaching a maximum temperature of about 50 deg. C in three hours.

Silicon Rectifiers

The silicon rectifiers, Ediswan type XU612, have ratings similar to S.T.C. type RS210AF and to G.E.C. type SX631. However, type SX631 have provision for 6A, stud mounting, while the XU612 and the RS210AF are wire-ended only and cannot be fitted to heat sinks.

In a compact power unit the proximity of the transformer and choke raises the ambient temperature and this limits the current that can be drawn continuously without exceeding the rating of the rectifiers. Although silicon rectifiers can be used at 100 deg. C their current rating is reduced considerably as compared with that at lower temperatures and, of course, the temperature has to be kept much lower if an electrolytic capacitor is to be included.

The time lag of three hours in warming up to the maximum temperature is accounted for by the large thermal capacity of the transformer and choke.

The Transformer

A less elaborate transformer than the one here proposed would usually suffice but a series of secondary tappings offers a more convenient and efficient method of controlling the output voltage than dropper resistors and raises the temperature less.

The provision of both coarse and fine tappings enables close adjustment of the output voltage to be made. The tappings are brought out to connector strips which extend along both sides of the power unit: 12-way for the principal tappings and 15-way for the fine tappings. This allows the r.m.s. input to the rectifiers to be adjusted from zero up to 26-7V in steps of 0-15V.

The use of switches for selecting the tappings was not considered advisable. These would require to be of a break-before-make type to avoid short-circuiting sections of the winding but, even so, sparking would probably cause rapid deterioration of the contacts. As the output voltages are low there is no objection to the use of connector strips along the sides of the box with flying leads for voltage selection. The connector strips are adequately insulated for much higher voltages than those encountered here.

Laminations with a window large enough to ensure ample winding space are required because a large number of tappings causes the windings to take up more room than straightforward calculation would suggest (see Fig. 2). The size of stack is chosen to give a cross-section large enough to keep the turns per volt to a reasonable number.

Primary Turns

The primary was wound with 1,560 turns of 35s.w.g. double silk covered wire for a nominal...
mains voltage of 240.

At first the actual mains voltage appeared less, but this was because allowance had not been made for the current (about 0.3A) taken by a large a.c. voltmeter used in measuring the secondary voltages. The unloaded a.c. voltages of the secondary tappings are therefore about 3% higher than the values that have been marked on them. This is not a large difference but it brings a close agreement between the voltage ratios and turns ratios. As the maximum open-circuit output voltage (measured by a d.c. voltmeter) has been adjusted in this circuit by means of a resistance to be approximately the maximum working voltage of the electrolytic capacitor, to obtain the same results on a different mains voltage would simply require proportionate change in the number of primary turns. The number of turns per volt is 6.5. Thus to obtain the same results on 250V would require 1,625 turns.

![Fig. 2: Details of the laminations of the mains transformer.](image)

It is necessary to check that the highest direct voltage obtained across the electrolytic capacitor does not exceed 23V with the 200Ω resistor in circuit. Should higher voltages be obtained, the secondary tappings giving these voltages would have to be disconnected, insulated and left unused.

**Winding the Transformer**

The transformer bobbin, made of \( \frac{1}{16} \) in. insulating material and provided with rows of holes in the cheeks to bring out the 2-2V tappings, was wound by fitting into it a wooden block drilled in the centre for a \( \frac{1}{4} \) in. shaft. This was retained between collars on the shaft. A screw inserted in the block and tied to a screw on one of the collars prevented the bobbin from slipping on the shaft.

The \( \frac{1}{4} \) in. shaft was fitted into bearings mounted on two supports on a base-board. A handle was fixed on one end and a short flexible drive at the other connected to a turns counter through a universal joint to give the maximum freedom from alignment difficulties.

With this arrangement the transformer bobbin could be wound quite rapidly. Flexible plastic-covered wire leads were used to the mains primary winding with the soldered joints well insulated by a double thickness of Empire cloth. Plastic insulating tape should not be used for such applications as it is easily pierced by any irregularity in the solder.

Three thicknesses of Empire cloth separated the primary and secondary. The secondary consisted of 180 turns of 212ins. enameled and single cotton covered wire, wax-dipped before winding to prevent fraying of the cotton. Double cotton covered wire takes up less than 10% more space and could possibly have been used instead. Double silk covered wire of the same gauge could certainly have been used as it takes up less room than E. and S.C. It, too, would preferably be waxed before winding to ensure undamaged insulation at bends in the wire. Enamelled wire without additional protection would require inter-leaving and special care in insulating the tappings. The 180-turn secondary has a resistance of 1Ω.

**Secondary Tappings**

Tappings extending 6in. outside the transformer were made at half-layer intervals (15 turns) by doubling the wire. The second and third tappings were taken out at the opposite side from the start of the winding, then the next two at the other (first) side and so on. Pieces of Empire cloth were applied as insulation above and below each loop where it traversed the winding and at the bends in the wire. The resulting bulge occurs on one of the exposed sides of the winding and does not affect the winding space set by the size of the window of the transformer laminations.

The outermost 15 turns were tapped at every turn, the loops being twisted to keep them from coming apart and insulated with small pieces of insulating tape, doubled and pressed around the place at which the tapping is made. When the secondary had been completed it was bound with insulation tape to secure it firmly. The laminations were then inserted from alternate sides and the entire transformer was wax-dipped to improve the insulation and exclude moisture. This seemed worth while, although under continuous working at maximum loading the transformer heats enough for some of the wax to run out.

Sleeping was used outside the transformer where necessary to separate the tappings. This requires to be of at least 2mm to allow the double wire to pass through it and a limp type of sleeping was found suitable.

In arranging the leads to the connector strips most of them required to be shortened slightly. The waxed cotton covering was pulled back and the enamel scraped off. The ends were then twisted together and soldered before insertion into the connector and screwing down the grub screw. As the tappings are loops the current of the winding has to pass through a succession of soldered joints, so it was necessary to ensure a low-resistance junction between the wires at each connector position.

**A.C. Ripple Reduction**

A power supply delivering a large current at low voltage has a tendency to give too much a.c. ripple, comparing very unfavourably with batteries as regards the background hum produced. Filtering poses a problem because the resistance of any series smoothing component has to be small to avoid a large voltage drop with correspondingly
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high power loss (which also adds to the temperature of the power unit).

Apart from decoupling individual transistor stages that do not require large currents, the only satisfactory method of reducing ripple is to include a low-resistance choke.

In this power unit the choke has an inductance of 0.12H with I.A flowing and a d.c. resistance of 4.2Ω. Although the inductance seems small its reactance is 75Ω at 100c/s—the ripple frequency from the full-wave rectifier bridge.

Connected between the output terminals is a 1mF capacitor (usually marked 1,000μF) which has a reactance of 1.6f1 at 100c/s, so the ripple will be attenuated about 46 times to a level which, although not totally imperceptible in a loudspeaker, should serve for working an output stage.

Earlier stages will, however, require additional decoupling, which may not be present in the simpler types of battery receiver where its only function would be to prevent feedback via the battery impedance and not to stop ripple—which does not occur with a battery supply.

Ripple will be greatest when the maximum a.c. input is applied to the rectifiers and it also varies with the load current due to variation in the choke inductance, which is about twice as high at small output currents.

With the entire secondary in circuit the ripple at the output terminals when drawing 1-2A at 14V is 210mV r.m.s. When the load is disconnected the output voltage rises to 24V but the r.m.s. ripple decreases to 90mV.

A reservoir capacitor of about 1,000μF, if added to the circuit, gives little improvement except at small output currents. The ripple voltage at full load is reduced only slightly, so a large ripple current flows through the capacitor. A surge resistor is necessary in series and this becomes quite hot, requiring to be of substantial wattage.

When a large direct current is flowing the reservoir capacitor is unable to charge sufficiently to raise the voltage and so to decrease the ripple (with a reduction in the conducting period of the rectifiers). To do this would apparently require at least 10mF (at 25V working), which is ruled out on the grounds of bulk and because of the large current pulses that would pass in the rectifiers. At least as much ripple reduction would be obtained by connecting such a capacitance across the output terminals.

There is also little improvement to be obtained by tuning the choke with electrolytic capacitors. For example, a 16μF capacitor halved the ripple at full load but slightly increased it at no load. It also distorted the ripple waveform by increasing the higher harmonics. Capacitors of 8μF and 25μF across the choke were even less beneficial.

Details of the Choke

The choke winding contains 400 turns of double silk covered wire of 25s.w.g.

The laminations, of the E and I pattern, are of the type shown in Fig. 3. The gap between the E and I laminations (which occurs as a double gap in the magnetic circuit) was adjusted, using slips of paper. These were cut from a page of a spiral-bound notebook and six pieces gave the optimum gap of 0.02in. As the graph in Fig. 4 shows, any size of gap is better than none. Complete removal of the 1 laminations gave an inductance of about 0.05H as compared with 0.12H at the optimum gap.

When completed the choke also was wax-dipped. The effect of this on the gapping paper was assumed negligible and the values of output ripple that have already been stated were measured subsequent to this wax impregnation.

The resistance of the choke, 4.2Ω, is not entirely a disadvantage, for it gives the rectifiers some protection against accidental short-circuits of the output, provided that these are only momentary. For this reason it was not considered necessary to add a fuse in the output circuit.

The 1,000μF, 25V working capacitor connected between the output terminals and positioned over the choke is a miniature type measuring 14in. x 1in. diameter. It is unnecessary to shorten its leads, but sleeving should be used on these.

Rectifier Assembly

The silicon junction rectifiers can be seen to have one axial lead in electrical connection with the metal case at the end with the circular flange. This lead is of + polarity, corresponding to the cathode of a thermionic diode.

The separation between the rectifiers must be sufficient to ensure that contact cannot occur between them. A suitable tag-board of the usual type was not at hand, so an eyeleted panel was made with 20s.w.g. tinned copper wire linking pairs of eyelets (see Fig. 5) and providing short projections on to which the leads of the rectifiers were hooked and soldered. The lead wires should not be bent close to the seal and are held with pliers during the soldering to keep the heat from reaching the rectifier.
The 200Ω resistor is connected on the input side of the choke because in this position it helps to safeguard the rectifiers against any voltage surges, and comes in parallel with the reverse resistances of the rectifiers during their non-conducting half-cycles, thus protecting them against surges via the mains. This resistor should therefore be considered an essential rather than an auxiliary component.

It is anticipated that the power unit will normally be supplying voltages well below the maximum. Where only a 9V supply is needed the much higher voltages available could represent a source of risk to the apparatus being supplied, but the tappings have been marked clearly and external meters would normally be used in adjusting the voltage to circuits under test, beginning at a lower voltage and gradually adjusting upwards until the correct output voltage was obtained on load.

Silicon rectifiers produce less heat as they are much more efficient than selenium rectifiers and drop far less voltage. Losses in the other components, however, make the overall efficiency of the supply much lower. The power unit consumes 35W when supplying an output of 14V at 1-1A, which implies an overall efficiency of 44%. The power losses consist of 5-1W in the choke and 1-7W in the 200Ω resistor. There are also those of the transformer and rectifiers whose combined efficiency at this output is 63%.

Output Characteristics

Except for currents of below 100mA, the source resistance of the supply is constant with loading and has a value of 5 to 7Ω according to the a.c. input voltage. The source resistance rises slightly with a higher a.c. input as more of the secondary is brought into circuit, corresponding to a slight increase in the slope of the upper regulation curves of Fig. 6, which are not quite parallel.

The a.c. input voltage from the transformer secondary falls slightly with increased loading due to the resistance of the transformer windings.

All four rectifiers were mounted vertically with the + end downwards, and the tag-board with backing piece is bolted on the inside of the box under the 15-way connector.

The Wire-wound Resistor

A 200Ω wire-wound resistor is connected across the output of the rectifiers. The purpose of this resistor is to prevent the output voltage from rising to an excessive value on no load. It ensures that the open-circuit output voltage is not too high for the electrolytic capacitor, which has a working voltage of 25V. There is a steep rise in the regulation curve at small direct currents and in the absence of this resistor over 30V would appear across the output (using the entire secondary) at zero direct current as against a maximum of 24V with the resistor included. It dissipates up to 3W and is positioned at the transformer end of the power unit.

Fig. 5: The rectifier bridge assembly.

Fig. 6: Regulation curves of external d.c. output at different a.c. input voltages. (There is also an internal resistance of 200Ω taking an additional current.)
With the entire secondary in circuit the input drops about 2V r.m.s. for an ampere of direct current in the external load.

The d.c. source resistance determines the fall in direct voltage for a given increase of direct current. Thus an increase of half an ampere in the current drawn will cause the output voltage to drop by about 3V. Although not exactly equal to the a.c. source resistance of the supply the d.c. value probably will not differ appreciably from it up to about 25c/s, where the 1,000µF capacitor begins to take over, making the output impedance capacitative with a reactance of only 1Ω at 100c/s.

A set of load lines have also been drawn on the regulation curves of Fig. 6. It is thus easy to determine the approximate output voltage and current for a given value of load resistance and input tapping.

