PRACTICAL WIRELESS

FEBRUARY 1970

THE MICROTEST

A MULTI-RANGE TESTMETER
ADCOLA PRODUCTS LTD
ADCOLA HOUSE
GAUDEN ROAD
LONDON SW4
Telephone 01-622 0291/3

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

SEND COUPON FOR LATEST LEAFLET

TO JACKSON BROTHERS

Kingsway, Waddon, Croydon, CR9 4DG. Phone: (01-688) 2754/5
U.S. Office: M. Swedgal, 258 Broadway, New York, N.Y. 10007

PHOTOELECTRIC KIT

39/6

Send for full details, a brief description and Photographs of all Kits and all
50 Helios, Electrolytic and Photoelectric Projects Assembled.

JACKSON BROTHERS

have acquired the manufacturing rights of

WAVEMASTER

VARIABLE CAPACITORS

‘Wavemaster’ variable capacitors have brass vanes and a
single ceramic end plate. All have .240" spindles, extended both
ends for ganging by means of our Universal Couplings. All are
designed for S.W. working and for one hole fixing.
6mm vane packs 300 pF (.017 air gap, 50 pF .064 air gap.

PHOTOELECTRIC KIT

CONTENTS: 2 P.C. Chassis Boards, Components, Etching Manual, Infra-Red Photoswitch, Latching Relays, 2 Transistors, Condensers, Resistors, Gain Control, Terminal Block, Rintravel, etc. Screws, etc. In fact everything you need to build a
Steady-Light Photo Switch/Counter/Burglar Alarm, etc. (Project No. 1) which can be modified for modulated light oscillograph.

PHOTOELECTRIC KIT

INVISIBLE BEAM OPTICAL KIT

Everything needed (except plywood) for building: 1 Invisible-Beam Projector and 1 Photocell Receiver (as illustrated). Suitable for all Photoelectric Burglar Alarms, Counters, Door Openers, etc.

CONTENTS: 2 pieces, 8 mirrors, 2 45-degree wooden blocks, Infra-Red Filters, projector lamp holder, building plans, performance data, etc. Price 29/6. Postage and Pack.

LONG RANGE INVISIBLE BEAM OPTICAL KIT


JUNIOR PHOTOELECTRIC KIT

Versatile Invisible-beam, Relay-box, Steady-Light Photo-Switch, Burglar Alarm, Door Closer, Container, etc., for the Experimenter.


JUNIOR OPTICAL KIT

CONTENTS: 2 Lenses, Infra-Red Filter, Lampholder, Bracket, Plans, etc. Everything (except plywood) to build 1 miniature invisible beam projector and photocell receiver for use with Junior Photocentric Kit.


YORK ELECTRICS

333 YORK ROAD, LONDON, S.W.11

Send a S.A.S.E. for full details, a brief description and Photographs of all Kits and all
50 Helios, Electrolytic and Photoelectric Projects Assembled.

PW177
Produced by experts for Engineers, Students and Enthusiasts

This is the book you've been waiting for! Over 200 information-packed pages. Circuits for audio amplifiers, record players, tape recorders, f.m. tuners and portable radio receivers up to hi-fi standards, all designed and proven in Mullard laboratories. Mullard publications are renowned for the technical authority of their contents and the clarity and style of their presentation. 'Transistor Audio and Radio Circuits' is another outstanding example - there's bound to be a big demand.

It's handy sized and strongly bound. Tremendous value at 30/-.
Get your copy from your local radio retailer, bookshop or direct from Mullard (cash with order) 32/- per copy including postage and packing.

Mullard
Mullard Limited, Distributor Sales Division, Mullard House, Torrington Place, London W.C.1.
EXCLUSIVE HI-FI STEREO TUNER AMP. OFFER
THE MT-65 CHASSIS

Solid state AM/FM multiplex tuner with FET front-end/17-17 watts stereo amplifier by world famous manufacturer. Frequency response 20-45kHz, inputs-2.3mV mag. p/u.s.m. 14mV tape, Tapes record/playback, Output: Left/right volume, bass, treble, loudness, monitor, Tuning meter and stereo beacon. Stereo ‘phone jack. Machined stainless steel front panel. Overall size 20 x 3 x 16in.

LASKY'S PRICE £78.0.0
CARRIAGE 12/6

DE-LUXE “COMPACT” PACKAGE OFFER
LASKY'S PACKAGE PRICE
GARRARD AS-79 3-speed Single Player £63.18.7
AUDIO DEVELOPMENT AD-70 Rega Bearing System £63.0.0
“Compact” Turntable Cabinet (as shown) £7.10.0
TOTAL RECOMMENDED LIST PRICE £161.5.1

SCOOPE! THE WORLD’S SMALLEST 6 TRANSISTOR TWO WAVEBAND RADIO RECEIVER
Over 10,000 sold
The Astraad ORION

Made to the highest space-age standards—this remarkable micro-set measures only 1.5 x 1.5 x 1.5in. It contains 6 transistors and other components combined in a photo-etched circuit, only 1 x 1cm., tuning capacitor, ferrite rod aerial, battery, ‘ve band selection switch, etc. Output to a high impedance crystal earphone, giving ample volume (automatically adjusted) and clear tone. Brtist tech spec.: Wavebands—Medium wave 540 to 1500Kc, Long wave 100Kc to 500Kc, Sensitivity: 30mV max. Selectivity—10DB at 20Kc (20dB at tuning). Power source: 1 x 1.4V mercury battery. The Orion is supplied fully tested and tested complete with battery, left and right fitting earphone supports and attractive black and ivory plastic carrying case—the Orion is an ideal gift for all, providing a constant source of amusement without disturbing others.

LASKY’S PRICE ONLY 39/6
Post 9/6. Extra rechargeable battery 9/6

NOTE: The battery we supply with the Orion is a rechargeable type. Change units are available enabling you to replace the battery by AC mains 250/240V supply.

PRICE 19/6 extra Post Free with radio—otherwise 1/-

NEW INTERNATIONAL TAPE
FAMOUS AMERICAN MADE BRAD TAPE at RECORD LOW PRICES

3in. Message tape, 400ft. £4.4.0
3in. Message tape, 1000ft. £12.3.0
3in. Message tape, 2000ft. £24.7.0
3in. Trippe play, 8000, Mylar £10.0.0
3in. Triple play, 8000, Mylar £16.0.0
3in. Double play, 8000, Mylar £19.0.0
3in. Standard play, 8000, Mylar £16.0.0
3in. Long play, 8000, Mylar £19.0.0
3in. Double play, 8000, Mylar £22.0.0
3in. Long play, 10000, Mylar £25.0.0

F. & P. £1.12.6 extra per reel, 4 reels and over Post Free. Special rates for quantities.

Garrard
SL55 with J2006 stereo cartridge £11.19.6

AUTOCARTRIDGES
105/5 £6.8.6
105 with GOM41 mono cartridge £6.19.6
205/7 £7.9.6
250/7 £9.15.6
250/7 TV £9.15.6
T71A stereo diamond cartridge £11.18.0
T71AII stereo diamond cartridge £11.18.0
T71B stereo diamond cartridge £11.18.0
T71BII stereo diamond cartridge £11.18.0
T71C stereo diamond cartridge £11.18.0
T71CII stereo diamond cartridge £11.18.0
T71D diamond cartridge £11.18.0
T71DII diamond cartridge £11.18.0
T71E diamond cartridge £11.18.0
T71EII diamond cartridge £11.18.0
T71F diamond cartridge £11.18.0
T71FII diamond cartridge £11.18.0
T71G diamond cartridge £11.18.0
T71GII diamond cartridge £11.18.0
T71H diamond cartridge £11.18.0
T71HII diamond cartridge £11.18.0
T71I diamond cartridge £11.18.0
T71I11 diamond cartridge £11.18.0
T71J diamond cartridge £11.18.0
T71JII diamond cartridge £11.18.0
T71K diamond cartridge £11.18.0
T71K11 diamond cartridge £11.18.0
T71L diamond cartridge £11.18.0
T71L11 diamond cartridge £11.18.0
T71M diamond cartridge £11.18.0
T71MII diamond cartridge £11.18.0
T71N diamond cartridge £11.18.0
T71NII diamond cartridge £11.18.0
T71O diamond cartridge £11.18.0
T71OII diamond cartridge £11.18.0
T71P diamond cartridge £11.18.0
T71P11 diamond cartridge £11.18.0
T71Q diamond cartridge £11.18.0
T71QII diamond cartridge £11.18.0
T71R diamond cartridge £11.18.0
T71RII diamond cartridge £11.18.0
T71S diamond cartridge £11.18.0
T71SII diamond cartridge £11.18.0
T71T diamond cartridge £11.18.0
T71TII diamond cartridge £11.18.0
T71U diamond cartridge £11.18.0
T71UII diamond cartridge £11.18.0
T71V diamond cartridge £11.18.0
T71VII diamond cartridge £11.18.0
T71W diamond cartridge £11.18.0
T71WII diamond cartridge £11.18.0
T71X diamond cartridge £11.18.0
T71XII diamond cartridge £11.18.0
T71Y diamond cartridge £11.18.0
T71YII diamond cartridge £11.18.0
T71Z diamond cartridge £11.18.0
T71ZII diamond cartridge £11.18.0

LASKY’S PRICE £87.6.0
Post 3/6

DENSHI BOARD KITS
EXPERIMENTAL AND EDUCATIONAL CIRCUIT SYSTEM
The DENSHI BOARD system enables the budding electronics enthusiast to produce a wide range of transistor circuits of increasing complexity—without soldering or the use of any tools at all! Basically the system comprises a printed circuit board into which plug-in components and bridge pieces are set to produce up to 30 different circuits. The components are segregated in transparent plastic blocks bearing the appropriate circuit symbol and value thus enabling even the complete novice to visually grasp the fundamentals of circuitry after only a few moments study. In addition each DENSHI BOARD KIT comes complete with an 80 page manual of circuits and data.

DENSHI BOARD KIT SR-1A comprises:
Base board; tuning block; 4 resistors; choke coil; transformer; 9V transistor for HP; 2 diodes; 3 capacitors; battery block; mono key; miniature loud crystal earphone; various bridge and connecting pieces. This kit permits the building of 16 basic circuits.

LASKY’S PRICE £87.6.0
Post 3/6

DENSHI BOARD KIT SR-2A as SR-1A but with the following additional parts: 2SB transistors for AF; 3 resistors; 1 capacitor; crystal microphone; test probes; electrode additional connecting pieces; 9V battery. This kit permits the building of 20 basic circuits.

LASKY’S PRICE £6.2.6
Post 2/6

NEW! FOSEBER TWO WAY BOOK-SHELF SPEAKER SYSTEM
Another high quality semi-miniature bookshelf system from Foster. The “Criterion” Mk 11 is a sealed infinite baffle type enclosure using 2in. base/mid-range woofers joined to a 2.5in. HF cone type tweeter. The compact cabinet is constructed of melamine laminate with aluminium oxide walnut veneer finish and black worn acoustic paint. Front panel with satin chrome edge trim. AFRC. Frequency range 60-20,000Hz. Power handling 10 watts, Impedance 8 ohms. HF tweeter, Screw for connections at rear, Base 157 x 71 x 45in. The performance of the “Criteria” Mk 11 is superior larger and more expensive units and at Lasky’s exclusive price offers absolutely unrepeatable value.

LASKY’S PRICE £9.10.0 or 2 for £17.10.0
The 1970 edition of Lasky's famous Audio-Tronics catalogue is now available - FREE on request. The 28 tabloid pages - many in full colour are packed with 1000's of items from the largest stocks in Great Britain, everything for the Radio and Hi-Fi enthusiast, Electronics Hobbyist, Serviceman and Communications Ham. Over half the pages are devoted exclusively to every aspect of Hi-Fi (including Lasky's budget Stereo Systems and Package Deals). Tape recording and Audio accessories plus LASKY'S AMAZING MONEY SAVING VOUCHERS WORTH OVER £25.0.0. All the goods shown in the "Audio-Tronics" catalogue are available from any of our branches or by Mail Order to any address in the U.K. or Overseas - bringing the benefits of shopping at Lasky’s to you in the comfort of your home. A 4-Million customers have already received their copy of the “Audio-Tronics” catalogue.

Send for your copy now.

SEND TODAY

Your name and address and 1/6d for post only and inclusion in our regular mailing list.

Branches
207 EDGWARE ROAD, LONDON, W.2 Tel.: 01-723 3271
Open all day, 9 a.m.-6 p.m. Monday to Saturday
33 TOTTENHAM CT. RD., LONDON, W.1 Tel.: 01-636 2605
Open all day, 9 a.m.-6 p.m. Monday to Saturday
152/3 FLEET STREET, LONDON, E.C.4 Tel.: 01-353 2833
Open all day Thursday, early closing 1 p.m. Saturday

High Fidelity Audio Centres
42-45 TOTTENHAM CT. RD., LONDON, W.1 Tel.: 01-580 2573
Open all day, 9 a.m.-6 p.m. Monday to Saturday
118 EDGWARE ROAD, LONDON, W.2 Tel.: 01-723 9789
Open all day Saturday, early closing 1 p.m. Thursday

ALL MAIL ORDERS AND CORRESPONDENCE TO: 3-15 CAVELL ST., TOWER HAMLETS, LONDON, E.1 Tel.: 01-790 4821
Whether you are a newcomer to radio and electronics, or are engaged in the industry and wish to prepare for a recognized examination, ICS can further your technical knowledge and provide the specialized training so essential to success. ICS has helped thousands of ambitious men to move up into higher paid jobs—they can help you too! Why not fill in the coupon below and find out how?

Many diploma and examination courses available, including expert coaching for:

- C. & G. Telecommunication Technicians' Certs.
- C. & G. Electronic Servicing
- Radio Amateurs' Examination
- P.M.G. Certs. in Radiotelegraphy
- General Certificate of Education, etc.

Examination Students coached until successful

NEW SELF-BUILD RADIO COURSES

Learn as you build. You can learn both the theory and practice of valve and transistor circuits, and servicing work while building your own 5-valve receiver, transistor portable, and high-grade test instruments, incl. professional-type valve volt meter—all under expert tuition. Transistor Portable available as separate course.

POST THIS COUPON TODAY for full details of ICS courses in Radio, T.V. and Electronics.

INTERNATIONAL CORRESPONDENCE SCHOOLS

Dept. 171, Intertext House, Stewarts Road, London, S.W.8

Please send me the ICS prospectus—free and without obligation.

(state Subject or Exam.)

_____________________________________________________________________

NAME

ADDRESS

INTERNATIONAL CORRESPONDENCE SCHOOLS

732
The Premier Stereo System consists of an all transistor stereo amplifier, Carrard Model 2025 auto/manual record player unit fitted stereo/mono cartridge and mounted in teak finish plinth with perspex cover and two matching teak finish loudspeaker systems. Absolutely complete and supplied ready to plug in and play. The 10 transistors have an output of 5 watts per channel with inputs for pick up, tape and tuner also tape output socket. Controls: Bass, Treble, Volume, Balance, Selector. Power on/off, stereo/mono switch. Brushed aluminium front panel. Black metal case with teakwood ends. Size 12 x 25/3 x 31/4 in. High (Amplifier available separately if required £1415.6. Carr. 7/6.)

### SPECIAL OFFER CARTRIDGES

<table>
<thead>
<tr>
<th>MODE</th>
<th>List Price</th>
<th>Premium Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>M3D</td>
<td>£10.10.0</td>
<td>£10.10.0</td>
</tr>
<tr>
<td>M44-9</td>
<td>£11.10.0</td>
<td>£11.10.0</td>
</tr>
<tr>
<td>M45</td>
<td>£11.10.0</td>
<td>£11.10.0</td>
</tr>
<tr>
<td>M44</td>
<td>£11.10.0</td>
<td>£11.10.0</td>
</tr>
<tr>
<td>M52</td>
<td>£11.10.0</td>
<td>£11.10.0</td>
</tr>
<tr>
<td>M76-6</td>
<td>£11.10.0</td>
<td>£11.10.0</td>
</tr>
<tr>
<td>M780</td>
<td>£20.15.0</td>
<td>£20.15.0</td>
</tr>
</tbody>
</table>

**A.A.T. 7X elliptical**

- Premium Price £25.0.0
- Carr. 7/6

- **1375E**
- **1375**
- **M55E**

### AUDIO TECHNICA

- **A.T.7x stereo**
- **A.T.7x subwoofer**

- **Plug in**

### THE PREMIER STEREO STETHOSCOPE SET

**LOW IMP.**

- **POST AND PACKING**
- **£1.15.0**

- **SPECIF. MADE IN D.S.A. FROM EXTRA STRONG**

### SAVINGS NEARLY £5!

**STEREO SET**

<table>
<thead>
<tr>
<th>MODE</th>
<th>Premium Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP5</td>
<td>£17.8.4</td>
</tr>
<tr>
<td>SP5</td>
<td>£13.19.6</td>
</tr>
</tbody>
</table>

**PREMIER**

<table>
<thead>
<tr>
<th>MODE</th>
<th>Premium Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP5</td>
<td>£17.8.4</td>
</tr>
<tr>
<td>SP5</td>
<td>£13.19.6</td>
</tr>
</tbody>
</table>

**VERITAS V-149 MIXER**

- Battery operated, 4-channel audio mixer providing four separate inputs. Blk 8 x 2 x 2 in. Available for crystal micro-phon in, low impedance micro-phon in line, transformer input, radio, tape, etc. Max. input 35 -max. output 2x2 in. 6 dB. Balanced jack plug socket interface. Phonomorphic output. Attractive teak wood grain finish case.

**STEREO MODEL 59/6**

- **STEREO 69/6**
- **P & P 2/6**

**VERITAS V-313 TAPE HEAD DEFLECTOR**

- A must for all tape users! Tape heads become permanently magnetized with constant use. Head leaves background noise that prevents perfect recordings. Simply applied to recording head the V313 leaves head free of magnetization. Change any tape head in seconds.

**JULIETTE's 8 HAND 18 TRANSISTOR MAINS BATTERY RADIO**

- **Covers AM 540-1600Kc, Marine 1.6-6.6MHz FM 88-108MHz**
- **Ferrite bar aerial for AM M.B. Transistor 8-channel aerial for FM/WJP PB. 4/5x6x1/4 in**
- **Power on/off, stereo/mono switch. Also features: Brushed aluminium front panel, Brass terminals, teak & black controls. Volume and Balance controls Mono/Stereo Switch. Also features gold-plated jack plug socket and tape output.**

**PRICE**

- **34/6 P & P 1/6**

### THREE BAND 18 TRANSISTOR BATTERY RADIO

- **COVERS:** AM 540-1600Kc, Marine 1.6-6.6MHz, FM 88-108MHz
- **Ferrite bar aerial for AM M.B. Transistor 8-channel aerial for FM/WJP PB. 4/5x6x1/4 in**
- **Power on/off, stereo/mono switch. Also features: Brushed aluminium front panel, Brass terminals, teak & black controls. Volume and Balance controls Mono/Stereo Switch. Also features gold-plated jack plug socket and tape output.**

**PRICE**

- **34/6 P & P 1/6**

### “TESTING” REFEREE

- **A really versatile instrument that makes a handy pocket size tool. Measures AC or DC voltage in three ranges of 0-150-1000 volts. Resistance 0-100,000 ohms. Current 0-150 mA D.C. Size only 11 x 3 x 2 in. Complete with battery, tool head and instructions.**

**PRICE**

- **£4.19.6 3/6**

### POCKET SIZE MULTI-TESTER

- **With wide range, for electrical, electronic, telephonic, radio, tape, etc. etc. etc.**
- **Excellent low cost instrument for the enthusiast. Output 1000 volts. Resistance 0.100 megohms, 0-100 volts.**
- **Size only 11 x 3 x 2 in. Battery, tool head and instructions.**

**PRICE**

- **£4.19.6 3/6**

### TWO STATION TRANSISTOR INTERCOM

- **Complete with battery and test leads for pick up, phone, etc. etc. etc.**
- **Complete battery, tool head and instructions.**

**PRICE**

- **65/- 4/-**

### FOUR STATION INTERCOM

- **Master unit and 3 slaves. Ideal for office and home, Complete with battery and connecting wire £7.13.6 F. & P. 2/6.**

### “PREMIER” TAPE CASSETTES

- **C60 (30) 7/6**
- **C90 (60) 12/6**
- **C120 (90) 17/6**

### CASSETTE HEAD CLEANER

- **Removes unwanted deposits from delicate tape heads. Fits all cassette recorders.**

- **11/6 F. & P. 1/2.**

---

**THE COMPLETIST STEREO SYSTEM FOR ONLY 39 GNS**

- **CARRIAGE 35/-**

---

**PREMIER RADIO**

23, TOTTENHAM COURT ROAD, LONDON, W.1

Tel: 01-636 3451

---

733
A LONG COOL LIFE

for your valuable components with the
S.D.C. DeC range of SOLDERLESS breadboards

S-DeC Available as single packs with accessories and
control panel @ 29/6d or the DeCSTOR double
pack containing 2 S-DeCs, accessories, control
panel, all in a plastic storage container. Only 67/6d.
A 4 DeC pack is available, only 117/6d.

T-DeC Now available to the amateur. 208 connection points.
38 independent junctions. Accommodates I.C.s using
standard carriers. Three times the capability for only
twice the price! Unit pack with control panel 50/-d.

µ-DeC Primarily for use with integrated circuits; further
details on request.

T-DeCs, S-DeCs and Accessories are all obtainable
from leading suppliers throughout the U.K.

In case of difficulty complete the coupon and
mail without delay.

S.D.C. Electronics (Sales) Ltd.,
34, Arkwright, Astmoor Industrial
Estate, Runcorn, Cheshire. Tel: Runcorn 5041

Please send me:

T-DeC Pack ............... S-DeC Single Pack

DeCSTOR Pack ............... 4-DeC Pack

Tick here if you require further details of the µ-DeC
I enclose PO/Check/Money Order value £ / / d.
Money refunded if not satisfied.

Name......................................................
Address..................................................

BUILD YOUR CIRCUITS
on
VEROBOARD

—the Universal Wiring Board—
obtainable from your local Retailer

Trade enquiries to:
NORMAN ROSE (ELECTRICAL) LTD.
8 St. Chad's Place, Gray's Inn Road, London, W.C.1

Technical enquiries to:
VERO ELECTRONICS LTD.
Industrial Estate, Chandler's Ford, Hants

A MUST FOR THE HI-FI PERFECTIONIST

AUDIO ADAPTOR UNITS

TYPE AAU-3 Provides switching between 2 pairs of speakers
and 1 pair of Stereo Headphones to 1 stereo Amplifier, which
can be either switched singly or simultaneously.

TYPE AAU-3 Provides switching between 3 Stereo Inputs to
a common Amplifier input. A general purpose unit suitable for
pick-ups, tuners, mixer, tape, etc.: 2 inputs at any time and 1 via
front DIN socket. Rear inputs are simultaneously switched to
front socket for feeding external equipment.

TYPE AAU-4 Provides Stereo Record/Replay connections
between 2 Stereo or Mono Tape Recorders, to 1 Stereo
Amplifier. One Recorder can be permanently installed in the
cabinet with amplifier, connected via the rear sockets. The
other can be used externally, and be connected to the front
socket as required.

TYPE AAU-TV Provides a ready means of connecting external
equipment to a TV receiver with complete safety.
We stock all the above and many other units manufactured by
M.A.C. Ltd.

Write for full details to
W. E. C. LTD. (AW)
74 THE STREET, ASHTEAD, SURREY
There's Something for Everyone in the NEW HEATHKIT CATALOGUE!

- GUITAR PRACTICE AMPLIFIER
- ELECTRONIC METRONOME
- AMBASSADOR SPEAKERS
- AUTO-TUNE-UP METER
- AIRCRAFT MONITOR RECEIVER
- CAR RADIO
- TECHNICIANS LOW-COST 'VVM'
- SEVERN AM/FM RADIO
- FABULOUS STEREO HI-FI COMPACTS
- STEREO RECORD PLAYER
- D.I.Y. SPEAKER SETS
- GENERATORS
- POWER SUPPLIES
- D.I.Y. RADIOGRAM PACKS
- MANY OTHER MODELS TOO NUMEROUS TO MENTION

Send for this FREE Catalogue and see for yourself, Today!

DAYSTROM LTD
GLOUCESTER
GL2-6EE

Please send me my free copy of the 1970 HEATHKIT CATALOGUE

NAME
ADDRESS
5/21B
Complete stereo system — £29-10

The new Duo general-purpose 2-way speaker system is beautifully finished in polished teak veneer, with matching vinyl grille. It is ideal for wall or shelf mounting either upright or horizontally.

Type 1 SPECIFICATION:
- Impedance 10 ohms. Incorporates Goodmans high flux 5-8 x 4" speaker and 2-1/2" tweeter. Each speaker 7-1/2d.p. &p., 600mV, cross-talk better than 30dB at 1Kc/s. CONTROLS: 4 position selector switch (2 pos. mono and 2 pos. stereo) and equalised output: Equalisation switch (200-20Hz for magnetic and 25dB below for cartridges) and test point for each channel. A.C. mains 200-20V, Built and tested, Size 12" long, 4" deep, 5" high. Teak finished case.

Type 2 as Type 1. Size 21" x 10" x 61/2" &p. Incorporating 10" x 41/2" bass unit and 2-1/2" tweeter. 3 ohms impedance. Each unit 94 guineas plus 7/6d. &p. 7/6d. &p.

Garrard Changers from £7.19.6d. &p. 7/6d. Cover and Teak finish Plinth £4.15.0d. 7/6d. &p.

The items illustrated can be purchased together for £29.10.

The Duetto is a good quality amplifier, attractively styled and finished. It gives superb reproduction previously associated with amplifiers costing far more.

SPECIFICATION:
- R.M.S. power output: 3 watts per channel into 10 ohms speakers.
- INPUT SENSITIVITY: Suitable for medium or high output crystal cartridges and turntables. Cross-talk better than 30dB at 1Kc/s.
- CONTROLS: 4 position selector switch (2 pos. mono and 2 pos. stereo) and dual ganged volume control.

Duetto Integrated Transistor Stereo Amplifier

£9-10 plus 7/6d. &p. &p.

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

The Classic

£9 plus 7/6d. &p.

Controes: Selector switch Tape speed equalisation switch (20 and 78 r.p.m.). Volume, Treble, Bass. 2 position scratch filter and 3 position rumble filter.

SPECIFICATION: Sensitivities for 10 watt output at 1KHz into 3 ohms. Tape head: 3mV (at 321/2 r.p.m.). Mag. P.U.: 2mV. Cer. P.U.: 10 mV. Tuner: 100mV. Aux.: 100mV.

Tape/Rec. output: Equalisation for each input is 32dB (R.A.A.) from 20Hz to 20kHz. Tone control range: Bass ±13dB at 60Hz. Treble ±14dB at 15kHz. Total distortion: (for 10 watt output) <1-95%. Signal noise: <—60dB. A.C. mains 200-20V, Built and tested. Size 12" long, 4" deep, 5" high. Teak finished case.

The Viscount

£14.5 plus 7/6d. &p.

Integrated High Fidelity Transistor Stereo Amplifier. Specification—Output: 10 watts per channel into 3 to 4 ohms speakers (20V morsala). Input: 6 position rotary selector switch (2 pos. mono and 2 pos. stereo), P.U., Tuner, Tape and Tape Rec. out. Sensitivities: All inputs 100mV into 1KHz. Frequency response: 40Hz-20kHz ±3dB. Tone Controls: Separate bass and treble controls; treble, 15dB lift and cut (-15kHz); Bass, 15dB lift and 25dB cut (-2kHz). Volume Controls: Separate for each channel. A.C. Mains Input: 200-29v. Size: 21" x 6" x 822" in teak finished case. Built and tested.

VISOUNT MARK II for use with magnetic pick-ups specification as above. Fully equalised for magnetic pick-ups. Suitable for cartridges with minimum output of 4mV/cm/see. at 1Kc, Input impedance 47k. £15.15 plus 7/6d. &p. &p.

SPECIAL OFFER!

Complete stereo system comprising BALFOUR 4-speed autolocker with stereo head, 2 Duo speaker systems, size 12" long, 6" deep, 5" high. Plinth (less cover) and the DUETTO stereo amplifier. All above items £20 plus 7/6d. &p. &p.

NEW COMPLETE HI-FI STEREO SYSTEM — £39

comprises SP 25 Garrard Mk II with diamond cartridge, Viscount Mk I amplifier, two type 2 speakers, plinth and cover £39 plus 7/6d. &p. &p.

also see opposite page
The ELEGANT SEVEN
Mk. III (350mW Output)
7 transistor fully transistorised M.W.-L.W. superhet portable. Set up completely with all components, including easily reached and cleaned printed circuit board—back printed for foolproof construction.

Mains Power Pack Kit: 9/6 extra.
Price £4.9.6 plus 7/6 P. & P.

The DORSET
(600mW Output)
7-transistor fully transistorised M.W.-L.W. superhet portable—w/ built-in alarm facility. Set up complete, with all components, including easily reached and cleaned printed circuit board—back printed for foolproof construction.

Mains Power Pack Kit: 9/6 extra.
Price £5.5.0 plus 7/6 P. & P.

EXTRACTOR FAN
A.C. mains 230/250v, complete with pull switch.
Size: 6 x 6 x 6in.
Price 27/6 plus 7/6 P. & P.

X101
10W SOLID-STATE HI-FI AMP WITH INTEGRAL PRE-AMP
Specifications:
- Power Output (into 3 ohms speaker) 10 watts.
- Sensitivity (for rated output): 1mV into 3k ohms (0.33 microamp).
- Total Distortion at 1KHz at 5 watts, 0.35% at rated output 1.5%.
- Frequency Response: Minus 3dB points 20Hz and 40KHz.
- Speaker: 3-4 ohms (0.5 ohms may be used).
- Supply voltage: 12v. DC. at 800mA (6-24v. may be used).

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

2, Treble: Price 5/6. 3. Comprehensive bass and treble controls. 4. The above 3 items can be purchased used with the X101.

Power Supplies for the X101:
- P101 M (or mono) 35/6 plus 7/6 P. & P.
- P101 S (or stereo) 42/6 plus 4/6 P. & P.

Price £14.19.6 plus 5/- P. & P.

50 WATT AMPLIFIER
A.C. Mains 200-250V
An extremely reliable general purpose valve amplifier. Its rugged construction and choice of valves give long life. High output gives excellent results.

Price £28.10

5 & 4 x 300mV at 1m. Suitable for most high output instrument input (e.g. tape, tuner, opera, etc.). Input sensitivity relative to 10w output. TONE CONTROLS ARE COMMON TO ALL INPUTS. Bass Boost -12dB at 50Hz. Bass Cut -12dB at 80Hz. Treble Boost +1dB at 15kHz. Treble Cut -12dB at 15kHz. With bass and treble controls central -1dB points are 30 Hz and 20 KHz. POWER OUTPUT: For speech and music 50 watts rms. 100 watts peak. For sustained music 45 watts rms. 90 watts peak. For single wave 18.5 watts rms. Nearly 80 watts peak. Total distortion at rated output 2.7% at 1KHz. Total distortion at 20 watts 0.15% at 1KHz. Output to match most 8 ohm loud speaker system. NEGATIVE FEEDBACK 20dB at 1KHz. SIGNAL TO NOISE RATIO 60dB. MAINS VOLTAGES adjustable from 200-250V.A.C. 50-60 Hz. Protective fuse is located at the rear of unit. Output impedance 3.8 and 15 ohms.

B.S.R. TD-2 TAPE DECK
Takes 5in. spools, fitted with B.S.R. 4 Track Heads. Size 13in. long by 8in. wide.
Price £6.19.6 plus 7/6 P. & P.

THE RELIANT
SOLID STATE GENERAL PURPOSE AMPLIFIER

SPECIFICATIONS
Output—10 watts
Inputs—1. xtal mic 10mV Tone Controls—2. -aram/radio 250mV
-aram/record 12dB at 10KHz

Price 

RECORD PLAYER SNIP
The "Princess", 4-speed automatic record changer and player engineered with the utmost precision for beauty, bone, leather and trouble free service. Will take up to ten records which may be mixed in 7” to 10". Patented stylus brush cleans sleeve after each playing and at the off. Pick-up locks itself into its recess, a most useful feature with portable equipment. Features include pickup height adjustment and stylus pressure adjustment. This truly is a fine instrument which you can purchase throughout at any 7/6.19.6 Complete with cartridge and ready to use. Price £6.16 plus 7/6 P. & P.

POCKET MULTI-METER
Size 3½ x 2½ x 1½. Meter size 2½ x 1½. Sensitivity 1000 O.F.V. on both A.C. and D.C. volts 0-15, 0-30, 0-100, 0-1000. Sensitivities taken for 200mV output. Controls—are separate volume controls for each channel. Twin headphones, 12dB switch and 15dB switch at 20dB. Twin switched treble, 10dB lift and 15dB cut at 10dB. Volume 3/4-30DC at 1mA. Price £5.19.6 plus 5/- P. & P.

STEREO PRE-AMPLIFIER
Inputs—3 position rotary switch (3 position mono, 3 position stereo). Capacitive pickup-filtered and suitable for magnetic cartridges with minimum output of 4mV/cm/sec. Load 47k. Ceramic pickup 150mV into 69k. Sensitivities taken for 200mV output. Controls—separate volume controls for each channel. Twin 12dB switch and 15dB switch at 20dB. Twin switched treble, 10dB lift and 15dB cut at 10dB. Volume 3/4-30DC at 1mA. Price £25.19.6 plus 5/- P. & P.

PYE CAR RADIO
Push Button Tuning Heart
This PRESTYLEO 7 station Push-Button Tuner Heart with Manual Over-ride is on ideal basis for a quality audio car radio. Size 6½ x 1½ x 1½. As illustrated but without knobs.
Price £7.0 plus 5/- P. & P.

QUALITY MAINS TRANSFORMER
Input 250 volts. OUTPUT (ALL RMS values) 4 windings of 11.5 volts connected in series total 46 volts at 4.5 amps conservatively rated. The following combinations may be used: 1. 230-0-230 volts, 2. 46 volts. Both of these above voltages are commonly used in medium to high power transistor amplifiers, power supplies, etc.
Price 35/- plus 7/6 P. & P.
SURPLUS EX GOVT. BARGAINS

AMPLIFIER RF No. 2
MK III, Increases output of 75v. 6T7G. Brand New. 12 v.
D.C. Power Units $15.00, 18/6, 12/6, D.C. Power Units with Vibrator MK II No. 2.
KTC 71, Carr. 10/-.
BASIC SETS, Used 15v., New 22/6, F & P, 6v. Mains P.B.I.I. For 28 20/6, Carr. 10/-, K.T.C. Antenna Tuner (ATU) 5/6, F & P 5/-.


30MCs AD or DC. Mains operation. Fully tested. 25/10.0, Carr. 15/-.

B.W. RECEIVER. LP Version of R-60. Coverage 15Kc-700Kc. Mains Operation. As new 28/6, Carr. 30/6. (Extra lead with DIN plug for Cassettes Recorder 7/6)

TELESCOPIC MASTS. 20ft.
Closed to 1/2, 36/6, Carr. 15/-, 25/10.0, Carr. 15/-.

SSFT. AERIAL MASTS.
Seven 6ft. diam. antenna, 20ft. section. 10/6, Carr. 15/-.

TELE "F" FIELD COMMUNICATION RECEIVERS. 11 valve. Curves 8AM/PM, 6W. 150 V, 12v. D.C. Internal Power Supply. Tested. 25/10.0, Carr. 15/-.

A.J. THOMPSON (Dept. P.V.)

"Milling Lodges", Godlees, Hichin, Herts.
Phone: Godlees 2429
C.W.C. Carryage charges apply to mainland only.

MAINS UNITS for all types of TRANSISTOR EQUIPMENT

The ideal, economical and safe way of running Transistor Radios, Record Players. Tape Recorders. Amplifiers etc. from A.C. Mains. All units are completely isolated from mains by double wound transformer ensuring 100% safety.

PLUS-3

MAINS UNIT for Cassettes Tape Recorders using 7/6. Complete with DIN plug for recorder power socket. Can also be supplied for a 6-volt output complete with suitable plug. (Please state model and voltage for two separate outputs, 6v., 12v., 18v., and 36v."

Also available—Unit to run your Cassettes Recorder from 12v. Car Battery 31/6, P & P 2/6. Mains Unit for Fi-Cord ZEA TAPE RECORDER. P & P 5/-.

£4.15.0

MAJOR POWER PLUS

BASIC ELECTRONICS (6VOLs)

The 'New Picture-Book' way of learning ELECTRICITY (5VOLs)

You'll find it easy to learn with this outstandingly successful NEW PICTORIAL METHOD—the essential facts are explained in the simplest language, one at a time, and each is illustrated by an accurate cartoon-type drawing. The books are based on the latest research into simplified learning techniques. This has proved that the PICTORIAL APPROACH to learning is the quickest and soundest way of gaining mastery over these subjects.

TO TRY IT, IS TO PROVE IT

To The SELBY BOOK CO., 50 HAYES HILL, HAYES, DROMLEY, KENT BR2 7HP

Please send me WITHOUT OBLIGATION TO PURCHASE, one of the above sets on 7 DAYS FREE TRIAL, I will either return set, carriage paid, in good condition within 7 days or send the following amounts. BASIC ELECTRONICS 75/- Cash Price, or Down Payment of 28/- followed by 3 fortnightly payments of 20/- each. BASIC ELECTRONICS 90/- Cash Price, or Down Payment of 20/- followed by 4 fortnightly payments of 20/- each.

This offer applies to UNITED KINGDOM ONLY. Overseas customers cash with order, prices as above.

Tick Set required (Only one set allowed on free trial)

BASIC ELECTRICITY □ BASIC ELECTRONICS □

Prices include Postage and Packing.

Signature

(If under 21 signature required of parent or guardian)

NAME

BLOCK LETTERS

FULL POSTAL ADDRESS
LINDAIR LARGE AND AT SPECIAL TRANSFORMER FOR OPERATING SINCLAIR IC

1. Long Play PVC 2250v. 3/4 P. & P. 1/2.
5. Long Play PVC 720v. 3/4 P. & P. 1/2.

TRANSFORMERS

A 35/6 P. & P. 3

VHF AIRCRAFT BAND COUNTER When placed within 18 ft of a VHF radio full coverage of VHF Aircraft Band 106-105 MHz can be obtained. All transmitters 

LOW VOLTAGE 12 VOLT RANGE

Primary 200-250v. 3/4 P. & P. 1/2.

LOW VOLTAGE 24 VOLT RANGE

Primary 200-250v. Secondary 24v.

LOW VOLTAGE 30 VOLT RANGE

Primary 200-250v. Secondary Tapped 24 - 28v.

LOW VOLTAGE 50 VOLT RANGE

Primary 200-250v. Secondary Tapped 24 - 28v.

LOW VOLTAGE 60 VOLT RANGE


Mains H.T. RANGE

Primary Tapped 250-250v. 125/125v. 250v. 250v. 250v. 250v.

BATTERY CHARGER TYPES

Primary Voltage 200-250v. Secondary 6-12v. (Rectifier not included)

Mains ISOLATING RANGE ALSO AVAILABLE

Visit our Branch New

Hi-Tone Recording Tape, Tape, Record Bar and Scientific Show of Microscope, Tele-

scopes and Watches at 18/19

Tottenham Court Road

LINDAIR OPTRONICS LTD

18/19, 25 & 53 TOTTENHAM CT ROAD, LONDON W.1.

Telephone: 01-580 2255/4532/7679

Shops open 9-6pm. Monday to Saturday. Thursday until 7pm.
Sonitone 9TA and ST/HC. Diamond Cartridge brand new, boxed in manufac-
turers' cartons 48/6 plus 2/6 p/p. Aoco GP 91-1 and GP 91-3 stereo compatible
cartridges, now in sealed manufacturers' cartons 22/6 plus 2/6 p/p.

**BASF TAPE 25% OFF**

5in. 600ft. 14/-; 900ft. 19/-; 1200ft. 30/-; 35in. 900ft. 19/-; 1200ft. 24/-; 1800ft. 39/-; 7in. 1200ft. 24/-; 1800ft. 35/-; 2400ft. 57/-; P/P 2/- per reel—over £5 FREE

**SPECIAL PURCHASE**

12in. 15 watt HI-FI LOUDSPEAKERS

Made by famous British manufacturer to very high standards, heavy duty cast
class, twin cone construction. Smoooth
extended range, with very low level of
distortion. Response 35-17,000Hz.—imp
cedance 16 ohms—flux, 11,000 gauss.

**WalDan PRICE**

79/6 each plus 6/6 P. & P.

**E.M.I. HI-FI SPEAKERS**

Set 450: 13 x 8 with two built-in tweeters
and cross-over unit. Our Price 89/6
3 or 15 ohm, 10W, 40-13,000Hz.
Set 850: 63in. bass plus 3in. tweeter
and cross-over unit. 8 ohm, 10W, 65-20,000Hz.
79/6
Set 250: 5in. heavy duty bass plus 3in.
tweeter and cross-over unit. 8 ohm, 6W.
80-20,000Hz. 65/-

Add 5/8 p/p for each speaker set.

**TRIO Stereo Moving Magnet Cartridge**

Model AD78K. Diamond stereo LP stylus.
Frequency response 20-20,000c/s output.
7mV tracking pressure 2 grams ±
0-6 gm. Fully guaranteed. Price 85/- p/p free.

**GARRARD UNITS**

£ s d
SP25 Mk. II 11 9 6
AP75 17 19 6
SL65 14 9 6
*3500 11 9 6

*Denotes including Sonitone 9TA-Stereo/
Diamond Cartridge. Elegantly styled plinth
and cover to suit the above units. From 5 gns.
Please add 10/- p/p each on all items above.

**SPEAKER ENCLOSURES**

Designed to accept the full range of E.M.I.
loadspeakers. Beautifully styled in teak.
Prices from 89/6 each.

25 WATT GROUP SPEAKERS

Guitar group 25. 12in. round, heavy duty
cone, with solid aluminium chassis, 15 ohms
imp. 12,000 gaus. Response 30-10,000c/s.
OUR SPECIAL PRICE

£5.9.6 each plus 6/6 P. & P.

**WALDON ELECTRONICS, 707 Blackburn Road, Bolton, Lancs.**

Bolton 54280

Please enclose 2/- in stamps with enquiries.

---

**ERBIN**

**5 CORE SOLDER**

Contains 5 cores of non-corrosive
flux, instantly cleaning heavily
oxidized surfaces. No extra flux
required.

**SAYBIT ALLOY**

**ALSO REDUCES COPPER BIT WEAR.**

Economically packed for
general electrical and electronic
soldering. 15ft. 18 gauge on
plastic reel. Recommended
retail price 15/-

**THIN GAUGE**

**SOLDER. ESSENTIAL FOR**

soldering small components and
thin wires. High tin
content; low melting point,
60/40 alloy, 1.75ft. 22 gauge
on plastic reel. Recommended
retail price 15/-

**A RANGE OF SOLDERS IN HANDY**

**DISPENSERS.**

**REF. ALLOY SWG**

4A, 60/40 16 3/-
Size 6
60/40 Savbit 18 3/4-

16 60/40 22 4/-

*Recommended Price

---

**INVALUABLE FOR STRIPPING**

**FLEX. THE NEW AUTOMATIC OPENING BIB WIRE STRIPPER**

and CUTTER, easily adjustable for all standard
diameters. Plastic covered handles can also be used
as wire cutter. Recommended
retail price 8/6

---

**TRIO Stereo Moving Magnet Cartridge**

Model AD78K. Diamond Stereo LP Stylus.
Frequency response 20-20,000c/s output.
7mV tracking pressure 2 grams ±
0-6 gm. Fully guaranteed. Price 85/- p/p free.

**GARRARD UNITS**

£ s d
SP25 Mk. II 11 9 6
AP75 17 19 6
SL65 14 9 6
*3500 11 9 6

*Denotes including Sonitone 9TA-Stereo/
Diamond Cartridge. Elegantly styled plinth
and cover to suit the above units. From 5 gns.
Please add 10/- p/p each on all items above.

**SPEAKER ENCLOSURES**

Designed to accept the full range of E.M.I.
loadspeakers. Beautifully styled in teak.
Prices from 89/6 each.

25 WATT GROUP SPEAKERS

Guitar group 25. 12in. round, heavy duty
cone, with solid aluminium chassis, 15 ohms
imp. 12,000 gaus. Response 30-10,000c/s.
OUR SPECIAL PRICE

£5.9.6 each plus 6/6 P. & P.

---

**WALDON ELECTRONICS, 707 Blackburn Road, Bolton, Lancs.**

Bolton 54280

Please enclose 2/- in stamps with enquiries.

---

**ERBIN**

**5 CORE SOLDER**

Contains 5 cores of non-corrosive
flux, instantly cleaning heavily
oxidized surfaces. No extra flux
required.

**SAYBIT ALLOY**

**ALSO REDUCES COPPER BIT WEAR.**

Economically packed for
general electrical and electronic
soldering. 15ft. 18 gauge on
plastic reel. Recommended
retail price 15/-

**THIN GAUGE**

**SOLDER. ESSENTIAL FOR**

soldering small components and
thin wires. High tin
content; low melting point,
60/40 alloy, 1.75ft. 22 gauge
on plastic reel. Recommended
retail price 15/-

**A RANGE OF SOLDERS IN HANDY**

**DISPENSERS.**

**REF. ALLOY SWG**

4A, 60/40 16 3/-
Size 6
60/40 Savbit 18 3/4-

16 60/40 22 4/-

*Recommended Price

---

**INVALUABLE FOR STRIPPING**

**FLEX. THE NEW AUTOMATIC OPENING BIB WIRE STRIPPER**

and CUTTER, easily adjustable for all standard
diameters. Plastic covered handles can also be used
as wire cutter. Recommended
retail price 8/6

---

**TRIO Stereo Moving Magnet Cartridge**

Model AD78K. Diamond Stereo LP Stylus.
Frequency response 20-20,000c/s output.
7mV tracking pressure 2 grams ±
0-6 gm. Fully guaranteed. Price 85/- p/p free.

**GARRARD UNITS**

£ s d
SP25 Mk. II 11 9 6
AP75 17 19 6
SL65 14 9 6
*3500 11 9 6

*Denotes including Sonitone 9TA-Stereo/
Diamond Cartridge. Elegantly styled plinth
and cover to suit the above units. From 5 gns.
Please add 10/- p/p each on all items above.

**SPEAKER ENCLOSURES**

Designed to accept the full range of E.M.I.
loadspeakers. Beautifully styled in teak.
Prices from 89/6 each.

25 WATT GROUP SPEAKERS

Guitar group 25. 12in. round, heavy duty
cone, with solid aluminium chassis, 15 ohms
imp. 12,000 gaus. Response 30-10,000c/s.
OUR SPECIAL PRICE

£5.9.6 each plus 6/6 P. & P.

---

**WALDON ELECTRONICS, 707 Blackburn Road, Bolton, Lancs.**

Bolton 54280

Please enclose 2/- in stamps with enquiries.

---

**ERBIN**

**5 CORE SOLDER**

Contains 5 cores of non-corrosive
flux, instantly cleaning heavily
oxidized surfaces. No extra flux
required.

**SAYBIT ALLOY**

**ALSO REDUCES COPPER BIT WEAR.**

Economically packed for
general electrical and electronic
soldering. 15ft. 18 gauge on
plastic reel. Recommended
retail price 15/-

**THIN GAUGE**

**SOLDER. ESSENTIAL FOR**

soldering small components and
thin wires. High tin
content; low melting point,
60/40 alloy, 1.75ft. 22 gauge
on plastic reel. Recommended
retail price 15/-

**A RANGE OF SOLDERS IN HANDY**

**DISPENSERS.**

**REF. ALLOY SWG**

4A, 60/40 16 3/-
Size 6
60/40 Savbit 18 3/4-

16 60/40 22 4/-

*Recommended Price

---

**INVALUABLE FOR STRIPPING**

**FLEX. THE NEW AUTOMATIC OPENING BIB WIRE STRIPPER**

and CUTTER, easily adjustable for all standard
diameters. Plastic covered handles can also be used
as wire cutter. Recommended
retail price 8/6

---

**TRIO Stereo Moving Magnet Cartridge**

Model AD78K. Diamond Stereo LP Stylus.
Frequency response 20-20,000c/s output.
7mV tracking pressure 2 grams ±
0-6 gm. Fully guaranteed. Price 85/- p/p free.
developed out of the highly successful PW. 12+12 and now in complete kit form to save you still more.

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

and this is the Peak Sound Specification Guarantee

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

The specification that tells you everything (See guarantee)

Using two Peak Sound PA, 12-15's, driven simultaneously at 1 KHz from 240 V. mains supply:

Output per channel: 11 watts into 15Ω: 14 watts into 8Ω.

Frequency bandwidth: 10Hz to 45 KHz for 1dB at 1 watt.

Total Harmonic Distortion at 1 KHz at 10 watt into 15Ω—0.1%.

Input sensitivities: Mag. PU.3.5 mV, R.I.A.A. equalized into 68K Ω; Tape, 100mV linear into 100K Ω; Radio, 100mV linear into 100K Ω. Overload factor: 29dB on all input channels.


Complete kit of parts including cabinet assembly, knobs, transistors, well-prepared instructions and wire to length, colour coded and stripped at ends as well as built-in mains power supply. (Post free in U.K.) £32.12.6

Englefield assembly as above, but in easy-to-put-together modules. (Post free in U.K.) £38.8.0

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

To Peak Sound, Saint Judes Road, Englefield Green, Egham, Surrey. Details of Englefield systems, please and...........................

Name ...................................................................................................................
Address ..............................................................................................................

Write your stockist's name and address in margin below and cut out with coupon if necessary.
R.S.C. SENSATIONAL HIGH FIDELITY STEREO "PACKAGE" OFFERS

30 WATT OUTPUT
* Goldring Transcription Turntable on Plinth
  * Garrard SP25 Mk II Ceramic P.U. Cartridge
  * Goldring CSD10 Magnetic Pick-up Cartridge
  * Super 30 Amplifier in veneered housing
  * 22 x 9in. Facia Plate Attractive design in rigid Perspex. Spun silver finish matching control knobs
  * Extremely Attractive PLINTHS finished in Teak or Afromosia veneer cover.

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

30 WATT OUTPUT
* Garrard SP25 Mk II Turntable on Plinth
  * Goldring CS90 Ceramic P.U. Cartridge with gold diamond stylus
  * Super 30 amplifier in veneered housing
  * 22 x 9in. Facia Plate Attractive design in rigid Perspex. Spun silver finish matching control knobs
  * Extremely Attractive PLINTHS finished in Teak or Afromosia veneer cover.

FULLY TRANSISTOURED SOLID STATE CONSTRUCTION OF 6.5 WATTS PER CHANNEL. Designed for optimum performance with any crystal or ceramic turntable, P.U. cartridge, Radio tuner, Tape recorder, "A" or factory built units.

ORDERS MUST NOT BE SENT TO SHOPS

R.S.C. T.M.F. SOLID STATE HIFI/RADIO TUNER

Hi-fi sensitivity. 200-250v.A.C. mains operation. 100% solid state construction.

Output power 200-250v.A.C. mains. 200-250v.A.C. mains. 100% solid state construction.

Cross talk 60 dB. Output power 200-250v.A.C. mains. 200-250v.A.C. mains. 100% solid state construction.

LOW FREQUENCY RESPONSE 15,000 C.E. CROSS TALK 75 d.B.

RECORD PLAYING UNITS

Money saving units. Mounted on Plinth. Suitable for Teak or Afromosia transparent plastic cover Ready to plug into Amplifier or Tape recorder.

R.P.C. Garrard SP25 Mk II (with heavy turntable fatted Goldring CS90 high compliance ceramic or magnetic cartridge with diamond stylus. 20Gns.

Moving coil units, cut for Garrard GCS 23 Stereo Cartridge with diamond tip inc. 15Gns.

EXTREMELY ATTRACTIVE PLINTHS finished in Teak or Afromosia veneer cover.

INTEREST CHARGES

On Credit Sales settled in 3 months. 12% Gns.

R.S.C. PLINTHS

For Record Playing unit, cut for Garrard GCS 25. For Garrard SP25 Mk II, cut for Garrard GCS 25. 9 Gns.

HARDCORE TVM PLINTHS finished in Teak or Afromosia veneer cover.

R.S.C. TMF SOLID STATE HIFI/RADIO TUNER

HARDCORE TVM PLINTHS finished in Teak or Afromosia veneer cover.

R.S.C. T.M.F. SOLID STATE HIFI/RADIO TUNER

Hi-fi sensitivity. 200-250v.A.C. mains operation. 100% solid state construction.

Output power 200-250v.A.C. mains. 200-250v.A.C. mains. 100% solid state construction.

Cross talk 60 dB. Output power 200-250v.A.C. mains. 200-250v.A.C. mains. 100% solid state construction.

LOW FREQUENCY RESPONSE 15,000 C.E. CROSS TALK 75 d.B.

RECORD PLAYING UNITS

Money saving units. Mounted on Plinth. Suitable for Teak or Afromosia transparent plastic cover Ready to plug into Amplifier or Tape recorder.

R.P.C. Garrard SP25 Mk II (with heavy turntable fatted Goldring CS90 high compliance ceramic or magnetic cartridge with diamond stylus. 20Gns.

Moving coil units, cut for Garrard GCS 23 Stereo Cartridge with diamond tip inc. 15Gns.

EXTREMELY ATTRACTIVE PLINTHS finished in Teak or Afromosia veneer cover.

INTEREST CHARGES

On Credit Sales settled in 3 months. 12% Gns.

R.S.C. PLINTHS

For Record Playing unit, cut for Garrard GCS 25. For Garrard SP25 Mk II, cut for Garrard GCS 25. 9 Gns.

HARDCORE TVM PLINTHS finished in Teak or Afromosia veneer cover.

R.S.C. TMF SOLID STATE HIFI/RADIO TUNER

Hi-fi sensitivity. 200-250v.A.C. mains operation. 100% solid state construction.

Output power 200-250v.A.C. mains. 200-250v.A.C. mains. 100% solid state construction.

Cross talk 60 dB. Output power 200-250v.A.C. mains. 200-250v.A.C. mains. 100% solid state construction.

LOW FREQUENCY RESPONSE 15,000 C.E. CROSS TALK 75 d.B.

RECORD PLAYING UNITS

Money saving units. Mounted on Plinth. Suitable for Teak or Afromosia transparent plastic cover Ready to plug into Amplifier or Tape recorder.

R.P.C. Garrard SP25 Mk II (with heavy turntable fatted Goldring CS90 high compliance ceramic or magnetic cartridge with diamond stylus. 20Gns.

Moving coil units, cut for Garrard GCS 23 Stereo Cartridge with diamond tip inc. 15Gns.

EXTREMELY ATTRACTIVE PLINTHS finished in Teak or Afromosia veneer cover.

INTEREST CHARGES

On Credit Sales settled in 3 months. 12% Gns.

R.S.C. PLINTHS

For Record Playing unit, cut for Garrard GCS 25. For Garrard SP25 Mk II, cut for Garrard GCS 25. 9 Gns.

HARDCORE TVM PLINTHS finished in Teak or Afromosia veneer cover.
THE " YORK " HIGH FIDELITY 3 SPEAKER SYSTEM

* Moderate size, only 25 x 14 x 10". Complete Kit 20 Gns.

R.S.C. 300-500 WATT ULTRA LINEAR HI-FI AMPLIFIER

Tone Control Stages. Performance figures of factory built unit in line with R.C.A. test. 15 60/4000 at 4 ohms. No 6.3 v. 100mA. Sectionally wound output transformer. All high grade components. Separate Bass and Treble controls. Sensitive input stages. Suitable for hi-fi recording, phonographs, 78s. Mains filter. 230/240v. with cast enamelled PCB. Complete kit of parts with detailed instructions and circuit. Carr. 12/6. 25 x 15 x 20". Deposit 16.3.0


TYPE 248 35-50 WATTS. Fitted four inch, high flux 8 watts speakers. Overall size approx. 62 x 8.2 x 11.6" With excellent low frequency response. Jet black. Two units per box. Price 69/9. " IMPORTANT: BANK HOLIDAY 1966, Thursday, May 26th." For 15 gns. each. 100's of component bargains from our easy to see and choose from self-service racks.


TYPE C48S 25/30 WATTS. Fitted four inch, high flux 8 watts speakers. Overall size approx. 62 x 8.2 x 11.6" With excellent low frequency response. Jet black. Two units per box. Price 69/9. " IMPORTANT: BANK HOLIDAY 1966, Thursday, May 26th." For 15 gns. each. 100's of component bargains from our easy to see and choose from self-service racks.

30 WATT HI-FI AMPLIFIER

For Guitar, Vocal or Instrumental Group. 5 watts. 3600 ohms input, 2 vol. con. output unit with Separate Bass and Treble controls. Output for Radio, Tape, Phonograph, Gramophone, etc.

ULTRA LINEAR OUTPUT (Bridged) 200-250v. 50c/s. Best of both worlds. 250W, 1000 ohms. Designed for Hi-Fi and ULTRA LINEAR OUTPUT (Bridged) 200-250v. 50c/s. Best of both worlds. 250W, 1000 ohms. Designed for Hi-Fi and Powerful S.A.E. for leaflet. Deposit 15, or assembled 15 Gns.

High QualityLOUDSPEAKERS

In Task or Aforemnia veneered Cabinets. 11.13" x 8" x 10". 20 Gns. each.

Jacks: 7.19. 12/6. 20 Gns. each.


F.A.L. ' Phase Fifty ' PUBLIC ADDRESS AMPLIFIER

Solid State Circuits. 50 Wats Peak Output. 1 separately controlled inputs for mixing purposes. Separate Bass and Treble controls. Output for Radio, Tape, Phonograph, Gramophone, etc.

' POP ' 100 Watt 15" 60 W 125 Watt 10 Gns. 7.25. 50 Gns. each.


Power Pack Kit

Constituting of Mains transformer, Metal Rectifier, Electrolytics, smoothing choke, chassis and circuit. 200/250v. A.C. mains. Output 250v. 60mA. 2a. Supplied with case in tinsel clutch 32/11, London's highest quality sectionally wound valves. Suitable for Dynamic, Ribbon or Crystal Mikes, for Clubs, Theatres. Restaurants. Hotels, schools, etc. For Vocal or only Carr., free.

 transistorised type.

Suitable for: " POP ' 100 Watt 15" 60 W 125 Watt 10 Gns. 7.25. 50 Gns. each.


Power Pack Kit

Constituting of Mains transformer, Metal Rectifier, Electrolytics, smoothing choke, chassis and circuit. 200/250v. A.C. mains. Output 250v. 60mA. 2a. Supplied with case in tinsel clutch 32/11, London's highest quality sectionally wound valves. Suitable for Dynamic, Ribbon or Crystal Mikes, for Clubs, Theatres. Restaurants. Hotels, schools, etc. For Vocal or only Carr., free.

Mini-8 Hi-Fi Loudspeaker Units Special Offer

Peak power handling watts 8-3.0 ohms. Inc. Carr. 69/11.
 Packet 254n 10A47 AA119 'AAY1 BCY182L ASY28 ASY27 BFY51 BCY71 BC214L
ACY40 13/5 ACY18

This unit ADD G.E. type DISTI
Mallard type

RCA type
RCA type
RCA type
G.E. type

2.00 p.m. SAE with enquiries. CALLERS WELCOME. Open 9.00 a.m.

Component Catalogue 2/ Post Free (U.K. Only)

Components Catalogue 2/- Post Free (U.K.)

To: B.I.E.T. Dept. 371B, Aldermaston Court, Berkshire.

I would like to know more about your Practical Radio & Electronics Course. Please send me full details and FREE 164-page book.

name
address

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY
Dept. 371B, Aldermaston Court, Aldermaston, Berkshire.

164 pages FREE!

Now! A Fast Easy Way to Learn Basic Radio and Electronics

Build as you learn with the exciting new TEKNATRON Outfit! No mathematics.
No soldering—but you learn the practical way.

Now you can learn basic Radio and Electronics at home—the fast, modern way. You can give yourself the essential technical 'know-how' sooner than you would have thought possible—read circuits, assemble standard components, experiment, build... and enjoy every moment of it. B.I.E.T.'s Simplified Study Method and the remarkable new TEKNATRON Self-Build Outfit take the mystery out of the subject—make learning easy and interesting.

Even if you don't know the first thing about Radio now, you'll build your own Radio set within a month or so!

and what's more, YOU'LL UNDERSTAND EXACTLY WHAT YOU ARE DOING. The Technatron Outfit contains everything you need, from tools to transistors... even a versatile Multimeter which we teach you how to use. You need only a little of your spare time, the cost is surprisingly low and the fee may be paid by convenient monthly instalments. You can use the equipment again and again—and it remains your own property.

You LEARN—but it's as fascinating as a hobby. Among many other interesting experiments, the Radio set you build—and it's a good one—is really a bonus; this is first and last a teaching course. But the training is as rewarding and interesting as any hobby. It could be the springboard for a career in Radio and Electronics or provide a great new, spare-time interest.

A 14-year-old could understand and benefit from this Course—but it teaches the real thing. Bite-size lessons—wonderfully clear and easy to understand, practical projects from a burglar-alarm to a sophisticated Radio set... here's your chance to master basic Radio and Electronics, even if you think you're a 'non-technical' type. And, if you want to carry on to more advanced work, B.I.E.T. has a fine range of Courses up to A.M.I.E.E. and City and Guilds standards.

Send now for free, 164-page book.
Like to know more about this intriguing new way to learn Radio and Electronics? Fill in the coupon and post it today. We'll send you full details and a 164-page book:
ENGINEERING OPPORTUNITIES—Free and without any obligation.
NEW! roamer eight mkI
WITH VARIABLE TONE CONTROL


Total building costs £6.19.6

Parts Price List and Easy Build Plans 5/- (FREE with parts).

NEW! trans eight
SIX WAVEBAND PORTABLE WITH 3in. SPEAKER

Attractive case in black with red grille and cream knobs and dial with polished brass inserts. Size 6 x 4 x 1½ in. approx. Tunable on Medium and Long Waves, three Short Waves and Trawler Band. Sensitive ferrite rod aerial for M.W. and L.W. Telescopic aerial for Short Waves. Eight improved type transistors plus 3 diodes. Push pull output. Ample power to drive a larger speaker. Parts price list and easy build plans 5/- (FREE with parts). Earpiece with switched socket for private listening 5/- extra.

Total building costs 89/6

roamer seven mkIV
SEVEN FULLY TUNABLE WAVEBANDS: MW1, MW2, LW, SW1, SW2, SW3 and Trawler Band. Built-in Ferrite Rod Aerial for Medium and Long Waves. Five sections 22in. chrome plated telescopic aerial for Short Waves can be angled and rotated for peak SW listening. Socket for ear aerial. Powerful push pull output. Seven transistors and 2 diodes including Micro-Alloy H.P. Transistors. Famous make. 7 x 4½ in. P.M. speaker.

Total building costs £5.19.6

pocket five
MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE
WITH SPEAKER AND EARPIECE

Attractive black and gold case. Size 6 x 4 x 1½ in. Tunable over both Mediums and Long Waves with extended M.W. band for easier tuning of Luxembourg, etc. 7 stages—5 transistors and 2 diodes, supersensitive ferrite rod aerial, 5x tone change switch. Telescopic aerial for Short Waves. Six transistors with switched socket for private listening. Easy to build plans and parts price list 1/6 (FREE with parts).

Total building costs 44/6

transona five
MEDIUM WAVE, LONG WAVE AND TRAWLER BAND PORTABLE
WITH SPEAKER AND EARPIECE

Attractive case with red speaker grille. Size 6 x 4 x 1½ in. 7 stages—5 transistors and 2 diodes, ferrite rod aerial, tuning condenser, volume control, fine tone moving coil speaker. Size 22 in. Earpiece with switched socket for private listening. Easy to build plan and parts price list 1/- (FREE with parts).

Total building costs 47/6

roamer six
SIX WAVEBAND PORTABLE
WITH 3in. SPEAKER

Attractive case with gill fittings. Size 6 x 4½ x 1½ in. Tunable on Medium and Long Waves, two Short Waves. Trawler Band. Plus an extra M.W. band for easier tuning of Luxembourg, etc. Six transistors and 2 diodes, supersensitive ferrite rod aerial and telescopic aerial for Short Waves, 8 stages—5 transistors and 2 diodes including Micro-Alloy H.P. Transistors etc. (Carrying strap 1/- extra. Easy to build plans and parts price list 1/6 (FREE with parts).

Total building costs 79/6

* Callers side entrance Stylo Shoe Shop
* Open 10-1, 2.30-4.30 Mon-Fri, 9-12 Sat

Address: PW14

RADIO EXCHANGE CO

61 HIGH STREET, BEDFORD. Tel. 0234 52367

I enclose £.......................... please send items marked

ROAMER EIGHT  □  ROAMER SEVEN  □
TRANSONA FIVE  □  TRANS EIGHT  □
POCKET FIVE  □  ROAMER SIX  □

Parts price list and plans for

Name ...........................................................................................................

Address .....................................................................................................

745
CAR LIGHT FLASHERS

Heavy duty light for a continuously discharge 500 mA, suitable for tropical use.

CARR. 7/6

TRIO JL 310 New Amateur Band 10-80 Metres in stock. £46.12.0

CLASS D WAVEMETERS

A crystal controlled instrument.

Carr. 7/6

TRIO COMMUNICATION RECEIVER MODEL SB-92 DE

A band receiver 600 Kc. to 30 Mc. Operates on 6 volts D.C. Elned for amateur use. Available in two useful conditions. £21.15.6. Carr. 7/6

TRIO JSR 8000E 10-80 Metre Receiver £26.10.0

LAFAYETTE SOLID STATE FM RECEIVER

A completely new transistorised receiver covering 150-174 Mc. Fully tunable or crystal controlled (not supplied) for fixed frequency operation. Incorporates 4 INTEGRATED CIRCUITS. Built in speaker and illuminating diodes. Squelch and volume control. Tape recorder output. Operation 240-supply. £41.10.0. Carr. 4.

TELETON MODEL CR-10 AM/FM STEREO TUNER AMPERIFIER

A new model from Teleton. 31 solid state devices. 4+4 watt output. Input for ceramic or crystal control. Frequency range AM 540-1600 kHz. FM 88-108 MHz. £59.10.0. Carr. 5.

CLEAR PLASTIC PANEL METERS

First grade quality Moving Coil panel meters. Type MB 3SP, 1" x 1" square fronts. 100A, 200A, 300A, 500A, 1000A.

Amperemeter Model 8

100A, 200A, 300A, 500A, 1000A.

5mA, 10mA

200V, 1000V, 1000V.

10μA, 100μA

200V, 300V, 500V, 1000V.

1μA, 1mA

10mA, 20mA, 30mA, 50mA.

5μA, 10μA

200V, 500V, 1000V.

1mA, 2mA

500V, 1000V.

10mA

500V, 1000V.

100mA

500V, 1000V.

500mA

1000V.

1A, 2A

1000V.

10A

1000V.

100A

1000V.

Full range of other sizes in stock. Send S.A.E. for leaflet

CRYSTAL CALIBRATORS NO. 10

Small portable crystal wavemeter. Size 2 1/2 x 4 1/4 x 3/8 in. Frequency range 300 Kc. to 10 Mcs. (up to 30 Mcs on higher quality unit). Calibrated dial. Suitable for all service requirements. £34.12.0. D.C.G. 0.2. Carr. 4.

SOLARTRON CD. 711S.2 OSCILLOSCOPES


TE-40 HIGH SENSITIVITY A.C. VOLTMETER

10 meg. input range. Output 500 V or 0.5 V. £45. Carr. 12.

LELAND MODEL 27 BEAT FREQUENCY OSCILLOGRAPH

Frequency 30-300 Kc. on 2 ranges. Output 300 V or 0.5 V. $45.00. Carr. 12.

COSSOR 1049 DOUBLE BEAM OSCILLOGRAPH


AM/FM SIGNAL GENERATORS

Oscillator Test No. 9. A high quality precision instrument made for the amateur. Frequency coverage 50-300 Kc. £15.0. Carr. 2.

FIELD TELEPHONES TYPE L

Generator/Regulating, metal cases. Operates from two 12V batteries. Excellent condition. £4.10.0 per pair. Carr. 12.

AUTO TRANSFORMERS

0.1/1500V. Step up or step down. Fully adjustable. £3.15.0. Carr. 2.

G. W. SMITH & CO (RADIO) LTD. Also see opp. page
**GARRARD**

**LATEST CATALOGUE**

SEND NOW—ONLY 7/6

**GARRARD**

FULL CURRENT RANGE OFFERED BRAND NEW AND AT FANTASTIC SAVINGS

- **9025 Stereo** £17.99
  - **9025/1C** £12.10
  - **Monoprice Stereo** £17.19
  - **9025M Stereo** £11.99

Carriage insurance 7/6 extra any model. WB Bases £3.19. *Special offer base and cover available for these models at £18.5. Carr. 5/- Full range of GARRARD accessories available.

**TRANSPORTER FM TUNER**

HIGH QUALITY TUNER £19.99

- **Only 6 x 4 in.**
  - **Outline** 6 x 4 in.
  - **Carr. 5/-
  - **Carr. 5/-

**TRANSPORTER TWO-WAY TELEPHONE INTERCOM**


**SICLAIN EQUIPMENT**

- **Z10 amplifier** £9.6
  - **P27 Power Supply Unit** £19.99
  - **P27 Power Supply** £17.99
  - **Stereo 60 Preamp. £59.19.6**
  - **Q8 Stockers £19.19.6**
  - **Microtransistor Radio Kit**
  - **Now in Stock**
  - **IC amplifier £19.19.6**
  - **SPECIAL OFFER** Two £20 Amplifiers £40. Power Supply Stereo 60 Preamp. £22.

**NEW SINCLAIR 2000 SYSTEM**

- **25 in. 10.9. Carr. 5/- Self-powered FM Tuner. £28.9. Carr. 5/-

**ECHO HS-085 STEREO HEADPHONES**

- **Fantastic quality and strength.**
  - **Warranty-Adjustable Light-weight.**
  - **Weight adjustable.**
  - **Light-weight.**
  - **Weight adjustable.**
  - **Weight adjustable.**

**RAGAL MA-158 TRANSPORTER DIVERSITY SWITCH**

Brand new condition. £15. Carr. 10/-

**TELEVISION ATTENTION**

- **TV 111. DECADE RESISTANCE**
  - **Variable range 0—150K in steps.**
  - **Unbalanced T and Bridge T. Impedance 500 K in steps 0—1000 K.**
  - **P. & P. 5/-

**RECORDING HEADS**

- **COMCORRO HEADS.**
  - **Head compressor.**
  - **Head compressor.**
  - **Head compressor.**
  - **Head compressor.**

**MAXELL TAPE CASSETTES**

- **C20, C40, C80, C120, C160, C180.**
  - **Post extra.**

**AMERICAN TAPE**

- **First grade quality American tape.**
  - **Brand new quality American tape.**
  - **Price £1.00.**
  - **Price £1.00.**

**MAXWELL TAPE CASSETTES**

- **C20, C40, C80, C120, C160, C180.**
  - **Post extra.**

---

**TRANSPORTER TWO-WAY TELEPHONE INTERCOM**


**ECHO HS-085 STEREO HEADPHONES**

- **Fantastic quality and strength.**
  - **Warranty-Adjustable Light-weight.**
  - **Weight adjustable.**
  - **Weight adjustable.**

**RAGAL MA-158 TRANSPORTER DIVERSITY SWITCH**

Brand new condition. £15. Carr. 10/-

**TELEVISION ATTENTION**

- **TV 111. DECADE RESISTANCE**
  - **Variable range 0—150K in steps.**
  - **Unbalanced T and Bridge T. Impedance 500 K in steps 0—1000 K.**
  - **P. & P. 5/-

**RECORDING HEADS**

- **COMCORRO HEADS.**
  - **Head compressor.**
  - **Head compressor.**
  - **Head compressor.**
  - **Head compressor.**

**MAXELL TAPE CASSETTES**

- **C20, C40, C80, C120, C160, C180.**
  - **Post extra.**

**AMERICAN TAPE**

- **First grade quality American tape.**
  - **Brand new quality American tape.**
  - **Price £1.00.**
  - **Price £1.00.**

**MAXWELL TAPE CASSETTES**

- **C20, C40, C80, C120, C160, C180.**
  - **Post extra.**
PERSONAL CALLERS WELCOME
Open 9-12.30, 1.30-5.30 p.m. Thursday 9-1 p.m.

MANY OTHERS IN STOCK Include Colodem Ray Tubes and Special Valves. U.K. Orders up to 10/-, 1/- off to 110, 5/- off over 110, 5/- per 61, over 15 post free. C.O.D. 4% extra.

TRANSISTORS, ZENER DIODES etc.

All valves guaranteed

P. C. RADIO LTD.
170 GOLDHAWK RD., W.12
(01) 743 4946

FULLY TESTED AND MARKED

NEW UNMARKED UNTESTED PAKS

NEW TESTED AND GUARANTEED PAKS

ALL OVERSEAS ENQUIRIES AND ORDERS
Colomem (Electronics) Ltd.
170 GOLDHAWK ROAD, LONDON W12.
Tel.: 01-743 4946

UNBEATABLE P.1. PAK.