The spacing of the regulation curves shows that each additional 2-2V step of a.c. input voltage gives just under 2V increase of direct volts output (for the same current), but there is the usual non-linearity with inputs of about 1V or less which has an effect somewhat like a small reverse bias voltage on an ideal resistanceless diode.

It is possible to draw an approximate equivalent circuit for the d.c. output as in Fig. 7. This is based upon the regulation curves.

**Dimensions**

The dimensions of the power unit (6½ in. x 3½ in. x 3 in.) are the minimum that will accommodate the transformer and choke and it was necessary to check that the components to be used would in fact fit into this limited space, especially as the bunching of the tappings tended to increase the room taken by the transformer. The arrangement of components and wiring is shown in Fig. 8.

A ready-made pressed-steel box of the required size for the power unit was not available, so a box was specially constructed from 18s.w.g. aluminium. Aluminium of this thickness is easily fretsawed and the narrow flanges required can be accurately formed by stages in a vice. Hammering should be avoided in this process to avoid distorting the metal, but if some proves necessary to flatten a bulge a piece of wood can be interposed to avoid damage. The line of the flange is set just at the top of the vice (with the flange gripped in the vice). The flange then turns out a little deeper while the dimension of the main part is kept close to the original measurement.

**Details of the Construction**

The top panel, which bridges the gap between the connector strips, is a piece of hardboard as this is less likely to damage the tappings on removal and replacement, Fig. 9(J).

---continued on page 835---

---Fig. 7: Equivalent circuit of d.c. output of power supply.---

---Fig. 8: The arrangement of the power unit.---
Fig. 91 Details and dimensions of the component parts of the power supply case.
Another piece of hardboard, Fig. 9(D), is used under the 18s.w.g. bottom of the box as the latter is too thin to take the 4B.A. countersunk screws which secure the transformer and choke. The rough side of the hardboard base is downwards to provide a non-slip surface which, with the 51lb weight of the power unit upon it, makes it less likely to be pushed out of position. The bottom of the box is a flanged tray of 18s.w.g. aluminium measuring 6in. x 3½in. and with½in. flanges as shown in Fig. 9(A). The sides of the box measure 6in. x 3½in. and have ½in. flanges which form ledges supporting the connector strips. Refer to Fig. 9(B) and (C).

Flanging is carried out before drilling. Holes for 6B.A. screws are drilled first in the sides, which are then used as templates for the 6B.A. holes in the flanges. After temporarily fixing the sides, holes are drilled in the ends and similarly transferred to the flanges and inner end pieces, Fig. 9(G) and (H). The end plates are shown in Fig. 9(E) and (F). These plates are without flanges to give the box nearer corners and are secured by the flanged end pieces which fit inside.

The top, of the hardboard, rests on the edges of the connector strips on each side and fastens at each end by a 6B.A. countersunk screw to a small bracket on the end plate. See Fig. 9(I). The use of countersunk screws throughout, although not essential except in the hardboard base, gives the box a much better appearance, but 18s.w.g. is rather thin and in countersinking the 6B.A. holes it is advisable not to go too deeply as the screw sinks in further than intended when it is tightened. A 60 deg. countersink drill appears to be best for countersinking holes for the 6B.A. screws but a 90 deg. countersink drill is more suitable for the 4B.A. holes in the base.

Final assembly of the power unit is greatly facilitated if 6B.A. hank nuts are fitted to all the flanges. Most of the interior of the box becomes inaccessible when the sides and ends are in position and the usual type of nut would be very awkward to get into position. Where a hank nut is to be fixed the 6B.A. hole previously made in the flange is drilled through with a ½in. drill and then lightly countersunk. The hank nut, which is really a sort of combined nut and rivet, is easily riveted into this hole by hammering.

The box was painted with grey plastic enamel, which it is thought should give better cooling than the polished aluminium left unpainted, although probably less efficient than a coating of black crackle paint.

**Connector Strips**

The connector strips are of the more compact type with 1cm spacing. The 12-way strip on one side does not extend the full length of the box and leaves a small aperture at each end for ventilation. The 15-way connector strip that fully occupies the other side consists of a 12-way strip with a three-way portion added at one end. The connectors are retained in position by 6B.A. bolts ½in. long, inserted from the top into hank nuts in the flanges, with a washer between the head of each nut and the connector strip. Countersunk bolts should not be used here as they would break the connector strips when tightened.

It is necessary to arrange the tappings in sequence to give an ascending series of voltages. The r.m.s. values are marked with Indian ink at 1cm intervals on ½in. strips of paper which are then covered with Sellotape for protection and glued along the edges of the top panel beside the multi-way connectors.

The ends of the flying leads are doubled and soldered to avoid breaking of the strands.

To guard against interchange of the red and black tops of the output terminals a small disc of paper with a + sign in red was stuck on beside the positive terminal.

**Mains Connection**

The lack of a switch in the primary circuit might be felt to be a disadvantage. A small snap-action switch could be fitted at the transformer end on the opposite side from the two-way connector. It is advisable to wrap insulating tape around the switch tags to ensure that if the switch should loosen no contact can be made with the metal box.

The plastic insulation of the wires entering the connector block must be carried right into the connector. No bare conductors should show in the primary circuit. With a three-pin plug and three-wire flex (red for live, black neutral and green to the large earthing pin) the green wire would be connected to a soldering tag under one of the nuts securing the transformer. In a two-wire system additional insulation is recommended, e.g. insulating tape over the plastic covering and possibly strips of plastic insulating tape covering adjacent metal surfaces.

Before use, an ohmmeter check is made to ensure that the insulation between the metal case and internal circuits is satisfactory. The wiring of the power unit is insulated from the metal box on both the primary and secondary sides. It is also important to check the wiring before connection to the mains. The fault most likely to damage the rectifiers would be connection of one of the flying leads to a wrong part of the rectifier bridge.

If, as a test, the flying leads are first connected to a 9V battery, a voltmeter across the output terminals should read over 7V with the battery connected either way round.

---

**Fig. 10:** The tag board mount for the wire-wound resistor.

**Fig. 11:** The terminal strip.
Here is a constant stream of "new entrants" to the hobby of radio receiver construction, many of whom are in search of a design for a receiver which, whilst simple to construct, will be reliable in operation and ensure really worthwhile reception of a selection of home and Continental programmes; at the same time the receiver must be inexpensive to construct and comprise only standard, easily obtainable components. With these criteria in view the author constructed the receiver described in the following paragraphs, and it is thoroughly recommended to the novice who has mastered the art of soldering and who, having possibly built one or two simple crystal and transistor receivers, is now desirous of tackling a mains operated valve receiver.

Reference to the theoretical circuit diagram, Fig. 1, will no doubt bring back to the older readers' memories of their early efforts at mains receiver construction. Basically the design employed is that which was regarded as "standard" in the early days of mains operated receivers, namely a three-stage t.r.f. ("straight") line-up comprising a vari-mu pentode r.f. amplifier stage, followed by a triode grid leak detector and a.f. amplifier and a pentode power output stage, the whole being fed with the necessary power supplies from a fully isolated mains transformer and full-wave rectifier with choke and capacity smoothing.

Many t.r.f. receiver designs, particularly those of the "midget" type, employ a.c.-d.c. power supply technique or a heater transformer in conjunction with a half-wave rectifier. Admittedly this gives a considerable saving in cost, but in the writer's view the greater safety factor given by the avoidance of a "live" chassis (unavoidable in the a.c.-d.c. type of receiver), when a full-wave power supply with double-wound mains transformer is employed, is particularly desirable in the case of all home-constructed receivers and especially so for those assembled by beginners. A further advantage is that performance of the completed receiver is enhanced by virtue of the fact that an h.t. positive line of a full 250V is available, allowing adequate voltage to be fed to the valve anodes and screen grids even after the "drop" due to load and decoupling resistors and at the same time smoothing is more efficient and the resultant hum level kept to a low order.

Octal-based valves are used throughout, as these are efficient and robust and very cheaply obtainable from numerous advertisers in this magazine, also their comparatively large base connections greatly facilitate wiring up for the novice. In spite of the fact that the basic principles of the circuit date back some 30 years, good results are assured in all but the very poorest reception locations, the inclusion of pre-set reaction in the detector stage greatly enhancing the sensitivity and selectivity of the receiver. Long and medium waveband coverage is provided, but listeners residing in areas where the B.B.C. Light Programme is satisfactorily received on 247 metres (such as the London area, for example) may omit the long waveband if desired, with resultant simplification and saving in cost.

**Circuit Description**

Signals are fed to the control grid of V1, which is a 6K7, by way of the aerial input coil L1 or L2 (as selected by the wavechange switch S1) and tuned by the section of the two-gang tuning capacitor VC1.

Wearite "P"-type coils are used throughout the receiver. They are easily obtainable, simple to mount and match up to the station markings of the standard type of tuning dial, and the necessary adjustable trimming capacitors can be soldered directly across the tuned windings of the coils themselves (see Fig. 3).

R.F. amplification takes place in V1, the gain of which is made variable by VR1 in the cathode circuit, which thus acts as a volume control. In some locations it would not be possible to reduce the volume sufficiently on strong local stations by variation of bias on V1 alone, so the "cold" end of VR1 is connected to the aerial input, with the result that as the volume control is turned "down" a progressively lower resistance is shunted across the primary of the aerial tuning coils until, at minimum volume setting, the aerial is virtually short-circuited to earth (chassis of the receiver). Conversely, at maximum volume setting, the shunting effect of the full 10kΩ resistance of VR1 is negligible.

The amplified r.f. signal at the anode of V1 is developed across the r.f. choke L3. A choke is used here in preference to a resistor as, being of comparatively low d.c. resistance, practically the full h.t. voltage is thus applied to the anode of V1, giving maximum efficiency.

C4 acts as a d.c. blocking capacitor to prevent flow of h.t. through the detector coils L4 or L5 to chassis but allows the r.f. signal to pass unimpeded, via the wavechange switch S1c, to the appropriate detector coil (tuned by VC2, the second section of...
the gang capacitor) and via the grid leak capacitor C5 to the control grid of V2, R3 being the grid leak resistor.

V2 is a 6J5 triode and the cathode of this valve is connected directly to earth and thus the valve combines the functions of demodulation (detection) and a.f. amplification. The values of C5 and R3 have considerable influence on overall performance and those finally chosen and specified in the parts list seemed to give the best compromise between "selectivity" and "quality".

The a.f. voltage appearing at the anode of V2 is developed across the load resistor R5; R4 and C6 provide decoupling from the h.t. line and serve both to prevent unwanted leakage of residual r.f. signals into the h.t. line (with risk of feedback to V1 and instability) and to provide additional smoothing for the h.t. supply to V2.

Grid leak detectors are very prone to "hum" pick-up unless adequately smoothed power supply is provided and neat, short wiring, particularly of the grid input circuit, is a must.

THE OUTPUT STAGE

The a.f. signal is fed via C8 to the control grid of V3, which is a high-slope pentode output valve of the 6P25 type. R7 is a grid stopper resistor inserted as close as possible to the control grid of V3 to prevent any r.f. voltages from reaching this valve, which could cause parasitic oscillation (sometimes at supersonic frequencies) to be set up, with resultant poor reproduction of speech and music.

R8 and C9 provide correct biasing conditions of V3 and the output is developed across the primary winding of the output transformer T1,
whose secondary winding is “matched” to the loudspeaker speech coil.

A simple type of tone control, comprising C10 and VR2, is connected across the primary of T1 and this gives the necessary control over frequency response. As pentode valves tend to accentuate the higher frequencies, including such unwanted noises as heterodyne whistles caused by transmitting stations radiating on frequencies near to the one being received, the inclusion of a means of “top cut” is very desirable. VR2 is thus useful in reducing background “noise”, especially when listening to the more distant stations.

FEEDBACK ARRANGEMENTS

Returning now to the anode circuit of V2, the purpose of the other components connected thereto will now be explained. In addition to the a.f. signal there will be signals at r.f. present at this electrode; a portion of these is bypassed to earth via C7 but the remainder is deliberately fed back through the coupling coils of L4 or L5 (according to setting of the wavechange switch S1d), via the preset trimmer capacitor TC5 or TC6, to earth. Variation of the setting of these trimmers allows the amount of feedback (“reaction”) to be controlled and in practice, when the receiver is completed, they are set to give the maximum amount of feedback which can be tolerated without the receiver bursting into self-oscillation, and an enormous increase in both sensitivity and selectivity results from this arrangement. It should be noted that the windings of the feedback coils must be connected in the correct “sense”, otherwise a diminution in signal strength, instead of an increase, will take place. The correct method of connecting the specified coils is indicated by reference to Figs. 1 and 3.

POWER SUPPLY

The power supply section comprises a double-wound mains transformer T2, provided with primary tappings to suit the various standard mains supply voltages. An on/off switch S2 (actually combined with VR2) is inserted in one of the primary leads. Two separate secondary windings provide 5V at 2A to feed the heater of the rectifier valve V4 (which is a 5Z4) and 6.3V at 3A to feed the heaters of all the other valves, plus any pilot bulb(s) provided for illumination of the tuning dial. The centre tapped 250−0−250V h.t. secondary winding of T2 should be rated at not less than 60mA.
Full-wave rectification takes place in V4 and
the resultant d.c. is smoothed by the reservoir
capacitor C12, l.f. choke L6 and smoothing
capacitor C11. The choke should be rated at
about 10H for a current of 60mA. C11 and C12
can conveniently be a “double” electrolytic
capacitor of 8-16 or 16+16µF of not less than
350V working. These values will be found to give
adequate smoothing and the resultant h.t. voltage
available at C11 should be approximately 250V
“on load”.

Provided that the stated values and voltage
ratings of the components given in the parts list
are adhered to then they can be of any make; only the
tuning coils (Wearite “P” type) are specified by
name, and as these were used in the original and
connection data for this is given the beginner in
particular is advised to adhere to the specification.

If alternative makes of coils are used the manu-
facturer’s data as to connections must, of course,
be adopted. It is not recommended that dual-
range types (i.e., those having both long and medium
waveband coils on one former) be employed, as these normally have only one
coupling or feedback winding common to both
wavebands. This would render the separate preset
adjustment of reaction in the detector stage no
longer possible on the two wavebands, with the
result that whilst it might be found possible to
advance the reception to a certain level on medium
waves, the same setting would not hold good on
long waves and a compromise setting would have
be accepted, with consequent loss of per-
formance. The slight extra expense and complica-
tion of separate coils is fully justified.

The r.f. choke should be of the standard “all
wave” type; the one used in the original was taken
from an old receiver but a Denco RFC Type 7A
or an Osmor Type QC1 should perform satisfac-
torily in this position.

In the case of valves the specified octal types
are very easily obtainable; a “metal” type is
recommended for V2 and if a “metal” type is
used for V1 the screening can shown in the illus-
tration and parts list can be omitted. If desired
an EF39 can be substituted for V1 and either a
KT61 or an EL33 substituted for V3 without any
circuit changes. It would also be possible to use
a directly heated rectifier such as a 5Y3 in the V4
position, but in the writer’s opinion the use of
the indirectly heated 5Z4 is to be preferred as it
prevents the rise of the h.t. voltage to too high a

<table>
<thead>
<tr>
<th>COMPONENTS LIST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Resistors:</strong></td>
</tr>
<tr>
<td>R1 47kΩ</td>
</tr>
<tr>
<td>R2 220kΩ</td>
</tr>
<tr>
<td>R3 1MΩ</td>
</tr>
<tr>
<td>R4 10kΩ</td>
</tr>
<tr>
<td>R5 47kΩ</td>
</tr>
<tr>
<td>R6 470kΩ</td>
</tr>
<tr>
<td>R7 47kΩ</td>
</tr>
<tr>
<td>R8 150Ω</td>
</tr>
<tr>
<td>VR1 10kΩ±2W wire-wound potentiometer</td>
</tr>
<tr>
<td>VR2 50kΩ±2W carbon potentiometer, with switch (S2)</td>
</tr>
<tr>
<td><strong>Capacitors:</strong></td>
</tr>
<tr>
<td>C1 500pF mica or ceramic</td>
</tr>
<tr>
<td>C2 0.1µF paper 350V</td>
</tr>
<tr>
<td>C3 0.1µF paper 350V</td>
</tr>
<tr>
<td>C4 100pF silver mica or ceramic</td>
</tr>
<tr>
<td>C5 100pF silver mica or ceramic</td>
</tr>
<tr>
<td>C6 8µF electrolytic 350V</td>
</tr>
<tr>
<td>C7 100pF silver mica or ceramic</td>
</tr>
<tr>
<td>C8 0.01µF paper 100V</td>
</tr>
<tr>
<td>C9 25µF electrolytic 25V</td>
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<tr>
<td>C10 0.02µF paper 100V</td>
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<tr>
<td>C11 16µF electrolytic 350V</td>
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<tr>
<td>C12 16µF electrolytic 350V</td>
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<tr>
<td>VC1 500pF J-twin-gang variable</td>
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<tr>
<td>VC2 500pF J-twin-gang variable</td>
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<tr>
<td>TC1 50pF compression type trimmer</td>
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<td>TC2 50pF compression type trimmer</td>
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<td>TC3 50pF compression type trimmer</td>
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<td>TC4 50pF compression type trimmer</td>
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<tr>
<td>TC5 200pF J-differential compression type trimmer</td>
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<tr>
<td>TC6 200pF J-differential compression type trimmer</td>
</tr>
<tr>
<td><strong>Inductors:</strong></td>
</tr>
<tr>
<td>L1 M.W. aerial coil (Wearite PA2)</td>
</tr>
<tr>
<td>L2 L.W. aerial coil (Wearite PA1)</td>
</tr>
<tr>
<td>L3 All-wave r.f. choke (Denco RFC7)</td>
</tr>
<tr>
<td>L4 M.W. h.f. coil (Wearite PHF2)</td>
</tr>
<tr>
<td>L5 L.W. h.f. coil (Wearite PHF1)</td>
</tr>
<tr>
<td>L6 Smoothing choke 10H 60mA</td>
</tr>
<tr>
<td><strong>Transformers:</strong></td>
</tr>
<tr>
<td>T1 Output transformer 5,000Ω primary, 3Ω secondary</td>
</tr>
<tr>
<td>T2 Mains transformer. Tapped primary. Secondaries: 250-0-250V 60mA; 5V 2A; 6.3V 3A</td>
</tr>
<tr>
<td><strong>Other Circuit Components:</strong></td>
</tr>
<tr>
<td>S1 4-pole 2-way water switch</td>
</tr>
<tr>
<td><strong>Valves:</strong></td>
</tr>
<tr>
<td>V1 6K7</td>
</tr>
<tr>
<td>V2 6P25</td>
</tr>
<tr>
<td>V3 6J5</td>
</tr>
<tr>
<td>V4 5Z4</td>
</tr>
<tr>
<td><strong>Miscellaneous:</strong></td>
</tr>
</tbody>
</table>

level while the other valves in the receiver are
warming up.

Considerable latitude of layout is permissible
in a receiver of this sort, provided that short and
direct wiring of the r.f. circuits is adopted. In
actual fact the prototype was constructed on the
chassis of a former 5-valve superhet receiver which
had been stripped of all components except the
two-gang tuning capacitor, drive mechanism and
tuning dial; and it may well be that the novice
constructor will have such a chassis in his posses-
sion—discarded as “junk” at some time in the
past! If this is the case and provided the existing
valveholder mounting holes are large enough to accommodate octal valveholders (or are capable of enlargement to enable this to be done), and that the gang capacitor is undamaged by rough storage or mishandling, much tedious metalwork can be avoided.

The use of a top-mounting type of mains transformer will obviate any need to cut out a large rectangular hole in the chassis such as would be needed to accommodate a component of the drop-through type. However, to suit the constructor who has not a suitable chassis already available, or who wishes to make a neater and more workmanlike job, a suggested layout plan, with the major dimensions indicated, is given in Fig. 2.

It is suggested that the components be mounted in the following order: Firstly the four international octal valveholders, which should be fixed with their locating spigots orientated as near as possible to that shown in Fig. 2 to facilitate short and direct wiring. This can be followed by bolting into position the mains transformer, output transformer, smoothing choke and the dual electrolytic capacitor C11/C12 (using a fixing clip for the purpose).

Next mount the controls, namely the volume control VR1, wavechange switch S1, tone control (with switch) VR2 and tuning drive spindle if this latter is not already fitted in the case of those utilising a "second-hand" chassis.

Aerial and earth and loudspeaker socket connecting strips can then be added and, lastly, the tuning coils.

The aerial coils (L1 and L2) should be mounted above chassis and the detector coils below chassis; any attempt to mount both sets of coils below chassis is almost certain to lead to uncontrollable feedback between the r.f. and detector stages, rendering the receiver completely unworkable.

Naturally a number of holes will be required in the chassis to permit the passage of leads from above-chassis components to those below; in the case of leads carrying supplies to and from the mains transformer the holes should be fitted with insulating rubber grommets; in all other cases the insulation of the wires themselves may be relied upon to give sufficient protection.

**WIRING UP THE RECEIVER**

Wiring up can now be carried out and reference to Fig. 5 and Fig. 1 should make this clear even to the beginner; even so it is recommended that a logical sequence be followed to obviate errors.

It is a good plan to start by carrying out all the wiring associated with the mains transformer, e.g. starting from the mains supply lead, connect these to the appropriate voltage tapping on the primary winding, including the on/off switch in one lead. Next connect the rectifier heater winding (5V) to the appropriate tags on V1 valveholder, noting that in the case of a 5Z4 valve this is pins 2 and 8; follow up by wiring the high-voltage secondary windings to the rectifier anodes (pins 3 and 5), not forgetting the connection from centre tap to earth. This leaves only the 6.3V heater supply to wire in and this is done by connecting one side of the AC mains to pilot light and the other via VR1, wavechange switch S1, sensitivity control, tone and On/Off switch.

**Fig. 5: The underchassis wiring diagram.**
6.3V winding to earth and taking an insulated wire from the other end of this winding to pin 7 on the valveholders V1, V2 and V3, also to any pilot bulb holder(s), or to the chassis. This wire should be pressed as close down to the chassis as possible. The return path for the heater supply is via the metal chassis itself and to provide for this pins 1 and 2 of V1, V2 and V3 are wired to earth (solder tags mounted on valveholder fixing bolts). Note that in the case of V2 pin 8 (cathode) is also earthed in this way.

Complete the power supply circuits by wiring in the smoothing choke L6 and the electrolytic capacitors C11/C12. Make sure that C12 does in fact form the reservoir capacitor, i.e. that which is connected to the cathode of V4; normally this section of the capacitor will be distinguished by a red-marked tag. The wiring of the h.t. supply can now be proceeded with, noting the use of pin 6 on V2 and V1 as anchoring points (these are "spare" pin no. with no internal valve connections); pin 4 of V2 is also used as an anchor point for the junction of R4, R5 and C6.

Interstage wiring is best carried out with bare tinned copper wire of about 22s.w.g. This wire is covered with systoflex sleeving. Resistors and capacitors are, of course, wired into place with their own lead-out wires, shortening where necessary and insulating with systoflex wherever there is any danger of accidental contact between wires or wiring and chassis.

The connections between the h.t. line and various valve electrodes, together with their associated decoupling capacitors, should now be completed; note the polarity of C6. Components associated with the cathode circuits of V1 and V3 can now be added, referring to Fig. 5 for correct method of wiring VR1 in order to ensure that the volume control works in the correct "sense" (clockwise rotation giving increased volume).

Last of all the "signal path" must be wired in. Starting from the aerial socket and including the various coils and capacitors as shown on the circuit diagram right through to the anode of V3.

Fig. 3 clearly shows the tag connections to the Weaireite coils and these numbers are repeated on the wiring diagram (Fig. 4), while Fig. 4 clearly shows the method of wiring up the wavechange switch. It is this latter that is most likely to puzzle the beginner, but if it is tackled methodically, working steadily round the tags of the switch in order, no trouble should be experienced.

As was mentioned earlier, the trimmer capacitors TC1, 2, 3 and 4 are soldered directly to the coil tags, while the large value reaction trimmers TC5 and TC6 are mounted on a small fixing bracket cut from scrap aluminium and mounted on the front chassis runner as close to the coils as possible.

---

**TESTING AND ALIGNMENT**

Unscrew all trimmer capacitors approximately three full turns from their "fully screwed up" position. If a meter or continuity checker is available test for any possible shorts between the h.t. line and chassis and verify that there is continuity between the main h.t. supply (pin 8 of 5Z4), through the smoothing circuits, to the anode and screen grid pins on V1, V2 and V3.

If no meter is available it will be as well carefully to check overall wiring once again. Insert all valves except V4, connect up mains supply point and switch on. The pilot bulb(s) should light up immediately and the valve heaters glow in a few seconds. Naturally, if "metal" valves are used in V1 and V2 positions, the heater glow cannot be seen, but after a couple of minutes or so the outer envelope of these valves should feel warm to the touch.

If all is well switch off, insert V4 and again switch on. Watch carefully for any signs of street in; if there is a "fizzing" sound, or signs of flashing as V4 warms up, switch off immediately as you have a short-circuit between the h.t. line and chassis at some point which must be put right before proceeding.

If the above test proves satisfactory turn up the volume control VR1 to maximum and insert an aerial in the aerial socket when, on swinging the tuning capacitor across the dial, some stations will almost certainly be heard. If no sign of life, try tapping the metal blade of a screwdriver on to pin 5 (the control grid) of V3, when a steady hum should be audible from the loudspeaker. Now transfer the screwdriver to pin 5 of V2, when a much louder hum should result. Finally, tapping the screwdriver on the aerial socket should produce a loud click in the speaker. Try this test with the wavechange switch in both positions.

If at any of the above test points the expected response is not obtained, investigate the wiring to that particular valve stage for possible errors or faulty components. Naturally, if a test meter is available, voltage readings taken at the valve electrodes will quickly reveal any faults. However, it is more than probable that in the case of a simple receiver of this sort first-time results will be achieved.

Set the wavechange switch to medium waves (clockwise) and endeavour to tune in a station near the low wavelength end of the dial such as Radio Luxembourg (or even the BBC Light Programme) and adjust the trimmers TC1 and TC3 for maximum volume consistent with reasonably accurate indication on the tuning dial. Reduce the volume with VR1 so that the effect of small changes in voltage is more easily noticeable.