FULLY TESTED AND MARKED

RETURN OF THE UNBEATABLE P.1. PAK.
NOW GREATER VALUE THAN EVER

Full of short lead semiconductors and electronic components, U.K. We guarantee at least 90% high quality factory marked Transistors (PNP and NPN) and all types of diodes and rectifiers. Mounted on printed circuit panels. Identification chart supplied to give some information on the Valves.
P1 PLEASE ASK FOR PAK. P.1. P. P. P on this Pak.

ONLY 10/-

RETURN OF THE UNBEATABLE P.1. PAK.
NOW GREATER VALUE THAN EVER

Full of short lead semiconductors and electronic components, U.K. We guarantee at least 90% high quality factory marked Transistors (PNP and NPN) and all types of diodes and rectifiers. Mounted on printed circuit panels. Identification chart supplied to give some information on the Valves.
P1 PLEASE ASK FOR PAK. P.1. P. P. P on this Pak.

ONLY 10/-

SEND FOR OUR FREE LIST AND CATALOGUE OF ALL OUR TRANISTORS AND SPECIAL VALVES. EQUIVALENT WITH OUR FREE SUBSTITUTION CHART.

SEND FOR OUR FREE LIST AND CATALOGUE OF ALL OUR TRANISTORS AND SPECIAL VALVES. EQUIVALENT WITH OUR FREE SUBSTITUTION CHART.

P.O. RELAYS

Mixed contacts and coil resistances.

post & packing 5/-

ALL OUR TESTED SEMICONDUCTORS HAVE A WRITTEN GUARANTEE

NO CONNECTION WITH ANY OTHER FIRM.

MINIMUM ORDER 10/-.

PLEASE ADD 1/- post and packing per order OVER-SEAS ADD EXTRA FOR AIRMAIL.
Everything brand new and to specification • Large stocks • Good service

RESISTORS:

<table>
<thead>
<tr>
<th>Code</th>
<th>Power</th>
<th>Tolerance</th>
<th>Range</th>
<th>Values</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1/2W</td>
<td>5%</td>
<td>100Ω-220Ω</td>
<td>E12</td>
<td>18</td>
</tr>
<tr>
<td>W</td>
<td>1/2W</td>
<td>5%</td>
<td>472Ω-1MΩ</td>
<td>E12</td>
<td>2.5</td>
</tr>
<tr>
<td>C</td>
<td>1W</td>
<td>2%</td>
<td>100Ω-2MΩ</td>
<td>E12</td>
<td>2.1</td>
</tr>
<tr>
<td>MO</td>
<td>2W</td>
<td>2%</td>
<td>100Ω-2MΩ</td>
<td>E12</td>
<td>2.1</td>
</tr>
<tr>
<td>WW</td>
<td>1W</td>
<td>10%</td>
<td>10Ω-120Ω</td>
<td>E12</td>
<td>2.1</td>
</tr>
<tr>
<td>WW</td>
<td>3W</td>
<td>10%</td>
<td>10Ω-120Ω</td>
<td>E12</td>
<td>2.1</td>
</tr>
<tr>
<td>WW</td>
<td>5W</td>
<td>10%</td>
<td>10Ω-120Ω</td>
<td>E12</td>
<td>2.1</td>
</tr>
</tbody>
</table>


Covlers 3 Watt Wire-Wound Potentiometers:

<table>
<thead>
<tr>
<th>Values</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>100Ω</td>
<td>1/6 each</td>
</tr>
<tr>
<td>150Ω</td>
<td>1/6 each</td>
</tr>
<tr>
<td>250Ω</td>
<td>1/6 each</td>
</tr>
<tr>
<td>500Ω</td>
<td>1/6 each</td>
</tr>
<tr>
<td>1KΩ</td>
<td>1/6 each</td>
</tr>
<tr>
<td>1.5KΩ</td>
<td>1/6 each</td>
</tr>
<tr>
<td>2.5KΩ</td>
<td>1/6 each</td>
</tr>
<tr>
<td>5KΩ</td>
<td>1/6 each</td>
</tr>
<tr>
<td>10KΩ</td>
<td>1/6 each</td>
</tr>
<tr>
<td>15KΩ</td>
<td>1/6 each</td>
</tr>
<tr>
<td>25KΩ</td>
<td>1/6 each</td>
</tr>
</tbody>
</table>

Complete unregulated power supply kit £6/11/0. (See separate list.)

Sinclair IC 10 Integrated Circuits Amplifier and Pre-amplifier:

- Easy to use.
- Low cost.
- Low distortion.
- Excellent quality.

Carbon Track Potentiometers: Double wiper ensures minimum noise level. Long plastic

<table>
<thead>
<tr>
<th>Values</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>22Ω</td>
<td>2/6 each</td>
</tr>
<tr>
<td>1KΩ</td>
<td>1/6 each</td>
</tr>
<tr>
<td>10KΩ</td>
<td>1/6 each</td>
</tr>
</tbody>
</table>

New Plessey Integrated Circuit Power Amplifier:

- Type: ST-5492A.
- 511-channel. Operates with 15V power supply.
- Sensitivity: 20 mV into 20Ω.
- Applications: General purpose. 90% of total resistors.

Carbon Skeletons Pre-sets:

- Single-use.
- Double-use.
- Small high quality.

Press for each unit.

BARGAINS in NEW TRANSISTORS

All power types supplied with free insulating sets.

<table>
<thead>
<tr>
<th>Values</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2N5458</td>
<td>6/9 each</td>
</tr>
<tr>
<td>2N3904</td>
<td>8/9 each</td>
</tr>
<tr>
<td>2N3708</td>
<td>3/9 each</td>
</tr>
<tr>
<td>2N5195</td>
<td>9/9 each</td>
</tr>
<tr>
<td>2N5194</td>
<td>10/9 each</td>
</tr>
<tr>
<td>2N5193</td>
<td>11/9 each</td>
</tr>
<tr>
<td>2N5192</td>
<td>12/9 each</td>
</tr>
</tbody>
</table>

Main Line Amplifier Kits advertised. Prices Net. Authorised dealer.

Component Discounts:
- 10% on orders for components for £5 or more.
- 15% on orders for components for £15 or more.

Postage and Packaging:
Free on orders over £2.
Please add 1/10 of order under £2. Overseas orders welcome: carriage charged at cost.
IF YOU HAVE

A HOME RADIO CATALOGUE

Ordering components is easier and quicker with our new

Credit Account Service

Our aim in life at Home Radio Components Ltd. is to make your life happier and less complicated! To this end we have recently introduced a Credit Account Service, one advantage of which is that you can order components by telephone any time, any day. If you phone out of shop hours a recording machine will take your message for us to deal with as soon as we open shop next day.

There are other advantages to the new Service—if you want to order by post we provide Order Forms and Prepaid Envelopes. You settle your account just once per month. We stipulate no minimum order value. Of course for ordering your components you first need our Catalogue, and after you have been in the Service 12 months we regularly send you an up-to-date catalogue—FREE!

For full details of our Credit Account service just drop us a line or phone 01-648 8422.

IF YOU HAVEN'T...

Whether or not you want to use the Credit Account Service described above, you certainly need the Home Radio Components Catalogue if you construct or repair radio and electronic gadgets. The catalogue has 350 pages, lists 8000 components and has over 1500 illustrations. It contains 6 vouchers, each worth 1/- when used as indicated. Post the coupon with 12/- (8/6 plus 3/6 postage and packing) and we will send a catalogue by return of post. By the way, we supply free a 30-page Price Supplement and a Bookmark giving electronic abbreviations.

Please write your Name and Address in block capitals

NAME ...........................................................................
ADDRESS .....................................................................
.....................................................................................
.....................................................................................
HOME RADIO (Components) LTD., Dept. PW,
234-240 London Road, Mitcham, Surrey CR4 3HD
TOPIC OF THE MONTH

The point is...

For as long as we can remember, Practical Wireless has offered a readers' postal query service. In a measure, of course, we are obliged, at least morally, to do all we can within reason to help out readers with problems relating to articles and projects which have been published in these pages. Nothing in this world is perfect, however; sometimes readers think we fall short of their ideal and sometimes we feel that readers expect too much. It might be helpful to consider what is involved, especially to newer readers.

First of all, cost. Even if a reader submits a query strictly to the rules, enclosing a prepaid envelope plus a query coupon, it can cost several shillings to process a reply, taking into account all the time and expenses involved. In fact, to answer a query costs us more than we get from the sale of a magazine! This is why we cannot guarantee a reply if the rules are broken.

Secondly, the time factor. Many queries can be dealt with immediately. Others involve a good deal of research, which may mean telephone calls and letters to manufacturers, etc. Also, in order to provide the best possible service, many queries are dealt with by a panel of outside specialists.

Thirdly, feasibility. We cannot be held responsible for poor workmanship!

Fourthly, terms of reference. Don't write asking for formulae or valve and transistor characteristics that can be obtained from standard data books; don't ask us to modify a P.W. design to suit a personal requirement. Of course, we cannot undertake to run a free professional advisory and design service.

Fifthly, procedure. All queries should conform to the rules: i.e., query coupon, SAE, etc. We regret that technical queries cannot be answered over the telephone.

Sixthly, period of validity. We cannot guarantee to answer queries relating to projects published more than two years ago.

We are constantly trying to improve the turn around in readers' queries, but the sheer volume often endangers the aims to provide a quick and effective advice service. We are fully conscious of the help often needed and we will continue to do everything possible to sort out the difficulties. All we ask in return is that readers try to appreciate just how much is involved in running a free query service.

W. N. STEVENS—Editor.
**First London rally**

We hear from Mr. A. P. Teale, G3SGT, the Hon. Sec. of the Ealing and District Amateur Radio Society, G3UUP, that the Society will be holding a Mobile Rally at the Hanwell Community Association on May 10th, 1970.

It is thought that this will be the first time a rally has been held in London and it is hoped that it will prove to be a large and successful one with attendance figures in excess of 500.

The Automobile Association will do the signposting (15 signposts in all) and have their own exhibition caravan at the sight. In the main hall there will be many other trade stalls. The Rally address will be: Hanwell Community Association, Westcott Crescent, Hanwell, London, W.7. Further details may be obtained by sending a s.a.e. to Bill Teale, G3SGT, 16 Whitestile Road, Brentford, Middlesex.

**Low pass filters**

Lionmount & Co. Ltd., are now manufacturing Low Pass Active Filters which can be varied continuously throughout the passband.

Two types are available, one of which covers the range 1kHz to 10kHz in one band—the other being a switched-band version covering the frequency range of 1Hz-10kHz in four switched bands. The designs are based on 9th order Butterworth or Chebyshev configuration and can realise 80 dB/decade attenuation at cut off.

The filters will accept an input voltage of ±10V. peak and may be loaded with a minimum of 2000 ohms. Lionmount & Co. Ltd., Bellevue Road, New Southgate, London, N.11.

**Interlocking boxes**

Liden Products (Whitewood) Ltd. introduce their storage boxes which interlock with each other. By sliding these in and out numerous permutations can be made. The all-round grooving allows for several boxes to be joined up. The boxes are provided with holes at the back for wall fixing; a slot in the front for inserting identification labels and removable plastic divider in each box. They are available in grey or white.

The measurements are: 2½ x 4½in. and the width for the large box is 4in. Small boxes cost 2s. 6d. and large boxes 4s. 6d.

**The Gunn effect**

An article on Gunn effect devices and their applications, originally published in Mullard Technical Communications, is now available as a pamphlet.

It contains an explanation of the Gunn effect, describes the construction of the device and gives advice on the design of oscillator cavities for Gunn devices. Factors affecting stability are discussed and information is given on noise, frequency locking and pulsed operation.

Requests for the pamphlet should be made on company-headed notepaper to I.E.D./Valves Sales, Mullard Limited, Mullard House, Torrington Place, London, W.C.1.

**Pathfinder radio group**

We have been informed by the organiser of the Pathfinder Radio Group, Mr. Lex-Arnold, that the Group is temporarily inactive due to reorganisation. Membership applications will be dealt with as and when the Group is re-formed.

**The sound of Eumig**

Eumig have announced the Mark S 712D projector which takes Super-8, single and standard-8 sound films, has an f.1.6 15/27mm zoom lens, and costs only £110 15s. 5d.

There is a combined record and playback amplifier with an integrated circuit (the first time that i.e.'s have been used in an amateur sound movie projector). Amplifier line-up is: type TAA 310 i.e., two 2N5172 transistors, two BC148B transistors, a complementary pair AC187K/188K, two DAX13 diodes, one MV1 varistor, a B832001P/130E thermistor and a type BY164 silicon bridge rectifier.

The frequency range on edge-striped film is 80-8,000Hz at 18 frames per second and 75-10,000Hz at 24 f.p.s. Signal to noise ratio is 40dB.

![The Eumig S 712D. Below, viewed from the back, the amplifier is seen mounted under the central flywheel.](image-url)
How your cassettes are recorded

Fraser-Peacock Ltd., announce that they have been appointed sole distributors for the Infonics range of high-speed tape duplicating equipment.

As well as reel-to-reel equipment, a new reel-to-Philips cassette duplicator is now available. The machine shown will make four 1-hour programmes (C60 cassette) in four minutes.

In addition to their reel-to-reel service, the company are now able to offer a high-speed cassette copying service. Fraser-Peacock Associates Ltd., 94 High Street, Wimbledon Village, London, S.W.19.

FET F.M. tuner

Tripletone announce their Solid State FET F.M. Tuner which uses a dual gate f.e.t., minimising drift and giving improved signal/noise performance. The outputs are fed via emitter followers.

The tuner can be supplied in mono form to which the decoder board can be plugged in at a later date. Price of the Stereo Mk. 2 F.M. Tuner is £37 19s. 10d. including PT complete with decoder. The mono version costs £31 9s. and the decoder unit separately is £8.

Both models are available without teak case at £35 1s. 3d. and £28 13s. 9d. respectively. The Tripletone Manufacturing Co. Ltd., 241a The Broadway, Wimbledon, S.W.19.

Mullard pocket data book

We hear from Mullard that stocks of their 1969 Pocket Data Book are now exhausted. It is regretted therefore that no further orders can be accepted. Preparations for the 1970 edition are, however, in hand and a further announcement will be made in due course.

V.H.F./F.M. reception on band II

With the announcement by the Minister of Posts and Telecommunications (G.P.O.) of the next twelve Local Broadcasting Stations, it is appropriate to draw attention to the need for suitable aerials and properly adjusted v.h.f. receivers.

The BBC recently completed an analysis of complaints of unsatisfactory v.h.f. reception received during 1968/69 and this shows that more than 50% of complaints were due to the use of inadequate aerials or to faulty or maladjusted receivers.

Class ‘B’ stereo

Welbrook Engineering and Electronics Ltd. have released two new stereo amplifiers both incorporating an entirely new design of output circuit.

For further details on the amplifiers, model W.30 priced at £52 and model W.20 priced at £42, contact Welbrook Engineering and Electronics Ltd., Brooks Street, Stockport, Cheshire, SK1 3HT.

Readers are cordially invited to the Practical Wireless and Practical Television Filmshow (in collaboration with Mullard Ltd.)

at Caxton Hall, Caxton Street, London, S.W.1 (Great Hall Site) on Friday 6th March, 1970

7-15 p.m. for 7-30 p.m.

W. N. Stevens, Editor Practical Wireless and Practical Television will be in the chair

The film this year is entitled “Something big in Microcircuits” and the principal speaker will be Mr. Ian Nicholson of Mullard Ltd.
IT is generally true that the more accurate a multi-

meter is, the larger it will be and the greater will

be its cost. For many home constructors both

space and money are severely limited, and they are

usually content to either buying or making a small,

cheap multimeter. The accuracy of such a meter is

limited partly by the short-scale length which limits

the reading accuracy, and partly because of the

limited number of ranges which are provided. This

latter failing means that many readings must be taken

near the zero end of the scale where the accuracy is

greatly reduced.

This article begins by discussing some of the

factors which limit the accuracy of a multimeter,

then describes a multimeter which reduces the effects

of these limitations by providing many more ranges

than usual but without using any non-standard

switches. The Microtest is both small and inexpen-
sive, but maintains a high standard of accuracy

comparable to instruments costing much more.

MULTIMETER ACCURACY

The most common measurement made by a multi-

meter is that of voltage, although the same sources

of error also affect the measurement of current. The

voltmeter is basically a high sensitivity current meter

in series with a high resistance, and there are five

sources of error associated with such an arrangement.

1. The voltmeter may draw current from the volt-

source it is required to measure, and this may

affect the voltage being measured. This situation can

best be improved by reducing the full scale current

required by the meter. It is normally difficult to ob-

tain meters more sensitive than 50μA f.s.d, and this

is the sensitivity that is used in the Microtest.

2. The meter scale on anything but the most

expensive meters is normally a mass-produced linear

scale, but unfortunately the actual meter deflection

may not be exactly linear, thus causing an error in

reading. This error is usually greatest at about centre

scale, but its magnitude is seldom quoted in advert-

issements for meters of the type intended for this

instrument. Its effect is normally lumped together

with the next source of error to give an overall

accuracy figure for the meter.

3. The meter required for the Microtest has a

nominal sensitivity of 50μA f.s.d., but unless the

meter is individually calibrated (and thus expensive),

its actual sensitivity will differ from the nominal

value. The magnitude of this error is normally given

so as to cover both the f.s.d. error and the non-

linearity error, and is typically about 2% of the

reading, although it is often quoted as the same per-

centage of the full-scale reading.

4. The most important source of error in a multi-
meter is the error involved in reading what the meter
deflection actually is, and this is the real limitation

on the smallness of a multimeter. A typical 2½ inch

square meter has a scale length of about 3 inches,

and with a fine knife-edge pointer it should be

possible to read the meter to within ±0.5μA, or 1%
f.s.d. The scale markings are normally so coarse that

any improvement on this would be difficult. It may

be thought that an error of 1% should hardly be
called "most important", and this would be true if
the error were to remain at a constant 1% over the

whole scale, but unfortunately this is not the case:
the error is a fixed 0.5μA at all points on the scale.

Most multimeters provide ranges which increase

in multiples of ten, such as 10V, 100V, 1000V etc. If

it were required to use such a meter to read a volt-
age of 101V, then this would have to be measured

on the 1000V scale, and the meter deflection would

be only about 10% full scale. When making this

reading our fixed error of 0.5μA causes an error of

no less than 10%, which is far from being unimport-

ant. If however the ranges were grouped closer

together so that it was never necessary to make a

reading at less than 25% full scale, then this error

is kept to the much more satisfactory level of 4%.

The ideal system would be to have the ranges

increasing in multiples of √10 each time, giving full

scale deflections of 1V, 3.16V, 10V, 31.6V, etc, and

a maximum error of about 3%, but unfortunately

meters with suitable scales are not generally available

in the price range required. However a reasonable

compromise can be made by having ranges of 1V,

2.5V, 10V, 25V, etc, where the maximum error is

4%. A scale divided into 100 equal divisions will
give easy reading on all ranges. To provide coverage

from 1V to 1000V f.s.d. using these scales would

normally require seven positions of the range switch,

and for a similar coverage of current ranges from

100μA to 2.5A would require a further ten positions.

Although it is not impossible to obtain eighteen way

switches, they are very expensive, and a much simpler

solution is possible. If ranges are provided on the

switch in the usual scale-of-ten series, and a separate
two way switch is used to change the meter sensi-
tivity to give the intermediate 25V ranges, then only

nine range positions are needed to give the required

coverage, leaving three other positions of a standard
twelve way switch for resistance ranges. This is the

method used in the Microtest to provide increased

accuracy for a given meter size, with fewer compo-
ments and reduced cost. The actual circuits used are described later.

5. The final source of error comes from the multiplier resistors themselves, and these are the components over which the constructor has the most control. These can be obtained to almost any required accuracy, and 1% resistors are the ones recommended for this circuit. A higher accuracy would greatly increase the cost without a great increase in meter accuracy, because of the other sources of error. If a somewhat lower performance is satisfactory then 2% resistors could be used instead. In order that the accuracy of the meter should not change with age, it is important that high stability resistors should be used throughout.

We have therefore three sources of error affecting the accuracy of our multimeter: a sensitivity error of 2%, a multiplier error of 1%, and a reading error of 0.5µA, which is at worst a 4% error. The maximum error should therefore not be greater than 7% at the worst case and 4% at the best. Fortunately, because these sources of error may be of differing signs the actual error is likely to be very much less than this, and it can be shown that a better estimate of the maximum error is given by taking the square root of the sum of the squares of the individual errors. This gives an error of 4.6% at the worst case and 2.5% at full scale, which is quite adequate for most construction and repair work.

As a comparison, if the accuracy of reading had been improved by doubling the scale length of the meter (and at least doubling its cost), and ranges were provided in the usual scale of ten, then the worst case accuracy would have been 5.5%. A ready built meter costing about £10 would not be expected to be better than about 3% accurate.

When a.c. voltages are being measured with a multimeter, the resistance of the bridge rectifier is in series with the multiplier, and this can cause additional errors on the low voltage ranges. On the Microtest, 1V and 2.5V a.c. ranges are provided with the intention that these be used only for indicating the presence of a small signal, not for making accurate measurements at these levels. The rectifier can cause gross non-linearity of the scales, and the maximum error on these ranges can easily be as high as 20%. Similar remarks would also apply to any other multimeter providing such ranges without the use of an amplifier. It is most important that this limitation is realised when using the Microtest.

THE CIRCUIT

The full circuit is shown in Fig. 1, and this will be studied in its separate functions.

Most of the circuitry is fairly standard, except for the two way switch associated with the meter which is used to change the sensitivity of the meter. With the switch in the x1 position the series and shunt resistors have no effect. If the meter is of 1000 ohms internal impedance (a typical value) the meter will read full scale when 50µA passes through it (voltage ranges) or when 50mV is applied across it (current ranges). When the switch is moved to the x2.5 position, a shunt is placed across the meter which reduces the sensitivity to 125µA f.s.d. The series resistor reduces the voltage sensitivity of the shunted meter to 125mV f.s.d. These two adjustments have the effect of multiplying the voltage or current required for full scale deflection on any range by 2.5. This function may be used on any voltage or current range provided by the meter, but not on the resistance ranges.

One small disadvantage of this feature should be pointed out here. When the Microtest is being used to measure a voltage on the x2.5 range, then the current drawn from the voltage source for full scale deflection will be 125µA, giving a sensitivity of only 8kΩ/V, compared to 20kΩ/V on the x1 range. If the source being measured is of a high internal impedance, then different readings would be obtained according to which range was being used for the measurement because of the different loadings imposed on the source. For most measurements this effect causes negligible error, but it is important to be aware that it can occur in certain cases.

The range switch S1 is a two-pole twelve-way switch and for most convenience in use it should be a type without a stop, to allow continuous rotation. A ceramic switch with silver plated contacts would be the best from the point of view of reliability, but a paxolin wafer switch costing only a few shillings can give many years good service before the contacts wear. Once again a compromise is necessary between cost and performance, and it is worth spending some time deciding just what sort of performance you
require from your Microtest, then spending accordingly.

S1b switches in the d.c. multiplier resistors and the appropriate batteries for the resistance ranges. S1a switches the shunts for the current ranges, and the multipliers for the a.c. voltage ranges and the ohms ranges. All the multipliers are standard values at 1% tolerance and little difficulty should be experienced in obtaining them. The a.c. voltage multipliers are chosen so that the meter reads r.m.s. voltage for a sine wave input: for other input waveforms the meter will read 1.11 times the average voltage.

The 1000V multipliers on the a.c. and d.c. ranges will have to withstand up to 2500V when the ×2.5 function is used. While this does not exceed the power rating of the resistors, it does exceed their voltage rating of about 750V. To get round this problem each of these multiplier resistors is made up from four separate resistors so as to divide the voltage load between them. Under no circumstances should fewer resistors be used, and even so, care must be taken when wiring up the Microtest to provide a good clearance between the high-voltage multipliers and the other components.

The bridge rectifier used in the original Microtest was a surplus unit advertised simply as a 50µA meter rectifier. Almost any meter rectifier will work in the circuit, but in order to keep the scale linear a metal oxide rectifier of the type intended for use at 50µA should be used. The leakage resistance of the bridge should be as high as possible or the meter sensitivity will be reduced. The addition of the bridge rectifier introduces an error of up to 2% on all a.c. voltage measurements.

The current ranges provided are of perfectly standard form, each range being obtained by a separate shunt. The resistance quoted for the shunts on the circuit are approximate values only, and are given for 1000 ohm meter. In practice the shunts have to be individually adjusted to give the required ranges, and this process is described in more detail below. A 50µA range was not provided on the original Microtest, 100µA being the most sensitive range. The reason for this was simply the lack of available positions on the range switch. If a 50µA range were considered essential, it could easily be provided, but only at the expense of, say, the 1A range.

Three resistance ranges are provided, these having 18Ω, 18kΩ and 180kΩ as the centre scale readings. These three ranges are adequate to cover the full range of preferred values of resistance, and to give reasonable indications down to 0.1Ω. Using standard 2% resistors for the resistance ranges will give an accuracy of between 5% and 10% over the useable portion of the scales, which is about as good as any other multimeter. For increased accuracy of measurement other techniques such as a bridge have to be employed. The accuracy of the resistance range is not greatly dependent upon the battery voltage, but these should be renewed as soon as their voltage begins to fall to prevent the possibility of their leaking into the case and damaging other components.

A few words about the choice of meter would not be amiss here, as this is the heart of the instrument. Within reason it is usually worth getting the most expensive meter you can afford, as its accuracy will increase with price. There would be little point in getting a meter bigger than about 4 inches square or the instrument would hardly warrant the Microtest; about 3 inches square would seem to be a reasonable compromise between cost and performance. The scale is best divided into 100 equal divisions, marked 0-10. A fine knife edge pointer will greatly increase the accuracy of reading the meter. The resistance scale may be either drawn directly onto the meter’s scale plate if great care is taken, or a calibration graph may be attached to the back of the Microtest. A graph suitable for either purpose is given in Fig. 2.

### CONSTRUCTION AND TESTING

The component layout of the Microtest is in no way critical, except that high current leads should be kept as short as possible to avoid unwanted voltage drops. Because the actual size and layout of the instrument will depend to a large extent on the meter chosen for the Microtest, no details are given of the cabinet construction or component layout. The prototype used a three inch square meter, and the whole instrument was built into a Formica box 4½”×3½”×1½” deep. Either the front or back of the instrument should be easily removable to enable the batteries to be changed when necessary.

All the multipliers and shunts are mounted directly onto the range switch to minimise their lead length. The shunt and series resistors used to change the meter sensitivity are mounted directly onto the multiplier switch, and the bridge rectifier is mounted on the a.c./d.c. switch. The batteries can be held in place by small sponge pads on the lid of the case. Contact is made to the 9V battery by a snap connector, and to the 1.5V battery by two small brass contacts fixed to the case. The “ohms-zero” control should preferably be a wire-wound control for reliability.

The Microtest should first be built omitting the current shunts and the ×2.5 multipliers. No provision is made in the circuit for accurately setting the voltage ranges, but if a high accuracy meter is available it is worth getting an estimate of the accuracy of the Microtest by comparing the readings of the two instruments when they are reading the same voltage. The accuracy should be within the limits stated in the first section. If such a comparison is not possible then it must be assumed that the error is zero when using the instrument.

The ×2.5 multiplier must now be added. Using
any convenient voltage source such as a twelve volt battery in series with a 50kΩ variable resistor, set the Microtest and the variable resistor until the meter reads full scale on the 10V range. The multiplier switch should be set to ×1. Now without altering any other components, select a resistor or a number of resistors so that when soldered directly across the meter terminals the reading drops from 10V to 4V.

While the meter is still set up reading 10V full scale the 100µA shunt can be prepared by the same technique. This time a resistor is required that will reduce the meter deflection to half scale (5V), and again this should be done as accurately as possible. When selected it should be wired directly onto the range switch in the correct position for the 100µA range. The series resistor of the ×2.5 multiplier can now be selected.

Connect a 9V battery, 100kΩ variable resistor and the Microtest set to read 100µA all in series, and adjust the variable resistor until the meter reads full scale. Now try a number of resistors in the multiplier position until one is found which gives a meter reading of 100µA in the ×1 position and 40µA in the ×2.5 position. This resistor may then be left in position, completing the setting up of the range multiplier. This will have a negligible effect on the accuracy of the voltage ranges.

There are two methods of adjusting the remaining current shunts. The simplest and most accurate method is to use a calibrated meter in series with the Microtest, then adjusting the appropriate shunt until the two instruments read exactly the same. All adjustments should be carried out at the current required to give full scale deflection of the Microtest. Great care must be taken to ensure that the full current is never passed through the meter except when the shunt is firmly soldered in place, or the meter will be severely, if not fatally, damaged. The 1A shunt should be made from wire no thinner than 22swg, or it will be burnt out when the 2.5A passes through it. The other shunts are not particularly critical as the currents involved are small. A few feet of thin copper wire should be sufficient for the 100mA shunt and two 10 ohm resistors in parallel form the basis of the 10mA shunt.

The alternative method of calibration is to use one range of the Microtest to set the current being used to calibrate the next range up. This method is not to be recommended if the first method is possible, because errors gradually creep in during the calibration, and the 1A range can easily be as much as 10% in error. A regulated supply of at least 30V in series with an appropriate value of variable resistor is used as the current source.

Initially the meter is set to read 250µA f.s.d, and the current adjusted to exactly this value. This setting should be continually checked during the next stage. Wire in an appropriate value resistor as a 1mA shunt, then turn to this range. With the multiplier switch set to ×1, adjust the 1mA shunt until the meter reads exactly 250µA. The 1mA range is now calibrated, and this range may now be used to set the reference current to 2.5mA, which is used in turn to calibrate the 10mA range. This process is repeated until all the shunts are correctly adjusted. It is then worth repeating the whole process to check the final accuracy. When using the meter it is important that all the ranges should agree with one another at the points where they overlap. When these shunts are finally set to your satisfaction, the Microtest is ready for use.

**components list**

### Resistors

<table>
<thead>
<tr>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1% high stability types</td>
<td>18kΩ, 20kΩ, 180kΩ, 200kΩ, 1.8MΩ, 2MΩ, 3.9MΩ, 4x4.7MΩ, 3x5.1MΩ.</td>
</tr>
<tr>
<td>2% high stability types</td>
<td>18Ω, 1.8kΩ, 150kΩ, 180kΩ.</td>
</tr>
<tr>
<td>High stability types selected for use as shunts</td>
<td>5Ω, 55Ω, 600Ω, 680Ω, 1kΩ.</td>
</tr>
<tr>
<td>Zero-ohms potentiometer, 50kΩ wirewound.</td>
<td></td>
</tr>
</tbody>
</table>

### Switches

- 2 pole 12 way rotary.
- 2 pole 2 way slide type.
- 1 pole 2 way slide type.

### Miscellaneous

- Batteries: 1.5V U16, 9V PP3; Rectifier: 50µA bridge meter type; Meter movement: 3in. square moving coil.

No meter will remain accurate for long if it is regularly overloaded: the needle will get bent and the coil will be damaged. To avoid such accidents with any multimeter always begin making a measurement with the meter set to the highest range, then working down. When making current measurements, do not change ranges while the meter has a high current flowing through it, as it is possible for the shunt to be disconnected for an instant as the switch is moved, and in that instant the meter may be damaged. Provided the Microtest is treated, like all other sensitive instruments, with care and respect, it will provide many years of useful service, repaying its cost many times over.
In January of 1968 Mullard introduced their TAD100 linear i.c. which was principally designed for use in medium and long wave portable receivers although the frequency response of the circuit was such that it could also be used as a 10.7MHz i.f. amplifier and audio preamp. in f.m. receivers. In addition to many of the passive components required in an ordinary radio set the circuit also incorporates all the active elements as far as the audio driver stage. Different output stages can therefore be chosen to suit individual requirements. This month's article describes how the TAD100 may be used in a m.w. receiver giving an audio output of about 500mW.

The complete receiver circuit is shown in Fig. 1. The first three transistors are used in the front end of the receiver with the first stage of the long-tailed pair transistors acting as an r.f. amplifier and the second stage as mixer. A separate transistor is used as the local oscillator with the oscillator signal injected at the base of Tr2 and the i.f. produced extracted at its collector. The block filter type LP1175 is the only selectivity element used to extract the 470kHz signal but it provides sufficient attenuation and bandwidth as three conventional i.f.t.'s.

Due to the emitter follower action of Tr4 and Tr5 the input impedance of the i.f. amplifier is very high and the three stages are arranged in a d.c. feedback circuit to the base of Tr3. Tr7 acts as the detector with the audio signal appearing across its emitter resistor and it also supplies the a.g.c. voltage for controlling the bias of Tr1.

Due to its stability and flexibility the differential amplifier or long-tailed pair arrangement forms the basic circuitry in most linear i.c.'s and previously it would have been economic madness to use extra discrete transistors the i.c. comes into its own. Even in the audio stages of the TAD100 this is evidenced with the use of four transistors in the preamp and driver stages. The audio signal from the volume control is applied to the base of Tr9 which is diode connected to the Darlington pair Tr10 and Tr11. Overall negative feedback of up to 20dB can very neatly be applied to the base of Tr8 thereby providing good stability under a wide range of operating conditions. The only two other active elements used in the set are the complementary output pair of transistors Tr12 and Tr13 and these are directly coupled to the i.c. driver stage and deliver 500mW into a 15 ohm speaker.

Continued on page 765
4! brings you a mountain of components at manufacturers' prices

The serious amateur should never be without this comprehensive price list and guide to semiconductors and electronic components from RCA, IR, SGS, Emihus, Semitron, Keyswitch, Plessey, Morganite, Litesold and others (together with manufacturers' application data) which you can buy direct from us at manufacturers' prices e.g. IN914 1/3d.

IN916 1/11d. 2N974 4/5d. 2N976 2/3d. 2N706A 2/9d. 2N929 5/8d.
2N1613 4/8d. 2N3011 9/1d. 2N3053 6/2d. 2N3055 15/9d. 3N140 15/3d.
BFY50 4/8d. BFY51 3/9d. BSY27 18/-
BSY95A 3/3d. C407 4/6d. CA3012 18/3d. CA3014 25/6d. CA3020 25/9d.
OA200 1/9d. OA202 1/11d.

Build the NEW Mainline Audio Amplifier kits - UP TO 70 WATTS

The result of the combined resources of SGS and RCA, these quasi circuits set new standards in quality and performance. Each kit is complete with circuit diagram, all semiconductors, resistors, capacitors and printed circuit board.

12A ........................................ £7.0.0.
25A ........................................ £8.5.0.
40A ........................................ £9.0.0.
70A ........................................ £10.10.0.

Any two will make an outstanding stereo equipment.

To: Mainline Electronics Limited, Thames Avenue, Windsor, Berkshire
I enclose 4/- Please send me your price list and guide
I am interested in Amp Mainline Audio Amplifier Kits. Please send me full data
I am interested in receiving data on preamplifier & power supply kits

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

(A member of the ECS Group of Companies)
THE cheap transistor radio can often pose something of a headache for the professional engineer. All repairs take time, and sometimes an elusive fault can take more time than a straightforward fault on a television receiver. The situation is aggravated by a lack of service information and spares where, as is more often than not, the radio is imported. A repair bill can result which is a large importation of the original cost of the set, and the owner naturally thinks he is being had.

Because of this, many dealers understandably refuse to accept these cheaper radios for repair. Amateur repairers not having to make their time pay may agree to have a go, often later to wish they had not!

In general, it is prudent to set a time limit of say a quarter of an hour and if the fault cannot be located in this time, the set should be returned to the owner as being beyond economic repair. This calls for quick, short-cut methods of diagnosis and repair, some of which may be frowned upon if used with conventional equipment, but which in many cases would be the only alternative to refusing the repair. We should add that these remarks do not apply to the better class transistor radio which is backed by spares service and technical information. These should, of course, be serviced in the normal way.

A common fault is for the receiver to be completely dead. While in theory a number of things could be responsible, in practice a few faults crop up with almost monotonous regularity, so these can be checked first.

Batteries that have been left in cause corrosion of the contacts which of course remains when the owner fits new batteries. Often the trouble is nothing more than poor battery contact due to this cause. The remedy is obvious.

Another very common source of trouble is the on/off switch. Generally an integral part of an edge-type volume control, they are impossible to repair economically and the only course is to fit a complete new control. Fortunately, the value of the volume control seems to be standardised at 5kΩ, and a number of component firms make controls that will fit. The main consideration is physical size, if too large it will jam in the case aperture, and if too small, will not reach far enough through. The disposition of the contacts may not line up with the original on the printed panel but this can usually be overcome by bending some of the contacts and soldering a section of copper wire to those that may not reach. A few controls have the switch mounted externally in which case a repair can often be made by adjusting the switch contacts.

A quick test can be made on both battery contacts and switch by taking a voltage reading at some convenient point on the print, from an earth point, say one of the coil screening cans to one of the tags on the output or driver transformer. This should show almost full battery voltage, if it is much less, there is a high resistance in series, possibly corroded battery contacts or faulty switch.

Correct voltage measured here means we must look further. Scratching the volume control terminals with the meter probe and the meter switched to the ohms range should produce crackling in the loudspeaker, and if so, suggests that the fault is in preceding stages. No crackling means trouble in driver or output circuit. Open-circuit loudspeaker speech coils are not at all uncommon, especially the higher impedances, so this is worth checking next; failing this, check earphone socket shorting contacts.

MECHANICAL DAMAGE

Often the radio has been subject to a fall and a frequent result is that the output or driver transformer is partly wrenched from its position in the print. A casual glance may not indicate this but sometimes one or more of the fine wires coming from the windings are broken away from their terminal posts. Whenever there is trouble in this end of the set, it is always worthwhile to make a visual examination of the transformers, especially the lead-out wires.

If the set is lively from the volume control onwards, flicking the waveband switch may produce clicks, which would suggest that the i.f. stages are working and that the mixer and r.f. stages should be investigated first. It is still possible for the i.f. stages to be at fault, but the odds are on the previous ones.

If the trouble appears in the first stage it is wise to check the connections to the ferrite aerial coils. The rod is not always rigidly mounted, and any mechanical shock could easily strain the fine wires from the coils to the print. In many cases these wires are left long enough by the makers to facilitate adjustment by sliding along the rod, but this slack may already be taken up by a previous alignment. Broken aerial wires are very common and can give rise to several faults. Complete lack of signals is one, where the broken lead is common to both wavebands or as is sometimes the case, where there are more than one broken. Often it leaves one waveband dead and sometimes produces a rather puzzling symptom of breakthrough from one band into the other. Thus the light programme on 1500 metres is superimposed on the BBC London or Welsh Home service.

A close look at the components mounted on the printed panel would not come amiss. Look for vertically mounted parts that are leaning over at an angle, suggesting they may have been forced and either damaged or pulled from their printed connection. Components mounted near the battery compartment are particularly prone to this sort of trouble by suffering from the attempts of a hand-handed owner to replace the batteries! A probe at any likely looking suspect with an insulated tool will confirm the suspicion.
The rough tests we have described followed by a visual check of the suspected part of the circuit will take just a matter of a few minutes. Many faults will come to light by this means. Remember that a large proportion of troubles with portable transistor radios are mechanical in origin.

Next, after these checks, the most likely possibilities to investigate are printed circuit faults or defective transistors. This is where the meter must be used again and voltage measurements taken. We will have already roughly isolated the section of the receiver in which the trouble lies, so now collector, base and emitter voltages of transistors within that section can be measured. If service information is not to hand, exact readings cannot be compared with correct figures, however in most cases defects can be quickly spotted.

Collector voltages are generally not less than about three-quarters of the battery voltage except in audio stages where the collector is directly coupled to the base of the following stage. Where two batteries or a tapped battery is used, the full voltage is often only applied to the output stage and perhaps the driver, the rest of the circuit being supplied from one battery or section.

Base and emitter voltages vary considerably according to the circuit from a few tenths of a volt to over one volt. The main thing is to compare the base voltage with the emitter. Assuming germanium p-n-p transistors, the base must be slightly more negative than the emitter, so a difference of one or two tenths of a volt should be measured. A higher base voltage could be due to an internal leak or an open-circuit bottom bleeder resistor to the base. A low base voltage could indicate an open-circuit top resistor. No emitter voltage is the result of an open-circuit transistor, unless of course the emitter has no series resistor. A high emitter and base voltage with a low collector voltage betrays excessive current due to internal leakage.

Some confusion can result when taking voltage readings as to which point to measure from, as some sets have positive earths and others negative. It is usually the most straightforward practice to ignore the earth and to clip the positive lead of the meter to the battery positive terminal taking all readings from there.

If a transistor appears to be at fault, it is not always necessary to remove it in order to try a replacement. This takes time, and more time is wasted re-fitting it if it is not the trouble, to say nothing of possible damage by soldering (it is usually impossible to use a heat sink). In most cases, just connect a substitute in parallel with the suspect on the print side of the board and without cutting the wires. If the set works, then the old one can be removed and the replacement fitted properly, if not, little time is wasted. The old one seems to have little effect on the working except where it is drawing excess current. In such case, just disconnect the collector wire.

Many imported sets use transistors with type numbers that mean little to the average engineer. An equivalent list is very handy if available. If not.
Wharfedale
Unit 3
build-it-yourself
high fidelity loudspeaker kit

A big success right from the word 'Go', the Wharfedale
Unit 3 kit gives you a genuine hi-fi speaker system at a
very low cost.
Thousands of satisfied buyers will confirm how simple it
is to build: assembly instructions are easy to follow, and
include plans of two different cabinets.

Each kit contains:
- 8" Speaker covering the bass and middle ranges.
- Wharfedale tweeter with Cellulose Acetate Butyrate
dome and plastic diffuser.
- Electrical cross-over unit.
- Acoustic wadding, wiring etc.

The bookshelf speaker you can build yourself

The Unit 3 kit can be built into two cabinet sizes: in the smaller cabinet the system gives faithful reproduction of all
musical sounds from 65—17,000 Hz; in the larger cabinet the range is increased from 40—17,000 Hz. Power handling
capacity 15 watts; impedance 4—8 ohms.

Recommended retail price, including purchase tax, only £10:19:6. Write for detailed leaflet, or see your dealer to-day.

RANK WHARFEDALE LIMITED, IDLE, BRADFORD, YORKSHIRE
### A SOLDER’S BEST FRIEND IS HIS GUN

From the Burgess All-electric Workshop: a light, balanced solder gun with a range of screw-in tips. The tips—and only the tips—heat up in 7 short seconds. Anti-thermal casing keeps the rest of the gun cool. Note the slim barrel—it reaches right down into confined spaces. There are spike-like extension barrels for real 'in-deep' work. A pre-focused lamp pinpoints work detail. Fail-safe soldering even for delicate work! The price of this tough, modern instrument? Just £4 12 6 complete with two tips; a 6' extension barrel, a double-ended probe and solder. **FREE 24-PAGE CATALOGUE**! For details of the Burgess instant heat solder gun, plus other equipment in the Burgess All-Electric Workshop, write for a free copy of our information-packed catalogue.

**BURGESS take the work out of your workshop.**

Burgess Products Company Limited, Electric Tools Division, Sapcote, Leicester LE9 6JW.

---

### Goodmans High Fidelity

**Let us give you the facts**

From cover to cover Goodmans Manual is packed with fascinating articles on Stereo; a beginners guide to High Fidelity: Stage-built Systems; complete details of Goodmans High Fidelity Audio products. 28 pages you can’t afford to miss... and it’s yours FREE!

---

**Please send me a free copy**

Name: 
Address: 

Goodmans Loudbspeakers Limited
Axiom Works, Wembley, Middlesex, Tel: 01-902 1200
or if the type is not listed, then fit anything which is in the same class (mixer, r.f., a.f. or output). Unlike valves, transistors have a high degree of compatibility and in the field of the cheap portable radio, any minor differences in performance are unimportant, it might even be better than the original! Certainly it is uneconomic to spend time trying to chase exact equivalents even if there are such. The output stage is the only one where some thought may have to be exercised in choosing a replacement, and alteration of the base forward bias may be required. After replacing such, check for distortion and that the quiescent current is reasonable for the type of set.

This brings us to perhaps the most troublesome and frustrating fault to locate, print faults. These may be dry joints between print and components or hair-line cracks in the print itself.

Bending and flexing the panel will often make the fault come and go although not necessarily indicate where it is. Gentle prodding around will sometimes bring it to light, but not always. Another way of tackling the trouble is to take a voltage reading around the suspected area, then flex the panel to see if there is any change in value. This can be repeated at various points, and any change discovered followed up through connecting print and components.

**DISTORTION**

Another very common complaint is distortion. In by far the majority of cases, the trouble is in the output circuit, so diagnosis should not take so long as with some other faults. First of all though, check the battery voltage. Even if it is claimed to be a new battery, it could have been left switched on when not in use, not an uncommon occurrence.

The usual source of trouble is failure of one half of the push-pull output pair. If the series configuration is used, take voltage readings to find if the collector of the bottom transistor and the emitter of the top one are about half of the battery voltage. If this mid-point is in fact either higher or lower by any marked extent from the half value, most likely one of the transistors is either open-circuit or partially so, or has a high leakage, depending on whether the voltage is high or low and which transistor is defective. The quickest and cheapest course is to replace both transistors. Before doing so though, just check the base-bias resistors, and take another measurement with the speaker disconnected. The capacitor feeding the speaker may be leaky and cause an abnormal voltage reading, disconnecting the speaker will remove the leakage return path and restore correct voltage if this is the cause of the trouble.

If the output stage is of the normal transformer push-pull type, voltage readings will not be a great help. Defective transistors will not have a great effect on voltage because of the low series impedances. Voltages should be measured of course, to make sure that bias is present and the output transformer windings are continuous. If these are in order, the quickest way of checking the transistors is to short the base to emitter of each in turn with a screwdriver blade. When both transistors are working correctly, the result will be distortion and a drop in volume. Shorting a defective one will have little or no effect, while shorting its companion will stop the set working completely or nearly so.

Thus the faulty transistor can be quickly located and replaced. Discretion can be used as to whether it is deemed necessary to replace the other as well. If only one is replaced, then the replacement should be of the same type.

A frequent cause of distortion is the loudspeaker. Trouble is due to the speech coil rubbing the pole pieces of the magnet. This is not always easy to identify as it can sound very much like distortion originating in the output stage. It is usually worse at low volume settings, because the rubbing tends to be masked at higher volumes. Often it can be felt by gently pushing the cone in and out with the finger tips, but this is not always decisive. Hooking up another speaker is the best test. Impedance is not too critical, a 3-ohm can be used in place of an 8-ohm for testing, but a series resistor should be used in a 30-ohm circuit. A 15-ohm speaker is very useful for bench testing if one can be acquired, as it can be used with almost any circuit.

Distortion can be traced to other causes than the output circuit. The driver stage can be responsible and even the pre-detector stages. These however are rarer and will have to be tackled by voltage measurements and other conventional servicing techniques.

**TO BE CONTINUED**

---

**I.C. OF THE MONTH**

—continued from page 758

**components list**

<table>
<thead>
<tr>
<th>Resistors</th>
<th>Capacitors</th>
<th>Semiconductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 820Ω</td>
<td>C1 01μF</td>
<td>TAD100 Integrated circuit</td>
</tr>
<tr>
<td>R2 390Ω</td>
<td>C2 005μF</td>
<td>Tr12 AC127</td>
</tr>
<tr>
<td>R3 82kΩ</td>
<td>C3 005μF</td>
<td>Tr13 AC128</td>
</tr>
<tr>
<td>R4 82kΩ</td>
<td>C4 022μF</td>
<td></td>
</tr>
<tr>
<td>R5 1kΩ</td>
<td>C5 10μF</td>
<td>Miscellaneous</td>
</tr>
<tr>
<td>R6 680Ω</td>
<td>C6 005μF</td>
<td>L1, L2, medium aerial on ferrite rod suitable for 208pF tuning with secondary; T1, oscillator coil Weyrad type P50/1AC; I.F. filter type LP 1175; TH1, VA1077; Loudspeaker 15Ω type.</td>
</tr>
<tr>
<td>All resistors, 4watt, 10% types</td>
<td>C7 200μF 12V</td>
<td></td>
</tr>
<tr>
<td>VR1 5kΩ pot. with switch</td>
<td>VC1, VC2 200μF + 176pF ganged tuning capacitor.</td>
<td></td>
</tr>
<tr>
<td>VR2 100Ω preset pot.</td>
<td>TC1, TC2 trimmer capacitors associated with above</td>
<td></td>
</tr>
</tbody>
</table>

The sensitivity of the receiver is very good giving a performance comparable to an equivalent eight transistor quality receiver using conventional discrete components. In addition the TAD100 integrates the major portion of the set providing a far more reliable and rugged receiver.
THE author's first attempts at transistor set construction were not very successful, mainly through being too ambitious with miniaturisation. The sets made were mixtures of reflex circuits, employing home wound ferrite aerials with feedback windings, but they could not be relied upon for stability, and reproduction quality was far removed from that easily obtainable with a modern superhet which may be built for little extra cost.

The author decided to adhere strictly to the superhet circuitry recommended by Weyrad and Mullard, which has stood the tests of time and reliability. There are a few slight deviations from some components used due to lack of availability of the original items, but the performance of the substitutes is well up to standard. The chassis design and layout of the components was, however, arranged by the author to give a really robust set, yet one which could be removed from its cabinet in a few seconds.

In fact the "Chelmer Six" is one hole fixing in its cabinet, the only control needing attachment being the tuning knob. To achieve this simplicity the speaker is mounted on the chassis, and the volume control and switch are mounted on two brass studding pedestals. No fixing screws are necessary, as four turnbuttons inside the cabinet press the chassis panel firmly against the front panel of its cabinet.

The circuit

The full circuit is shown in Fig. 1. The signal received in the ferrite aerial is tuned by VC1, the aerial section of the ganged capacitor. The signal is then fed into the mixer/oscillator Tr1 via the small coupling coil on the aerial. The signal, now at i.f., passes on to two stages of i.f. amplification. The amplified signal is then fed by the third i.f. transformer to the detector diode, D1, where the audio signal is extracted.

This signal is tapped off by the 5kΩ potentiometer VR1, the volume control. The signal passes on to Tr4, the driver stage, and on to the phase-splitting driver transformer T2. The push-pull amplifier consists of Tr5 and Tr6. The much amplified signal is then fed to the loudspeaker via the output transformer T2. There is, of course, an a.c. system, R5 and C3, which controls the bias of Tr2.

One detail that must be explained is a series resistance of 100Ω, R21. This allows a faint signal to be received immediately the set is switched on, thus acting as a safety precaution to prevent one unwittingly leaving the set on when not in use.

Construction

The main component board drilling plan is shown
in Fig. 2 and the plan for the front panel in Fig. 3. The two panels, when all the components are mounted, are bolted together with studding and nuts. Studding is also used for mounting the slide switch and volume control to the component board, and also to retain a perspex panel holding the 250pF padding capacitor. Diagrams of all the sub-panels, control mountings and chassis feet are in Fig. 4. The tag panels A and B have to be made up as shown to fit the available panel space. The rear feet are simply to allow the board to stand upright when out of the case.

The chassis

The chassis is constructed from two panels of thin, perspex. These are connected together by four lengths of 4BA or 6BA brass studding. The main (rear) panel carries all of the components, except the loudspeaker, while the larger second panel has mounted on it the loudspeaker. This system allows the speaker to be positioned close to the front of the cabinet and provides a convenient battery space.

All the component centres and positions for the various holes are shown in Figs. 2 and 3. When drilling for the tuning capacitor shaft and the six holes for the screwed brass rods, bind the two panels firmly together with plastic tape and drill holes in both simultaneously. Make sure, of course, that the panels are correctly aligned with the shorter panel on the left. It is not necessary, however, to drill the two or three fixing holes for the tuning capacitor through both panels as the extension spindle or shaft only passes through the front panel. Note the clearance hole for the knob of the potentiometer; these components usually have only flat edge controls which are not long enough, so the author stuck on a tapered type knob with Epo-Stik. The loudspeaker holes will have to be determined by the speaker itself which can, of course, be positioned on the panel to mark the fixing hole centres.

Referring to Fig. 2 again, it is as well to make a paper template for marking out the centres for the oscillator coil and i.f. transformer pins, and advisable to keep the pins of the latter the same way round as shown. The oscillator coil should be

spot marked on the panel in red between pins 1 and 6 so that intermediate pin numbers can be identified. On the P50/1 transformer there will be found an identifying red spot on the top of the screening can, and between pins 1 and 6. A template should also be made for the tags of the driver and output transformers.

Special care should be taken when drilling the centres for the Jackson '00' gang capacitor. Take great care that the mounting screws are not too long, or the fixed plates of the capacitor may be fouled.
marking beside these pins is useful to avoid mistakes when the transistors are soldered on finally. The spot marks should be put on both sides of the panel.

Care is needed when soldering to the i.f. transformer and oscillator coil pins, which should be gripped with a pair of thin nosed pliers to form a heat-sink.

The potentiometer with its incorporated switch is a little tricky to wire up and colour coding beside the small tags might be an idea to avoid mistakes. Note also the colour coded and numbered tags on panel A (Fig. 4) which tie up on the circuit, with the leads taken from the ferrite rod aerial.

A little extra spacing is needed, incidentally, at each side of the tuning capacitor to avoid the grub screws of the extension spindle, these project slightly, and free rotation of the control is essential.

Fig. 6 gives an idea of the length of the various wires required. Wires not connected are shown crossing, and only where a black dot is shown are the wires soldered together.

The Weyrad transformer LFD1T3 has a split secondary, and there is a correct way of wiring it so the author advises the reader to study the Weyrad literature before connecting it. The colour code spot denotes the start of the primary.

**Alignment**

A signal generator is, of course, the ideal instrument to use for alignment, but an alternative procedure is feasible, and will be described.

1. Switch the set to m.w.
2. Set the aerial and oscillator trimmers to mid-point.
3. Use tuning scale to set tuning capacitor to correct position for the local station.
4. Adjust the oscillator coil core to bring this station in at the correct point on the tuning scale.
5. Tune to a weak signal anywhere in the band, preferably one not subject to fading, and adjust the i.f. transformer cores for maximum output. This will ensure that the i.f.'s are peaked for maximum gain.
6. Tune to the high frequency end of the band and adjust the oscillator trimmer to bring the station in line with the scale calibration.
7. Tune to other end of band and adjust the medium wave coil on the ferrite rod for maximum gain.
8. Repeat steps 5 and 6 until adjustment of one end has no effect on the other.
9. Switch the set to l.w.
10. Tune in Radio 2 on 1500m. and adjust l.w. aerial winding for maximum volume.
11. Trim C15 to obtain maximum volume of Radio 2.

Use the correct trimming tool; a thin brass strip mounted in an insulating handle. The brass strip should pass right through the full length of the slot in the iron cores of the transformers and oscillator coil. Do not use an ordinary screwdriver for these adjustments or the lugs will break up and jam in the thread.

The scale used is that issued by Weyrad for use in conjunction with their rod aerial RA2W. Unless the set is incorporated in its cabinet, on to which the scale is glued, the alignment adjustments will have to be delayed until the cabinet is completed.

**Wiring**

With the circuit diagram Fig. 1 and the wiring plan Fig. 6 to refer to, the constructor should find no difficulty as there is plenty of space available. The author prefers the method of laying resistors and capacitors flat on or near to the panel, rather than the more conventional method of mounting these components vertically. Make sure that all the electrolytic capacitors are correctly connected for polarity. It is best to solder the transistors on last, the triangular arrays of screws on tag panel B being provided to allow all other components to be put into position and wiring completed first. Colour spot
**The cabinet**

The author has always favoured plastic laminate material, such as Formica, for radio cabinets. The material is light and very strong, so that when built on a light section wood frame it cannot warp. Further it can be obtained in many attractive colours.

When the panels are cut out they should be fastened together with adhesive tape and trimmed up to make exact pairs. Unbind and bevel all the edges at 45°, which makes a neat cabinet with flush edges. On the front panel a frame of ¼ in square stripwood is next glued, spaced from the edges to a distance equal to the thickness of the material. The frame thus formed need not be
Components list

Resistors

<table>
<thead>
<tr>
<th>R1</th>
<th>56k Ω</th>
<th>R12</th>
<th>100k Ω</th>
</tr>
</thead>
<tbody>
<tr>
<td>R2</td>
<td>5k Ω</td>
<td>R13</td>
<td>15k Ω</td>
</tr>
<tr>
<td>R3</td>
<td>2k Ω</td>
<td>R14</td>
<td>680 Ω</td>
</tr>
<tr>
<td>R4</td>
<td>56k Ω</td>
<td>R15</td>
<td>680 Ω</td>
</tr>
<tr>
<td>R5</td>
<td>2k Ω</td>
<td>R16</td>
<td>47k Ω</td>
</tr>
<tr>
<td>R6</td>
<td>1k Ω</td>
<td>R17</td>
<td>4.7k Ω</td>
</tr>
<tr>
<td>R7</td>
<td>4.7k Ω</td>
<td>R18</td>
<td>8.2k Ω</td>
</tr>
<tr>
<td>R8</td>
<td>22k Ω</td>
<td>R19</td>
<td>8.2k Ω</td>
</tr>
<tr>
<td>R9</td>
<td>1k Ω</td>
<td>R20</td>
<td>1k Ω</td>
</tr>
<tr>
<td>R10</td>
<td>1k Ω</td>
<td>R21</td>
<td>100 Ω</td>
</tr>
<tr>
<td>R11</td>
<td>22k Ω</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All resistors 1/2 watt, 10% tolerance

VR1 5 kΩ log. potentiometer with switch

Capacitors

<table>
<thead>
<tr>
<th>C1</th>
<th>0.02μF</th>
<th>C9</th>
<th>0.01μF</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2</td>
<td>0.01μF</td>
<td>C10</td>
<td>100μF, 12V</td>
</tr>
<tr>
<td>C3</td>
<td>8μF, 12V</td>
<td>C11</td>
<td>2μF, 12V</td>
</tr>
<tr>
<td>C4</td>
<td>0.02μF</td>
<td>C12</td>
<td>2μF, 12V</td>
</tr>
<tr>
<td>C5</td>
<td>22μF, 2% ceramic</td>
<td>C13</td>
<td>100μF, 12V</td>
</tr>
<tr>
<td>C6</td>
<td>175μF, 2% ceramic</td>
<td>C14</td>
<td>100μF, 12V</td>
</tr>
<tr>
<td>C7</td>
<td>0.02μF</td>
<td>C15</td>
<td>2.5μF trimmer</td>
</tr>
<tr>
<td>C8</td>
<td>0.02μF</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

VC1, VC2 20k+170pF tuning capacitor. Jackson type “00”.

Inductors

<table>
<thead>
<tr>
<th>L1</th>
<th>Ferrite rod aerial, 6in. x 3/4in., Weyrad RA2W</th>
</tr>
</thead>
<tbody>
<tr>
<td>L2</td>
<td>Weyrad P50/1AC oscillator coil (red spot)</td>
</tr>
<tr>
<td>IFT1, IFT2</td>
<td>Weyrad i.f. transformers type P50/2CC (white spot)</td>
</tr>
<tr>
<td>IFT3</td>
<td>Weyrad i.f. transformer type P50/3CC (blue spot)</td>
</tr>
<tr>
<td>T1</td>
<td>Driver transformer. Weyrad LFDT3 or Radiospares T/T1</td>
</tr>
<tr>
<td>T2</td>
<td>Output transformer. Radiospares T/T2</td>
</tr>
</tbody>
</table>

Semiconductors

<table>
<thead>
<tr>
<th>Tr1</th>
<th>AF117</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tr2</td>
<td>AF117</td>
</tr>
<tr>
<td>Tr3</td>
<td>AF117</td>
</tr>
<tr>
<td>Tr4</td>
<td>OC81D</td>
</tr>
</tbody>
</table>

Matched pair

Miscellaneous

Loudspeaker 2½in. diameter 3 Ω or 8 Ω, SW2, 2 pole 2 way slide switch; paxolin sheet; 4BA brass studs; battery clips; Formica for case etc.—see text for case materials.
I was recently asked for advice about an old 12in. loudspeaker that had suffered from the attentions of house-proud mice. The mice had succeeded in removing most of the cone but the voice coil, leads and inner cone support were intact. (Fig. 1.)

I suggested that the unit should be returned to the makers for re-coning, but the owner was horrified to learn that this would cost at least £2 and probably £4. He bought a new low-cost 12in. unit for 32s. and presented me with the relics of a first-class loudspeaker.

This presented such a challenge that I decided to try to make an entirely new cone, incorporating some ideas I have had on this subject.

A BIT OF THEORY

The problem is that the cone should be as light and rigid as possible and also be very free to move. Some of the best loudspeakers use expanded plastic foam diaphragms, constrained by a soft plastic roll surround. This arrangement produces a loudspeaker that is very free of distortion and coloration over a band from maybe 40Hz to 2kHz, but a tweeter is also needed.

Alternatively, a soft corrugated paper cone can produce sound over the whole audio band, but this is achieved because the cone does not vibrate as a whole at the highest frequencies; only the centre moves and h.f. radiation may be improved by fitting a small inner cone to the voice coil. This type of speaker generally gives a rather poorer performance than is realised with separate l.f. and h.f. units.

In production, the cones for both types of speaker are stamped or cast in a mould. Obviously, it is unrealistic to try to make a mould for a single loudspeaker and the amateur must try to build cones in a different manner, not losing sight of the need for lightness, strength, and a flexible surround.

There must be thousands of old loudspeaker units lying around unused because the cones are damaged. Any of these is a suitable subject for restoration and the methods suggested should make a unit with a very good performance.

MAKING THE OUTER CONE

The first thing with any unit is to remove most of the old cone; this may sound drastic, but it makes things far easier. Remove the paper or felt gasket from the chassis and remove the old cone surround from the chassis. Trim the cone to leave a rim about ¾in. wide around the coil former and leave a support for the voice coil leads. (Fig. 2.) You must be very careful of the voice coil leads; if you wreck them it is very difficult to save the speaker.

The outer cone is made from a sheet of thin good quality paper. I used tracing paper, but good lightweight drawing paper is also suitable. This must be marked out in such a way as to make a suitable shaped cone. In the case of a 12in. Good-
inside of the chassis level with the rim. The outer diameter can be trimmed to size by cutting all round one of the lines that you draw. The inner diameter should be made a snug fit around the outside of the voice coil former, again by trimming all round inside the template, using the lines as a guide. Then mark the template to indicate the degree of overlap required to get the correct angle.

The template for a 12in. Goodman's unit is shown in Fig. 3. Very conveniently, the cone is made by cutting out a 90° sector. The outer radius is about 6in. and the inner radius about 3¼ in. After marking out the circles with compasses, mark out a series of radii as is shown in the diagram: these and the tags “A” and “B” are used later to align the cone in the chassis. I have drawn the cone template so as to suit either a 6-hole chassis or a 4 or 8-hole chassis. If the chassis has 3 or 6 holes, draw in the radii and tags shown as full lines in the diagram. For a 4 or 8-hole chassis, 3 equidistant lines should be drawn, as shown dotted and the tags “B” should be made. Cut out the paper and glue it up using the overlap and the various circles as guides: if you do this, it should be truly conical.

Obviously, if the loudspeaker had a flatter cone, requiring a sector of only 60° to be removed, the “A” radii should be spaced 100° apart or the “B” radii 75° apart.

Now you must attach the paper cone to the existing voice coil. This job must be done perfectly as it is the basis for the final cone. I used balsa wood cement spread pretty thickly on the old cone and then offered up the new paper cone, fitting it, rather like a motor tyre so that the lines drawn around the new cone were concentric with the voice coil. While setting, the cone was held in place by Sellotape between the chassis and the tags on the edge of the cone.

When the glue has set, it is an advantage to fit an extra layer to the inside or apex of the cone: this inner cone can be about 1½ in. wide and serves to strengthen the attachment of the new cone to the voice coil.

**SUSPENDING THE CONE**

The edge suspension should be firm enough to support the coil in the magnet but flexible enough to allow free movement of the cone. Suitable materials for the suspension are chamois leather (expensive), cloth or polyurethane foam. A sheet of foam, 15in. square and ⅛in. thick costs 7d at Woolworths, but be careful to get the thinnest material!

This foam is marked out into a ring of the same outside diameter as the chassis and an inside diameter about ¾ in. smaller than the new cone.

The new cone is temporarily suspended by attaching the tags on its edge to the chassis. In doing so, ensure that the cone is circular and centred (I found that it was a help to put a disc into the cone to shape it: try a 7in. gramophone record). The chassis holes can be used as guides.

The foam surround is cut into 4, 6 or 8 equal sectors and two opposite sectors are glued to the chassis using Copydex adhesive. The inner edges of these sectors are then glued to the cone. After the glue has set, test that the cone moves freely. Continue thus until a complete surround has been built and replace the gasket strips (Fig. 4).

**STRENGTHENING THE CONE**

The thin paper cone will be far too flexible for hi-fi purposes. It can be made very much more rigid by reinforcement with expanded polystyrene foam. The centre is reinforced and guide lines help in centring the cone.

![Fig. 4: The thin paper cone is suspended at its edge by polyurethane foam. The centre is reinforced and guide lines help in centring the cone.](image-url)
foam. The foam can be bought as a roll of household insulation costing about 6s 11d for 3ft. x 3ft. x 2mm. This very light material is cut to the same shape as the cone template (Fig. 3) and divided into three or four sectors. The sectors are then glued around the inside of the thin paper cone. This gluing must be as strong as possible and I suggest you use either Copydex or Britflex balsa cement (many glues dissolve polystyrene—carry out a test).

At this point you must decide whether you want a hi-fi bass unit or a medium quality full range unit. For hi-fi you need a rigid cone, but this will not respond well above 2kHz. For medium quality, the cone may be less rigid but should be fitted with an auxiliary high frequency cone at the centre.

The rigid l.f. cone is made by adding three further layers to the cone. The gaps between the sectors of succeeding layers should be staggered for strength. These layers are glued on with Copydex. The cone is finished off with a layer of aluminium cooking foil, again cut to the template and glued with Copydex. This foil is rolled down on to the cone with a smooth object to ensure adhesion and is rolled over the inside and outside of the cone. The centre of the cone is finished with a dust cap of polyurethane foam (Fig. 5). This speaker should not be expected to perform well above 2kHz.

The medium quality full range version uses only two layers of polystyrene foam and no aluminium skin. It is fitted with a laminated inner cone of 60° angle. This accessory cone is made from a circle of radius 4in. marked out as in Fig. 6. Use thin card, similar to postcard, and mark out a series of guide-rings 3in. apart; these will help in fitting the cone to the voice coil. Cut along a single radius and fold the two cut edges, one inside and one outside the cone to form the double cone. Glue it carefully all over with Copydex.

As the purpose of this small cone is to radiate directly from the coil, it must be fastened firmly to the voice coil tube. First, trim up the polystyrene foam around the apex of the large cone, until the small cone is a snug fit on the large cone and edge of the coil former (see Fig. 7). Then trim the apex of the small cone, using the guide-rings to ensure concentricity until the cone apex is only slightly smaller than the large cone. Then glue the small cone on to the large cone and coil former with balsa cement.

Practical experience shows that thin cones of this type have undesirable resonances. These can be damped to a great extent by fitting a ring of polyurethane foam between the h.f. cone and the main cone. This should be made of 3½in. thick foam (Woolworths, again cut in a ring of outside radius 2½in. and inside radius 1½in. and fitted over the inner cone as it
**components list**

<table>
<thead>
<tr>
<th>Materials required</th>
<th>Approximate cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 sheet tracing or drawing paper 15in. x 20in.</td>
<td>6d.</td>
</tr>
<tr>
<td>1 roll polystyrene foam wall covering 3ft. x 2ft. x 2mm.</td>
<td>6s.11d.* (You only need about 3ft. of this, so you can scrounge it!)</td>
</tr>
<tr>
<td>1 tube balsa wood cement (Britex)</td>
<td>1s. 3d.</td>
</tr>
<tr>
<td>1 tube Copydex</td>
<td>2s. 6d.</td>
</tr>
<tr>
<td>1 sq. ft. of domestic foil (L.F. unit only)</td>
<td>2s. 9d.* (Give the rest to your unit only)</td>
</tr>
<tr>
<td>8 in. square of card 0.015 in. thick (Full range unit only)</td>
<td></td>
</tr>
<tr>
<td>1 sheet polyurethane foam 16 in. x 16 in. x 1 in.</td>
<td>7d. Woolworths.</td>
</tr>
<tr>
<td>1 sheet polyurethane foam 6 in. x 6 in. x 1 in. (Full range unit only)</td>
<td>14s. 9d. or 12s. 7d.</td>
</tr>
</tbody>
</table>

* You can restore about ten loudspeakers from these packages!

**Tools**

- Pencil, ruler, protractor, pair of compasses and scissors.

Fig. 7: this is not glued in place. An appropriate circle of foam should be cut and glued inside the inner cone to protect the pole of the magnet from dust.

The main problem is that the new cone may be eccentric or may not be firmly glued to the voice coil. This is very easily tested by feeding the speaker with between 3 and 10 watts of 50Hz signal; for a 3Ω speaker, 4 to 6 volts; or for a 15Ω speaker 8 to 12 volts from a transformer will provide this power. The cone should vibrate through about 1/4 in., but should not set up a scraping noise in the process. If the speaker can stand this usage, it should stand domestic music.

For various purposes, it is useful to find the bass resonant frequency: unfortunately, you will need an a.f. generator and an amplifier for this. Connect an a.c. voltmeter across the loudspeaker and feed from the amplifier via a 15Ω to 30Ω resistor. Resonance causes the loudspeaker impedance to rise and thus the voltage across the voice coil rises and the point at which this voltage is maximum is the resonant frequency. Alternatively, the resonance can be seen as a greatly increased amplitude of cone movement. When designing a new enclosure, the resonance is used to assist in tuning the enclosure and so the value should be noted carefully.

If the finished cone causes rubbing on the poles of the magnet, it is a comparatively simple task to re-align it: the site of friction can be observed and the whole cone pulled to and fro to free the coil. After the correct pull has been found, the foam surround can be freed from the cone and re-glued appropriately.

The instructions given here hold for a typical 12 in loudspeaker with a pole piece of about 12 in. diameter. For other units, appropriate adjustments to the dimensions will have to be made.

If you do not have a tweeter or crossover unit, the wide range medium fidelity unit can be used without further modification.

For the best results, the l.f. unit is preferred. My speaker responds very smoothly from 50Hz to 1.5kHz, and is flatter than this range to ± about 5dB. The bass resonance is 32Hz.

---

**THE MW COLUMN**

**D**uring the winter months there is quite a lot of DX on the medium waves from about 1500 hrs. GMT onwards. Stations reported recently include Taiwan 750 KHz; Bagdad 760; *Radio Irania* Teheran 895 (closes down at 1930 hrs.; Anwhei China on 940; Kermanshah Iran 985; *AIR* Calcutta on 1130; *VOA* Okinawa 1178 (behind Horby Sweden); Kabul Afghanistan 1280; China 1290; Teheran 1325; Kuwait 1345; Alwaz Iran 1390. The *VOA* station in Malalos in the Philippines on 920 was transferred recently to the Philippines government and is now called the Voice of the Philippines, it has programmes in English and signs off at 1600 hrs. Later in the evening a number of interesting African stations can be heard. Tenerife in the Canaries is usually a prominent signal on 620 KHz. Monrovia in Liberia on 629 is more difficult but has been logged. EA1J03 *Radio Sahara* in El Aioun is on 656; Dakar in Senegal on 764 is generally strong after Sottens closes down; EAK92 Las Palmas Canaries is on 827 mixed with EA1J Barcelona: EJF57 in Tenerife is now on 894 after moving recently from 872; EA2J02 *Radio Villa Cisneros* in Spanish Sahara is on 998; *Radio Atlantico* Las Palmas on 1097 is behind EFE14 Madrid; Conakry Guinea on 1403 is invariably a strong signal with African music after 2300 hrs.; Funchal Madeira 1529 is sometimes audible before close down at 2300 hrs.

A number of European MW stations broadcast special programmes in English for DXers. *Sweden Calling DXers* is on 1178 KHz at 2300 hrs. GMT on Tuesdays, *Radio Portugal* has a DX programme on Mondays on 755 and 1161 at 2300 hrs. and on 1412 at 2315 hrs. Recently, *Deutschlandfunk* on 1268 has started *DX Circle* at 1800 hrs. on alternate Wednesdays. This programme is introduced by Alan Thompson of the World DX Club. *Radio Andorra* 701 KHz now has a nightly programme of pop music and announcements in English starting at midnight GMT. Reports are requested and should go to PO Box 1, Andorra.

The writer is often asked by newcomers how they can find North America on the MWs. At this time of the year, the easiest station to locate is CBA Moncton New Brunswick, an outlet of the Canadian Broadcasting Corporation on 1070 KHz. Paris II on the same frequency closes down at 2300 hrs. GMT nightly and when the path is open CBA should be audible after the Paris carrier is switched off. If it is not heard by 2330 hrs. then conditions are below average and a further attempt should be made a few days later, conditions do vary. Other stations that have been logged recently between 2300 hrs. and midnight GMT are VOCM on 590 in St. John’s, Newfoundland; WOR New York City on 710; WABC also in NYC on 770; WHDH Boston on 850; CJON St. John’s Newfoundland on 930; WINS in NYC on 1010; WBAL Baltimore on 1090 and WNEW 1130 in NYC. When conditions are good numerous NA stations can be heard up to 0300 hrs. when interference starts to become troublesome.

**CHARLES MOLLOY**

774
home and dry!