Having done this, swing the ganged capacitor across the full range of the medium waveband, when a number of stations should be receivable at their correct dial indications. Now select any weak transmission and gradually screw up the medium wave reaction trimmer TC3; there should be a noticeable increase in signal strength until a point is reached where the set bursts into self-oscillation. Slacken the trimmer sufficiently to stop the oscillation and then swing the tuning back and forth across the dial. If at any setting the set tends to go into oscillation, slacken TC3 a little further. Now switch over to long waves and locate the BBC Light Programme on 1,500 metres. Adjust TC2 and TC4 for maximum volume at this point and setting and screw up reaction trimmer TC6 until just below point of oscillation. Ensure that the receiver is stable at all settings of the tuning capacitor and alignment is then complete.

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**AERIAL AND EARTH**

The type and position of aerial used will have a marked effect on the ability of the receiver to continue on page 865.
Simple Impedance and Reactance Calculations

BY G. A. W. PARTRIDGE

CONTINUED FROM PAGE 745 OF THE DECEMBER ISSUE.

Checking the impedance of a coil or the reactance of a capacitor may prove necessary from time to time. The impedance is the total resistance an inductive or capacitive circuit offers to alternating current. The resistance that a capacitor offers to d.c. can be regarded as infinite, so only its reactance is considered here.

**Inductor Measurements**

There are instruments such as impedance meters for this purpose, but they are rather expensive, so for reasonable accuracy the simple ammeter and voltmeter method when applied to coils is most suitable. Fig. 6 illustrates the basic circuit. The impedance \( Z \) is equal to the voltage divided by the current in amperes.

\[ Z = \frac{V}{I} \]

**Fig. 6:** The basic circuit for inductor measurements.

It is obvious that such a circuit needs considerable modification. First, the voltmeter will have to be extremely sensitive. In other words it will have to have a very high internal resistance. For this reason an electronic voltmeter or a calibrated oscillograph will have to be used. Second, a low reading milliammeter or in some cases a microammeter will be necessary to measure the small current.

Failing this a non-inductive resistor may have to be connected in series with the impedance and the current found by dividing the voltage across it by its resistance. Fig. 7 shows the modified circuit.

\[ Z = \frac{V}{I} \]

**Fig. 7:** The modified circuit of Fig. 6.

\[ I = \frac{V}{Z} \]

The value of \( R \) depends upon the safe current consumption of the impedance. For example, if the current is 1mA, it will need a 10,000Ω resistor to give a deflection of 10V. The most suitable resistance is most usually found by experiment.

The voltage across \( R \) is first measured and then the voltage across \( Z \). The current consumption in amperes is:

\[ I = \frac{\text{Voltage across } R}{\text{Resistance of } R} \]

The impedance of \( Z \) is:

\[ Z = \frac{\text{Voltage across } Z}{\text{The current consumption in amperes}} \]

Milliampere or microampere values have to be converted to fractions of an ampere for the impedance formula. Remember that the supply must be also at the frequency which the impedance will be operating on. Impedance varies with frequency.

This method is suitable for low frequencies only. Anything above 5kc/s would usually require more elaborate apparatus. However, there are other ways of calculating impedances provided a few facts are known. Take the formula:

\[ Z = \sqrt{L^2 + R^2} \]

where \( Z \) = Impedance in ohms

\( L \) = Inductance in henries

\( f = 3.142 \)

\( f \) = Frequency in cycles per second

\( R \) = D.C. resistance in ohms

The inductance may have to be measured if it is not marked on the coil. The d.c. resistance can be checked with an ohmmeter, Wheatstone bridge, or d.c. milliammeter and voltmeter method.

For example, a coil has an inductance of 300 henries and the d.c. resistance is 250 ohms. What is its impedance at 1,000 cycles per second?

\[ Z = \sqrt{(300)^2 + (250)^2} \]

\[ = \sqrt{90000 + 62500} \]

\[ = \sqrt{1947700} \]

Therefore \( Z = 1396Ω \) approximately.

**Capacitor Measurements**

Much the same idea can be applied to a capacitor. The formula in this case is:

\[ Xc = \frac{1}{2\pi fC} \]

where \( Xc \) = Capacitive reactance in ohms

\( f = 3.142 \)

\( f \) = Frequency in cycles per second

\( C \) = Capacitance in Farads.

An 0.2µF capacitor is connected to a 100c/s supply. What is its reactance?

\[ Xc = \frac{1}{2\pi fC} \]

\[ = \frac{1}{2\pi \times 3.142 \times 100 \times 0.2} \]

\[ = 1.000,000 \]
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[ 마음의]
January, 1964

\[ 1,000,000 \]

\[ 2 \times 3.142 \times 100 \times 0.2 \]

\[ 1,000,000 \]

\[ 125.68 \]

Therefore \( X_c = 7,956 \Omega \) approximately.

These formulae are suitable for a.f. and r.f. circuits, but the results must be regarded as approximate, especially on the higher frequencies due to stray capacitances and inductances.

**IMPEDANCE TRIANGLES AND L.F. COILS**

Testing low frequency coils can be very interesting as well as instructive. Such work is also necessary when the efficiency of a coil is in question. The impedance triangle can be used to find out all sorts of information without using expensive apparatus. Fig. 8 shows how it adds up the three great resistive quantities.

**Fig. 8: The impedance triangle.**

- **D.C. resistance (R)**
- **AC. resistance (XL)**
- **Impedance (Z)**
- \( \theta \) (angle)

The d.c. resistance of the coil can be checked with an ohmmeter after disconnecting it from the a.c. supply.

We now know two sides of the triangle. The reactance can be found from:

\[ XL = \sqrt{Z^2 - r^2} \]

All sides of the triangle are now known. The power factor which is the cosine of the angle \( \theta \) is found by:

\[ \cos \theta = \frac{r}{Z} \]

The nearer the power factor comes to one the greater is the efficiency of the coil.

Finally, the inductance in henries is:

\[ L = \frac{XL}{2nf} \]

where \( n = 3.142 \)

\( f \) = frequency in cycles per second.

Here is an example:

A coil is tested at a frequency of 50 c/s. The resistor \( R \) is 100 \( \Omega \) and the voltage (E) developed across it is 30. The voltage (E) across the coil is 150, while its d.c. resistance (r) is 450 \( \Omega \).

The current (I) flowing through the coil and resistor is:

\[ I = \frac{E}{R} \]

\[ 30 \]

\[ 100 \]

\[ 3 \]

\[ 0.3 \]

The impedance is:

\[ Z = \frac{E}{I} \]

\[ 150 \]

\[ 0.3 \]

\[ 500 \Omega \]

The reactance is:

\[ XL = \sqrt{(500)^2 - (450)^2} \]

\[ \sqrt{250,000 - 202,500} \]

\[ \sqrt{47,500} \]

\[ = 218 \Omega \] approx. (by logs).

The power factor is:

\[ \cos \theta = \frac{r}{Z} \]

\[ 450 \]

\[ 50 \]

\[ 0.9 \] power factor.

This is a very efficient coil.

The inductance is:

\[ L = \frac{XL}{2nf} \]

where \( n = 3.142 \)

\( f \) = frequency in cycles per second.
We have now completed the impedance triangle which gives us useful information about the coil we have tested.

**IMPEDANCE TRIANGLES and CAPACITORS**

It is obvious that the impedance triangle cannot really be applied to a capacitor alone. First of all a good capacitor would have almost infinite resistance to d.c., so the base of the triangle (Fig. 10) would be undecided. The power factor would be at almost zero lead, so the angle \( \theta \) would be about 90°.

![Impedance triangle as applied to capacitors.](image)

A capacitor can, however, be tested with a known non-inductive resistor connected in series with it, as shown in Fig. 11. The capacity is measured on a capacity bridge and the capacitive reactance \( X_c \) calculated from

\[
X_c = \frac{1}{2\pi fC}
\]

where \( f \) = frequency in cycles per second,

\( C \) = capacity in farads.

Two sides of the triangle, \( X_c \) and \( R \) are now known. The third side \( Z \) is calculated from:

\[
Z = \sqrt{R^2 + X_c^2}
\]

This gives the correct impedance of the circuit. Now this impedance is checked directly. The correct impedance \( Z \) has only so far been calculated. It remains to be seen if the circuit really has this value.

The voltages \( E_s \) and \( E \) are carefully measured with a valve voltmeter.

\[
Z = \frac{E_s R}{I E}
\]

A good capacitor should have \( -\frac{X_c}{E} \) equal to \( \sqrt{R^2 + X_c^2} \) or very close to it.

The correct power factor of the circuit can be calculated from:

\[
\text{Correct power factor} = \frac{R}{\sqrt{R^2 + X_c^2}}
\]

The actual power factor will be:

\[
\text{Actual power factor} = \frac{R}{\frac{E_s R}{I E}}
\]

The difference in the correct and actual power factors is very close, which is quite good. A large difference would indicate a faulty capacitor.

For example:

A capacitor is found to have a value of 0.01\( \mu \)F and it is connected to a non-inductive resistance of 1.000\( \Omega \). The circuit is connected to a 100V 50kc/s supply (Fig. 11).

Before starting the test calculate the correct capacitive reactance:

\[
X_c = \frac{1}{2\pi fC} = \frac{1}{2 \times 3.142 \times 50 \times 1,000 \times 0.01} = 0.003 \Omega
\]

Now calculate the impedance

\[
Z = \sqrt{R^2 + X_c^2} = \sqrt{(1,000)^2 + (0.003)^2} = \sqrt{1,000,000 + 0.01} = \sqrt{1,000,001.01} = 1000.001 \Omega
\]

The circuit is checked with the valve voltmeter. \( E_s \) is found to be 100 and \( E \) 90V. The actual impedance is:

\[
Z = \frac{E_s R}{I E} = \frac{100 \times 1,000}{90} = 1111.11 \Omega
\]

There is a difference of 58\( \Omega \), which is probably due to leakage in the capacitor.

The correct power factor of the circuit will be:

\[
\text{Correct power factor} = \frac{R}{\sqrt{R^2 + X_c^2}} = \frac{1,000}{1,053} = 0.95 \text{ lead.}
\]

The actual power factor of the circuit is:

\[
\text{Actual power factor} = \frac{R}{Z} = \frac{1,000}{1111.11} = 0.90 \text{ lead.}
\]

The difference in the correct and actual power factors is very close, which is quite good. A large difference would indicate a faulty capacitor.
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Challenge your friends to
BEAT the 'BEAM'

A Novel Device to keep your Christmas Guests Amused

By G. A. MELLOR

Some kind of electronic game was required to provide an amusing distraction at a recent party. The unit had to be fairly inexpensive to build and automatic in operation. With these points in mind the following unit was devised, which may be constructed in two forms, beatable and non-beatable.

The finished product is a square box with perspex windows, internally illuminated by a 100W lamp. In the front is a hole 6in. square through which the competitor must put his hand to reach a prize placed on a shelf at the rear of the box. A beam of light is projected across the inside of the hole, the light falling on a photo-sensitive device. Immediately a hand is put through the hole, the beam of light is interrupted, causing a relay to become energised. This relay performs two operations, (a) switches off the interior light, (b) brings a "cheat" alarm to the ready.

The idea of the game is to reach in the box and remove the prize before the interior light goes out; if the prize is lifted from the shelf when the light is out, the "cheat" alarm rings.

Light Sensitive Unit and Amplifier

Various methods were tried to sense the cutting of the beam of light. The method finally adopted uses a glass encased transistor with the protective paint removed.

This transistor TR1 is mounted in the reflector from a disused torch, the reflector being pushed into a 35mm film tin, see Fig. 1. The transistor leads are brought through a hole in the base of the tin and fastened to a three-way terminal strip. Connections to the transistor should be made with twin core screened cable. A number of transistors were tried in the prototype and all worked very well, even one which had been slightly damaged by heat gave good results as a detecting device.

TR2 acts as a d.c. coupled amplifier. When light reaches the junction of TR1, its collector current increases, this increase is accompanied by an even greater rise in TR2. When TR2 collector current reaches 750mA the relay RLA energises. If the light beam to TR1 is interrupted RLA de-energises.

RLA is a Carpenter's type polarised relay in which the contact screws have been adjusted to make it a monostable type, this is a simple adjustment. Any other type of relay would work in RLA position, the only requirements being a low resistance coil and a low energising current.

Light Source

The light beam to the transistor is provided by a 6V 3W bulb. This bulb LPI is also contained in a film tin, connections being made to a two-way terminal strip bolted to the bottom of the tin. A reflector was used in the prototype, but was found to be unnecessary if the tin be polished on the inside to give a good reflecting surface. Lamp brilliance is adjusted by RVI.

Switching Circuits

Fig. 2 shows the relay switching circuits, and the sequence of operation is as follows. When the light beam to TR1 is interrupted, RLA de-energises, its contacts RLA1 make, feeding 50V...
to RLB. This second relay RLB energises, contacts RLB1 open so switching off the 100W lamp LP2; contacts RLB2 close, feeding 6.3V to S1.