F.G. SADLER, G3UZ

HERE is one item that seems to have escaped discovery, and I have never seen in print, and that is "How to buy and get into the shack, unbeknown to the wife, new gear". I have been around this country and abroad visiting other "Hams" at various times and during this period, have picked up quite a few hints and tips on this subject, and for what they are worth I will try to pass them on.

First tip is to get the XYL to pay a visit to her mother and as soon as she is out of the way, go out and buy a new bit of gear. As soon as you arrive home place it on the bench with other equipment, if after a time she happens to spot it, do not worry, you can get away with it in nine cases out of ten, by saying: "Haven't you seen that before dear, it has been laying on the bench for years." I know this can work very well, as, just after the war. I got rid of XYL as described above, and straightaway went down to radio dealer and bought a R1155 receiver. I had to carry it about two miles to my home, but I was so pleased about it all, it seemed to me as light as a feather!

Tip No. 2, again you are thinking about a piece of new gear, first thing to do is to get your best friend, who by the way is also a "Ham", to pay you a visit then after he has been there for about half an hour and just as the XYL is bringing a cup of tea into shack, let him drop the remark that he has a bit of useless gear at home that he intends to throw out, you up and say (while wife listens) as a great favour to him you will take it off his hands for spare parts.

As soon as XYL is out, bring in gear, place on bench, when she arrives home again, take her in shack, show her gear with the remark, "What a good chap that Fred is to be sure, look dear he has even brought it around". One look at it, and she will reply "Another bit of rubbish, I expect". Alas it is a sad state of affairs that wives think this way but you've got your new piece of gear!

No. 3 tip and best of all, to my way of thinking, was passed to me by a friend who resides in Eire, and this is how it goes.

When you come home from work, and you are having your meal, get your copy of PRACTICAL WIRELESS out and start to read it. Suddenly you read out to the XYL an advert., contained therein relating to "So and So quick drying paint". "I must get a tin of that" you say and you do so.

Now you have got your new gear, which you have hidden under cover of bench, so straight to the shack you go, open up the tin of paint, and paint an old cabinet. When this has been done (door and windows have been kept shut whilst doing the job so the smell of the paint cannot get out), put new gear on bench, stick old repainted cabinet under bench, then rush out of shack, to living room where XYL is reading paper and say: "Come and have a look at the job I have just painted." When she gets into the shack the smell of paint is really awful, however, do not let her go back to her newspaper yet. Just say: "I reckon this paint is wonderful, don't you? Just feel that shiny surface dear, it is bone dry." Though she may feel the top of gear, she will not take much notice of it being new as she will want to get away from smell of paint, so once again you have run out as a winner!

If later on, she does happen to see it and asks about it, and where it came from you can always turn around to her and say "Why you silly billy, that's that bit of old gear I painted up, don't you remember?" Well, Mr. Editor, I have done my best to help other "Hams" in their painful ordeals, and I sincerely trust they have happier times buying their gear.
NOW that the 2-metre (144-146 MHz) amateur band is usable by GPO-licensed G8 (Class B) call-signs additional to Class A licensees, a reasonably potent v.h.f. transmitter design may be of interest to readers. All parts used in the transmitter are readily obtainable and the total building cost, when every item has to be purchased, is in the region of £10.

When operated in the author’s preferred mode, viz. A1 (c.w.) emission the transmitter will run at up to 40W input from a 300V d.c. supply rail voltage and at 25W input from 250V d.c.; running the transmitter from a h.t. rail voltage lower than 250V is not recommended, except perhaps for preliminary setting-up operations.

Current requirements are 200mA (minimum) plus 3 amps from a 6-3V a.c. source for the heaters and panel warning lamp. A complete power supply unit (PSU) should be provided as an outboard item.

The transmitter keying socket is associated with the penultimate r.f. stage but the final valve is fully protected during “key-up” conditions by fitment of a clamp valve. Provision is also made for type A3 emission (phone) working via an external modulator;

Fig. 1: The complete circuit of the transmitter.
anode and screen modulation requires audio power of some 15W and must be provided by a separate unit. Clamp valve modulation, although not so effective as preferred anode and screen systems, can possibly be used; this does confer simplicity and a suggestion regarding it will be made later.

CIRCUITRY

The complete circuit of the “Two-Fifty” transmitter is given in Fig. 1 where the required final output in the 2-metre band is secured via multiplied oscillations generated initially at a nominal frequency of 8MHz and obtained via a crystal. The crystal oscillator coil L1 in conjunction with the triode section of V1a is tuned to the third crystal harmonic in the 24MHz region; this is injected into the pentode grid circuit of V1b. Output multiplied to 72MHz is available at the pentode anode and is developed across coil L2. The 5763 valve, V2 then doubles the 72MHz input applied to it and signals in the 144MHz band are developed at the pi-tuned anode-grid coil Le. The PA valve, a 6146, then raises the signals to a suitable level for transmission. Output is taken from a small link coil, L5, wound centrally within series-tuned coil L4. In the PA stage choke RFC3 and trimmer CT2 are neutralising items whilst the pair of sockets SK1-2 fitted in d.c. supply circuit permit modulation to be applied to both anode and screen from an external unit.

The PA anode meter M is useful as a current monitor but for more precise tuning-up an absorption type wavemeter is preferred; meter M in the prototype is a 5mA f.s.d. item shunted to read 0-150mA. The shunt value required is 0-2 ohms approximately for the particular movement used and this is made up by winding some fine enamelled copper wire on to a ½in. former and checking the panel meter to f.s.d. against an external test meter appropriately driven to 150mA.

PA PROTECTION

The drive voltage present at the “earthly” end of choke RFC2 when the transmitter is operating is in connection with the control grid of clamp valve V4, but biasing it to cut-off; V4 is thus normally inoperative. If the voltage developed across R13-14 by drive disappears at any time however, the clamp valve conducts heavily and a large voltage drop occurs across R15 as extra current is drawn; the 6146 valve screen voltage then falls low and the valve is protected. The clamp valve thus immediately offers itself as a keying safety device which can operate in sympathy with the Morse characters keyed. The valve specified for the clamp operation is a 6CH6 but any small output pentode capable of accommodating a current capacity of 40mA or so is suitable.

Keying the transmitter causes h.t. voltage fluctuations thus it is essential to stabilise the supply to V1; series-connected stabiliser valves V5 and V6 enable this to be done satisfactorily. A single OA2 stabiliser valve can be tried but this does reduce the available h.t. potential to V1 to 150V. A type QS70/25 can be used in place of the QS70/20 specified, provided base differences are noted at the wiring-up stage. Series resistor R6 should be so chosen that current taken by the stabiliser valves does not exceed 20mA under any circumstances.

SWITCHING

The function switching of the “Two-Fifty” transmitter is simply, if crudely, done by means of S1A-B, one section being used for h.t. purposes and the other for aerial change-over. A more refined method of switching r.f. may be desirable but since the system seems to work to date it is retained. Resistor R16 is fitted as a current “bleeder” during “receive” periods. On/Off switching proper is associated with the external PSU.

LAYOUT AND CONSTRUCTION

Layout of v.h.f. equipment requires care and it is thought that the layout adopted can hardly be improved upon since it affords short, direct wiring. Wiring-up should follow normal v.h.f. practice with a single chassis connecting point being used for each stage; thick connecting wire of solid core—
say 18s.w.g.—is required. Ceramic valveholders must be used for V1, V2 and V3; a metal ring should be associated with the V3 valveholder and tags No. 1, 4, 6 and 8 should be soldered directly to it with short lengths of 18s.w.g. copper wire.

COIL WINDING

All coils are wound by hand and full details are given below:

<table>
<thead>
<tr>
<th>Coil No.</th>
<th>Frequency MHz</th>
<th>Turns Wire s.w.g.</th>
<th>Coil former and spacing etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>24</td>
<td>25 30 enam.</td>
<td>1in. dust-coated former, turns close wound, tapped 5 turns from X1 end.</td>
</tr>
<tr>
<td>L2</td>
<td>72</td>
<td>4 16 t.c.</td>
<td>1/4in. air-coated, turns spaced wire thickness.</td>
</tr>
<tr>
<td>L3</td>
<td>144</td>
<td>32 16 t.c.</td>
<td>1/4in. dust-coated former, turns spaced wire thickness, centre tapped.</td>
</tr>
<tr>
<td>L4</td>
<td>144</td>
<td>4 16 t.c.</td>
<td>1/4in. air-coated, turns spaced wire thickness × 2. Tapped centrally.</td>
</tr>
<tr>
<td>L5</td>
<td>—</td>
<td>1 22 t.c.</td>
<td>1/8in. air-coated, P.V.C. insulated and inserted centrally in L4.</td>
</tr>
</tbody>
</table>

Note: t.c.—tinned copper wire, enam.—enamelled copper wire.

RF chokes RFC1 and RFC2 can be v.h.f. types or some 100 turns of fine enamelled copper wire may be wound on to a 1MΩ resistor. For choke RFC3 40 turns of 36d.c. copper wire are close-wound on a 1/8in. diameter air-cooled former whilst choke RFC4 consists of 50 turns of 30s.w.g. enamelled copper wire close-wound on to a 1/4in. length of ball-pen barrel approximately 1 in. diameter.

TESTING

Initially the oscillator should be checked with a low h.t. voltage applied and with V2 and the insulated jumper to sockets SK1-2 removed. A test meter set to read 0-10mA connected from TP1 to chassis (chassis +ve meter prod) should indicate where the core of L1 is adjusted; the core is first adjusted for maximum meter indication then rotated to slightly disengage the windings and until the meter reading falls by a small amount. Failure to make this adjustment may result in the oscillator going "dead" when switched on next time. An absorption type wavemeter should now show the circuit to be operative at the crystal frequency X 3, viz. in the 24MHz region. With V2 plugged in, the meter is moved to TP2 and CT1 adjusted for maximum indication after which L2 is checked with a wavemeter for output in the 72MHz region. At TP3 the core of L3 is set for maximum meter indication and a wavemeter check at 144MHz made. If VC1 is now rotated the test meter at TP3 should show little or no change as L4 is tuned through resonance but in practice a sharp downward kick may be observed; when this occurs CT2 needs to be reset and should be adjusted to provide but the smallest change in reading when the test is repeated.

With the function switch S1 set to receive an insulated jumper can be applied to sockets SK1-2, a low-wattage lamp applied to the aerial socket and power applied. The lamp should glow when S1 is moved to "Transmit" and when VC1 is adjusted for lowest panel meter reading—say 100mA.

When the key jack-plug is inserted—or the keying contacts opened—the panel meter reading should fall very low and the lamp should go out. If this does not occur either the clamp valve is not functioning or the 6146 valve has "taken off"; this can be checked by momentarily touching the tapping point of L1 with a screwdriver blade whereupon the lamp should dim and then recover from the disturbance.

The current passing through the stabiliser valves should also be checked; if they remain unlit resistor R6 is too high in value.

---continued on page 781---
BY D. BOLLEN

PART 2

Last month the theory and circuit of the Panadaptor were given. This month's article deals with the construction.

PANORAMIC RECEIVER CONSTRUCTION

USING Fig. 6 as a guide, drill a 5½in. x 7in. s.r.b.p. panel to take the tuning capacitor mounting screws, B9A coil holders, i.f. transformer tags, VR4, C12, the bias battery, and all turret tags. Also, holes to take the aluminium bracket screws and the two wires going to the diode tuner panel. Insert and rivet all turret tags before mounting the above components on the s.r.b.p. panel. Complete coil holder and i.f. transformer wiring using Fig. 6b as a guide, but ignore for the time being all connections to the converter controls and diode tuner panel.

The next stage is to make up the diode tuner panel on either 0-1in. matrix Veroboard, with 21 x 30 holes and copper strips running parallel to the longest side, or else plain drilled s.r.b.p. or the same matrix with copper wire or Cir-Kit strips on the underside. Insert and wire up diode tuner components as shown in Fig. 7, and take care to observe the correct diode polarities.

Four short 18s.w.g. copper wire legs will serve to mount the diode tuner panel on top of the

---

Top view of the Panadaptor—compare this with Fig. 6.

---

Fig. 6: The layout and wiring diagram.
The plate is bolted to the tuning scale drive assembly with two 4BA screws and nuts, which also serve to secure the aluminium brackets on the main s.r.b.p. converter panel. If it is desired to have a tuning scale with the lowest frequency on the left-hand side, it will be necessary to lengthen the drive cord and then re-wind it as shown in Fig. 8a. Whichever way the drive cord is wound, a clockwise rotation of the tuning knob gives a natural deflection of signals on the oscilloscope display to the right, and the bandspread control VR2 works similarly.

After mounting the converter controls VR1, VR2, VR3, and S1, offer up the tuning capacitor spindle and s.r.b.p. converter panel to the scale drive assembly, then complete final wiring.

**COUPLING ARRANGEMENTS**

If a transistor medium wave portable receiver is to hand, this can be employed as a mixer-i.f. strip without any modification, by feeding the output from the converter straight to the aerial socket of the receiver, and by taking an output straight from the receiver detector diode to the oscilloscope Y amplifier. The resistor R8 shown in Fig. 4 can be inserted if instability is experienced. A slightly better arrangement is shown in Fig 9a, where switching is included after the diode detector to prevent the loud, rasping note of the sweep input being relayed to the headphones or loudspeaker. Note also the use of a 10mH r.f. choke in series with lead from the oscilloscope X terminal, to reduce harmonic interference from the timebase flyback, which can be especially troublesome on Top Band.

A problem likely to be encountered when the converter output is coupled to a medium wave receiver via the ferrite aerial winding is that, with the ferrite aerial still in circuit, it may be difficult to avoid spurious medium wave signals, especially after dark. Figure 9b gives an alternative method of coupling which removes the ferrite aerial from circuit. Where the ferrite aerial has a separate base winding, the circuit of Fig. 9c can be employed.

If a transistor receiver is not available for use with the converter, a 1.6MHz i.f. strip will have to be constructed, or purchased as a module. To achieve a performance comparable to that obtained with a mixer stage and 465kHz i.f. strip, the 1.6MHz i.f. strip should have three stages of amplification. A way of connecting the first i.f. stage to the converter output is shown in Fig. 9d.

converter tuning capacitor, for details see Fig. 8b. Solder tags (4BA) to accept the ends of the wire legs are screwed to the tuning capacitor frame by means of the tapped holes provided. After offering up the tuner panel, solder the legs to the solder tags.

Make up and drill an 18s.w.g. aluminium plate to take the converter controls, according to Fig. 8a.
When the medium wave receiver or 1.6MHz i.f. strip employs p-n-p transistors its supply rail will, of course, be at negative potential, which will conflict with the power requirements of the n-p-n transistor converter. However, in the interests of stability as well as simplicity, it is preferable anyway to employ two batteries, one for the converter and one for the receiver or i.f. strip.

Next month's final part will describe the alignment procedure and show the traces given on an oscilloscope by the prototype.

Although in no way comparable to anode-and-screen modulation a clamp valve system can be tried when the simple additional switchery around SF in Fig. 3 is suggested. Negative bias—3 or 4 volts—sufficient to bring the panel meter pointer to about half-scale is needed. Modulation from a simple 2- or 3-stage speech amplifier using say 12AX7s and with a crystal microphone should swing the screen potential of the 6146 valve in sympathy with the input signals. Adequate space exists on the transmitter chassis for the inclusion of such a simple modulator. It must be appreciated however that no practical tests with this form of modulation have been made.

So far no mention has been made of the actual crystal frequency except to say that it should be in the 8MHz region; it should of course be selected in relation to the particular area in which the transmitter is to be used. The 144-144.10MHz region is a nationwide c.w. segment but for phone working the 2-metre Band Plan zonings should be observed; it is also necessary to keep clear of various Services guard channels.

Final loading into the station aerial can follow preferably using as an aid an absorption type wavemeter; the setting assigned to trimmer CT3 can then be found which affords optimum performance.
H
alf the fun of reading the glossier technical magazines comes from their correspondence columns. Professor Pundit begs for space to point out that the formula for interactive floating feedback given by J. Sprogs in his otherwise interesting article contained the sort of popular error usually attributed to inattentive schoolboys. The parsating factor, given as \(10^{-2Z_{\text{tip}}}\), had been proved 0.0072%, too large in detailed experiment by the Capanfish Laboratories in 1937, and verified by independent field research.

Well, of course, Sprogs is not the man to take that lying down and he parries smartly to the effect that the learned Professor should have taken more trouble to read right through the offending article, where, in para 4 of Page 391 he would have seen that parsation was indeed compensated by factor K. Mr. S. goes on to say that he is surprised that Prof. P. should have seen fit to use the now discredited Binnacle Assessment. It was to be hoped, for the sake of the professor's pupils, that the bulk of his teaching was not based on such fallacious argument.

Thoroughly incensed, the Prof. fights back, quoting armful of sources, and Sprogs caps him with reference to recent spin-off researches from the NASA programme. He implies that the Prof.

has his head buried too deeply in the historical sand.

It goes on for a few months, with others joining in to add their weight or vilify; with the inevitable red herring letter (which Henry always suspects the Editor to have written himself), until a terse 'This correspondence is now closed' allows us to concentrate on another argument that has sprung up.

Half the trouble with these 'frank exchanges' is lack of communication. Words are a treacherous form of communication, especially when used to discuss a subject as beset by different standards as electronics. Or, worse, high fidelity audio, where one man's power is another man's fixation.

Just at present there rages an argument about the relative merits of Class A and Class B operation of push-pull transistorised output stages. The protagonists have been polite, so far. Gordon J. King has recently been experimenting with amplifier assessment, and concludes that crossover distortion is such a subjective matter that by the time you have got down to the low levels where you doubt the validity of your instruments, the noise level of the amplifier masks instrumental interpretation anyway. Agreed! There does not seem much point in donning earphones to listen to your hair grow.

Taking a practical example of a 20-watt amplifier (r.m.s., we presume?) with the good noise figure (overall noise relative to full power output) of 78dB ... You will already have noted that we needed to qualify two of our parameters—that's how it goes with hi-fi lads ... he works out the maximum distortion measurable by the usual methods, and finds that this gives a ratio to the noise level of 2900:18 (44dB, or 0.65%).

From which we conclude that it is virtually impossible to measure low-level distortion at power around the 10mW mark (for the aforementioned amplifier) as the distortion falls into noise.

Let's come down a bit to where the air is not refined. Down to information retrieval, in fact. That formidable term simply means being able to flip over the pages until you find the data you want. My back numbers of PW are well-thumbed and dog-earred by this process because I had no way of finding the information I wanted except a vague jog of the memory and a patient flip. Now you would think that someone as erudite as Marshall McLuhan would see the value of browsing.

But, No Sir, in Dewline Newsletter he talks about communications and says: 'To go on building nineteenth century spaces for the storing and dissemination of classified information is perfectly natural. It is also fatal.' He goes on to advocate microfilmed books, available to all at the touch of a button, extracts appearing on your TV screen.

If the Dewline extract had appeared in one of our technical glossies, McLuhan would soon have been challenged. What seems obvious to the dogmatist can be torn to pieces by the terriers of technical readership. He has overlooked the basic point about books—that all the information is under one's hand; that browsing can turn up related facts as we subconsciously do our ferreting.
THE club was formed in January 1965 when John Harvey, a keen SWL, decided to put a CQ in the local newspaper calling any radio enthusiasts to a meeting at the Bromsgrove Co-op Hall. Twelve chaps turned up for the first meeting.

Among them was the Late Jack Casey, G8JC. Jack was a great help in helping to form the rules of the club and getting the finances organised. The present chairman Jack Gwynne, G2CLN has held that office right from the first meeting and has played a major part in the development of the club. G2CLN has been a source of inspiration to the members in getting club projects organised and also in helping with RAE lectures.

Other founder members include the present treasurer, John Harvey and J. Dufrane (Hon. Sec.). Since then the club has made great strides, a prominent landmark being the acquisition of a club shack. January 1st 1967 saw every able-bodied member armed with paints, brushes, tools, etc. and in a short time work benches and an “operating table” were fixed up. Now the shack boasts a top band Tx and various Rx sets for members’ use. In addition, the club, using its call sign G3VGG takes part in various contests.

NFD is a very popular event and at the present rate of progress we should win the event in 1975! VHF and f.m. in particular is becoming very popular and a club project organised by G2CLN is for a 2m f.e.t. converter. The club has operated portable on 2m on the Clee Mills.

A very popular event is the annual mobile picnic: this is a true picnic and the aim is to cater for the wives and kids as well as the amateurs. This year’s picnic on August 31st was held in the grounds of Hartlebury Castle, near Kidderminster, talk-in stations operating on 2m and top band.

Other outdoor activities include several exhibition stations put on at local fêtes and flower shows. The club’s newsletter is edited by Ray Young and his XYL.

Licensed members include Howard, G3NOY: Robin, G3WNT; Hugh, G3VHL; Ian, G3WUG: Ken, G810 and several perspiring RAE candidates.

For SWL members the club runs a logging contest — each month a specified band with points for number of calls logged. A trophy has been presented by G2CLN to be awarded to the winner at the end of the year.

Club meetings are held every second Friday of the month at the Co-op Hall in Bromsgrove, talks and demonstrations with film shows, etc. Visitors are welcomed.

Details from Jack Dufrane, Hon. Sec., 44 Hazelton Road Marlbrook Bromsgrove, Worcestershire.

A group of members at the finish of the 1967 NFD event

TAKE 20
JULIAN ANDERSON

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

It was not many years ago that virtually all transistor amplifiers consisted of a driver transistor feeding its output into a phase-splitting transformer which powered a couple of output transistors which in turn fed their output to an output transformer. Things have changed, however; firstly with the introduction of cheap pairs of complementary transistors and secondly the rapid rise in the price of transformers against the general trend of price reductions in the electronic component field.

It is now possible to build a really simple transformerless amplifier giving an output of between 750mW and 1W feeding into a 3Ω speaker which costs well under £1. The quality is not high fidelity but it does compare favourably with the better quality transistor radios. The supply voltage shown, 9V, is about the lowest that this type of amplifier will operate from. However, a greater output can easily be achieved merely by increasing the supply to a maximum of 20V—no circuit modifications are necessary.

The Circuit

Tr1 acts as a high gain amplifier feeding a complementary pair; one of the output transistors amplifies the positive going signal which appears at the collector of Tr1, while the other takes care of the negative going signal.

The circuit is a very common type but most recommend the use of 15Ω or even higher impedance speakers. 3Ω speakers are, however, far more common and are generally cheaper and the component values have been chosen to ensure that this impedance speaker can operate with the circuit. If higher impedance speakers are already available they may, of course, be used, but this will be at the expense of volume.

Considerable heat is dissipated from the output transistors—especially when using a supply in excess of 9V—and adequate heat sinks are imperative. The larger types of battery should be used as the current drawn at full output can be as much as 150mA—far too much for the PP3, etc.

The Complementary Pair

Several complementary pairs of transistors were tried and all worked perfectly including an unmarked pair retailing at 3s. 6d. including postage and packing from Bi-Pre-Pak Ltd. These transistors are germanium types and are matched, but the gain of one pair is not necessarily the same as another; three pairs were built into circuits, one low gain, one high gain and the other chosen at random—all worked well.

The prototype is constructed on a small piece of Veroboard but almost any method of construction should be satisfactory.

Fig. 1: The circuit diagram of the Take 20 amplifier.

<table>
<thead>
<tr>
<th>components list</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1 100Ω 10%, 1Watt</td>
</tr>
<tr>
<td>R2 1MΩ</td>
</tr>
<tr>
<td>R3, R4 1Ω</td>
</tr>
<tr>
<td>R5 1kΩ</td>
</tr>
<tr>
<td>C1 10µF 25V</td>
</tr>
<tr>
<td>C2 200µF 25V</td>
</tr>
<tr>
<td>CR 5kΩ log.</td>
</tr>
<tr>
<td>Tr1 2N2926G</td>
</tr>
<tr>
<td>Tr2, Tr3 pair†</td>
</tr>
<tr>
<td>3Ω Loudspeaker‖</td>
</tr>
<tr>
<td>† Bi-Pre-Pak Ltd.</td>
</tr>
<tr>
<td>‡ Ex TV set speaker, Padgetts Radio Store, see advertisements for addresses.</td>
</tr>
<tr>
<td>Prices are only a guide.</td>
</tr>
</tbody>
</table>

Construction and layout are absolutely straightforward and so no layout diagram is shown. The prototypes, one of which is shown in the photograph, were built on Veroboard, but there is no reason why pin board or even tag board should not be used.
Readers' letters which have been received in connection with the series of "Clubman" receiver articles, (Practical Wireless, January to July 1968), indicate that an "S" meter would be a desirable addition to the receiver. A simple circuit has therefore been developed and tested in the prototype, and will be described here. It is suitable for use in the Mk II version onwards, and could possibly be used in other transistor receivers having similar i.f. circuits.

The main requirements of an "S" meter circuit are that it should give a sensible indication of signal strength and, for transistorised equipment, it should have a low current consumption.

Circuit Description

The "S" meter circuit (Fig. 44) operates from the a.g.c. line of the receiver. It consists of two silicon transistors Tr12 and Tr13 connected as a "long-tailed pair". The base of Tr12 is connected to the receiver a.g.c. line on the i.f. panel at D5-9, the junction of R12, R13, C13 etc. (see P.W. March 1968, Page 831, Fig. 23) and the base of Tr13 is connected to the slider of the "zero" control VR4. A current is fed to both emitters via R37 and the "S" meter itself is in the collector circuit of Tr12.

With no input signal, the base of Tr12 is at approximately -0.9 volts, with respect to chassis. VR4 is adjusted so that Tr13 is conducting all the current supplied by R37 and no current is passing through Tr12 to the meter. In the presence of any signal, a positive voltage is developed at the detector diode causing the base of Tr12 to become less negative. This results in Tr12 conducting and allowing the current supplied by R37 to flow through the collector of Tr12 to the meter. The increase of meter current with increase of input signal is approximately logarithmic, which will give a linear scale for the meter when this is calibrated in decibels. The particular meter used is a MR38P "S" meter which is scaled in "S" units and in dB above S9.

It is usual to make each "S" unit equal to a 4dB increase in signal. Unfortunately the "S" units and dB markings on the scale are not linear and do not agree exactly with the changes of input signal. However, the error is sufficiently small over the major portion of the scale to be neglected for most practical purposes. The meter indication has been found to agree well with "S" reports based on personal estimation of the received signal.

The graph in Fig. 45 shows the relationship between input signal and "S" meter reading for the Clubman II and Clubman III with its r.f. stage.

The position and mounting of the meter depends on personal requirements. It is obviously easier to
could be positioned 3 in. further back to give the necessary clearance. In the Clubman III etc., the r.f. tuning control is in the position required by the meter. The more experienced constructor will find it still possible to fit the meter to the front panel but it is necessary to dispose of the separate r.f. tuning control. This may be done by replacing the two-gang tuning capacitor VC1, VC2 and the single r.f. tuning capacitor VC4 with a three-gang unit, e.g. Wingrove & Rogers, C73-23. The capacitance law of this unit is different to the Jackson one used originally and a new dial will be required. The use of a three-gang tuning capacitor in the Clubman V, with the d/f loop aerial, is not recommended due to difficulties in getting the loop aerial to track the main tuning circuits. The “S” meter circuit may be built on a small tagstrip under the chassis as shown in Fig. 47, or on Veroboard and mounted in some convenient position.

**components list**

<table>
<thead>
<tr>
<th>Resistors:</th>
</tr>
</thead>
<tbody>
<tr>
<td>R37 6-8kΩ, ½ watt, 10% carbon</td>
</tr>
<tr>
<td>R38 22kΩ, ½ watt, 10% carbon.</td>
</tr>
<tr>
<td>VR4 5kΩ, skeleton preset, or similar.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Semiconductors:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tr12 2N2926</td>
</tr>
<tr>
<td>Tr13 2N2926</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Meter:</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1 MR38P “S” Meter (1mA)</td>
</tr>
</tbody>
</table>

**‘S’ Meter Adjustment**

With no signal input to the receiver, the “S” meter zero control VR4 should be adjusted so that the pointer indicates just off the zero end of the scale, about 50 microamps (0-05 milliamps). This ensures that the meter indicates the weakest of signals and does not have a “dead” zone at zero.

**BINDERS AND INDEX**

Don’t let your copies of PRACTICAL WIRELESS become torn and dirty: hard-cover binders are available at 14s. 6d. from:

BINDING SECTION,
IPC MAGAZINES, LTD.,
SOUTHAMPTON STREET,
LONDON, W.C.2.

Indexes to Vol. 43, 1967-8, are also available at 1s. 6d.
These prices include post and packing.
plug in

the smallest
soldering iron available

Antex irons will give you fingertip control for precision soldering of small component and transistors.

Send for one if your local shop cannot supply, or send for our 16 page colour catalogue by completing the coupon below.

CN 15 Watts. Ideal for miniature and micro miniature soldering. 18 interchangeable spare bits available from .040" (1mm) up to 3/16"
For 240, 220, 110, 50 or 24 volts. from 32'6

Complete precision soldering kit

This kit—a rigid plastic "tool-box"—contains
- Model CN 15 watts miniature iron, fitted with interchangeable spare bits .050", .080".
- Rest of resin-coated solder
- Felt cleaning pad
- Stand for soldering iron

From Electrical and Radio Shops or send cash to Antex.

49/6

Model CN 240/2

15 watts · 240 volts
Fitted with nickel plated bit (3/32") and in handy transparent pack. From Electrical and Radio Shops or send cash to Antex.

31/6

Antex, Mayflower House, Plymouth, Devon.
Telephone: Plymouth 67377/8.
LOW PRICE, HIGH QUALITY SPEAKER SYSTEMS

All cabinets are new and carefully designed acoustically with speakers mounted on 119 chinboard baffles. All speakers are ex-T.V. high quality with high-flux magnets carefully matched and tested.

COWDERY FIVE. Specially designed Corner Cabinet, 28 x 15 x 7 in. deep. Finished in natural teak veneer and with veneer front. Fitted with rubber feet. Five speaker units 15 ohms. Impedence handles 15 watts. £8.8.9 P. & P. 8/- each.

ADASTRA DOUBLE 5 stereo solid state amplifier housed in handsome cabinet veneered in natural teak. Size 11 x 15 x 7 in. 10 Transistors—15 watts peak per channel. £40-600 AC. Output impedance 8 ohms or 10 ohms (our Cowderay system eminently suitable). Smart blue enclotcheon. £14.16.6 P. & P. 10/-

SCOTT. This elegant tapered cabinet 10 x 10 x 31/2 in. deep is attractively finished in black cloth with triple grey wood finish. Suitable for table or for wall mounting. Fitted with 10 J in. speaker unit and volume control. 2 or 15 ohms impedence—please state impedance required. £4.6.9 P. & P. 7/- extra. Fitted with E.M.I. 15 x 8 in. speaker unit and bell tweeter. 15 ohms impedence, capacity 10 watts. 30/- extra.

SPEAKERS: Elec Heavy duty Ceramic Magnets 11,000 line. 16in. round. 19/6. 3 ohm or 3 ohm, 4/6, 6/8, P. & P. 3/6, 11 in. round or 10 in. 4/6, P. & P. 3/6, 11 in. round or 10 in. 4/6, P. & P. 3/6, E.M.I. 12 x 6 in. 3ohm. 45/-, 15 ohm 45/-, P. & P. 1/6. E.M.I. 12 in. tweeter 17/-, P. & P. 1/6. E.M.I. 12 x 8 in. tweeter. Two £2.5/- units. 15 ohm £16/-, 6/-, E.M.I. 15 x 8 in. tweeter.

IMP: Woods shaped extension speaker 7 x 6 x 4 in. (max). Covered in walnut wood grain cloth with foam Vynair front. Keyhole slot at back. Fitted with 3 ohm speaker unit only. 29/-6. P. & P. 3/- each.

4-Station Transistor Intercom System 1 master and 3 stations. Twin plastic cabinets for desk or wall mounting. Call/talk: from Master to Slave and Slave to Master. Ideal for Businesses, Garages, Schools, Hospital, Office and Home. Operates on one 9 V battery. On/off switch. Volume control. Complete. £7.15. P. & P. 1/- extra.

4-STATION INTERCOM

Solve your communication problems with this 4-Station Transistor Intercom System 1 master and 3 stations. Twin plastic cabinets for desk or wall mounting. Call/talk: from Master to Slave and Slave to Master. Ideal for Businesses, Garages, Schools, Hospital, Office and Home. Operates on one 9 V battery. On/off switch. Volume control. Complete. £7.15. P. & P. 1/- extra.

MAINS INTERCOM


TEAR PLINTH AND PEERSPEX DUST COVER FOR ST25 en 23 x 5 0 P. & P. 5/-

VYNAIR Widths from 40 ft to 60 ft. 17/- yd. off roll. P. & P. 1/9. 5 yd. 9/- P. & P. 1/9. Send 1/- for swatches.


MICROPHONES: Xtal Hand Mikes. B1021 with stand. £4.15 P. & P. 3/- 1/6, Mike FM-39/1, 39/-, CR121 Xti, 12/-, Telephone Pick-up. 10/- & P. & P. 1/6, Xtal lavalier. £7/6. Gitar Mike. £12/6. P. & P. 1/-

FEROX RODS: 6 x 4 in. 1/6/3/-, 4 x 4 in. £1/-, 3 x 3 in. 3/-, 3 x 3 in. 6/-, 2/- each.

FEROX RODS WITH COILS: 41 x 3/-, 6/-, 3 x 3 in. 5/-, £1/- each.

ROTARY SWITCHES: 3 Pole Mains Switch. 31/2 x 3/4 in. £7/15/0. 3 pole 3 way, 3 pole 4 way, 4 pole 3 way. 3/6 each. P. & P. 1/-

TRANSISTOR SPEAKERS 8 ohm 2 in. 4/-, 5/-, 10/-, P. & P. 1/-.

CARRIAGES: Stereo: Sonitone 9TA H/C Diamond, 47/-, 9TA Sapphire, 37/-, 9TA Sapphire, 31/-, Rosecr S18 Medium Output, 28/-, 5106 High Output, 28/-, DC286 Stereo Compatible, 22/-, Acos GP931 Sapphire, 31/-, GP941 Sapphire, 39/-, GP91 Diamond, 42/-, GP91 Stereo Compatible (High, Medium or Low Output), 29/-, DC288 Stereo Compatible, 29/-, Philips AG3380, 40/-, B.R.S. SX1. £54/-, Japan equivalent, 26/-, Sonitone 28/6, 54/-, Japan equivalent, 26/-, Sonitone 28/6, 54/-, Japan equivalent, 26/-, Sonitone 28/6, 54/-, Japan equivalent, 26/-.

EARPIECES WITH CORD and 3.5mm. plug, 8 ohm magnetic, 31/-, 250 ohm £1/-, 180 ohm with clip, 6/6. Xtal. P. & P. 6/6.

PIANO KEY PUSH BUTTON SWITCHES. 7 button line. makes or off. 6 banks of 6 P.C.O. 8/6, P. & P. 1/-

TRADER SERVICE SHEETS

5/- each plus postage

We can supply Trader Service Sheets for most makes and types of Radios, Tape Recorders and Televisions—Manuals for some.

Cheques and open P.O.S returned if sheets not available.

OAKFIELD ENTERPRISES
LIMITED
30 CRAVEN STREET, STRAND
LONDON WC2

Make

Model

Radio/TV

1969 List available at 2/- plus postage

If list is required indicate with X

From

Address

enclose remittance of

(same stamped addressed envelope)

s.a.e. with enquiries please

MAIL ORDER ONLY (February PW)
BY the time that you read this a tragic event may have occurred in the world of Shortwave radio. I am referring to the cessation of foreign language broadcasts from the *Voice of Denmark*. Originally scheduled for the 1st. April 1970, the date of closure was brought forward to the 1st. January 1970.

The decision was taken by the Danish Radio Committee and two reasons were given: (1) very few people listen to the *Voice of Denmark* (although 3,000 letters were received in the last half year); (2) The Danish Radio and Television Service has to cut its budget (although the Shortwave department costs only 345,000 D. Kr. annually, which is a fraction of the cost of one of the expensive TV productions).

If you have any loggings of *Radio Denmark* which you have not used for reception reports I suggest that you use them now and include a plea to keep the station open. Rodney Baggaley wrote to me from Daventry suggesting that protests should also be sent to the Director-General of Danmarks Radio at the following address:—Mr. Hans Sølvhø, The Director-General, Danmarks Radio, Radio House, Copenhagen, Denmark.

In the past several stations have made similar decisions only to have them reversed by the large number of protests from shortwave enthusiasts from all over the world. Please act as soon as possible and we may yet be able to save this excellent station from extinction.

**Worldwide QSL Card Poll**

The results of this poll, which was conducted by the Cellardyke Short Wave Radio Group to find the shortwave station which has issued the best QSL card since January 1967, arrived just too late for inclusion in the last issue. Votes were received for nearly fifty stations and the top five with the number of votes in parentheses were:—

1) *Radio Portugal* (62)
2) *Radio Australiia* (48)
3) = *Radio RSA* (47)
4) = *Radio Nederland* (47)
5) *Radio Canada* (46)

Congratulations to *Radio Portugal* who emerged as clear winners.