If now the prize is lifted from the shelf, S1 closes putting 6.3V across the alarm bell, the bell will commence to ring and will not stop until the prize is replaced or the hand is withdrawn from the unit.

The microswitch S1 is mounted as shown in Fig. 3. The button should be sufficiently proud of the shelf to ensure reliable operation. In the prototype a ½ lb box of chocolates operated the switch reliably.

**Power Supplies**

As the maximum consumption of the amplifier was only 1mA it was considered unnecessary to build a mains power unit, so instead two 4.5V flat batteries were used, one half of S2 being utilised to switch off this supply with the rest of the equipment.

The lamp LP2 is powered from the mains. While LP1 and the alarm bell are fed from a 6.3V heater transformer, T1. The 50V for RLB is also taken from this transformer, a tap being made between the 200V and the 250V windings. This a.c. supply is rectified by MR1 and smoothed by C1, the value of C1 need only be sufficient to prevent relay chatter. It should be noted at this point that the coil and contacts of RLB and the contacts of RLA are all at mains potential, these contacts should therefore be well out of reach of the hand in the box.

**Fig. 3: The mounting for S1.**

**Fig. 4: The C-R network necessary to provide a time delay.**

**Construction**

The box is 18 in. square with perspex windows as shown in Fig. 3. The amplifier, bell and transformer are all mounted on a small sub-chassis beneath the shelf. It is advisable to conceal the main on/off switch or the constructor may find himself buying a large number of prizes!

One important point to note in the construction is the position of the interior lamp. This must have no effect on TR1, for this reason it has been mounted above and behind TR1 as shown.

**Setting Up**

When the unit is finished, turn RV1 to maximum resistance and switch on, relay RLA should not hold in. Increase the lamp brilliance until RLA becomes energised. Cutting the light beam should now operate the unit.

If RLB is fed directly from the 50V supply it will energise as soon as RLA contacts make, and the competitor therefore has no chance of reaching the prize before the light goes out. To give the competitor a chance to win a prize it is possible to insert a long C-R network into the supply of RLB as shown in Fig. 4. The time delay may be varied by adjusting RV2. The component values shown gave a delay from almost zero to four seconds in the original model.
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**Fig. 7:** The driver and Class B push-pull output stage.

**Fig. 8:** The circuit for dual-wave coverage.

**SUMMARY OF REQUIREMENTS FOR FOURTH, FIFTH AND SIXTH STAGES**

**Driver and Class B Push-Pull Output (Fig. 7)**
- Resistors: R20-22
- Capacitors: C15-C16
- Transistor: Tr6
- Transformer: T2

**Long Wave Coverage (Fig. 8)**
- Capacitors: C17, TC3, TC4
- Inductor: l.w. winding for L1
- Switch: S2

**CONTINUED FROM PAGE 745 OF THE DECEMBER ISSUE**
put stages. This is obtained by means of the 100kΩ resistor R24 in Figs. 9, 10 and 11.

One loudspeaker tag is returned to the "earth" line, as in Fig. 10. The 100kΩ resistor is taken from the other loudspeaker tag, to the OC71 base (Fig. 11). There should be a slight drop in volume, as the resistor is connected. If oscillation results instead, switch off and reverse the two wires which go from the output transformer secondary to the loudspeaker.
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Dear Sir, Mrs.,
Please send your general catalogues, addresses to...
and then followed eleven addresses. No money was enclosed so we thought it might be a case of barter.

We tried to conjure up the list of items we might receive. We thought of Hookahs, Fezes, Yashmaks... and then we thought he might send us a small Harem, roof garden size. My fellow directors and I had almost finished washing a dozen catalogues in rose water to make sure they were pure, when our wives got to hear about it. Well, fellow sufferers, you know wimmen... no sense of humour! However, we can still dream. In the meantime a Happy New Year, and if it's not too late, a Merry Christmas!

And don't forget we still have some excellent catalogues (unwashed) at 3/6 post paid

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The required additions for dual-wave tuning can be made at any time, irrespective of the number of stages so far provided in the receiver. When adding long waves, no changes have to be made to the other parts of the receiver. In the same way, if long wave tuning has already been fitted at an earlier stage, this has no effect on the other constructional details.

The extra items required, to permit dual-wave coverage, are shown in Fig. 8. A Long Wave winding section is added to the ferrite rod. There is a 180pF fixed capacitor C17, and two 60pF compression trimmers TC3, TC4, in addition to the single pole two-way wavechange switch S2.

The two trimmers, TC3 and TC4, are positioned as in Fig. 10. Holes are drilled to clear the projecting tags, and also the adjusting screws. Bending the tags slightly will hold the trimmers in place.

The actual wiring will be clear from Figs. 10 and 11. Green is used for the beginning of the Medium Wave winding, which already goes to VC1, and is unchanged. Black is used for the coupling winding, and already goes to C1, this being unchanged.

The free end of the coupling winding no longer goes to the "earth" line, but is wired to the tapping on the Long Wave coil; this lead is shown as orange in Figs. 8, 9 and 10. The end of the Long Wave coil electrically near the tap is wired to the "earth" line at the volume control, as in Fig. 10. The other end of the Long Wave coil is joined to the Medium Wave, and to tag C on the wavechange switch, this lead being shown as white. The two new trimmers are connected up as in Figs. 10 and 11.

After these changes have been made, place the switch in the Medium Wave position (A switched to C). Slight readjustment of TC1 and TC2 will be needed, to compensate for stray capacity. Also check that the Medium Wave winding is still in its best position, by moving it along the rod, if necessary, for best volume at a fairly high wavelength on the Medium Wave band (tuning capacitor fairly well closed). Turn the switch for long waves (A switched to --continued on page 865

![Fig. 11: The wiring diagram of the front of the panel.](image)

![Fig. 12: The tuning scale of the receiver, drawn actual size.](image)
Many readers have written to the author of the series of articles which described the construction of this tape recorder, requesting modification details for using different tape decks. For their benefit and for any other readers contemplating building the Malvern, this present article has been prepared, showing how two very popular decks are used with the original design.

The recorder circuitry, as described in July, August and September issues of P.W. is suitable for all decks with medium to high impedance record play heads and low impedance erase heads. However it only gives correct frequency response for 3¾ in/sec; so below will be found information on how to convert the Malvern tape recorder for use with a very popular deck.

**THE COLLARO STUDIO DECK**

The inductance of heads fitted on the Collaro studio deck is similar to those on the B.S.R. deck, thus no change is required to the output stage or input circuit. The bias and erasure circuits will also stay unchanged.

Compensation to the frequency response of the amplifier is necessary for the three speeds. Frequency responses which should be easily obtainable are given below:
- 1 in/sec 80c/s to 4kc/s At a recording
- 3¾ in/sec 60c/s to 6kc/s current of 100µA
- 7¾ in/sec 50c/s to 12kc/s and bias of 0.9mA

The circuit changes to obtain these responses are indicated below and in Fig. 1.

**On Record**

The treble boost inductor L1 has to be tuned to 4, 6 and 12kc/s with a boost of 10dB, involving the addition of two capacitors, C25 and C26, and also changing the value of C11, C12 and R16.

**On Playback**

The time constant of the integrator has to be changed from 100µS at 7¾ in/sec to 200µS at 3¾ in/sec and 300µS at 1½ in/sec respectively.

This is achieved by adding C27 and C28, also changing the values of C5 and C4 and R8. See Fig. 2.

This corrects the low frequency end of the characteristic, but some top boost is best applied by varying the value of C13 as shown in Fig. 3.
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This completes the modifications for use with the Collaro deck, but since the article was originally published, a considerable number of constructors have requested details on how to make the recorder completely portable.

Obviously a battery driven tape deck is the main requirement here, and the Garrard Battery Tape Deck, which runs at 1 4/3 in/sec and 3 2/3 in/sec and is powered from a 9V battery, supplies this need.

**THE GARRARD BATTERY TAPE DECK**

The modifications required when this deck is used are similar to those just given for the Collaro deck. However, only two speeds are involved, and because of the lower inductance heads the output stage can advantageously changed.

In the output stage there are at least three possibilities, each one having its own particular merit.

(a) Leave the output circuit as designed.

(b) Leave the output circuit unchanged but change the head transformer.

(c) Change the output circuit and head transformer.

Method (a) is perfectly correct, but it uses expensive output transistors, which are not needed unless high power (0.35 to 2W) is required. It also demands large batteries, PP1 or "Lantern" type cells as a minimum.

Considering (b), there is a case for redesign of the output transformer, because of the different head inductance.

This head inductance is given as 0.1 TH with a recording current of 60-200µA r.m.s. If the 10dB of top boost is used then, as the amplifier will give out 3.8V r.m.s. in this condition; a normal output is 10dB down on 3.8V r.m.s., or 1.25V, which should give a recording current of approximately 100µA.

The impedance of the head at 5kc/s is 3.5kΩ from XL = 2πfL. So in order to get a constant recording current the series resistor is made ten times larger, i.e. 39kΩ. The transformer output of 3.9V r.m.s. will give a recording current of 100µA. Therefore the output transformer ratio should be

\[ \frac{3.9}{1.25} = \frac{1}{3}. \]

Winding the transformer on the same core LA1 now means that a higher primary inductance can be used, thus demanding less amplifier current and reduced risk of core saturation at low frequencies.

The redesigned transformer should therefore have 2,400 turns of 44 s.w.g. enameled wire, tapped at 800 turns. This gives a primary
inductance of 220mH, and presents a load of 60Ω at 50c/s, whereas the original transformer only presented 12Ω.

Now for method (e). The last fact mentioned above means that with the rewound transformer the circuit can be simplified for less battery drain.

The modification limits the audio output on playback to 350mW which is, of course, eminently suitable for a small portable tape recorder. In this modification the two power output transistors are omitted and the head transformer is driven directly from the OC140 and OC72 as shown in Fig. 5.

The loudspeaker can still monitor on record, but the loading must be matched by means of an output transformer or a 35Ω loudspeaker must be used. If a 3Ω loudspeaker is used, the transformer ratio needs to be $\sqrt{\frac{35}{3}} = 3.41/1$, with a primary inductance of at least 50mH. See Fig. 6. This can be easily made by the constructor because, as the inductance required is low, so are the number of turns. And on a normal loudspeaker transformer core, which is about ½ in. x ½ in., the required inductance is given by 250 turns, tapped at 70 turns. The gauge of wire is chosen so as to fairly well fill the bobbin, 30 s.w.g. is a good guide. C17 can be reduced to 100µF because of the higher output impedance.

So to review these three types of output stages:
(a) Is suitable if large batteries and output power is needed, and requires no extra work.
(b) Is the best theoretical answer and is recommended.
(c) Is suitable if reduced battery and audio power satisfies the constructor's requirement.

Now to finish the circuit modifications.

On Record

The treble boost circuit should be similar to the Collaro circuit, keeping only C25 and C11.

C25 = 200pF, C11 = 200pF, C26 = not used.

Also on record, which of course includes the function of erasure and bias, the circuit needs to
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(Block letters) PW14
be changed considerably. Here because of the high efficiency of the Garrard heads a great saving of battery current is possible.

The erase oscillator employs only one transistor—an OC72, GET104, or NKT243. The erase head is also the oscillator coil and the consumption is very small; 20mA at 9V is quoted.

Bias is supplied from an overwind on the oscillator coil, this develops 65V which is applied to the recording head via a 100µF capacitor.

On Replay
Once again as the Collaro modifications with:
C27 = 0.5µF
C5 = 0.5µF
C28 = not used.
C29 = 0.02µF
C13 = 0.01µF
C30 = not used.

When using the Garrard deck a separate 9V battery is recommended for the motor. Because the motor is governor-controlled, some interference may enter the amplifier unless some supply filtering is done.

Progressive Portable
B) and adjust TC4 and the position of the Long Wave coil on the rod, for best sensitivity, at a high wavelength. Then tune to a low wavelength on this band (tuning capacitor fairly well open) and adjust TC3 for best results. In reasonable circumstances, some Long Wave stations other than the Light Programme on 1500m should be received, and these can be used for adjustments.

For maximum possible performance, it is usual to repeat all adjustments on both Medium Wave and Long Wave bands, until no further improvement can be obtained.

Figs. 9, 10 and 11 show the complete receiver, using six transistors, and covering both wavebands. The type of connector illustrated in Fig. 10 is for a 7½V battery, which has a very long working life indeed.

Tuning Dial
The tuning dial is shown in Fig. 12, and is marked in wavelengths, for Medium and Long Waves. This dial is fitted on the panel under the tuning knob, and held with adhesive. A piece of thin Perspex or other transparent material will protect the dial.

To obtain best agreement with the wavelengths marked, adjust the trimmers at a low wavelength, and the oscillator coil and aerial windings at a high wavelength, on each band, in the previously described manner.

DOMESTIC STRAIGHT THREE
pick up the weaker transmissions, but in almost every case a picture-rail aerial, comprising some 12 to 20ft of insulated wire, will suffice. The use of a good earth connection will also be found beneficial in the poorer reception areas.

Volume obtainable from the local BBC transmitters should be more than adequate for all domestic requirements and the quality of reproduction will be found to be remarkably good, particularly in view of the simple nature of the circuit and few components employed.

FADING
It is only in especially adverse situations, such as the East Coast of England, where after dark there is trouble from fading of BBC stations and interference from the more powerful Continentals, that results may disappoint; there is no easy remedy for this, as even quite elaborate superhet receivers are frequently incapable of giving a satisfactory performance in these areas. Sometimes the use of a short indoor aerial is beneficial, but this, of course, renders it impossible to receive more distant stations when these are required. But in the vast majority of cases this receiver will prove a fitting reward to the effort of building it, particularly in the case of the novice building his first mains operated set and will, it is hoped, provide the spurt to go ahead with more ambitious designs in due course.
New Range of Hi-Fi Equipment

A NEW range of high fidelity tuners and amplifiers has recently been introduced by Armstrong Audio Limited. Included in this range is an integrated stereo amplifier, model 222, which delivers 20W output. It has been designed to accommodate the high quality ceramic pick-ups which are now coming on to the market. The controls include wide range bass, treble and balance controls and the circuit incorporates a rumble filter. The price of this amplifier is £27 10s.

Also in the new Armstrong range are two tuners; the type 224, which is an f.m. tuner costing £22 10s., and the type 223, which is an a.m./f.m. model and costs £28 15s. The manufacturers of this new range of equipment are Armstrong Audio Limited, Walthers Road, Holloway, London, N.7.

Sound Effects Records

A NEW series of sound effects records has recently been introduced by Recorded Tuition Ltd. On the Contrast label, MFX1 has a general selection of 14 sound effects, including train, car, ship and aircraft sounds, storm effects, etc. MFX2 augments this with a further selection of 12 assorted effects with the emphasis on footsteps, American police cars, but includes other effects such as applause, car crash, etc. Between them, these two records present a good general purpose library of 26 different sound effects.

More specialised is Contrast TFX1, which is devoted entirely to train sounds and the 11 tracks provide a comprehensive selection ranging from a tank loco to a diesel express. Contrast AFX1 is also specialised, this time the subject being wild animals—there are 15 tracks.

Electronic sounds are dealt with on Castle EFX1. Side 1 is taken up with electronic music intended for dramatic introduction and background in plays, documentaries, etc. Side 2 has several tracks devoted to "space ship" effects, the remainder being a selection of miscellaneous electronic sounds suitable for a variety of applications.

All these records are 7in. e.p.'s (45r.p.m.) and all the sounds were recorded by F. C. Judd, A.Inst.E. The quality of reproduction justifies the "hi-fi" claim, the realism is first rate. There are two practical points to note: the length of every individual item is given in seconds on the record sleeves and, secondly, all the tracks are free of copyright to all amateur users.

The standard price for any of these records is 8s. Od., including tax, postage and packing. They may be obtained from Recorded Tuition Ltd., 174 Maybank Road, Woodford, London, E.17.

General-coverage Receiver Kit

THE model RG-1 general-coverage receiver is available from Heathkit either in kit form or ready-assembled. It tunes over the medium wave band and short wave bands from 1.7Mc/s to 32Mc/s in five ranges.

The sensitivity of the receiver on short waves is 3μV for 10dB signal/noise ratio or better. The eight valve circuit incorporates a variable noise limiter and a half-lattice crystal filter. When built, the set has an i.f. of 1621kc/s and an audio output of 2W.

The kit includes an attractive, robust steel cabinet measuring 13½in. x 11¼in. x 6¼in., and a tuning meter is a feature of the front panel.

The Heathkit RG-1 is made by Daystrom Limited, Gloucester.

The Armstrong type 223 a.m./f.m. tuner.

Dual-trace Oscilloscope

THE new dual trace oscilloscope, type CD.1183, designed by the Solartron Electronic Group, Ltd., has made use of the principle of modular construction so that the "X" and "Y" self-contained modules may be interchanged speedily and easily when required.

The main unit contains a high resolution c.r.t., a multi-range 1kc/s calibrator, two main vertical deflection amplifiers, one main horizontal deflection amplifier, and all power supplies.

The type CD.1183 oscilloscope is manufactured by the Solartron Electronic Group, Ltd., Farnborough, Hampshire.
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On Your Wavelength
By THERMION

Judging by our correspondence it seems that large numbers of beginners are unable (or unwilling) to make the effort and do their own shopping for radio parts, but seek a complete kit even for some of the most basic receiver designs. Is this a lack of enterprise by the beginners of today or is it just another manifestation of the affluent age? At any rate it set me thinking of those far-off days when I embarked upon the construction of my first one-valver.

Private Enterprise

First, the piecemeal collection of components—a few purchased but most obtained through divers other methods not involving the transfer of currency, such as exchange or the badgering of elders to donate parts. The preparation of the bread-board and front panel, the winding of the coil, the assembly of components and the wiring up. All ready now except for that one vital but expensive article—the valve.

Weeks of careful hoarding of pocket money would culminate in a Saturday morning expedition to the local radio shop and the dissipation of this accumulated wealth in one glorious fling. The brand new HL210 would be carried home in triumph, where trembling fingers would insert it in the long-vacant socket. The receiver was complete! Dare we connect up the accumulator and battery? Eagerness to try out the receiver would be tempered by fear of irrevocably damaging the valve, and so yet once more the wiring would be checked. Finally, the excitement and thrill as the phones became alive and emitted growls and squalls which were eventually coaxed away, leaving the broadcast signal in the clear.

The Way to Learn

Prepared kits of components are unquestionably a boon in many respects, on the other hand I do feel that the youngsters taking up radio construction as a hobby will obtain far more satisfaction from a piece of apparatus which has been built up from a host of individually selected parts. The many ensuing visits to radio shops in the process will provide valuable experience and a sense of judgment and discrimination over the disadvantages and advantages of various types and makes of component will, in this manner, soon be developed.

Finally, a word of advice. Even the rawest beginners should appreciate the need to present an orderly shopping list at the counter. This is particularly important when a large number of resistors or capacitors are to be purchased. Tot up the quantity of each value required and tick these off on the published components list as a check before setting out.

R.S.G.B. Exhibition

Upon visiting the Seymour Hall in London last month my first impressions of the ponderously (and, perhaps, misleadingly) named “International Radio Communication Exhibition” were that I had entered a commercial equipment-cum-Forces’ recruiting show. Wandering past the proud and magnificent factory-made receivers and transmitters, I was suitably humbled as thoughts of the chaste appearance of the homespun equipment in my garden shack flashed across my mind. Still, I mentally cheered myself, a highly garnished facia panel does not help when trying to pull in that much-desired VR or HP.

I did regret the blatant professionalism everywhere and the abundance of shamateur operating stations, but on the credit side both the BATC exhibit, which included a demonstration of the reception of an actual ham TV transmission (from Harrow), and the teleprinter demonstration provided a touch of real amateur enterprise. It was interesting also to gaze upon the bygones of wireless in a display of components and equipment ranging from the 1920’s to the middle 1930’s.

But the most heartening sight as far as your scribe was concerned was not even in the main hall. In the far end of a small backstage room, beyond a surplus components shop, I found the Roding Boys’ Society stand. Here were examples of radio equipment built entirely by the young members of this organisation, each item a happy reminder that the spirit of amateur radio is very much alive among the lads of today, emphasising once again that enthusiasm and ability to use one’s hands are the most important assets for success in this hobby.

On departing, I thought that the R.S.G.B. had done a great injustice in placing this boys’ club exhibit in a remote corner apart from the main show, then upon reflection it occurred to me that perhaps this arrangement will (albeit unintentionally) bring home to the visitor the gulf, not merely in space but in mind, that exists between the genuine and the pseudo amateur.
Home Inter-com Unit Mk II

A recently published circuit for a home intercom unit contains a fundamental error and this has not escaped the attention of many of our hawk-eyed readers! (See page 442, Sept. issue.)

A number of different re-arrangements have been proposed and we are publishing here (Fig. 1) one revised version which will perform satisfactorily while not requiring too drastic changes to the original design.

It will be seen that the telephone rest switch now has two contacts 'A' and 'B', and when one makes, the other is open.

Since the two poles of this switch must be completely isolated from each other, a different form of construction is needed for the handset rest. A suitable design is given in Fig. 2, where the rest is shown in the unloaded position, i.e. handset removed.

The main portion of the rest consists of a strip of Paxolin or other insulating material. The springs are soldered to the brass wing pieces, and the latter are screwed or rivetted to the Paxolin. Brass strip is used for the two switch contact arms. 'B' is made a fixture to the top of the wooden housing, while 'A' is fixed to the insulated part of the rest. Contact arm 'A' operates a spring contact—this should be made from a piece of phosphor bronze.

Wide Range L.F. Oscillator
---continued from page 815

These frequencies being above the normal audible hearing range. These can be checked on an oscilloscope, if available. An oscilloscope would also be an advantage when setting up the other ranges as any distortion would be at once evident.

If possible the oscillator should be calibrated against a commercially built instrument by the use of Lissajous figures on an oscilloscope, this giving extremely high accuracy. Another simple frequency check is to compare the audio tones heard in the headphones with the notes of a piano scale, this giving an approximate calibration over the audio range.

The calibration points may be marked on a large radio type dial with transparent cursor, or a simple pointer knob used with a 100° or 180° scale, a graph or table being drawn for each range, degrees against frequency.

Finally, the impedance of the low impedance output is of the order of 1000Ω and any external load much below this value may cause distortion. If the unit is to work into a lower impedance load, a series resistance should be used (in series with the output lead), to increase the total impedance to about 1000Ω level. Another method is to use a step-down transformer of the correct ratio.
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BRITISH NATIONAL RADIO SCHOOL

January, 1964
MORE than 2,000 tape recorders are sold each week. Yet, the author points out, they are prone to a strange hibernating instinct that afflicts them three or four months after their purchase, driving them into cupboards, under beds and into attics where they lie inactive.

It is this phenomena that the author seeks to remedy, by the simple process of exploring, and explaining, followed by some variety on tape, which a tape recorder may be put. And although dyed-in-the-wool radio enthusiasts are less likely to neglect their tape recorders than non-technical members of the public who often buy a machine on impulse for its novelty value which soon evaporates, they too will find a great deal of interest in this book.

It is essentially a practical book, its aim being to investigate a possibility, explain the principles, give an example. Apart from advice and information provided, it also leaves room for individual experiment by virtue of the ideas it propounds. The treatment is non-mathematical and essentially non-technical. But although it is aimed at the non-technical reader, this need not deter those with technical knowledge, for it incorporates subjects on which information is not too readily available.

There are two introductory chapters which are designed to assist prospective owners to choose a tape recorder and there is a lot of good practical advice here. This is followed by chapters on conventional usage of tape recorders, with some interesting ideas on things such as sound effects and continuous loops (marred only by a curiously incorrect drawing on page 56).

From here the author delves into such subjects as interviewing techniques, "audible colour" (tape-slide, tape and cine combinations), and "music on tape" utilising the potentialities of the tape recorder as a musical instrument itself.

This takes up to little under half the book. Chapters follow on indexing systems for sound libraries, "tapesponding" and tape clubs, home plays, party ideas. There is a chapter on hi-fi, again containing some good advice for the less well informed, followed by some notes on stereo.

The book rounds off with some general observations on audio maintenance, with a trouble-shooting chart, and a section listing the various accessories which the keen enthusiast might require. In this, as in other chapters dealing with products, prices are given as a guide.

All in all, despite the rather high price, the book should prove most informative to those with limited technical knowledge about to buy a tape recorder and to those who already have one lying inactive in some dark hideaway in the house. It certainly shows that the tape recorder has many facets for the enthusiast, some of them largely unexplored.—W.N.S.

FREQUENCY DIVIDER ORGANS FOR THE CONSTRUCTOR
By Alan Douglas, I.E.E.; published by Sir Isaac Pitman & Sons Ltd.
72 pages, 67 diagrams, $5\frac{1}{2} in. x 8\frac{1}{2} in. Price 25s.

THIS book concentrates on the practical aspects of electronic organ building and the theory of the circuitry involved is not explained, although a general descriptive treatment is given.

There are two main chapters and these describe (1) a resistance-capacitance valve frequency-divider organ and (2) a gas-tube frequency-divider organ.

Both of these chapters contain full design details for the essential electronic components such as oscillator coils as well as chassis layout diagrams and circuit diagrams of all the units, e.g. tone-forming circuits, keying arrangements and oscillator and divider chains, etc. The construction of the electro-mechanical devices such as stop keys and pedal controls is also well covered in diagram and text.

Another chapter gives details of an instrument described as a simple melodic transistorised keyboard. This instrument operates from dry batteries and will provide sufficient audio output for an average-sized room.

The final chapter contains information concerning frequency-divider circuits at present used in commercial electronic organs and so may well give the amateur constructor further ideas to develop for his own purpose.—D.D.K.

RADIO AND TELEVISION REFERENCE DATA
96 pages, 9 in. x 6 in. Price 10s. 6d.