The poll was also used to determine what details were thought to contribute to an ideal QSL card. The results indicated that date, time and frequency were regarded as essentials. The next most popular detail was transmitter power followed by transmitter location, reporter’s name, genuine signature on the QSL, etc.
G

OOD news this month for the ten metre fans. The band has been providing some very good openings and quite a large number of eager hearing utensils have been frantically logging most continents. Signal levels have varied and it must be admitted that some of the signs from further afield have been down in the 5 and 4 range.

One item of interest for those who like tuning in to something a bit different. Why not tune down between 28 and 27MHz and eavesdrop on the American citizens band? Some of these stations have to be heard to be believed. Seriously though, the citizens band does give an excellent indication of just how much the band is open, particularly towards W land.

As might be expected, the fifteen metre band opened up with ten and some very good openings here too. Down another notch on twenty things have been quite good but surprisingly enough it is the ten metres which has provided the majority of DX signals. Twenty has been open at times but mostly to S. America with good sigs from PY and surrounding districts. Africa, too, has done quite well on twenty from the s.w.l. in Britain’s point of view.

Forty and eighty have had their moments but mostly Europeans (EUs) logged at this QTH. One or two W stations made it through the QRM on forty and in the W segment of eighty.

Topband hasn’t fared too well. Lots and lots of QRM/QRN and the best for the month was only GW and GM. No W stations were logged on c.w. Anyone hear any W-type tweets down the l.f. end?

Logland

On to the field where lovely logs grow. This one was cared for by John Moore (Leicester) and is an all-band edition. Envious readers should like me gnash CQ on their teeth while reading—160: GM3ONS/A, GM3UYYF, GM3WDF GW3RB.

80: CT1GD, JW1CI (Bear Is.), KV4FZ, OY1X, UA9KAX, VE1IE, VP2VP, W1EC.

40: EA6BN, PJ0DX, WA2ZAA.

20: CT2AK, DU1BEN, ET3ZU, FG77I/P/FS7, FG7XT, HK3RQ, HK4AXZ, HZ1AB, JA8EL, JW1CI, KP4AST, KR6NR, KV4FZ, KZ5DA, LU8DF, OD5BZ, PJ0DX, PY1NBK, TA2SC, TG9RZ, TF2WLN, VE15H, VE2DHF/YV1, W6MLZ, VP2VI (Tortola), VP7DL, VP8KD, VS6DR, YV1EJ, ZS5XA, 4X4UF, 5A1TL, HS1LV, 8P6AZ, 9H1BL, 9Y4AA.

15: CR7ZI, DU1FZ, F6ABP/FC, JA3LVT, JX3JQL, KH6SP, KL7MF, OD5FA, PJ0DX, PZ1CU, TG9F, UA9FJ, VE2AF, VE3BMB, VE5XC, VE7TL, VP2VP, VK6US, W7RM, ZS6AR, 4M1A (Venezuela ?), 4X4KT, 9S5GV, 9Y4A.

10: CN8DW, CN8HD, CR6DLV, CT2AS, CX7BF, EP2BQ, ET3USA, HC1RF, HK4DF, K6NA, KV4AD, KZ5AT, LUQOT, MP4BBA, OA1BT, OA4PF, OD5BZ, PJ1AA, PJ0DX, PY1NBK, PZ1DB, UA3BP, VE1ATC, VE2AYW, VE3BIZ, VO2AP, VP2VI, VS6AL, VS6DR, VU0DK, W6ESI, WX8CR, ZS5DC, 4Z4HF, 5Z4ALS, 9H1BP.

All this bunch on s.s.b. picked up with the aid of a 60ft. end fed and a CR100/2.

A. Woodland (Somerset), confesses to usually listening to non-amateur type stations (some people have no shame) but admits to weakening while ill. His receiver is a Hammerslund SP600JX (suddenly I'm green) and the aerial a V-beam 40ft. up plus a 72ft. vertical “condensed” into 41ft. (Good Gawd!) Stations logged on ten metres include—CE3OE, CR6CA, EP2BQ, GC4LI, HK4DF, JA1AEB, JA2CLI, JA4FRB, JA6YCU, JA7BCR, J8AAPK, KA4F9M, KH6SP, KR6VX, KV4FZ, KZ5CD, K6CM, K6KCU, K7AB, LU7FAG, LU8DKA, LXBW, MP4BL, OA10X, OA4PF, OD5EP, PJ0DX, VE6AUT, VE6ADX, VE7AGZ, VE8YM, VK6US, VP2G8B, VP9BU, VP9EP, W6ABN, W6EJE, WA6EPO, W7AC, W7GUX, XE1WS, WX8CS, YN1HS, YV6GL, ZE1CY, ZE1JU, 6Y5DW, 8P6CX, 9Y4AA. All these on s.s.b.

A. Crooks (Leicester), recently had his RA1 serviced and peaked up. It showed its appreciation by teaming up with a PR30 and 45ft. end fed to hook these on 15 s.s.b.—CX1JM, JW1CI, K0VBX, K5QHS, JA2KKZ, TF3EA, UD6BD, V6EXF, VE7HN, VP8KO, (S. Orkneys), W6ZQI, W7GVA, WF2LIB, ZS5JY, 91EJZ (Jamaica).

B. Hughes (Worcester), JR5OOS, dipole, had a quick squint at 20 and came up with—CR7DS, CR6IK, CR4BC, JX8IL, LA0AD, SV0WN, TG9EP, TR8MC, VU6GE, VK9KY, (Cocos Keeling), VK2BKM/VK2 (Lord Howe Is.), VP2GLE, VR1L, ZS2MI, 6W8BD, 9V1PA, 9X5AA.

All these on s.s.b. except ZS2MI on Marion Island who was a.m., just shows what you can receive without a b.f.o.

A. Lister (London), CR70A, home brew preselector and 150ft. end feed informs that ZL’s are loitering on 3.8MHz from 0600-0700. Fifteen with this set up raised—AP2AGC, CT1GD, EA6BN, IS1LIO, KP4KBS, KV4FZ, LG5LG, LX1JES, PY1MT, TF2WKO, VE3ZO, VO2DAL, VQ8CR, dozens of W’s, ZS6QK, 4X4LN, 5A3JR, 9Q5FM, 9Q5AE. On eighty, Adrian’s best were five ZL’s and he managed VK2WX on ten metres.

R. Hall (Belfast) modified AR88D, 50ft. end fed; listens at weekends. The last session on twenty s.s.b. produced—AP5HQ, CR61K, CT1WB, FP8AP, HK3RQ, HR1KA, JA9AG, KC4CL, KZ5NG, 0Z7TF, PJ1AA, TF2WKL, VE3CBG, VK6RU, VP7DL, 3Z3AMZ, 4X4OS, 6Y5SR, 8R1UC, 9H1M, 9K2CF, 9N1MM, 9Y4UV to mention just a few.

NEWS of contests—

According to my diary, contest lovers will be out of luck for the cold days in January. I can find only two with February not faring very much better. January 10-11th., AFS contest; 31-Feb. 1st., French c.w. contest.

Logs for the Amateur Bands, with stations in alphabetical order, must arrive before the 18th. of each month. Logs only to: 5 Edward Close, St. Albans, Herts.
a new 4-way method of mastering ELECTRONICS
by doing — and — seeing . . .

1. OWN and HANDLE a complete range of present-day ELECTRONIC PARTS and COMPONENTS

2. BUILD and USE a modern and professional CATHODE RAY OSCILLOSCOPE

3. READ and DRAW and UNDERSTAND CIRCUIT DIAGRAMS

4. CARRY OUT OVER 40 EXPERIMENTS ON BASIC ELECTRONIC CIRCUITS AND SEE HOW THEY WORK . . . INCLUDING . . .

- VALVE EXPERIMENTS
- TRANSISTOR EXPERIMENTS
- AMPLIFIERS
- OSCILLATORS
- SIGNAL TRACER
- PHOTO ELECTRIC CIRCUIT
- COMPUTER CIRCUIT
- BASIC RADIO RECEIVER
- ELECTRONIC SWITCH
- SIMPLE TRANSMITTER
- A.C. EXPERIMENTS
- D.C. EXPERIMENTS
- SIMPLE COUNTER
- TIME DELAY CIRCUIT
- SERVICING PROCEDURES

This new style course will enable anyone to really understand electronics by a modern, practical and visual method—no maths, and a minimum of theory—no previous knowledge required. It will also enable anyone to understand how to test, service and maintain all types of Electronic equipment, Radio and TV receivers, etc.

FREE POST NOW for BROCHURE
or write if you prefer not to cut page

To: BRITISH NATIONAL RADIO SCHOOL, READING, BERKS. Please send your free Brochure, without obligation, to: we do not employ representatives.

NAME:_______________________________________ BLOCK CAPS
ADDRESS:_______________________________________ PLEASE PW1
SINGLE semiconductor devices can be produced easily nowadays. They are rugged, stable and efficient. An early thought was why not put several devices on to one chip so that even more space saving could be achieved, not to mention the other advantages of this method. The advent of planar technology, where devices are produced by diffusion from one side of the chip only, brought this idea to economic feasibility in the form of integrated circuits.

The Planar Process

The techniques used to produce a planar epitaxial transistor and the diode counterpart are the same as those used to produce integrated circuits and it is convenient to discuss them together at this point. As was explained some time ago an epitaxial layer is one which has been produced on the surface of a silicon chip in such a way that its crystal structure is the same as that of the underlying layer or substrate. It is possible to produce an epitaxial layer of intrinsic p- or n-type material depending on the requirements.

An essential part of the process of producing devices by this method is that of masking the areas which are not to be affected by the various diffusion processes that are to take place. The method most commonly used is that of silicon dioxide masking. After a layer of epitaxial silicon has been grown on the surface of the crystal a layer of silicon dioxide (SiO2) is produced over this either by an electrolytic oxidation (anodising) or by chemical deposition of silicon dioxide by oxidation of an organic silicon compound (tetraethyl orthosilicate). The uniform layer of silicon dioxide can then be etched with hydrofluoric acid to expose sites for later diffusion processing to take place. In order to locate the regions to be diffused, photolithographic techniques are used. A layer of photoresist is painted on to the slice, a suitable mask is used to protect the required pattern, and unexposed photoresist is removed to leave a mask which is resistant to hydrofluoric acid. Following this it is possible to etch the exposed regions to reveal the epitaxial layer into which dopent atoms can be diffused to produce the devices.

When producing a single silicon planar epitaxial diode it is only necessary to expose one region, although generally several hundred diodes are produced on a single wafer. If an n-type epitaxial layer has been grown then a diffusion of p-type impurity into the exposed region will produce a graded junction diode structure as seen in Fig. 1, where the various stages in the production of a single diode are shown in detail. In order to provide an ohmic contact to the n-type region it is necessary to go through the processes of photolithography and etching once more in order to allow a heavy diffusion of n+-type dopent to provide a cathode contact. Finally, metallising is carried out to provide contact to the n+- and p-type regions, and leads are attached to these regions after the slices have been cut to separate the individual diodes. The current and voltage ratings of the devices depend as always on the geometry of the arrangement and on the doping levels used. A compromise between the speed, capacity and maximum rating of the devices has to be made in order to suit the individual requirements.

Advantages of the epitaxial planar process described are numerous. The devices are produced by diffusion from one side of the chip only, simplifying manufacturing techniques; the epitaxial layer has reproducible properties which are uniform across the surface of the wafer, and it is possible to produce high resistivity material in this way. Of course, not only diodes are produced in this manner; resistors, capacitors, transistors and field effect transistors can all be produced by the planar process.

Isolation in I.C.s

Integrated circuits usually include several of the different devices on the same chip. The problem which now arises is that of isolation of one device from another to avoid unwanted circuit interconnections. Two processes are commonly used to achieve this. First, the use of two back-to-back diodes can be conveniently obtained in integrated circuit form. Both diodes are arranged to be reverse
biased all the time the circuit is in use. This reduces the coupling between the devices to that across a reverse biased diode, namely, several tens of megohms with a parallel capacitance of a few picofarads. Fig. 2 shows two diode structures in an integrated circuit together with this isolation arrangement. The diodes in this case are produced by double diffusion. In order to provide isolation with this arrangement the substrate has to be held more positive than any other point in the integrated circuit, and, of course, with a p-type substrate the substrate has to be made negative.

The second method is to produce isolated pockets of epitaxial material inside regions of polycrystalline material surrounded by thin layers of silicon dioxide. The method of achieving this is somewhat involved, but the important consideration is that the lifetime of the charge carriers in such polycrystalline material is very short. Hence the conductivity is very low so that good isolation is achieved. This method is not used so extensively in manufacturing because of the extra number of steps required in the process. Back-to-back diode isolation provides sufficient immunity to interference for the majority of applications.

Devices can be made in a similar way, not using an epitaxial layer but simply by carrying out diffusion into the surface of the substrate. These devices are called planar devices, sometimes abbreviated to just planar. They are also passivated with silicon dioxide in a similar way to that in which the planar epitaxial devices are treated, as described below.

**Integrated Circuit Components**

Capacitors are required in many circuits, but unfortunately they are difficult to fabricate in integrated circuit form. It is relatively easy to produce small value capacitors, as described in a previous article, using the capacitance of a reverse biased diode. In this way capacitors of up to 0.001 microfarad can be made. Larger values have to be obtained in other ways, either by use of external capacitors or by using electronic methods of multiplying the diode capacitance.

Another method of producing capacitors is by utilising the capacitance across the silicon dioxide layer. During the diffusion processes involved in making the integrated circuit a layer of high conductivity silicon is produced where the capacitor is required. Subsequently a layer of silicon dioxide is grown over this and finally a layer of metal is put on top to produce the second electrode. An advantage of this structure is that the capacitor produced is non-polar, that is it can be used with voltages applied in either direction.

The other passive element which can be fabricated using the diffusion process is the resistor. Since very thin sheets of high resistivity epitaxial material are available it is possible to produce resistors simply by placing two contacts on to a suitably shaped region of the epitaxial layer. There are two ways a given resistor can be made. First, a long wide resistor can be used; secondly, a short thin resistor may be used. The choice depends on several factors including the accuracy required and the power which the resistor will have to dissipate. The important factor determining the resistance is the aspect ratio of the resistor, that is, of course, the ratio of the length to the width of the resistor. It is possible to produce resistors with values up to 20,000 ohms, but it is very difficult to make the value of the resistor exactly equal to the circuit requirements. To overcome this difficulty the circuit of an integrated unit is designed so that its operation depends not so much on the absolute value of each resistor but on their relative values. Thus, in bias chains a potential divider is used rather than a single series resistor. This is because the relative values are determined by the mask shape whereas the absolute values depend strongly on the characteristics of the epitaxial layer. It is practical to produce resistor values accurate to within 10%, but ratios can be obtained with an accuracy better than 2%.

It is not practical to use or produce inductors using integration techniques. Consequently if it is essential to use these components they have to be provided externally to the circuit. However, using active filter techniques it is possible to dispense with the inductors in many circuit arrangements. In this way it is possible to produce filter circuits using only resistors and capacitors and yet attain very high Q values.

Bipolar transistors are produced in integrated circuits by multiple diffusion techniques. For instance, an n-p-n silicon epitaxial transistor, as shown in Fig. 3, could be produced in an integrated circuit by the following processes common to all diffusion device production. A layer of epitaxial n-type silicon is grown over a clean p-type silicon wafer. This epitaxial layer later becomes the collector of the transistor and because of this it has a high resistivity or low impurity concentration. After suitable oxide masking, photolithography and etching, a p-type diffusion is carried out to produce the base region and also in integrated circuits to produce the isolation region previously described. During the diffusion an oxide layer is regrown over the exposed region. Subsequently this is etched in the position of the emitter and an n-type diffusion is carried out to produce a low resistivity emitter with the resultant high injection efficiency. Finally a layer of silicon dioxide is grown over the device completely in order to passivate it against atmospheric contamination, and small areas are
INCREASE YOUR KNOWLEDGE

Established 1891

MANY COURSES TO CHOOSE FROM incl.
RADIO & TV ENGINEERING & SERVICING,
TRANSISTOR & PRINTED CIRCUIT SERVICING,
CLOSED CIRCUIT TV, ELECTRONICS,
NUMERICAL CONTROL ELECTRONICS,
TELEMETRY TECHNIQUES, CONTROL SYSTEMS,
ELECTRONICS FOR AUTOMATION,
COMPUTERS, ETC.

ALSO EXAMINATION COURSES FOR
C. & G. Telecommunication Technicians' Certs
C. & G. Electronic Servicing
R.T.E.B. Radio/TV Servicing Certificate
P.M.G. Certificates in Radiotelegraphy
Radio Amateurs' Examination
General Certificate of Education, etc

BUILD YOUR OWN RADIO AND INSTRUMENTS
With an ICS Practical Radio & Electronics Course you gain a sound knowledge of circuits and applications as you build your own 5-valve Superhet Receiver, Transistor Portable, and high-grade test instruments, incl. professional-type valve volt meter (shown below). Everything simply explained. All components and tools supplied. For illustrated brochure, post coupon below.

MEMBER OF THE ASSOCIATION
OF BRITISH CORRESPONDENCE COLLEGES

THERE IS AN ICS COURSE FOR YOU

Whether you need a basic grounding, tuition to complete your technical qualifications, or further specialized knowledge, ICS can help you with a course individually adapted to your requirements.

There is a place for you among the fully-trained men. They are the highly paid men—the men of the future. If you want to get to the top, or to succeed in your own business, put your technical training in our experienced hands.

ICS Courses are written in clear, simple and direct language, fully illustrated and specially edited to facilitate individual home study. You will learn in the comfort of your own home—at your own speed. The unique ICS teaching method embodies the teacher in the text; it combines expert practical experience with clearly explained theoretical training. Let ICS help you to develop your ambitions and ensure a successful future. Invest in your own capabilities.

FILL IN AND POST THIS COUPON TODAY
You will receive the FREE ICS Prospectus listing the examination and ICS technical courses in radio, television and electronics PLUS details of over 150 specialized subjects.

PLEASE SEND FREE BOOK ON

NAME

ADDRESS

OCCUPATION

AGE

INTERNATIONAL CORRESPONDENCE SCHOOLS
Dept. 170, INTERTEXT HOUSE, PARKGATE ROAD, London, SW11

2/70

795
DISCOSOUND

NEW DISCOSOUND PRE-4

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

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

Specification:
- Inputs: Vol. 1. 10 mv at 50k Ohms | Other
  Vol. 2. 10 mv at 50k Ohms | Impedances
  Vol. 3. 50 mv at 500k Ohms | can be made
  Vol. 4. 50 mv at 500k Ohms | to special order.
- Frequency Response: 30—20,000 Hz ± 1db.
- Signal/Noise Ratio: —65db.
- Bass: continuously variable 20db, at 100 Hz.
- Treble: continuously variable 20db, at 1000 Hz.
- Output: variable up to 1 volt RMS at 25k Ohms.
- Size: front panel 12\(\times\)5\(\frac{1}{2}\) cut out required 11\(\frac{1}{2}\) \(\times\) 4\(\frac{1}{2}\).

Completely built and tested.

PRICE £37.10.0 inc. P. & P.

NEW DISCOSOUND 70 MAIN AMPLIFIER

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

Specification:
- Power Output: 70 watts RMS into 8 Ohms.
- Frequency response: 20—20,000 Hz ± 2db.
- Harmonic distortion: less than 0.5% at 70 watts RMS.
- Input Impedance and Sensitivity: 700 mv at 20-30k Ohms.
- Size: 7\(\times\)9\(\times\)6\(\frac{1}{2}\).

Completely built and tested on steel Chassis.

PRICE £30.00 inc. P. & P.

DJ 30L PSYCHEDELIC LIGHT CONTROL UNIT

3 channel light control unit that handles up to 1,000 watts per channel. Separate bass, middle and treble controls for full frequency separation.

Completely built and tested.

PRICE £60.00 inc. P. & P.

NEW RANGE OF COMPLETELY BUILT & TESTED MODULES USING P.C. BOARDS. FIRST GRADE COMPONENTS AND SILICON TRANSISTORS THROUGHOUT

Model 106F. 4 channel mixer with separate bass and treble controls. Complete with pots, connecting diagram, etc. Power requirements 18 volts D.C.

Specification:
- Vol. 1. 20 mv at 50k Ohms | Other
  Vol. 2. 20 mv at 50k Ohms | Impedances
  Vol. 3. 50 mv at 500k Ohms | can be made
  Vol. 4. 50 mv at 500k Ohms | to special order.
- Frequency: 30—20,000 Hz ± 3db.
- Signal/Noise: —65db.
- Output: variable up to 1 volt RMS.

PRICE £7.00 inc. P. & P.

Model 106SP. 2 channel mixer with separate bass, treble and master volume controls. Fibreglass 'P.C. board complete with pots, connecting diagrams etc. Power requirements 18 volts D.C.

Specification:
- Vol. 1/2 can be from 50k upwards. Please state requirements.
  All other details as 106F.

PRICE £5.00 inc. P. & P.

For full details of these and all Discosound Products write direct to:

DISCOSOUND, 170 ALBION ROAD, LONDON, N.16. Tel: 01-254 5779

Full money back guarantee if returned within 10 days. All Discosound Products are guaranteed for 12 months. Demonstrations given at any time.
etched away to allow metallising of the required external contacts.

One point not yet mentioned is the presence of the n⁺ region in the collector layer. This is provided to give a uniform field across the collector to base junction, effectively lowering the collector output impedance.

Logic and Linear I.C.s

It should now be apparent that most semiconductor devices can be produced in integrated circuit form and thus circuits of high complexity can be produced on a single chip of silicon. The procedures involved in producing optimisation of the manufacturing techniques for a given circuit are very involved, but in most cases it is possible to arrange that an integrated circuit will perform the desired function as well as its discrete component counterpart.

There are basically two types of integrated circuit available and these can conveniently be classified as “logic” and “linear” circuits. The difference between the two classes is that the logic circuits are used in applications where they are required to give yes/no types of output, whereas linear circuits are expected to give an output which has some continuous relationship with the input signal. In this context linear is used somewhat inappropriately as it in fact covers circuits with feedback which results in their output varying with the input signal but in a far from linear manner.

Types of Logic Circuit

The logic circuits are of very varied type. The first solid state logic circuits made were combinations of resistors and diodes and they performed numerous gating functions. Fig. 4 shows an “and” gate using these elements. If A and B are at the +5V level then C will also be at the +5V level, otherwise C will be at the zero level. Notice that if A and B are open circuit C assumes the high state.

![Fig. 4: Simple diode-resistor logical AND gate with corresponding truth table.](image)

Following on from this start there have evolved Resistor Transistor Logic (RTL), Diode Transistor Logic (DTL), Transistor Transistor Logic (TTL), Emitter Coupled Logic (ECL), Emitter Emitter Coupled Logic (E2CL) and MOST logic circuits. Each of these types has its own advantages as seen in the following examples. RTL has a medium speed of operation which means that when a logical switch is made to the input the output follows this change within about 20 nanosec and the circuit also has a fairly low power consumption, each gate taking about 10mW. DTL is somewhat faster than RTL, especially when the nonsaturating type of logic is used so that all the transistors are in the active state rather than being either fully on or off. TTL has a very long propagation delay. Emitter coupled logic has a very short propagation delay but has a large dissipation per gate. ECL is mainly used in the central processors of computers: it has an even shorter delay, typically one or two nanoseconds.

The final arrangement considered here is the MOST logic circuit which consists of arrays of MOS transistors. A MOST logical “and” and “or” gate are shown in Fig. 5. The advantage of this circuit type is that it is relatively cheap to make in highly complex arrangements as no isolation is required between the elements. They are slow but happily consume very little power.

Thus, there is a trade off between the speed of operation of the logical element and the power dissipation per gate. This is an important criterion for the circuit designer and the ideal system would use a combination of the different types to achieve maximum efficiency.

The final article in this series will describe the different linear circuits which are available and also the principles underlying thick and thin film circuit manufacture.

TO BE CONTINUED

PRACTICAL TELEVISION

in the FEBRUARY issue

🌟 CAPACITOR TESTER

Specially designed for the service engineer, providing clear and rapid readings of capacitance values, leakage conditions if any and changes in capacitance and leakage with applied voltage.

🌟 LINE OUTPUT STAGE TUNING

If you've ever wondered just why the line output stage is tuned to the third harmonic of the fundamental frequency, this aspect of line output stage mystique is fully explained.

🌟 LUMINANCE STAGES

A detailed look at the luminance circuitry used in colour receivers, including grey-scale tracking, beam limiting, flyback suppression and so on.

🌟 TV RECEIVER SERVICING

Servicing the Philips 210 series dual-standard hybrid chassis.

PLUS ALL THE REGULAR FEATURES on sale

JANUARY 23rd
Air wave wasters

Recently I have heard a large amount of discussion on the BBC World Service on Commercial Radio in Great Britain. As you probably know, Australia has had commercial radio ever since broadcasting began. I think therefore that I am qualified to pass judgement on these nuisances and air-wave wasters.

I listen to many commercial radio stations in Australia and can state that what I have heard has been nothing but a programme format of continuous pop, high-powered advertisements rammed down the listener’s throat and news that is often inaccurate. The number of advertisements is fantastic. For instance, in one quarter-hour on the local radio station up here (8DN-1240kHz) there was one-half of a gramophone record played (a latest pop of course) and all the rest of the time was taken up with advertisements.

I think therefore, that these air-wave wasters should be banned from cluttering up the air-waves and government radio should be developed to the point of having a service not unlike the BBC. Terry Robinson (Darwin, Australia).

A few memories

As a reader of your excellent magazine for more years than I care to recall, together with some of its early contemporaries which did not make the grade, your editorial article of issue 751 September 1969, encouraged me to write to you for the first time.

Needless to say I heartily applaud the sentiment of your article, we do with the advent of the i.c. have chance once again to rationalise, human nature being what it is, however, I wonder if the nettle will be grasped?

Whilst pondering on this matter and the extent to which the art of radio construction has changed my mind went back to the halcyon days of the spaghetti resistance, Lewcos coils, Telsen, dutch R. valves, and all the last word gadgetry which was penetrated upon the somewhat bewildered constructor even in those early days. I feel certain that some of your more senior readers must recall the “Magic” indoor aerials, the Loewe valves, and even then the attempts at integrated circuitry, I seem to recall that one could purchase a large black box which contained a transformer coupled amplifier, and which had three valve holders mounted upon its top, all one required was the ability to wire up an H. F. section and Volta! a wireless set.

In my opinion the period from the early twenties up to the late thirties was a fascinating one in the development of radio, and I write to ask if it would be possible for a series of articles with pictures and circuitry of constructional projects of the period could be printed, even small articles of the period would I feel raise a smile, and probably the wry comment that little is really new under the sun.

In closing I should like to do something that I have intended to do for so many years, that is to thank you for a very well produced magazine which has remained a real constructors magazine for so long. Long may you flourish. R. C. Armet (Transvaal, Republic of South Africa).

[I would like to hear from readers who would like to see reprints of parts of 1920-1930 articles.]—Editor

Ban the speaker!

Nowadays one reads of semiconductor devices being used to produce coherent light, etc. but nowhere can I find any reference to their being used to produce sound. This surprises me as I remember witnessing this phenomenon in 1964 whilst playing around with a set of transistors. (These transistors came boxed in a set and were, I believe, of Italian manufacture. They were encased in black-painted metal cans.)

I had built a crystal set at this time and was using the transistors to amplify the signal sufficiently to feed a loudspeaker. Being a newcomer to electronics at this time and entirely ignorant of circuitry I remember that in the three-transistor amplifier lash-up I employed a separate battery for each transistor! Unorthodox as this procedure was, it worked well and to my great delight the strains of music obligingly came blasting out of the speaker! On removing the speaker, however, to make some adjustment or other, I noticed that I could still hear the music! The volume was not as high as with the speaker connected but was still at a comfortable level. My first thought was that the sounds were emanating from the speaker transformer core (a large, ex-TV item) but this was not the case. The sound source was the transistors themselves. I cannot now recall if one or all of the transistors were “sounding-off,” but at least one of them was. I believe the actual sound came from the transistor cans which, as mentioned above, were metal and rang when “pinged” with a finger nail, but what caused them to vibrate I have never been able to ascertain.

I should be extremely grateful if any of your readers can collaborate this phenomenon or offer any explanation as to how it could have occurred.—J. B. Jobe (Worcester).

Marconi station

I thought that some history of the above station might be of interest to readers. It was opened in 1910 and was an outstanding landmark round these parts. It could be seen for many miles with its 400ft. aerials standing along the slopes of Caen Dee mountain near Caernarvon.

With the advance of modern developments the old station went out of commission in 1939 and the aerials were pulled down.

During the First World War, the first wireless transmission ever sent to Australia from this country was transmitted from this station by Lloyd George to Hughes, another Welshman who was Prime Minister of Australia at the time.—H. Roberts (Caernarvon, N. Wales).
The Codar CR.70A is an excellent general coverage communications receiver for the keen short wave listener. Very reasonably priced at just £21 the CR.70A is outstanding value for money.

In four stable ranges, the receiver covers from 540 metres medium wave, right through the shipping and coastguard frequencies all the short wave and international amateur bands up to and including 10 metres, where the responsive tuning allows the regular reception of world-wide call-signs!

The CR.70A has a high 'Q' aerial input stage using exclusive CODAR COIL air space inducitor, Double tuned, iron core I.F. transformers produce high selectivity. Ready to plug into 200-250 volt AC mains, the CR.70A needs only your aerial and a 2-3 ohm loudspeaker. The cabinet measures only 13" x 51" x 72" and the control panel is finished in black and white with chrome trim knobs. Fully guaranteed for 12 months!

New model has separate direct output socket for feeding tape recorder, Hi-Fi equipment, etc.

20 gns.
Carriage 7/6 extra

* Ideal for SWLs * 5 valves (inc. two twin triodes) giving 7 valve line-up * Excellent on amateur and shipping frequencies * Calibrated signal strength meter (illuminated) * Automatic volume control * Separate B.F. oscillator for Morse and S.S.B. signals * Two speed vernier tuning * Separate output for recording etc.

**CODAR CR.70A**
Communications Receiver 540-10 metres

The Codar CR.70A is an excellent general coverage communications receiver for the keen short wave listener. Very reasonably priced at just £21 the CR.70A is outstanding value for money.

In four stable ranges, the receiver covers from 540 metres medium wave, right through the shipping and coastguard frequencies all the short wave and international amateur bands up to and including 10 metres, where the responsive tuning allows the regular reception of world-wide call-signs!

The CR.70A has a high 'Q' aerial input stage using exclusive CODAR COIL air space inducitor, Double tuned, iron core I.F. transformers produce high selectivity. Ready to plug into 200-250 volt AC mains, the CR.70A needs only your aerial and a 2-3 ohm loudspeaker. The cabinet measures only 13" x 51" x 72" and the control panel is finished in black and white with chrome trim knobs. Fully guaranteed for 12 months!

New model has separate direct output socket for feeding tape recorder, Hi-Fi equipment, etc.

20 gns.
Carriage 7/6 extra

* Ideal for SWLs * 5 valves (inc. two twin triodes) giving 7 valve line-up * Excellent on amateur and shipping frequencies * Calibrated signal strength meter (illuminated) * Automatic volume control * Separate B.F. oscillator for Morse and S.S.B. signals * Two speed vernier tuning * Separate output for recording etc.

**CODAR CR.70A**
Communications Receiver 540-10 metres

The Codar CR.70A is an excellent general coverage communications receiver for the keen short wave listener. Very reasonably priced at just £21 the CR.70A is outstanding value for money.

In four stable ranges, the receiver covers from 540 metres medium wave, right through the shipping and coastguard frequencies all the short wave and international amateur bands up to and including 10 metres, where the responsive tuning allows the regular reception of world-wide call-signs!

The CR.70A has a high 'Q' aerial input stage using exclusive CODAR COIL air space inducitor, Double tuned, iron core I.F. transformers produce high selectivity. Ready to plug into 200-250 volt AC mains, the CR.70A needs only your aerial and a 2-3 ohm loudspeaker. The cabinet measures only 13" x 51" x 72" and the control panel is finished in black and white with chrome trim knobs. Fully guaranteed for 12 months!

New model has separate direct output socket for feeding tape recorder, Hi-Fi equipment, etc.

20 gns.
Carriage 7/6 extra

* Ideal for SWLs * 5 valves (inc. two twin triodes) giving 7 valve line-up * Excellent on amateur and shipping frequencies * Calibrated signal strength meter (illuminated) * Automatic volume control * Separate B.F. oscillator for Morse and S.S.B. signals * Two speed vernier tuning * Separate output for recording etc.

**CODAR CR.70A**
Communications Receiver 540-10 metres

The Codar CR.70A is an excellent general coverage communications receiver for the keen short wave listener. Very reasonably priced at just £21 the CR.70A is outstanding value for money.

In four stable ranges, the receiver covers from 540 metres medium wave, right through the shipping and coastguard frequencies all the short wave and international amateur bands up to and including 10 metres, where the responsive tuning allows the regular reception of world-wide call-signs!

The CR.70A has a high 'Q' aerial input stage using exclusive CODAR COIL air space inducitor, Double tuned, iron core I.F. transformers produce high selectivity. Ready to plug into 200-250 volt AC mains, the CR.70A needs only your aerial and a 2-3 ohm loudspeaker. The cabinet measures only 13" x 51" x 72" and the control panel is finished in black and white with chrome trim knobs. Fully guaranteed for 12 months!

New model has separate direct output socket for feeding tape recorder, Hi-Fi equipment, etc.

20 gns.
Carriage 7/6 extra

* Ideal for SWLs * 5 valves (inc. two twin triodes) giving 7 valve line-up * Excellent on amateur and shipping frequencies * Calibrated signal strength meter (illuminated) * Automatic volume control * Separate B.F. oscillator for Morse and S.S.B. signals * Two speed vernier tuning * Separate output for recording etc.

**CODAR CR.70A**
Communications Receiver 540-10 metres

The Codar CR.70A is an excellent general coverage communications receiver for the keen short wave listener. Very reasonably priced at just £21 the CR.70A is outstanding value for money.

In four stable ranges, the receiver covers from 540 metres medium wave, right through the shipping and coastguard frequencies all the short wave and international amateur bands up to and including 10 metres, where the responsive tuning allows the regular reception of world-wide call-signs!

The CR.70A has a high 'Q' aerial input stage using exclusive CODAR COIL air space inducitor, Double tuned, iron core I.F. transformers produce high selectivity. Ready to plug into 200-250 volt AC mains, the CR.70A needs only your aerial and a 2-3 ohm loudspeaker. The cabinet measures only 13" x 51" x 72" and the control panel is finished in black and white with chrome trim knobs. Fully guaranteed for 12 months!

New model has separate direct output socket for feeding tape recorder, Hi-Fi equipment, etc.

20 gns.
Carriage 7/6 extra

* Ideal for SWLs * 5 valves (inc. two twin triodes) giving 7 valve line-up * Excellent on amateur and shipping frequencies * Calibrated signal strength meter (illuminated) * Automatic volume control * Separate B.F. oscillator for Morse and S.S.B. signals * Two speed vernier tuning * Separate output for recording etc.
WEYRAD

COILS & TRANSFORMERS FOR CONSTRUCTORS

Special versions of our P50 Series are now available for AF117 or OC45 Transistors. They can be used in the standard superhet circuit with slight changes in component values.

Oscillator Coil P50/1AC (For OC45) P50/1AC (For AF117) 5/4
1st I.F. Transformer P50/2CC (For OC45) P51/1 (For AF117) 5/7
2nd I.F. Transformer P50/2CC (For OC45) P51/2 (For AF117) 5/7
3rd I.F. Transformer P50/3CC (For OC45) P50/3V (For AF117) 6/-

Rod Aerial RA2W 12/6
Driver Transformer LFDT4/1 9/6
Output Transformer OPT1 10/6
Printed Circuit PCA1 9/6

I.F. TRANSFORMERS FOR "PRACTICAL WIRELESS" CIRCUITS

Components for several receivers are available, including the following for the "Clubman".

T41/1E 1st I.F. Transformer 7/6
T41/2E 2nd I.F. Transformer 7/6
T41/3T 3rd I.F. Transformer 10/6
T41/3T B.F.O. Coil 10/6

Details of these and our other components are given in an illustrated folder which will be supplied on request with 4d. postage please.

WEYRAD (ELECTRONICS) LIMITED
SCHOOL STREET, WEYMOUTH, DORSET

R.S.T. VALVE MAIL ORDER CO.
BLACKWOOD HALL, 16a WELLFIELD ROAD, STREATHAM S.W.16

Mon.-Sat. 9 a.m.
Closed Sat. 1.30-2.30 p.m.
Open Daily to Callers

Tel. 789-0199/1489

Special Express Mail Order Service
SEND S.A.E. FOR LIST OF 2,000 TYPES

Manufacturers and Export Inquiries Welcome

Distributor Types A & Speciality

QUOTATIONS FOR ANY VALVE NOT LISTED
Express postage 3d. per valve.
Ordinary postage 6d. per valve. C.W.O. No C.O.D.