THIS is a handy reference book containing, as the title implies, data of interest to radio and TV service engineers, amateur constructors and enthusiasts. Contents include a section on formulae in frequent use, details of colour codes, formulae and dimensions relating to aerials (including a frequency-wavelength conversion table) and a section on symbols and abbreviations. Also featured is a list of broadcasting allocations and station frequencies, including a list of the major European broadcasting stations, together with details of television broadcasting standards. A short section on amateur radio gives a summary of facilities available, amateur radio abbreviations and prefixes, and a list of i.f.'s used in a wide range of commercial communications receivers.

Other information deals with mathematical data, including log tables, wire and cable data and battery equivalents. There is also a listing of valve, transistor and cathode ray tube pin connections, ratings, bases and equivalents, including selected CV types.—D.C.
BURSLEM AMATEUR RADIO CLUB
Hon. Sec.: W. Luscott, 36 Rosehay Avenue, Sneyd Green, Stoke-on-Trent, Staffordshire.

Any local radio enthusiasts who are interested in joining the Club are invited to contact the Secretary. A full programme of film shows, lectures, etc., has been arranged for Club meetings, which are held on the third Wednesday of each month.

CLIFTON AMATEUR RADIO SOCIETY
Hon. Sec.: G3OGE, 63 Broomfield Road, Beckenham, Kent.

On 16th November, members of this Society made a visit to the headquarters of the Crystal Palace Amateur Radio Club for a “hi-fi” demonstration. Later in the month, on the 22nd, members took part in a quiz organised by the Secretary.

DERBY AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: F. C. Ward, G2CVY, 5 Uplands Avenue, Littleover, Derby.

A social evening which included a supper — was organised by T. Darn on 13th November. 20th November was declared an open evening and Juniors’ Night.

A week later a demonstration on providing the finishing touch to home-built equipment was given by A. Hitchcock.

December began, as usual, with a surplus sale on the 4th.

MELTON MOWBRAY AMATEUR RADIO SOCIETY
Hon. Sec.: D. W. Lilley, G3PDF, 23 Melton Road, Asfordby Hill, Melton Mowbray, Leicestershire.

On 21st November the Secretary was “at home” to members when the Society made a visit to his shack.

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

This Society reports increasing membership and attendance figures, with a growing proportion of licensed amateurs among its members.

“Antenna Problems” was the title of the lecture given by A. Bailey (G3JBN) on 4th December.

PETERBOROUGH AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: D. Byrne, G3KPO, Jersey House, Eye, Peterborough.

At the recent meeting which officially opened the Society’s winter session, Frank Crabtree (G3BK) demonstrated the KW77 communications received.

PLYMOUTH RADIO CLUB
Hon. Sec.: B. J. Curnow, 112 Mount Gold Road, Plymouth, Devon.

On 9th November, members of this Club faced members of Torbay A.R.S. in a friendly battle of wits, organised by the two societies.

READING AMATEUR RADIO CLUB
Hon. Sec.: R. G. Nash, G3JA, “Peacehaven”, 9 Holybrook Road, Reading, Berkshire.

Participants attended the meeting of 30th November, G3HGE gave a demonstration of some equipment about which members were invited to discuss any points that arose.

RODING BOYS’ SOCIETY RADIO SECTION

Recently much of the Society’s activity has been directed towards a Club stand at a local exhibition.

SCARBOROUGH AMATEUR RADIO SOCIETY
Hon. Sec.: P. B. Briscoe, G8KU, “Roseacre”, Irton, Scarborough, Yorkshire.

November began with a surplus sale on the 7th. At the second meeting of the month, however, members enjoyed a film show.

The first meeting of December — which was on the 5th — was also a sale of surplus gear.

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

“The Electronic Marshalling Yard” was the title of the lecture given by Mr. S. Jones at the meeting on 14th November. On 12th November, the Society travelled to Bradford to see a film show at St. George’s Hall.

On 28th November, J. Spivey (G2HHV) talked about “Office Electronics” and on 5th December, a party of members visited the Basinghall Street telephone exchange in Leeds.

STRATFORD-ON-AVON AND DISTRICT AMATEUR RADIO CLUB
Hon. Sec.: N. Smith, 54 Clifton Road, Stratford-on-Avon, Warwickshire.

The meeting for 8th November was an open evening, but a week later, on the 15th, G3OPF gave a lecture on “Transistors”. This was followed on the 22nd by a film show and the month ended with another open evening on the 29th.

THAMES VALLEY AMATEUR RADIO TRANSMITTERS SOCIETY
Hon. Sec.: K. Rogers, G3LIU, 21 Links Road, Epsom, Surrey.

November began with a constructional contest at the meeting on the 9th. One of the Society’s foremost events of the year was held on 9th November, when members attended the 30th Annual Dinner.

On 4th December, A. Taylor gave a lecture entitled “Nuclear Power”.

WESSEX AMATEUR RADIO GROUP
Hon. Sec.: G. J. Fowle, 138 Surrey Road, Branksome, Poole, Dorset.

On 14th November a group of members visited the headquarters of the Bournemouth Police, when the radio equipment installed in the police cars came in for some close scrutiny. The home of the President of the Group became the meeting place for members on 25th November.

A film show, which included a record of the Group’s activities for the year, was given on 2nd December.

WEST KENT AMATEUR RADIO SOCIETY
R. Trevitt, 28 Dales Avenue, Tunbridge Wells, Kent.

At the meeting on 8th November, Ben Pooley gave an interesting talk on his experiences of VE-, VR2- and VK-lands. The only other meeting for November was on the 32nd when L. King gave a talk and demonstration called “SSB and the Linear Amplifier”.

WIRRAL AMATEUR RADIO SOCIETY
Hon. Sec.: A. Seed, G3FPO, 31 Withert Avenue, Bebington, Wirral, Cheshire.

“On First Working Single Side Band” was the title of the lecture given by Mr. J. Wylde on 6th November. The Society’s Annual Dinner was held on 9th November, and on the 20th the Secretary gave a lecture on “Electronics in Industry”.

The first meeting in December was devoted to a surplus sale.

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AS YOU WERE

SIR,—I agree entirely with the opinion expressed by Mr. P. A. Roe in the November issue, that considerable confusion exists as to the correct meaning of the words 'vibrato' and 'tremolo,' but I feel that Mr. Roe has done little to clear the air. In fact, by setting himself up as an authority, he will have, no doubt, made matters worse.

If Mr. Roe consults the available literature on orchestral and electronic musical instruments, he will find that the universally accepted definition of the terms vibrato and tremolo are exactly opposite to those given in his letter.—A. G. BRIDGE (Dagenham, Essex).

SIR,—I would refer to the comments of Mr. P. A. Roe in the November P.W. relating to tremolo and vibrato. While I agree that these terms are sometimes incorrectly used, Mr. Roe now wishes to place on record a statement which I cannot accept.

After reading books and articles on the subject for over twenty years, it would now appear that writers like R. H. Dorf, Robert Eby, Emerson Anderson, to mention but a few, have been using the incorrect terms all along the line. Without going into too much detail, I quote from a glossary of these terms which will be confirmed by any book of reference: Tremolo—the variation in volume of a tone; Vibrato—the periodic variation in frequency of a tone.

If you accept these definitions, this completely contradicts Mr. Roe's statements. —S. J. Lewis (Narberth, Pembrokeshire)

DECLINING MORSE STANDARDS

SIR.—As a S.W.L. of the tender age of fifty-six, I find myself in absolute agreement with those of your correspondents who observe that amateur operators should be well technically qualified. When I listen to some of the amateur transmissions, I sometimes wonder if the G.P.O. should not stiffen the examination.

I am however, in disagreement with the present morse code qualification. This is said to be necessary, firstly by the G.P.O., because any amateur must be able to receive any traffic directed to him, and secondly by already licensed amateurs, mainly on the basis that because they had to undergo the test, so should everyone else.

Yet after a certain amount of listening to stations from all over the U.K., no one can help but be astonished by the number of amateurs who openly admit that their morse is not up to the required standard, either because they have never indulged in it since taking the test, or because they have been off the air for as long as eight, ten and thirteen years.

SIR.,—I would be grateful if any reader could sell or loan me...

...information and equivalents for the following valves: VT62, VT26A, AT20, AT370, CV125, PT15 and 8013.—P. LAYTON, 26 Grattan Hill, Cork, Ireland.

...the circuit or any details of the H.M.V. model 1423 transistor receiver.—R. PETTAS, 66 Beethoven Street, Paddington, London, W.10.

...the circuit and/or manual of the Eddystone type B receiver.—H. MULLIGAN, 103 Beresford Road, Longsight, Manchester.

...the August 1961 issue of P.W.—M. C. GREEN, 6 The College, Malvern, Worcestershire.

...any information concerning the R1155 receiver.—L. P. GREEN, 141 Easterly Road, Leeds 8.

...the circuit or any information on the American receiver R-3/ARR—L. E. NICOLLS, 5 Centre Drive, Newmarket, Suffolk.

...circuit information on the set 22 and set 62 MkII and the W2113A transmitter.—V. G. W. EGGLETON, 30 Mincinglake Road, Stoke Hill, Exeter, Devon.

...the circuit for a transistorised process timer with a range of 0 to 120 seconds.—W. DEIGHAM, 2 Borrowing Road, Manor Park, London, E.12.

...information on the plug-in crystals originally fitted to a Collins receiver, type COL 46159. Also I would like any circuit information and details of power supply requirements.—N. T. FRANCIS, 71 Oxford Grove, Bolton, Lancashire.

NOTES TO MEDIUM-WAVE DX FANS

Now that the medium wave DX season is with us again, "Medium Wave News" is again being issued. This is an extremely informative news letter publication which is issued through the winter months. Edited by Ken Brownless and published by Bernard Brown, it contains news of DX stations logged, notes on how to hear m.w. DX and competitive features. For those interested in this sideline of DX listening it is highly recommended. Details are available from Bernard Brown, 60 White Street, Derby. Please enclose a S.A.E.

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Those who have a whistle which has a builtin buzzer, and also have a whistle which is unscrewed, will have noticed that the whistle is whistled through. The whistling whistle is generally screwed on; however, if it is left unscrewed, it is whistled through at once. This is all due to the sound waves of the whistle passing round the lips of the user.

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NOW THREE LOW COST COURSES TO HELP YOU BECOME AN EXPERT IN RADIO, ELECTRONICS, OR TELEVISION

Our new Electronic Course won instant acclaim when offered just over one year ago.

NOW WE ARE PROUD TO BE ABLE TO OFFER TO YOU OUR NEW COMPANION COURSES IN RADIO AND TV FOR THE SAME REASONABLE COST.

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C.W.O. or C.O.D.
4/7 PACKING CHARGE ON ALL C.O.D.
ORDERS. POSTAGE 6d. per VALVE
MINIATURE 'SCOPE

Features 2½in. DG7/5 Tube. Level 2dB, 50 c/s to 2 Mc/s, 3½ Sec. to 80m Sec. Sweep. High sensitivity. Fully portable scopes. Ideal for all transistor and valve design or servicing. 24 volt operated.

NEW CT84

DEAC RECHARGEABLE BATTERIES
(a) 18 volt 100mA/H 4 x tin. diameter. Brand new sealed, 30c.
(b) As above but 150mA/H, 35c.
(c) 3.9 volt 450mA/H, 12½.
All types easily split into any multiple of 1.2 volt. Brand new.

MULTI-METERS
Multi-range test meters featuring easy to read scales and provided with full operating instructions, lead and batteries. Suitable for amateur, designers, repair shops, all domestic uses. Full details and specifications in our catalogue.

- PT34 1 Kohm/volt........ 2£ 5 0
- M1 2 ........................ 2£ 9 6
- TH33 2 ........................ (illus.) 3£ 15 0
- P10K ........................ 4£ 9 6
- T102 20 ........................ 5£ 5 0
- TP55 20 ........................ 5£ 19 6
- S90 .......................... 6£ 19 6
- 500 30 ........................ 8£ 19 6
- EPS05 50 ........................ 9£ 19 6

SUBSTITUTION BOXES
- Capacitor Box: Provides 9 standard values from 0.001 to 0.22 mfd at 600 volt working, 29½.
- Resistor Box. Provides 24 standard values at 1 watt, 15 ohms to 10 meg., 37½.
Each box fully calibrated with insulated leads. Invulnerable for service and design.

NOMREX TEST EQUIPMENT
All transistor portable items supplied with full instructions.

LEAFLETS ON REQUEST

- 150 Kc/s to 350 Mc/s generator. RF, Mod., AF. 8 ranges. Leads, batt., instructions. £7.18.6. P.P. 2½.
- Resistance/ capacitance Bridge. 1 pf to 1000mfd and 1 ohm to 100meg. Leakage. PF Tests, with batt. and Instructions. £7.2.3. P.P. 2½.
- Power Supply. Gives any voltage 1 to 15 D.C. up to 0.1 amp. From Mains. £15.17.6. P.P. 2½.
- Audio Generator, 10 c/s to 100,000 c/s. Sine and square wave. With batt. and Instructions. £15.2.3. P.P. 2½.

- 4-WAYBAND COMMUNICATIONS RECEIVER
- 9 valve version of above, 40 gns. P.P. 1½. Details on request.

100 kc/s QUARTZ CRYSTALS
2 pin: Octal or 3 pin.............. 15½ each.
500 kc/s 2 Pin...................... 15½
455 kc/s (AR88)..................... 12½
456 kc/s HRO......................... 15½
5000 kc/s 2 Pin..................... 10½
10 Mc/s 2 Pin...................... 15½
27 Mc/s Radio Control.............. 15½
(Over 600 Frequencies in Stock for all purposes).

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- S300 4 x 4 watt DECKS........ 10£ 9 0
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- Unpluggable 6V................ 7£ 18 10
- 5RP10 4-speed or GU7868.. 5£ 7 6
- Garrard AT6 with Stereo........ 5£ 5
- Collaro, 2-track Deck Studio 10£ 19 6
- 4-track Deck.................. 13£ 6 6
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- 45 or 33 r.p.m, Star, 9½........ 2½
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- Garrard 9V, 2-speed, 2-track...... 6£ 12 10
- Tape Deck..................... 6£ 12 10
- P. & P. 3½ of any above.

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Complete with full function pre-amplifiers and controls.
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- S415 3.5 mc/s................... 9£ 10 0
- S300 15 mc/s................... 3£ 10 0
- S3916 with Stand............... 12£ 16
- B.M.3 Stick with Stand........ 3½
- Lapel/Hand Magnetic........... 12£

MINIATURE PANEL METERS
- 0/50uA (D.C.) 3½ each........ 2½
- 0/50uA (D.C.) 3½/0/300V (D.C.) 2½
- 0/1mA (D.C.) 27½
- 0/5mA (D.C.) 27½
- 10/1mA (D.C.) 27½
- 0/10mA (D.C.) 27½
- 25mA (D.C.) 27½

HI-FI SPEAKERS
- CX300 12 inch 25 watt........ 12 Gns.
- CR12AE 12 inch 8 watt........ 8 Gns.
- CR10AE 10 inch 8 watt........ 7 Gns.
- 10 inch Horn Speaker....... 25½

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We can supply from stock most of the components and items specified on circuits published in this and other magazines and radio books. Let us quote for your circuit. First grade components at realistic prices.

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- Printed circuit.
- Record/playback 2 Track, 11 gns.
- Amplifier Kits. 4 Track, 12 gns.
- Studio Deck. 2 Track, £10.19.6
- 3 speed
- Cabinet with Speaker 5 gns.
Leaflet on Request.

Crystal Contact Microphone 12½ P.P. 9d.
2K, 1-track Tape Head........ 15½ P.P. 9d.
BPL 5, 4 Track A.C. Record- 12½ P.P. 9d.
4-channel Transistor Mixer 3½.
Unit................... 59½ P.P. 1½
Jack Tap Radio Tuner........ 29½ P.P. 1½

TEST LEAD KIT supplied in Pocket Pouch. Contains probes, leads, clips, etc. 8½ P.P. 7d.

BOAC VHF POCKET RECEIVERS
- Complete units with C5 5A 12V Detec- 5½/6R (OC44) Trans- 5, 450 mA re- tor, 5-VAC. A.C re-chargeable Deac 3—A91, OA 10 rectifiers, 1k ohm stetho- Scope headphone moulded cas- ing, etc.

- Complete Unit with Full Circuit 35½ P.P. 2½
- OR DEAC BATTERY AND HEADSET 1½
- Unleed DEAC & HEADSET 12½, P.P. 1½.

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RUN YOUR RADIO OR AMPLI- FIER FROM MAINS BATTERY ELIMINATORS AND CHARGERS
1. For PP3 or equivalent 9 volt Pocket Radio Battery, 18½ P.P. 1½. For PP4, PP7, PP8, 9 volt Portable Radio and Equipment. Supplies up to 300mA, 49½, P.P. 2½.
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Complete with 5 valves. In new condition. These sets are sold without guarantee but are serviceable. 22½ P.P. 2½.

Headphones 7/6 pair. Junction Box 2½
Throat Mike 4½, Aerial Rod 2½

Henry’s Radio Ltd
PADDINGTON 1008/9
303 EDGWARE RD, LONDON W.2
Open Monday to Sat. 9-6, Thurs. 1 o’clock.

PLEASE TURN TO BACK PAGE
**Practical Wireless**

**BLUEPRINT SERVICE**

All of these blueprints are drawn full-size and although the issues containing descriptions of these sets are now out of print, constructional details are available free with each blueprint except for those marked thus (*).

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.

### DOUBLE-SIDED BLUEPRINTS

<table>
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<th>Blueprint Description</th>
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<tr>
<td>The Strand Amplifier</td>
<td>5/-</td>
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<tr>
<td>The PW Signal Generator</td>
<td>5/-</td>
</tr>
<tr>
<td>The Savoy VHF Tuner</td>
<td>5/-</td>
</tr>
<tr>
<td>The Mayfair Pre-amplifier</td>
<td>5/-</td>
</tr>
<tr>
<td>The Berkeley Loudspeaker Enclosure</td>
<td>5/-</td>
</tr>
<tr>
<td>The Luxembourg Tuner</td>
<td>5/-</td>
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<tr>
<td>The PW Troubadour</td>
<td>7/6</td>
</tr>
<tr>
<td>The PW Everest Tuner</td>
<td>6/-</td>
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<tr>
<td>The PW Britannic Two</td>
<td>5/-</td>
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<tr>
<td>The PW Mercury Six</td>
<td>5/-</td>
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<td>The PW Regency</td>
<td>5/-</td>
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<td>The PW International Short Wave Two</td>
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### MISCELLANEOUS

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<tr>
<td>The PW 3-speed Autogram</td>
<td>8/-</td>
</tr>
<tr>
<td>The PW Monophonic Electric Organ</td>
<td>8/-</td>
</tr>
<tr>
<td>The PW Roadfarer *</td>
<td>5/-</td>
</tr>
<tr>
<td>The PT Band III TV converter</td>
<td>1/6</td>
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<tr>
<td>The Mini-amp *</td>
<td>5/-</td>
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<tr>
<td>The PT Olympic *</td>
<td>7/6</td>
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<tr>
<td>The PT Multimeter *</td>
<td>5/-</td>
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### SOME EARLIER DESIGNS

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.

<table>
<thead>
<tr>
<th>Blueprint Description</th>
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<tbody>
<tr>
<td>Experimenters Short Wave</td>
<td>PW30a 2/6</td>
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<tr>
<td>Midget Short Wave Two</td>
<td>PW38a 2/6</td>
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<tr>
<td>Simple S.W. One-valver</td>
<td>PW88 2/6</td>
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<tr>
<td>Pyramid One-valver</td>
<td>PW93 2/6</td>
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<tr>
<td>BBC Special One-valver</td>
<td>AW387 2/6</td>
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<td>A One-valver for America</td>
<td>AW429 2/6</td>
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<tr>
<td>Short-Wave World Beater</td>
<td>AW436 3/6</td>
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<tr>
<td>Standard Four Valve S.W.</td>
<td>WM383 3/6</td>
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<tr>
<td>Enthusiast’s Power Amplifier</td>
<td>WM387 3/6</td>
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<tr>
<td>Standard Four Valve</td>
<td>WM391 3/6</td>
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<td>Listener’s 5-Watt Amplifier</td>
<td>WM392 3/6</td>
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### RECEIVERS

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<td>The Tutor *</td>
<td>3/-</td>
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<td>The Citizen *</td>
<td>5/-</td>
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<td>Junior Crystal Set</td>
<td>PW94 2/-</td>
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<td>Dual-wave Crystal Diode</td>
<td>PW95 2/6</td>
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<td>Modern One-valver</td>
<td>PW96 2/6</td>
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<td>All-dry Three</td>
<td>PW97 3/6</td>
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<td>Modern Two-valver</td>
<td>PW98 3/6</td>
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<tr>
<td>A.C. Band-pass Three</td>
<td>PW99 4/-</td>
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<td>A.C. Coronet-4</td>
<td>PW100 4/-</td>
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<tr>
<td>A.C. D.C. Coronet</td>
<td>PW101 4/-</td>
</tr>
<tr>
<td>The PW Pocket Superhet</td>
<td>5/-</td>
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**QUERY COUPON**

This coupon is available until 7th January, 1964, and must accompany all queries in accordance with the notice on our "Letters to the Editor" page.

PRACTICAL WIRELESS, JANUARY, 1964.
“THE CONTESSA”

**COMBINED PORTABLE AND CAR RADIO**

- **AMAZING SENSITIVITY**
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The easiest Superhet Radio to build on the market. Features clearly-marked printed circuit and packaged components with full illustrated building instructions. Full tuning of medium and long wave bands with unbeatable sensitivity and selectivity. Excellent tone and volume with over 600mW push-pull output.

- Clearly marked horizontal station dial with slow motion tuning.
- Two colour, Blue and Beige cabinets with Gold handles, grilles and fittings. Size 10½ x 7½ x 3½ ins. Includes car aerial sockets, recording sockets.
- Uses Mullard Transistors and 2 Diodes.

**PERFORMANCE**

- **UNBEATABLE FOR QUALITY AND VALUE**
- **10 WATT TRANSISTOR HI-FI AMPLIFIER AND PREAMPLIFIER**

**AVAILABLE IN KIT FORM OR PREBUILT PANELS**

- **LOW NOISE**
- **LOW POWER REQUIREMENTS**

**MONO OR STEREO**

Circuits and details FREE on Request.

**CALL FOR DEMONSTRATION—ANY TIME**

7-TRANSISTOR RECORD PLAYER / RADIogram AMPLIFIER

- 4 watt peak output.
- Full Treble and Bass boost and cut.
- 40 c/s to 20 kc/s = ±4dB.
- Inputs for Pick-ups, Radio Tuners, Microphones, mixers.

BOOKLET FREE ON REQUEST

- TWO VARIATIONS AVAILABLE
  - 12½ volt for 15 ohm speakers.
    - (mains unit 80½ volt extra).
  - 12 volt for 1 ohm speakers.
    - (mains unit 49½ volt extra).
- Size only 6½ x 3½ x 2½ ins.
- Ideal for mains or battery, portable or domestic record player, gramophone, etc. Or car.

Built Ready To Use £5.19.6 P.P.

**MINIGRAM TRANSISTOR PORTABLE RECORD PLAYER**

- Made by well-known British manufacturer. Features ready built 4-transistor printed circuit 1 watt amplifier, elliptical speaker and volume control. Low current Star, constant speed 45 r.p.m. turntable with crystal pick-up. Strong moulded two colour cabinet with handle. Plays anywhere where on long life 9 volt battery. Requires less than half an hour's work to connect up using ready built units and easy instructions.

**TOTAL COST 79½.P.P.**

- **BATTERY 2½X EXTRA**
- **ALL UNITS SOLD SEPARATELY**
- **READY BUILT AMPLIFIER WITH SPEAKER AND VOLUME CONTROL**
  - **35½.P.P.**
- **TURNTABLE WITH PICKUP**
  - **39½.P.P.**
- **TWO TONE CASE WITH HANDLE**
  - **5½.P.P.**

- **EXCELLENT QUALITY AND VALUE**

**PERFORMANCE EQUIVALENT TO VALVE AMPLIFIERS OF FOUR TIMES THE PRICE AND MANY TIMES THE SIZE.**

- Power output 10 watts at 400 c/s. Second harmonic distortion 0.1%. Total harmonic distortion 0.25% at 10 watts. Signal to noise ratio at 10 watts 70 dB. Overall response within 3 dB 40 c/s to 20 kc/s.
- 6-Transistor 10 watt power amplifier. 0.25 ohm output impedance for 3 ohms. 20 volt supply, 300mA average for 10 watts. 100mV into 33 kohms sensitivity. 1 dB, 40 c/s to 20 kc/s.
- Built £5.19½.P.P. 2½ ins. or Kit £5.15½.P.P. 2½ ins. (Mains Unit £3.9½.P.P. 2½ ins.)
- As above but 10 watts for 15 ohm speakers. 40 volt supply, 150mA average for 10 watts. 1 db, 40 c/s to 20 kc/s.
- Full function pre-amplifier and control unit on printed circuit. Size 9 x 2½ ins. Features 6 position input selector for microphones, tuners, tape, pick-ups—treble and bass controls +10dB at 50 c/s and 12 kHz—40dB at 50 c/s and 12 kHz. Four-position filter and volume controls. 1.5mV input sensitivity. Front panel B/F ins. Built £7.10½.P.P. 2½ ins. or Kit £9.9½.P.P. 2½ ins.

**“CAPRI” POCKET RADIO 6-TRANSISTOR SUPERHET**

The most compact 6-transistor and diode radio with speaker available to the home constructor. Features the latest in miniature components and circuitry. Supplied with Mullard transistors and moulded cabinets in red-white or blue-white with gold fittings. All components supplied in packets and clearly identified. A printed circuit is used with fully illustrated building instructions. Push-pull output coupled with a sensitive 11 kHz selective circuit make the "CAPRI" hard to beat. Earphone output with a socket. 100mA average for 10 watts. Construction is built on 15½½ ins. x 2½½ ins. Printed circuit. Full tuning on medium waves with long wave Light. All parts sold separately.

**TOTAL COST 79½.P.P.**

- **BATTERY 2½X EXTRA**
- **EARPHONE 6½X EXTRA**

Illustrated leaflet on request.

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