Tube postage 7/6 each

TUBES

SETS OF VALVES

A14寸 (4x 0) 14/- plus postage
A17寸 (4x 5) 14/- plus postage

EXPRESS POSTAGE 3d. PER VALVE
ORDINARY POSTAGE 6D. PER VALVE C.W.O. NO.C.O.D.

Tube postage 7/6 each

Special Express Mail Order Service
SEND S.A.E. FOR LIST OF 2,000 TYPES
Field Effect Transistors

There are two basic forms of construction used in the manufacture of field effect transistors (f.e.t.s). The resulting devices are known as junction f.e.t.s and insulated gate f.e.t.s. It will be convenient to examine each type separately.

Junction f.e.t.

The junction f.e.t. is a device utilizing a single p-n junction with a structure very similar to the unijunction transistor which is a related device. The basic structure is illustrated in Fig. 12 and consists of a bar of n-type semiconductor, usually silicon, with a p-type region on either side of the bar. The n-type portion between the p-type regions is called the channel and current flows through the channel from drain to source. Now if the diode formed between the p-type region, termed the gate, and the source is reverse biased by a negative potential on the gate, an electric field is set up in the channel which restricts the current flow through it. If the voltage is sufficiently negative all current flow is inhibited through the channel. The bias voltage for zero current is called the pinch off voltage (Vp).

The operation of an f.e.t. depends on an input through a reverse-biased diode and therefore the f.e.t. characteristically has a very high input impedance (~10MΩ). As with other semiconductor devices p-type and n-type materials can be reversed to give a p-channel f.e.t. with an n-type gate, and in this case the potential on the gate is reversed. The symbols for n-channel and p-channel f.e.t.s are shown in Fig. 13 together with the biasing voltages for normal operation. It should be remembered that the arrow direction indicates the diode forward current direction and hence potentials are such as to reverse bias the diode.

At this point most of us with valve experience will have noted the similarity between valves and f.e.t.s. In fact the n-channel f.e.t., which is by far the most commonly available f.e.t., is strikingly similar both in voltage polarities, as shown in Fig. 14, and characteristics, shown in Fig. 15. Unlike the valve however the maximum drain to source voltage is limited by breakdown characteristics, whilst f.e.t. transconductance \( \frac{\text{Ids}}{\text{Vgs}} \) varies with bias voltage (Vgs) and is a maximum at Vgs = 0. The transconductance is more linear than for conventional transistors.

![Fig. 12: Basic structure of a junction F.E.T.](image)

![Fig. 13: B.S. preferred symbols and applied polarities for junction F.E.T.'s.](image)

![Fig. 14: (left) Comparison of F.E.T. and pentode symbols.](image)

![Fig. 15: (right) Comparison of F.E.T. and pentode characteristics.](image)

Manufacturer's parameters for f.e.t.s usually include the items shown in Table 2, which also includes typical ranges of values for n-channel devices. Other parameters include maximum reverse transfer capacitance at 0.5-10pF and noise figures between 1-5dB. These are usually only important for critical applications.

Field effect transistors are used for many applications including microphone preamplifiers, d.c. differential amplifiers, r.f. amplifiers in v.h.f. radio circuits, switching circuits and instrument input amplifiers. At present they are used in circuits which particularly require the special features of low noise levels and high input impedance. The extremely low drift currents of 1pA (10^-12A) per °C and high input impedances make them particularly suitable for use in input and buffer circuits.
Table 2: Typical f.e.t. parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Typical values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. gate-source voltage</td>
<td>Vgs</td>
<td>20-50V</td>
</tr>
<tr>
<td>Max. drain-source voltage</td>
<td>Vds</td>
<td>20-100V</td>
</tr>
<tr>
<td>Drain-source current at Vgs=0</td>
<td>Idss</td>
<td>0.5-100mA</td>
</tr>
<tr>
<td>Max. pinch off voltage Vgs=Vp</td>
<td>Vp</td>
<td>2-10V</td>
</tr>
<tr>
<td>Max. gate current</td>
<td>Vgss</td>
<td>0.1-10nA</td>
</tr>
<tr>
<td>Transconductance</td>
<td>gm</td>
<td>0.25-30mA/V</td>
</tr>
</tbody>
</table>

Typical input characteristics of an f.e.t. preamplifier are Zin >1MΩ, Cin >10pF, noise voltage <0.5mV and bandwidth >100MHz.

Figure 16 illustrates the two basic forms of junction f.e.t. construction which are used at present. The alloy construction of Fig. 16(a) is still the most common where p-type pellets are alloyed to either side of an n-type slice. The geometrical outline is also used for diffused junction f.e.t.s. As with conventional transistors planar construction, using the more accurate photographic techniques, is used increasingly in close tolerance f.e.t. manufacture, and this form of construction is illustrated in Fig. 16(b).

A special form of construction used to obtain good high frequency characteristics is illustrated in Fig. 17 and this device is known as a tecntron. Indium is deposited on the surface of an n-type slice etched to receive the plating. The result is a thin channel region of small area giving low capacitance and therefore good high frequency characteristics. The structure is however electrically and thermally less robust and is at present rather uncommon.

As with conventional transistors the encapsulation of f.e.t.s is mainly of the popular TO-18 or TO-5 types. A plastic encapsulation is shown in Fig. 18 but as the lead out connections are still unstandardised the precise terminal designations should be obtained from the manufacturer.

![Fig. 18](image_url)

We have now examined the junction field effect transistor and should consider the second basic form of construction known as insulated gate f.e.t. It is interesting to note that it was experiments with crude constructions to obtain the insulated gate f.e.t., or unipolar transistor as it was then known, that led to the discovery by Shockley of the conventional or bipolar transistor. The insulated gate f.e.t. was therefore a forerunner of the modern transistor but it is only with the discovery of planar epitaxial techniques that the insulated gate or metal-oxide semiconductor (m.o.s.) transistor has been a practical proposition in terms of noise and gain.

**Insulated Gate f.e.t. or Metal-Oxide Semiconductor Transistor (m.o.s.t.)**

Metal-oxide semiconductor transistors (m.o.s.t.s) are constructed with p- or n-type semiconductor channels. In place of the reverse biased p-n junction which provides the controlling electric field, the field is formed through an extremely thin insulated junction. The insulation is provided by a silicon dioxide layer which acts as an efficient insulator. The basic form of construction is similar to that shown in Fig. 12 for a junction f.e.t. except that the junction is formed between a metal connection and the p- or n-type channel. The insulation is silicon dioxide thermally grown by passing steam over the basic chip. The basic symbol for a m.o.s.t. is shown in Fig. 19.

![Fig. 19](image_url)

The m.o.s.t. has properties which are peculiar to insulated gate structures. Two basic modes of action are possible. Firstly the depletion mode in which current normally flows through the channel but is reduced by channel width depletion until zero current flows at maximum gate voltage. The second mode of operation is known as the enhancement mode and in this mode the device is normally off but is turned on up to saturation point by increasing gate potentials. The enhancement mode is achieved by altering the end connections and type of channel material so that the path between the drain and source appears as back-to-back diodes and the gate potential increasingly reduces the blocking effect. It is clear from this that all junction f.e.t.s belong to the depletion mode of operation since the gate p-n junctions must be reverse biased.

---continued on page 806---
Heathkit for the new “Compact” Sound of the 70’s

The fabulous stereo “Compacts” Models AD–17 and AD–27 are setting the pace in hi-fi for the 1970’s. They offer outstanding value and performance. The AD–17 comprises a BSR MA-65 turntable/Shure M44-MB magnetic cartridge and a 10 watt (RMS) per channel stereo amplifier all mounted on a Teak or Walnut plinth.

**Kit Price £54. Carr. 13/-**

The AD–27 is similar but uses the MA–70 turntable and includes an FM stereo tuner. In this case the “plinth” is better described as a small cabinet. It has the additional features of a “Roller Shutter” lid and is available in Teak or Walnut.

**Kit Price £82. Carr 13/-**

Heathkit offer many excellent loudspeaker systems the new “Ambassador” Hi-Fi loudspeaker is winning many friends. Its cabinet is supplied ready assembled and finished in selected Teak or Walnut veneers to harmonise with other current Heathkit hi-fi equipment. It uses three loudspeaker units a 12in. bass, 5in. mid range and a 1in. Dome Pressure Tweeter.

**Kit Price £29.16.0 Carr. 15/-**

The complete Heathkit hi-fi range of stereo amplifiers, tuner/amplifiers, FM tuners, Stereo “Compacts”, loudspeaker systems and ancilliary hi-fi equipment are all described and illustrated, many in full colour. In a wonderful free catalogue.

Send for the FREE Catalogue and see for yourself . . . Today!

---

**TO DAYSTROM LTD., GLOUCESTER, GL2-6EE**

☐ Please rush me details of the latest Heathkit Hi-Fi Models

**NAME:**

**ADDRESS:**

**S12A**
WHARFEDALE Rosendale... £59.0 0  £50.19 6
WHARFEDALE UNIT 3 Speaker Kit... £55.9 0  £47.19 6
WHARFEDALE DOLCI... £43.9 0  £37.19 6

Most types of chassis, speakers, cross-over networks, etc., available ex stock.

TURNTABLES

ARENA SP-25 complete with cover... £40.10 0  £32.19 6
GARRARD SP-29, Mark II... £44.10 0  £36.19 6
GARRARD AP-39... £50.19 6
GARRARD SL-55... £61.19 6
GARRARD SL-65... £51.00 0  £43.19 6
GARRARD SL-75... £75.19 6
GARRARD SL-95B... £47.19 6
GARRARD 401... £32.19 6
GARRARD 5000 fitted with GKS-25 Cartridge... £32.19 6
GARRARD 5000 fitted with GKS-25 Cartridge... £32.19 6
GOLDING GL49... £32.19 6
GOLDING 69P... £32.19 6
GOLDING Lenco GL75... £32.19 6
GOLDING LSP Inc. cover... £32.19 6
GOODMANS Model 300S complete with magnetic cartridge... £32.19 6
THORENS TD-125... £35.10 0  £27.19 6
THORENS TD-150A Mark II... £35.10 0  £27.19 6
THORENS TD-150AB Mark II... £35.10 0  £27.19 6
THORENS TD-194/2... £35.10 0  £27.19 6

Base, plinth and covers stocked to suit all the above turntables.

HI-FI STEREO TAPE DECKS AND TAPE RECORDERS

AKAI X-360 4-track... £35.10 0  £29.19 6
AKAI X-3800 deck 4-track... £40.10 0  £32.19 6
AKAI X-1170 4-track without accessories... £40.10 0  £32.19 6
AKAI X-1800 4-track... £40.10 0  £32.19 6
AKAI X-1800SD 4-track... £40.10 0  £32.19 6
AKAI X-4000D 4-track... £50.10 0  £42.19 6
FERGUSON 3224 Twin Track... £50.10 0  £42.19 6
FERGUSON 3224 Four Track... £50.10 0  £42.19 6
GRUNDIG TK124... £50.10 0  £42.19 6
GRUNDIG TK144... £50.10 0  £42.19 6
GRUNDIG TK148... £50.10 0  £42.19 6
MARCONI 4128 Stereo Tape Recorder... £50.10 0  £42.19 6
MARCONI 4224 8-track Tape Recorder... £50.10 0  £42.19 6
TRUVOX R52 & R56 3-speed 8-track... £50.10 0  £42.19 6

PICKUP ARMS

GOLDING Lenco L75... £12.50 0  £10.19 6
GOLDING Lenco G45... £12.50 0  £10.19 6
SME 309 with S2 shell... £32.19 6
SME 309 with S2 shell... £32.19 6

COMET DISCOUNT WAREHOUSE

Reservoir Road, Clough Road, Hull. Tel 407906
68a Armley Rd (Artist St) Leeds LS12 2EF Tel 32055

Customers are welcome to call personally.
Ample Car Parking facilities

Comet guarantees all prices quoted are genuine. All items offered available at these prices at the time this issue closed for press.
Add 9% for post and packing on all orders. Make cheques, Money Orders payable to "COMET".
Receivers in the higher price range often have a crystal filter to give a very considerable increase in selectivity compared with transformers, thus reducing interference from adjacent transmissions. The simplest type of filter is that with a single crystal and variable phasing. The filter described here was fitted as an addition in the all-wave "Progressive Superhet" (March 1969 issue) but could equally well be included in other home-constructed, surplus, communications-type receivers.

Figure 1 is the circuit and uses the centre-tapped i.f. transformer listed, numbers being for the pins of this component. This i.f.t. is intended for 465kHz, but was found to be satisfactory anywhere in the 455-470kHz range.

The crystal was 464-75kHz, obtained from the supplier listed. There is no need to use this exact frequency, as all the i.f.t.s are later aligned on the crystal frequency.

When the 20pF variable capacitor is adjusted to balance the stray crystal circuit capacitance a symmetrical response curve similar to that at A in Fig. 2 is obtained. The crystal has a Q very much higher than that of an ordinary tuned circuit, so the response curve is very sharp, giving high selectivity. F is the crystal frequency. The ordinary tuned circuits of the other i.f.t.s help to reduce the response at the wider skirt frequencies, F1 and F2.

If the variable capacitor is adjusted slightly, changes in phase produce the notch shown at B: this is a frequency at which there is minimum response. The position of this rejection notch can be varied by adjusting the phasing capacitor, and can be moved to the other side of the resonant frequency F. The normal selectivity of the other i.f.t. tuned circuits helps compensate for the hump and extended skirt of B.

Maximum selectivity may be increased by reducing the value of the 33kΩ resistor, or reduced by increasing the resistor value. Selectivity with the circuit balanced (A, Fig. 2) is too great for normal reception, so for this purpose some means of cutting out the crystal or reducing its effect becomes necessary. The best method is to short out the crystal with a low-loss low-capacitance switch connected with short leads, but there are other ways such as adjusting the phasing capacitor well off optimum setting or bending one corner of a moving plate so that the capacitor shorts when closed. These methods avoid the switch but leave a secondary dip from the crystal when tuning.

![Fig. 1: The circuit](image1)

![Fig. 2: The response curves—see text.](image2)

In the receiver mentioned, the first i.f.t. is removed and the centre-tapped type fitted in its place. The phasing capacitor is mounted on paxolin, fixed to the chassis with brackets. A 1/8in. dia. insulated extension rod is attached to the capacitor spindle with a coupling, and passes through a bush placed in the "R.F./I.F. Gain" control position, this potentiometer being moved to the right of the panel above the chassis.

With other receivers, a well-screened layout is best, to avoid stray coupling round the crystal, thereby reducing its efficiency. The layout should also permit short wiring. Some commercial receivers have the phasing capacitor fitted to the panel, with only an insulated bush, but this can cause misalignment because of hand capacitance effects.

For best possible results alignment is quite critical, and is best done by tuning-in a quite strong, steady signal, such as that from a BBC transmitter.

With the crystal in circuit and the phasing capacitor about half closed, tune slowly through the signal, observing the S-meter or a meter temporarily placed in the h.f. circuit to one i.f. stage.

A very sharp peak should be seen, with a

---

**Components list**

- Type IFT11/465/CT i.f. transformer (Denco, Clacton, Ltd., 357/9 Old Road, Clacton-on-Sea, Essex).
- Crystal, 464-75kHz or similar (Henry’s Radio Ltd., 303 Edgware Road, London, W.2).
- 33kΩ 1/8-watt resistor.
- 20pF or similar miniature air-spaced variable capacitor.
- Insulated extension spindle, coupling, bush etc. (Home Radio, 187 London Road, Mitcham, Surrey.)
broader but similarly strong response at a second but near frequency. The sharp peak is from the crystal, and broad peak from the i.f. tuned circuits.

Tune to the sharp peak, and adjust all the i.f. cores slightly for best results. As this is done, the second broad peak will disappear, and signal strength at the sharp peak will rise considerably.

Careful tuning will now probably show a response similar to that at B, Fig. 2. Adjust the phasing capacitor until this changes to that at A. Reduce signal input (a very short aerial can be used to do this) and carefully touch-up the i.f. cores.

With all i.f.t.s tuned exactly on the crystal, and the latter balanced, observation of the S-meter will give a response like that at A. If the receiver is tuned slightly above or below a carrier, adjustment of the phasing capacitor one way or the other should be found to place the carrier in the rejection notch, B, so that it almost completely disappears.

As the receiver i.f. has been modified, the oscillator cores and trimmers should be touched up, for best results on each band.

Maximum selectivity is primarily for c.w. only, the passband being too narrow for speech. However, when operating in a congested amateur or other band, selectivity can be degraded somewhat by adjusting to obtain the curve B, meanwhile placing the notch so as to reduce interference. This allows a great improvement in the reception of voice transmissions.

P.W. GUIDE TO COMPONENTS

continued from page 802

Insulated gate f.e.t.s are commonly of the depletion type and can be directly substituted with junction f.e.t.s of the same effective channel type. Gate currents are of course considerably lower and gate-source bleed resistors can be as high as 1,000MΩ and mainly depend only on external leakage requirements. The principal disadvantage of m.o.s. transistors is the high noise levels which are associated with the insulated gate and which preclude their use in small signal circuits.

Field effect transistors therefore are an extremely useful alternative to conventional bipolar transistors. They are encapsulated in similar cases to transistors, and where heavy current devices are required an interdigitated or multichannel device is used. At present plastic encapsulated, wide tolerance junction f.e.t.s (n-channel) are available from 5s. whilst closer tolerance f.e.t.s, both n- and p-channel, are usually available from £1 to £20. Insulated gate f.e.t.s are of the same order of price. Since the vast majority of f.e.t.s are junction n-channel devices it would be wise for the amateur to use these widely available and hence cheaper devices.

TO BE CONTINUED

QUERY COUPON

This coupon is available until 6th February 1970 and must accompany all queries in accordance with the rules of our Query Service.

PRACTICAL WIRELESS, FEBRUARY 1970

NEXT MONTH IN

PRACTICAL WIRELESS

TWELVE TRANSISTOR RECEIVER

A real communications type receiver with continuous coverage from 550kHz to 30MHz in four switched bands. Incorporated in the design are a variety of features found only in the best sets—switched a.g.c., S-Meter and B.F.O.

The problem of tackling a set of this complexity is overcome to such an extent that it can truly be classed in the beginners range. The set initially starts as a six transistor receiver and will provide excellent coverage in this form, but it builds up to a twelve transistor plus four diode set with the features mentioned above.

METAL DETECTOR

This article describes the principles of metal detection including the limitations of amateur types and goes on to describe a practical circuit which in addition to being useful for locating house wiring etc. can give endless hours of fun. In the described form the metal detector should cost under 50s. including headphones but a cheaper and simpler version making use of a standard radio set is also described.

BOOKSHELF SPEAKER

The "Decibella" speaker enclosure contains a woofer and a tweeter, frequencies above 3kHz being fed to the tweeter and below 3kHz to the woofer. A series L-C crossover network is employed.

Size of the enclosure is 13 x 8in. with a depth of 8½in. and fed from a 10 Watt amplifier, two of these units will give really good stereo listening.

PLUS THE REGULAR "TAKE 20" AND "I.C. OF THE MONTH" FEATURES AND OTHER CONSTRUCTIONAL ARTICLES AND FEATURES

Don't miss your copy of the March issue of Practical Wireless—on sale 6th February—price 3s.
the world's most advanced high fidelity amplifier

The Sinclair IC-10 is the world's first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself, a chip of silicon only a twentieth of an inch square by a hundredth of an inch thick, has an output of 5 watts R.M.S. (10 watts peak). It contains 13 transistors (including two power types), 2 diodes, 1 zenor diode and 18 resistors, formed simultaneously in the silicon by a series of diffusions. The chip is encapsulated in a solid plastic package which holds the metal heat sink and connecting pins. This exciting device is not only more rugged and reliable than any previous amplifier, it also has considerable performance advantages. The most important are complete freedom from thermal runaway due to the close thermal coupling between the output transistors and the bias diodes and very low level of distortion.

The IC-10 is primarily intended as a full performance high fidelity power and pre-amplifier, for which application it only requires the addition of the usual tone and volume controls and a battery or mains power supply. However, it is so designed that it may be used simply in many other applications including car radios, electronic organs, servo amplifiers (it is d.c. coupled throughout) etc. The photographic masks required for producing monolithic I.C.s are expensive but once made, the circuits can be produced with complete uniformity and at very low cost. It also enables us to give a 5 year guarantee on each IC-10 knowing that every unit will work as perfectly as the original and do so for a lifetime.

- **SPECIFICATIONS**
  - Output: 10 Watts peak, 5 Watts R.M.S. continuous.
  - Frequency response: 5 Hz to 100 KHz ±1dB.
  - Total harmonic distortion: Less than 1% at full output.
  - Load impedance: 3 to 15 ohms.
  - Power gain: 110dB (100,000,000,000 times) total.
  - Supply voltage: 8 to 18 volts.
  - Size: 1 x 0.4 x 0.2 inches.
  - Sensitivity: 5mV, adjustable externally up to 2.5 M ohms.

- **CIRCUIT DESCRIPTION**
  The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. Class AB output is used with closely controlled quiescent current which is independent of temperature. Generous negative feedback is used round both sections and the amplifier is completely free from crossover distortion at all supply voltages, making battery operation eminently satisfactory.

- **APPLICATIONS**
  Each IC-10 is sold with a very comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity. These include stabilised power supplies, oscillators, etc. The pre-amp section can be used as an R.F. or I.F. amplifier without any additional transistors.

**SINCLAIR**

IC.10 with IC.10 manual and 5 year guarantee

59/6

POST FREE

SINCLAIR RADIONICS LIMITED
22 NEWMARKET ROAD · CAMBRIDGE
Tel. 0233-52731
For four years, the Sinclair Z.12 dominated the constructor world, being the best selling unit of its kind this side of the Atlantic. Excellent as it was, the new Sinclair Z.30 is still better. Half the size of the Z.12, it has more than twice the power, very much greater gain and a level of distortion 50 times lower. This incredible figure results from using over 60dB of negative feed back with a constant current load to the driver stage obtained by incorporating a two transistor circuit in place of the more usual boot-strapping. 9 silicon epitaxial planar transistors are used to provide enormous power (up to 20 watts RMS continuous sine wave, 40 watts peak). The circuitry of this marvellous amplifier allows it to be operated from any voltage from 8 to 35 to perfection. At all output levels, distortion is only 0.02%. This puts true laboratory standards into the hands of every user of a Z.30. Two Z.30s and a new Stereo Sixty will make a stereo assembly of such perfection that it could not be bettered in its class no matter how much you spent. But the Z.30 has an enormous variety of applications, particularly where quality, precision and reliability are essential. Yet this brilliant new Sinclair design costs not a penny more than its famous predecessor.

SPECIFICATIONS

Power output: 15 watts R.M.S. into 8 ohms using a 35 volt supply; 20 watts R.M.S. into 3 ohms using a 30 volt supply.

Output: Class AB

Frequency response: 30 to 300,000Hz ± 1dB.

Distortion: 0.02% total harmonic distortion at full output into 8 ohms and at all lower output levels.

Signal-to-noise ratio: better than 70dB unweighted.

Input sensitivity: 250mV into 100 Kohms.

Damping factor: > 500.

Loudspeaker impedances: 3 to 15 ohms.

Power requirements: From 8 to 35V d.c.

(The Z.30 will operate ideally from batteries if required).

Size: 3½ x 2½ x ¾ inches.
This attractive and completely new unit is intended for use with two new Z.30 amplifiers to provide the finest possible standards of stereo reproduction. Four press buttons and four rotary controls are used to provide on-off, three input selectors and Volume, Bass cut/boost, Treble cut/boost and Stereo balance. The on-off button also switches the power amplifiers. The front panel in brushed aluminium is flush mounted to the cabinet front, it being necessary only to drill holes to accommodate the controls. Rear adjustable brackets hold the chassis tight to the cabinet. The very latest ganged rotary controls are used to afford compactness and extra long working life free from noise.

The Stereo-60 may also be used with 21C-10’s or any other high performance amplifiers.

**SPECIFICATIONS**

- Input sensitivities—Radio—up to 3mV
- Magnetic Pickup—3mV; correct to R.I.A.A. curve ±1dB; 20 to 25,000 Hz.
- Ceramic Pickup—up to 3mV: Auxiliary—up to 3mV.
- Output—250mv.
- Signal-to-noise ratio—better than 70dB.
- Channel matching—within 1dB.
- Tone Controls—TREBLE +15 to -15dB at 10kHz. BASS +15 to -15dB at 100Hz.
- Power consumption 5mA.
- Front panel—brushed aluminium with black knobs and controls.
- Size 8 x 3 x 4 ins.

**PZ.5 POWER SUPPLY UNIT**

A new heavy duty mains power supply unit designed specially to drive two Z.30s and a Stereo Sixty. New compact design.

For AC Mains, 200-240V/50Hz.

£4.19.6

---

To: SINCLAIR RADIONICS LTD., 22 NEWMARKET RD., CAMBRIDGE

Please send

NAME

ADDRESS

For which I enclose cash/cheque/money order

---

PW2/70
SINCLAIR Q.16

new elegance in an outstanding loudspeaker

All the superb features which went to make the Sinclair Q.14 have been incorporated in the new Q.16 which gives an exciting new opportunity for you to match your Sinclair equipment with modern decor. Employing the same well proven acoustic system in which materials, processing and styling are used in such a radical and successful departure from conventional design, the new Q.16 presents an entirely new appearance with its attractive teak surround and all-over special cellular foam front chosen as much for its appearance as for its ability to pass all audio frequencies without loss. The Q.16 is compact and slim. Its new styling makes it eminently suitable for shelf mounting, but it is no less versatile than its famous predecessor. Listen to a pair of Q.16s in stereo and marvel at the standards of quality and clarity they give.

The Q.16 will handle loading up to 14 watts R.M.S. and presents an 8 ohm impedance to the amplifier output. Frequency response extends from 60 to 16,000Hz with exceptional smoothness. A specially designed driver system is used in a sealed and contoured pressure chamber to ensure good transient response at all frequencies. Size: 9\(\frac{3}{4}\) square \(\times 4\frac{1}{2}\) deep from front to back.

£8.19.6
POST FREE

The world's most successful miniature radio

SPECIFICATIONS—Size: 1\(\frac{3}{4}\)\(\times\)1\(\frac{3}{4}\)\(\times\)\(\frac{1}{2}\) (46\(\times\)33:\(\times\)15mm). Weight incl. batteries: 1 oz. (28-35g) approx. Tuning: Medium wave band with bandspread at higher frequency end. Earpiece: Magnetic type. Case: Black plastic with anodized aluminium front panel, spun aluminium dial.

Complete kit incl. earpiece, case, solder and instructions in fitted back. Plus 1\(\frac{1}{4}\) dr. P.T. surcharge ready built, tested and guaranteed with earpiece. Plus 1\(\frac{1}{4}\) dr. P.T. surcharge Mallory Mercury Cell RM575 (2 req.) 2\(\frac{1}{2}\) each

Complete kit, 49/6

Plus 1\(\frac{1}{4}\) dr. P.T. surcharge

49/6

59/6

To: SINCLAIR RADIONICS LTD., 22 NEWMARKET RD., CAMBRIDGE
Please send

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

For which I enclose cash/cheque/money order

SINCLAIR GENERAL GUARANTEE

Should you not be completely satisfied with your purchase when you receive it from us, return the goods without delay and your money will be refunded in full, including cost of return postage, at once and without question. Full service facilities are available to all Sinclair customers.

SINCLAIR RADIONICS LIMITED
22 NEWMARKET RD., CAMBRIDGE
Tel: 0223 52731
YOUR CAREER in RADIO & ELECTRONICS?

Big opportunities and big money await the qualified man in every field of Electronics today—both in the U.K. and throughout the world. We offer the finest home study training for all subjects in radio, television, etc., especially for the CITY & Guilds Exams (Technicians' Certificates); the Grad. Brit. I.E.R. Exam.; the RADIO AMATEUR'S LICENCE; F.M.G. Certificates; the R.T.E.B. Servicing Certificates; etc. Also courses in Television; Transistors; Radar; Computers; Servo-mechanisms; Mathematics and Practical Transistor Radio course with equipment. We have OVER 20 YEARS' experience in teaching radio subjects and an unbroken record of exam successes. We are the only privately run British home study College specialising in electronics subjects only. Fullest details will be gladly sent without any obligation.

To: British National Radio School, Reading, Berks.

Please send FREE BROCHURE to

NAME .............................................................. Block
ADDRESS .......................................................... Caps.
................................................................. Please

3170

BETTER Service

FROM TRS

BUILD THIS FINE VERSION OF THE PW.12-12 WITH A TRS KIT

T.R.S. have produced their own kit version of this outstanding combined stereo amp and pre-amplifier. It conforms precisely to Practical Wireless' excellent circuit but is styled for a flatter, more conventional cabinet which will be available shortly. Kit includes two-tone front panel and control knobs, components and transistors.

Inputs—Map. P.UG. (R.I.A.A.) 2-mV into 68 KOhms; Ceramic P.U. and Radio: Response 90Hz to 30KHz ±1dB. Output—12 watts per channel. R.M.S. into 15 ohms.

Kit complete ........................................ £24.10.0 (Carr. 7/0)
Power Amplifier & pre-amp Kits available separately, less cabinet ..................................... £14.10.0 (Carr. 7/0)

AMPLIFIERS

Stylish and kidded by T.R.S., using quality components, including valves or transistors as necessary and excellent instruction. Backed by T.R.S. Service.

MULLARD 5.10. Basic kit (requires pre-amp). Input Sensitivity—40mV; Response 80Hz-15KHz ±1dB; Output 10 watts R.M.S. at 3 or 15 ohms.

Basic Kit £10.16.0. BUILT £22.9.8 (Carr. either 7/0).

MULLARD 2 VALE. VALVE Pre-amp. Switching for 5 inputs: bass/treble/volume controls, etc. Sensitivity at input—4mV max into 50K-1 Megohm; Response 20-30,000Hz ±1dB. KIT £6.15.6. BUILT £15.10.9 (Carr. either 5/0).

MULLARD 10-16 STEREO AMPLIFIER. Input sensitivity—510mV per channel; Response 12Hz-35KHz ±1dB: 10 watts R.M.S. output per channel into 3 or 15 ohms. KIT £16.10.9. BUILT £33.10.0 (Carr. either 12/0).

Basic Kit (no panel or controls) £7.17.6. BUILT £21.10.0. Pre-amp must be used here.

MULLARD 2 × 2 STEREO Pre-amp with same characteristics per channel as mono pre-amp (+ balance). BUILT £13.10.9. (Carr. 7/0).

T.R.S. 4 × 4 ECONOMY STEREO. Modular assembly. With cabinet power supply and Din plugs £12.10.0 (Carr. 7/0).

GRAMO UNITS & PLINTHS

GARRARD SP.23 MK. II. Manual: Arm and 10In. die-cast or table, cueing device, etc. less cartridge. Brand new in maker's carton £12.7.6.


Garrard HB:1 Plinth £3.7.6. (Carr. 5/-)
Garrard CLEARVIEW Cover SCP.1 £3.5.0. (Carr. 4/6)
Garrard Scandinavian Type Plinth £5.5.0. (Carr. 5/-)

ALWAYS IN STOCK

Resistors in all values; wire-wound resistors; volume controls log or linear. 10K-3Meg. Mono 3/4 (with switch). Stereo 8/8 (with switch: certain values 16/0). Log/taper/balance controls, capacitors and electrolytics; Vibration speaker covers 46/s.—22/s. yrs; Bondacoust 48In. x 1in. thick. T.V. etc.; Veroboard; Cir-Kit; valves; transistors, S.A.E. with inquiries please.
SOLDERING IRONS?

Whatever your particular application we are almost certain to have just the tool for the job.

ADAMIN—featherweight instruments with the slip-on bits and the big performance.

LITESOLD—the best-selling seven-model range of top-quality 'conventional' irons.

You ought to get the whole story. Ask for catalogues L10. Free.

THERMOSTATIC CONTROL? The new LIFESTAT instruments are surely the most advanced available—at not so advanced prices.

LIGHT SOLDERING DEVELOPMENTS LTD
28 Sydenham Road, Groydon, CR9 2LL
Telephone: 01-688-8589 & 4559

| TRANSISTORS etc. | SII 812C MODEL | Rectifiers | Midget Electrolytic
|------------------|----------------|------------|-----------------
| AC107 2C-470152 | RC 250 47-1 | P180A, 23505 | 60 A, 250 V, 12 A |
| AC108 2C-470152 | RC 250 47-1 | P180A, 23505 | 60 A, 250 V, 12 A |
| AC115 2C-470152 | RC 250 47-1 | P180A, 23505 | 60 A, 250 V, 12 A |
| AC116 2C-470152 | RC 250 47-1 | P180A, 23505 | 60 A, 250 V, 12 A |
| AC117 2C-470152 | RC 250 47-1 | P180A, 23505 | 60 A, 250 V, 12 A |
| BF117 2C-470152 | RC 250 47-1 | P180A, 23505 | 60 A, 250 V, 12 A |
| BF118 2C-470152 | RC 250 47-1 | P180A, 23505 | 60 A, 250 V, 12 A |
| BF119 2C-470152 | RC 250 47-1 | P180A, 23505 | 60 A, 250 V, 12 A |
| BF120 2C-470152 | RC 250 47-1 | P180A, 23505 | 60 A, 250 V, 12 A |

MIDWEST ELECTRONICS
(PW27) LONGLEY LANE, GATLEY, CHEADLE, CHESHIRE, SK8 4EE
Telephone: 01-780-5123

Felstead Dorset, Tel. COVENTRY 2158. Cash with order or 30 days' credit. No C.O.D. or cash sales. Prices and details subject to change without notice. Minimum order £10. Free delivery by post within the United Kingdom. Further information on request.
DE LUXE PLAYERS
PORTABLE CABINET As illustrated. To fit standard player or amplifier. 12 in. R.C.S. AMPLIFIER 3 WATT Ready made frame. This is a 3 mm unit only a

A self-contained fully portable mini-p.a. system. Many uses—ideal for the breadwinner as a Baby Alcove, Instrumn, Telephone or Car Amplifier etc. Attractive icing covered cabinet, 12 in. 9 X 4 in. very powerful! 1 x 4 in. speaker and four transformers one power amplifier plus ultra-sensitive microphone. Uses F39 battery. Brand new in carton's with manufacturers' guarantee 30 days Free.

WEYRSD P65—TRANSISTOR COILS
RAW 1 12 X 1/2 in. with carrel unit 126
Das: Pot: 1/2 in. 1045
LP: 10 x 3/4 in. 103
W: 8 x 7/8 in. 102
W.: 8 x 3/4 in. 101
Telecoms Chromo Air Coil, 45s, 4s, 25s.

VOLUME CONTROLS
Long spinials. Midi Size 5/ x 8 in. 50
5/ x 9 1/2 in. 50

80 Ohm Coax 8d, LITHE AERIALITE ACED AIRAERIAL SPACED 20, 30, 50, 100, 150, 250, 300, 450, 500, 600 [FRINGE LOW LOAD 1/6]

WIRE-WOUND 3-WATT PENCIL VOLUME CONTROLS 1/2 x 7/10 in. 100
WIRE-WOUND 2-WATT Stamped Steel Size Pots 250

VEROBOAD 0.15 MATRIX
2 x 5 in. 3/4 x 5 in. 3/4 x 6 in. 3/4 x 7 in. 3/4 x 8 in. 3/4 x 9 in. 3/4 x 10 in. PINS 36 per packet 1/4 in. FACE CUTTERS 7/16
S.R.B.P. boxes: 3.5 x 5 3/4 x 6 3/4 x 7 3/4 x 8 3/4 x 9 3/4 x 10 1/2 in. 36 x 1/8 in. 36 x 1/4 in. 36 x 1/8 in. 36 x 1/4 in.
BLANK ALUMINIUM CHASSIS 18 s.w.g. 12 x 12 in. 14 x 14 in. 16 x 16 in. 18 x 18 in. 20 x 20 in. 24 x 24 in. 28 x 28 in. 30 x 30 in.
ALUMINIUM PANELS 18 s.w.g. 12 x 12 in. 14 x 14 in. 16 x 16 in. 18 x 18 in. 20 x 20 in. 24 x 24 in. 28 x 28 in. 30 x 30 in.

Q MAX CHASSIS CUTTER
Complete: a sieve, a punch, an Allen screw and key 1 in. 15 mm 2 in. 15/16 in. 2 1/4 in. 1 3/4 in. 3 in. 2 5/8 in.
1 5/8 in. 3 5/16 in. 3 5/8 in. 3 7/8 in. 4 in. 1 1/4 in. 2 3/4 in.
4 1/4 in. 3 1/2 in. 3 3/4 in. 3 1/8 in. 2 3/4 in. 2 1/4 in. 1 3/4 in.
1 5/8 in. 1 7/8 in. 1 9/16 in. 1 5/8 in. 1 1/8 in. 1 5/16 in. 1 1/16 in.

H.B. HEADPHONES 2000 ohms Super Sensitive 3/2 in. LOW RESISTANCE HEADPHONES 5 ohms 70 ohms

RADIO COMPONENT SPECIALISTS
Full List 11. Written guarantee with every purchase. (Export: Renish and extra postage.) Buses 133 68 pass door. S.R. Sin. Sevenhurst. Tel. 01-664-568

BARGAIN STEREO/MONO SYSTEM
Attractive Slim Player Cabinet with B.S.R. Stereo Automatic 3 Valve MICROPHONE LOUDSPEAKERS. (Only 4 pairs of wires to join.)


cat.: 100 in.

THOMAS S. MILLER 50-12,000 Hz. £9.60

2000 in.

12 in.

UT1246

2200 in.

2000 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.

1200 in.
I have recently been going through eight of your books and they have been a feast of information. I have been like a dog with eight tasty dishes, not knowing which one to tackle first but nipping about and sampling each one.

Somerset, Sept. 69

Having read the majority of your 'Bibles on Hi Fi', of such a remarkably 'hi' standard, I eagerly await a copy of your Cabinet Handbook.

London N22, Nov. 69

Please send orders and enquiries to—

RANK WHARFEDALE BOOK DEPT. B.W.S.
13 WELLS ROAD ILKLEY YORKS

Telephone: ILKLEY 4248

Published by:
RANK WHARFEDALE LTD Idle Bradford Yorkshire

F.A.L. 'PHASE 100'

Public Address Amplifier

A superb solid state A.C. Mains unit for vocal and Instrumental groups and General Public Address use.

59 Gns

Recommended Retail price

★ 70 Watts RMS Output ★ High Sensitivity
★ Output matching for speakers from 3-30 ohms
★ 4 separately controlled inputs plus master
★ Separate Bass and Treble Controls
★ Frequency Response 20c.p.s.to 30 Kcs

Send S.A.E. for fully descriptive leaflet

Available from your local Dealer

Wholesale and Retail enquiries to Manufacturers

FUTURISTIC AIDS LTD, 103 Henconner Lane, Leeds 13

M. & B. RADIO

15a HUNSLET ROAD, LEEDS LS10 1JQ

Telephone: 0532-35649

STEREO CABINETS. A beautifully finished polished wood cabinet supplied in original carton. Size approx. 22 x 16 x 8in. New 47/6 plus 6/6 carriage.

TELEMETERS. A well finished cabinet containing lots of useful items for the constructor. Endless tape unit and tape head, 2 motors, auto and mains transformers, miniature valve I.F. strip etc. Ideal for modifying or stripping. 77/6 plus 7/6 carr.

STETHOSCOPE HEADSETS. Brand New. Ideal for stereo or mono. Low impedance. 27/6 plus 3/6 pp.

MICROPHONES. Radiotelephone type, used. 5/- plus 2/- pp.


TRANSISTORISED 2 METER CONVERTERS. Please state preference of I.F. frequency when ordering. £7.15.0 plus 5/- pp. 4 metre models available at the same price. VHF Marine band model £8.5.0 plus 5/- pp.

VHF MOBILE TX/RX. miniature valve vertical controlled trans-receiver with 12 volt transistorised power unit. Internal speaker. Double conversion receiver easily modified to tuneable. Ideal for 4 metres. £9.10.0 plus 27/6 carriage.

MODULATION TRANSFORMERS. scr522 type. 7/6 plus 2/- pp.

AERIAL CHANGE OVER RELAYS 12 volt. Used 4/- plus 1/6 pp. 60 UNTESTED DIODES 2/6 plus 1/6 pp

60 UNTESTED TRANSISTORS 5/- plus 1/- pp.

2-JW. INTEGRATED CIRCUIT AMPLIFIERS. Tested £1, plus 1/- pp.

USED TESTED VALVES, QQQ3/10 6/-, 6AQ5 3/-, 6BJ6 1/6, ECC83 2/6, 5U4 6/-, all plus 1/6 pp.

LOTS OF OTHER EQUIPMENT

PLEASE SEND 6d. PLUS S.A.E. FOR LIST
TRANSFORMER STEREO 8 - 8 MK II

Now using silicon transistors in first five stages on each channel resulting in even lower noise level with improved frequency response. High F. I. Loudspeaker System. Hi-Fi Mono Transistor Amplifier Kit. Uses 14 transistors giving 2 watts push pull output per channel. Pre-amplifier circuit with Bass, Treble and Volume controls. Suitable for use with floor standing, wall, shelf, large bookshelf speakers. Each output stage for one speaker from 5 to 15 ohms. Compact design, all parts are mounted on one circuit board. Cost Price 2/6. Pri. 200/240v. Output 8 watts. Bass boost and cut. A Dual volume control is used. Wireless and right hand channels can be adjusted by means of a separate "Balance" control. At the rear of the chassis. Input sensitivity is approximately 0.15V. For full rated output of 2 watts into 8 ohms (watts into 8 ohms). Speaker must be a minimum of 8 ohms. Full negative feedback in an aid F.M. circuit, allows high volume levels to be used with negligible distortion. Supplied complete with speaker terminals. Chassis size 11 x 11 x 11/2 in. Includes valves 25G. Ready built and tested to a standard.

Price:

P. & P. 7/6

SPECIAL OFFER!

Your opportunity to secure a first class Hi-Fi Loudspeaker System at spectacular price. Beautifully made test finish ensures with most attractive front panel finish. Built to order with E.M.I. Cermax 15" x 9" bass unit, two H.F. winder units giving 10 watts output. Available 8 or 15 ohm loads.

Our Price while Limited Stocks Last

8 Ohm

50/9

15 Ohm

75/9

TRANSFORMER BARGAINS!

Now using silicon transistors in first five stages on each channel resulting in even lower noise level with improved frequency response. High F. I. Loudspeaker System. Hi-Fi Mono Transistor Amplifier Kit. Uses 14 transistors giving 2 watts push pull output per channel. Pre-amplifier circuit with Bass, Treble and Volume controls. Suitable for use with floor standing, wall, shelf, large bookshelf speakers. Each output stage for one speaker from 5 to 15 ohms. Compact design, all parts are mounted on one circuit board. Cost Price 2/6. Pri. 200/240v. Output 8 watts. Bass boost and cut. A Dual volume control is used. Wireless and right hand channels can be adjusted by means of a separate "Balance" control. At the rear of the chassis. Input sensitivity is approximately 0.15V. For full rated output of 2 watts into 8 ohms (watts into 8 ohms). Speaker must be a minimum of 8 ohms. Full negative feedback in an aid F.M. circuit, allows high volume levels to be used with negligible distortion. Supplied complete with speaker terminals. Chassis size 11 x 11 x 11/2 in. Includes valves 25G. Ready built and tested to a standard.

Price:

P. & P. 7/6

SPECIAL OFFER!

Your opportunity to secure a first class Hi-Fi Loudspeaker System at spectacular price. Beautifully made test finish ensures with most attractive front panel finish. Built to order with E.M.I. Cermax 15" x 9" bass unit, two H.F. winder units giving 10 watts output. Available 8 or 15 ohm loads.

Our Price while Limited Stocks Last

8 Ohm

50/9

15 Ohm

75/9

MONO TRANSISTOR AMPLIFIER

HSL.700

A really high fidelity mono amplifier with performance characteristics to suit all musical discriminations.

Features:

- On special printed panel
- Fully wired for operation
- In symmetrical complementary pair
- Transformer output
- Transformer secondary speaker socket shackles
- Full wave bridge rectifier power supply
- Two-stage simple moving iron voltage stabiliser. Optimized for all transmitter voltages
- Switchable Hi-Fi treble boost
- Built-in fuses
- Blown fuse replacement
- Panel fitted
- Blown fuse replacement
- Panel fitted
- Built-in fuses
- Blown fuse replacement
- Panel fitted

Our Price:

£19.16

LOUDBOSSER BARGAINS

Fin. £3.98 inc. P. & P. 3/0. 7 in. 3 ohm H/M. £4.98 inc. P. & P. 3/0. 7 in. 8 ohm H/M. £5.98 inc. P. & P. 3/0. 7 in. 16 ohm H/M. £7.98 inc. P. & P. 3/0. 7 in. 32 ohm H/M.

BRAND NEW. £8.98 inc. P. & P. 3/0. 8 in. 3 ohm H/M. £9.98 inc. P. & P. 3/0. 8 in. 8 ohm H/M. £10.98 inc. P. & P. 3/0. 8 in. 16 ohm H/M. £12.98 inc. P. & P. 3/0. 8 in. 32 ohm H/M.


CRystal Movers. High top, for disk or head mic. High sensitivity. £15.98 inc. P. & P. 5/6.


troscoplc AERIALS with SWIVEL JOINT. Can be bought in 4, 6, 8, 10 and 12 yards lengths. Price £19.98 inc. P. & P. 5/6.

TRANSFORMER BARGAINS!


DE LUXE STEREO AMPLIFIER


DE LUXE STEREO AMPLIFIER


DE LUXE STEREO AMPLIFIER

THE RSGB AMATEUR RADIO CALL BOOK
Complete up to date listing of all amateur stations in the UK and Eire together with much operating information including beam headings and list of prefixes.

Radio Communication Handbook

Weld at Their Fingertips
The first and only complete story of the evolution of Amateur Radio.* Published. An entertaining and instructive account of notable events and progress from the first days up to the present period. This book is published in two styles: a hardbound version and a paperback. Both contain 308 pages and are profusely illustrated. De-luxe hardbound version £9.5s, paperback 14s 6d (both post paid).

Obtainable from:
RADIO SOCIETY of GREAT BRITAIN
35 Doughtrey Street, London, W1C

SOLDER GUN
A must for every busy man. Drives almost instantly and illuminates join 100 watt 220/240v 3/16" (saves you over 30/-) post and inc. 5/-.

BULB GUN 250 watt model 99/6 (saves you over £3.10/9d) post and inc. 6/6.

BURGLAR ALARM KIT
Protect your home and family by frightening away the burglars. The kit contains 2 mains operated bell rings loudly directly the door or window is opened, 2 red 12 volt switches, 12 magnets, relay, relay transformer and bell with circuit. Price 40/6 output 5/6.

Mains Transformer Power Pack
Designed to operate transistor sets and amplifiers. Adjustable output 0-50 volts for up to 500mA (class B working). Take the place of any of the following: P17, P19, P36, P44, P46, PP9, and others. Kit comprises: mains transformer, rectifier, stabilizer and instructions.

New Listing of Components
Made up model 376/6 plus 2/6 post and insurance.

WAFFER SWITCHS TO THE REQUIREMENTS
Standard Size 1½ waffer — silver plated 5 amp contact standard 3½ spindle 2½ ins.—with locking washer and nut.
No. of Waffers
2 way 3 way 4 way 5 way 6 way 10 way 12 way
1 pole 6/6 6/6 6/6 6/6 6/6 6/6 6/6
2 poles 6/6 6/6 6/6 6/6 6/6 6/6 6/6
3 poles 6/6 6/6 6/6 6/6 6/6 6/6 6/6
4 poles 6/6 6/6 6/6 6/6 6/6 6/6 6/6
5 poles 6/6 6/6 6/6 6/6 6/6 6/6 6/6
6 poles 6/6 6/6 6/6 6/6 6/6 6/6 6/6
7 poles 6/6 6/6 6/6 6/6 6/6 6/6 6/6
8 poles 6/6 6/6 6/6 6/6 6/6 6/6 6/6
9 poles 6/6 6/6 6/6 6/6 6/6 6/6 6/6
10 poles 6/6 6/6 6/6 6/6 6/6 6/6 6/6
12 poles 6/6 6/6 6/6 6/6 6/6 6/6 6/6
16 poles 6/6 6/6 6/6 6/6 6/6 6/6 6/6
32 poles 6/6 6/6 6/6 6/6 6/6 6/6 6/6

Switches uses 10/6 each are from stock—others 7 days.

TANGENTIAL HEATER UNIT
Winter is comin' but not today and you won't won't be cold in this heater unit. The very latest type, most efficient and quiet running. Is as fitted in all the better hotels. Efficiency 95 per cent. Price 21/-.

Where postage is not stated then orders over £3 are post free. Below £3 add 2/9d. Semi-conductors add 1/-. Post free. S.A.E. with enquiries please.

Mains Motor
Price listed make sure it is used in record decks and phonographs and it will be ideal also for extractors fans, blowers, heaters, etc. New and serviceable. Sizes at 9/6. Postage 3/- for first one then 1/- for each, one ordered 12 and over post free.

DIAMOND IV/0 THERMOSTAT
Type 20 with capillary tube and sensor. 20 amp a.c. type fitted to many cookers adjustable by control knob (not supplied) 12½ each.

BLANKING SIMMERSTAT
Although looking like, and fitted as an ordinary blanket switch, this is in fact a device for switching on for a short time only. Periods, thus giving a complete control from off to full heat. Although suitable for controlling the temperature of any other appliances using up to 1 amp. Laided at 27½ each we offer these while stocks last just at 12½ each.

E/L.A. IMMERSOR
Although looks like a immersion heater, it is in fact a small adjustable transformer to fit any 500w. heating coil. Control is fitted by finger tip control. Is as fitted in many houses. Price 10/6.

DIAMOND CONDENSERS
Made by famous Company. Very powerful, although only quite small. Overall dimensions approximate. 1½ in. deep by 2½ in. diameter

DIAMOND CONDENSERS TCC
Made up model 376/6 plus 2/6 post and insurance.

DRILL CONTROLLER
Electronically changes speed from approximately 10 revs. to full speed by finger-tip control. Kit includes all parts, case, everything and full instructions. £10/6 plus 2/6 post and insurance. Made up model 376/6 plus 2/6 post.

DST 55000 WATT TRANSISTOR RADIO
A powerful 55000 watt transistor radio. Can be fitted to any 20 watt amplifier. Thanks to an automatic volume control the user is always assured of the correct volume level. Price £29.5/6.

DST 55000 WATT TRANSISTOR TV
A powerful 55000 watt transistor TV, made to accept any 300 or 500 watt amplifier. Also fitted for a 50 watt amplifier. Price £29.5/6.
and work at the nerve centres of civil aviation

The National Air Traffic Control Service of the Board of Trade needs Radio Technicians to install and maintain the very latest electronic aids at Civil Airports. Air Traffic Control Centres, Radar Stations and specialist establishments. Vacancies exist in various parts of the United Kingdom.

This is responsible demanding work (for which you will get familiarisation training) involving communications, computers, radar and data extraction, automatic landing systems, and closed-circuit television. It offers excellent prospects with ample opportunities to study for higher qualifications in this fast-expanding field.

If you are 19 or over, with at least one year's practical experience in telecommunications, fill in the coupon now. Preference will be given to those having ONC or qualifications in Telecommunications.

Salary £865 (at 19) to £1,295 (at 25 or over); scale maximum £1,500 [higher rates at Heathrow]. Some posts attract shift-duty payments. The annual leave allowance is good and there is a non-contributory pension scheme for established staff.

Complete this coupon for full details and application form:


Name ........................................
Address ........................................

Not applicable to residents outside the United Kingdom.

817
The pre-paid rate for classified advertisements is 1/8d. per word (minimum order 20/-), box number 1/6d. extra. Semi-displayed setting £5 2s. 0d. per single column inch. All cheques, postal orders, etc., to be made payable to PRACTICAL WIRELESS and crossed "Lloyds Bank Ltd." Treasury notes should always be sent registered post. Advertisements, together with remittance, should be sent to the Classified Advertisement Manager, PRACTICAL WIRELESS, IPC Magazines Ltd., Fleetway House, Farringdon Street, London, E.C.4 for insertion in the next available issue.
WANTED NEW VALVES ONLY
Must be new and boxed. Payment by return.
WILLIAM CARVIS LTD.
108 North Street, Leeds 7

WE BUY New Valves, Transistors and clean new components. Large or small quantities all details, quotation by return. WALTON’S WIRELESS STORES, 55 Worcester Street, Wolverhampton.

SERVICE SHEETS
SERVICE SHEETS, RADIO, TV. 5,000 Models, list 1/-, S.A.E. Enquiries, TEL-RAY, 11 Maudland Bank, Preston, Lancs.

SERVICE SHEETS (75,000) 5/- each; please add 4d. stamp: callers welcome: always open. THOMAS BOWER, 5 South Street, Oakenshaw, Bradford.

SERVICE SHEETS (1925-1969) for TELEVISIONS, TRANSISTORS, TAPE RECORDERS, RECORD PLAYERS, etc., by return post, with free fault-finding guide, Prices from 1/- Over 8,000 models available. Please send S.A.E. with all orders/enquiries. HAMILTON RADIO, 54 London Road, Bexhill, Sussex.

RADIO, TELEVISION over 3,000 models.

LARGE SUPPLIER OF SERVICE SHEETS
(T.V., RADIO, TAPE RECORDERS, RECORD PLAYERS, TRANSISTORS, STEREOSGRAMS, RADIOGRAMS, CAR RADIOS)
Only 10/- each, plus large S.A.E.
(Uncrossed P.O.’s please, returned if service sheets not available.)

C. CARANNA
71 BEAUFORT PARK
LONDON, N.W.11
We have the largest supplies of Service Sheets (strictly by return of post). Please state make and model number alternative.
Free TV fault tracing chart or TV list on request.
Mail order only.

EDUCATIONAL

WANTED (continued)
AVO METERS, MODELS 8 & 9, ANY QUANTITY, ANY CONDITION, ALSO WEE MEGS, S.A.E. SEND FOR PACKING INSTRUCTIONS. HUGGETT’S LTD., 2/4 PAWSONS ROAD, W. CROYDON.

RADIO AND TELEVISION SERVICING
RADAR THEORY AND MAINTENANCE
TELECOMMUNICATIONS
This private College provides a good theoretical and practical training in the above subjects. One-year day courses are available for beginners and short courses for men who have had previous training.
Write for details to:
The Secretary, London Electronics College, 20 Penywern Road, Earls Court, London, S.W.5.
Tel. 01-373-8721

EDUCATIONAL (continued)

CITY & GUILDS (electrical, etc.) on “Satisfaction or Refund of Fee” terms. Thousands of places. Modern courses in all branches of electrical engineering, electronics, radio, TV, automation, etc., send for free course handbook—FREE. B.I.E.T. (Dept. 168K), Aldermaston Court, Aldermaston, Berks.

RADIO-TELEVISION training courses. Write: Principal, Newport and Monmouthshire College of Technology, Newport, Mon. Y.

TRAIN FOR SUCCESS WITH ICS

ICS, DEPT. 541 INTEXT HOUSE, STEWARTS ROAD, LONDON. SW6

SITUATIONS VACANT
(continued)

Radio Operators

There will be a number of vacancies at the present, in the Composite Signals Organisation for experienced Radio Operators in 1970 and in subsequent years.
Specialist training courses lasting approximately one year only, according to the trainee’s progress and at intervals. Applications are now invited for the course starting in September 1970. During this course a daily will be paid on the following scale—:

Age 23: £80 per annum
22: £75 . .
21: £70 . .
20: £65 . .
19 and over: £60 . .

Free accommodation will be provided at the Training School. After successful completion of the course, operators will be paid on the Grade 1 scale—:

Age 23: £900 per annum
22: £850 . .
21: £800 . .
20: £750 . .
19 and over: £700

then by six annual increases to a maximum of £1,500 per annum. Excellent conditions and good prospects of promotion. Opportunities for service abroad. Applicants must normally be under 20 years of age at start of training course and must have at least two years’ operating experience. Preference given to those who also have G.C.E. or equivalent qualifications.

Applications forms and further particulars from:

RECRUITMENT OFFICER,
Government Communications Headquarters,
Oakley, Priors Road,
CHELTENHAM, Glos.
GL52 5AJ
Tel: No. Cheltenham 21491 Ext 2270

HENRY’S RADIO LTD.
30 EDGWARE ROAD, LONDON, W.2
HAVE THE FOLLOWING VACANCIES IN THEIR ORGANISATION.

Sales Assistants
Young men with good general knowledge of electronic components required for our retail sales dept. Please phone 723 1906/9 Exte. 1.

Sales Assistants Hi-Fi Dept.
Young men with a good general knowledge of HIGH FIDELITY EQUIPMENT required for our retail Hi-Fi SALES DEPT. Please contact Mr. STEVENS. Telephone 723 6063.

SKILLED OR SEMISKILLED ENGINEER required for service electronic department of large photographic importers. Congenial conditions, interesting work, and salary. For appointment telephone 252-8031 Mr. Vassay.
RECEIVERS & COMPONENTS (continued)

NEW FULL SPECIFICATION DEVICES.
Integrated Circuits complete with data:
GE PA234 1W Audio Amplifier 17/6 each
GE PA237 2W Audio Amplifier 32/6 each
ME 25 High V.F. Audio Amplifier 9/6 each
High quality low cost plastic transistor
GE 2NS172 NPN 200V/200W Transistor 1/3 each
Mullard N60/172 NPN 9/6 each
Westinghouse guaranteed plastic rectifier
(Silk) 5A 2000V 6T Rectifier 2/6 each
C.W.O. P. F. 1.0. /- per order.
JER
ELECTRONICS, York House, 12 York Drive,
Greenhill, Warrington, Lancs.
Mail Order Only.

HI-FI loudspeaker systems for the home constructor, kit boxes, the new range of
Peerless speaker parts systems and cross-over networks.
B.A.F. wadding speaker fabric (samples on request) and all other
necessary components. Send 5d in stamps to:
AUDIOSCAN, Dept. PW, 4 Princes Square, Harrowgate, Yorks.

COMPLETE RANGE of Amateur Aircraft, Communications receivers, Chassis, panels,
meters, cabinets, microphones etc. Stephens-Jame.
L Ltd., 70 Trivory Road, Liverpool 4.
Tel. 051-263-7829.

WE ARE BREAKING UP COMPUTERS

EX COMPUTER PRINTED CIRCUIT
PANELS 2in x 4in, packed with semi-conductors
and top quality parts, diodes, capacitors, diodes,
prices. Our offer, 10 boards, 10/-, P. & P. 2/-.
With a guaranteed minimum of 55 transistors.
SPECIAL BARGAIN PACK, 75 boards for £1.
P. & P. 2/-. With a guaranteed minimum of 65
transistors. 100 boards 35/-, P. & P. 6/-.
GIANT PANELS, 5in. x 4in., min. 20
transistors, 9 x 56 micro resistors, diodes, capacitors,
est. for £5 & P. 2/-.
As above, only 2-transistors, 70 diode, 62 min.
shelf resistors, 3 for 25/-, P. & P. 2/-.
PANELS with 2 power transistors sim. to OC38
these on each board + components. 2 boards (4
OC38) 10/-, P. & P. 2/-.
TRIM POTS. On 2in x 4in. boards + 32 caps
and other components. Ideal for organ, keyboard
tuning etc. 150/-, 500/-, 15K etc.
State requirements. 5 boards 10/-, P. & P. 2/-.
NPN GERMANIUM 12 A-D: 2 N-P-T WITH
MATTER TRANSISTORS. On small heat sink, on 2in.
x 4in. panel. 10 for 10/-, P. & P. 2/-.
POWER TRANSISTORS, sim. to 2N174
P. & P.
DIODES, 2 per pack, Silicon, 150 PIV, 10 amp.
4 for 10/-, 150 PIV, 20 amp. 4 for £1. Post free.
MINIATURE GLASS NEONS, 12/6 doz.
PAPST FANS. Powerful Extractor/Blower
fans. 4in. x 4in. x 2in. 900/250V. 100 c.f.m.
2,800 r.p.m. Weight 2 lb. 12 oz. 50/- post free.
SPRAYGE POLYSTER. 0.22/2F 250V small
capacity electrolytic, P. & P. 1/-.
SPRAGE ELECTROLYTICS. 4.5F 150V.
5/-, doz. P. & P. 1/-.
TANTALUM CAPS. 2.2uF 50V. 8/- per
doz. P. & P. 1/-.
NEW MIXED COMPONENTS
100 High stab. resistors 5% and better.
12/4, P. & P. 1/-.
250 mixed resistors 1W + 1W, 12/4, P. & P. 1/-.
Large handful of mixed capacitors. 12/4, P. & P. 1/-.
LARGE, CAPACITY ELECTROLYTICS
4in. x 2in. diameter, electrolytic
10 each post free.
1000uF 50V.
4in. x 8in. 1500uF 150V. 6B, 80/-
each. 4in. x 11in. 1550uF 200uF 250V.
4in. x 12in.

KEYTRONICS, 52 Earl's Court Road
Mail order only.
Tel. 01-478 8469

A. H. SUPPLIES, 57 Main Road,
SHEFFIELD, S9 5HL.

Shop open Mon., Tues., Wed., Fri. & Sat.
Carriage applies to U.K. Mainland only.
CHASSIS in Aluminium, Standard Sizes, with Gusset Plates
Sizes to fit Cases. All 2½" Walls
6" x 6", 7½" x 7½", 8" x 8"... £1.50, £1.40, £1.00...
Cases—Post 3s, 0d, per order.
Discounts available on quantities.

E. R. NICHOLLS
Manufacturer of Electronic Instrument Cases
46 LOWFIELD ROAD
STOCKPORT—CHESHIRE
Tel: 061-408 2179

GIANI 10% SALE

YES 10% IS ALL YOU PAY!! ALL PACKS ARE POST PAID, ALL DELIVERIES BY RETURN OF POST OR YOUR MONEY BACK PLUS FREE GIFT!!

<table>
<thead>
<tr>
<th>Pack</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES1</td>
<td>EXPERIMENTS PARCEL—2LBS WEIGHT ASSORTED ELECTRONIC COMPONENTS INCL. PART MADE EQUIPMENT</td>
<td>10/-</td>
</tr>
<tr>
<td>ES2</td>
<td>200 ASSORTED RESISTORS—CARBON, WIRE-WOUND, HIGH STABS, LARGE &amp; MINIATURE TYPES</td>
<td>10/-</td>
</tr>
<tr>
<td>ES3</td>
<td>75 ASSORTED CAPACITORS—CERAMIC, SQUAD, ULTRA, PAPER IN AN ELECTRIC</td>
<td>10/-</td>
</tr>
<tr>
<td>ES4</td>
<td>100 MIXED TRANSISTORS, DIODES, RECTIFIERS, ETC. MANUFACTURERS REJECTS. GOOD PERCENTAGE USEABLE</td>
<td>10/-</td>
</tr>
<tr>
<td>ES5</td>
<td>10 PRINTED CIRCUIT BOARDS CONTAINING TRANSISTORS, DIODES, RESISTORS, CAPACITORS, ETC.</td>
<td>10/-</td>
</tr>
<tr>
<td>ES6</td>
<td>PRINTED CIRCUIT LAMINATE—DOUBLE &amp; SINGLE SIDED COPPER—1 LB OF GOOD SIZED OFFCUTS FOR</td>
<td>10/-</td>
</tr>
<tr>
<td>ES7</td>
<td>20 ASSORTED COILS &amp; INDUCTORS COIL FORMERS FERRITES JFT's ETC.</td>
<td>10/-</td>
</tr>
<tr>
<td>ES8</td>
<td>8 ASSORTED CARBON &amp; WIRE-WOUND POTENTIOMETERS &amp; PRESETS (SOME WITH SWITCHES)</td>
<td>10/-</td>
</tr>
<tr>
<td>ES9</td>
<td>5 ASSORTED SWITCHES INCLUDING MULTI—WAFFER (YAXLEY ETC) TYPES &amp; SOME TOGGLE SWITCHES</td>
<td>10/-</td>
</tr>
<tr>
<td>ES10</td>
<td>3 ASSORTED RELAYS OF VARIOUS VOLTAGES &amp; RESISTANCES G.P.O. &amp; INDUSTRIAL TYPES</td>
<td>10/-</td>
</tr>
<tr>
<td>ES11</td>
<td>10 SUB-MINIATURE NEON BULBS WIRE ENDED PLUS ONE MAINS NEON INDICATOR PANEL MOUNTING</td>
<td>10/-</td>
</tr>
<tr>
<td>ES12</td>
<td>10 TRANSISTOR SOCKETS TO TAKE 3 OR 4 WIRE TRANSISTORS</td>
<td>10/-</td>
</tr>
</tbody>
</table>

IT'S EASY TO ORDER FROM ELECTROSAPSES BY MAIL—JUST FOLLOW THESE INSTRUCTIONS FOR YOUR PARCEL BY RETURN OF POST

1. Please PRINT your name and full address clearly in box below.
2. Place a cross (X) in the square beside the pack you require.
3. Tear out this advertisement.
4. Enclose 10/- for each pack ordered. Remember NO POST CHARGES TO PAY.
5. Post your order to—

ELECTROSAPSES, POST BOX 48, BRENTO, ESSEX

(No C.O.D.—Mail orders only—only items advertised are FREE OF CHARGE)

SPECIAL FREE OFFER!! ORDER 10 PACKS (ANY I.E. & SPEC. ONLY 2/- GET ONE PACK OF YOUR CHOICE FREE OF CHARGE

Name
Number & Road
Town
County

1 enclose £ s for. packs as indicated X
Cheque/Cash/Postal Orders.

REMEMBER—ELECTROSAPSES WILL SEND BY RETURN OF POST OR YOUR MONEY BACK PLUS A FREE GIFT—ELECTROSAPSES
NEW RANGE U.H.F. TV AERIALS

All U.H.F. aerials now fitted with tilting antennas and 4 element reflectors.

BBC - ITV AERIALS


Callers welcomed - open all day Saturday

K.V.A. ELECTRONICS (Dept. P.W.)
40-41 MONARCH PARK ROAD
LONDON ROAD, MITCHAM
SURREY 01-648 4844

H.A.C. SHORT-WAVE KITS

WORLD-WIDE RECEPTION

FACTOR/ for Proven 3 years Short-Wave Equip-
ment of quality, "H.A.C." over the Original suppliers of Short-Wave Receivers kits for the
short-wave listener. Over 10,000 satisfied customers -including Technical College, Hos-
itals, Public Schools, I.A.F., Army, Home, etc.

IMPROVED 1970 RANGE

One-valve model kit, complete - kit price 50/6

POSTAGE (Postage and packing 3/6)

Customer writes - "Definitely the best one-valve S.W. Kit available at any price, easy to assemble and of course, as all our products - fully guaranteed. Full range of other S.W. kits including the famous model "K" and "K" plus." Illustrate above.)

"H.A.C." SHORT-WAVE PRODUCTS
29 Old Bond Street. London W.I

Est. 1943

JOHNSONS

Tel: 24864

New! CV2—a unique triple-purpose VHF kit for the Amateur enthusiast. Integrated converter, receiver, and tuner-feeder. Fantastic single-transistor performance! Comprehensive Kit of high grade parts with three coils covering 80-178MHz. 9v battery, etc., together with simplified diagrams and instructions. Price complete, £4. post, packing and insurance paid, direct from makers. S.A.E. for literature.

JOHNSON’S (RADIO)
St. Martin’s Gate, Worcester

Please mention PRACTICAL WIRELESS when replying to advertisements
INTEGRATED CIRCUIT AMPLIFIERS

CA3056 RF Amplifier, with 1000c/s bandwidth, Max. dissipation 360mW. Suitable for IF amplifier, balanced mixer, product detector or self-oscillating mixer.

CA3058 Wide Band Amplifier, 10mW(s), suitable for IF Amplifier for VHF/FM receivers.

CA3060 General Purpose Audio Amplifier of 50kW output.

CA3061 Buffer Amplifier consisting of two 'super-sensitive' pairs of transistors, suitable for pick-up operators.

The above four IC's are in TO-99 encapsulation.

PA223 Audio Amplifier providing a max. output of 1.2 watts.

PA224 Audio Amplifier providing a max. output of 1 watts.

PA237 2 watts Audio Amplifier.

The above three IC's are in epoxy mounted double four-pin line package.

MC1506 General Purpose operational amplifier in TO-99 case.

TA3303 3-stage direct coupled amplifier for use from DC to 600MHz. Overload 10,000W into 1500 load.

TA2503 3-stage amplifier with connection brought out to the individual leads. Bandwidth 500kHz. 160W dissipation. Output 100mA into 1500 load.

TA2512 MOST input stage followed by a bipolar transistor stage. 200W dissipation.

TA2610 Integrated AM receiver circuit containing all the components, extra output stage, required to build a complete receiver.

TA2636 4 watts Audio Amplifier into 500W Loudspeaker. Operating voltage 18V. Overload protection.

Data sheets are available for all the above IC's.

OUR NEW CATALOGUE 1969/1970 IS NOW READY. IT INCLUDES PRICES OF SOME 4,000 TYPES OF VACUUM AND SEMICONDUCTOR. ESSENTIAL CHARACTERISTICS OF KLYSTRONS, MAGNETRONS, VACUUM TUBES AND SEMICONDUCTORS ARE GIVEN. THIS IS A REFERENCE BOOKLET ANG."DO NOT FORget WHAT CHARGE. PLEASE ENCLOSE QUANTO S.A.E.

WESTINGHOUSE EPOXY ENCAPSULATED WIRE ENDED MULTIMETERS

IN599, 1.000 p.i.v., 1.5 amp. D.C.; Max. surge 50A. Diameter 1/4". Overall length (with leads) 2.510.

IN1000, 5.000 p.i.v., Max. surge 250A. Diameter 2100; overall length (with leads) 2475m. 63

NEW OSCILLOSCOPE FROM RUSSIA

SYNCHROSCOPE TYPE C-15

NOW AT NEW REDUCED PRICE OF £39

Packaging, carriage £1.06

ZENER DIODES

300W wire ended, 10% tolerance

K515A 3-9V K515B 6-3V $11.4V 9.5V

K515A 3-9V K515B 6-3V $11.4V 9.5V

5 watts Steady Mounted 15% tolerance

2V $11.6V 3V $11.6V 4V $11.6V 5V $11.6V

8 watts Steady Mounted 15% tolerance

4-7V $11.65V 5.6V $11.65V 6V $11.65V 6V $11.65V

Silicon MATCHED DIODE PAIRS

IN491 Two diodes in common TO92 epoxy case. Separate anode leads and common cathode. Diodes are statistically and dynamically balanced. Max. reverse voltage 30V. Max. dissipation 200mW. Suitable for TV horizontal phase discriminators. Price £0.5. Considerable discount for quantities.

MULTIMETERS

TYPE MF16

D.C. voltage range: 0-9V

A.C. voltage range: 0-150V

D.C. current range: 5mA-100mA

Resistance ranges: 50MΩ-10MΩ

DC: 0-9V. Accuracy ±2.5% for D.C. ±10% for A.C. Measurements.

Dimensions: 45 x 25 x 5 in. Price £4.50.


SPECIAL OFFER OF PNP GERMANIUM TRANSISTORS

AC144 large signal type, suitable for class B output and high frequency applications. Max. collector-base voltage 1000V. Max. dissipation 300mW. Audio output power per pair 0.5mW. £0.05 each. Price per pair £0.5.

AC149 PNP Diode-connected Bias Stabilizing Transistor. Max. dissipation 300mW. Max. collector-base voltage 30V. Max. collector current 20mA, £0.05 each.

ION415 Two diodes in common TO-92 epoxy case. Separated anode leads and common cathode. Diodes are statistically and dynamically balanced. Max. reverse voltage 300V. Max. dissipation 200mW. Suitable for TV horizontal phase discriminators. Price £0.5. Considerable discount for quantities.

First Quality Fully Guaranteed
HAVE YOU HAD YOUR COPY OF "ENGINEERING OPPORTUNITIES"?

The new edition of "ENGINEERING OPPORTUNITIES" is now available—without charge—to all who are anxious for a worthwhile post in Engineering. Frank, informative and completely up to date, the new "ENGINEERING OPPORTUNITIES" should be in the hands of every person engaged in any branch of the Engineering industry, irrespective of age, experience or training.

**On 'SATISFACTION or REFUND of FEE' terms**

This remarkable book gives details of examinations and courses in every branch of Engineering, Building, etc., outlines the openings available and describes our Special Appointments Department.

**WHICH OF THESE IS YOUR PET SUBJECT?**

**RADIO ENGINEERING**
- Advanced Radio — Gen.
- TV & Radio & TV Servicing — TV Eng.
- Telecommunications — Sound Recording & Broadcasting — Automation

**ELECTRICAL ENG.**
- Electrical Science — Electrical Supply — Mining Elec. Engineering

**MECHANICAL ENG.**
- Advanced Mechanical Eng. — Gen.

**CIVIL ENGINEERING**
- Advanced Civil Eng. — Gen.

**AUTOMOBILE ENG.**
- Advanced Automobile Eng. — Gen.

**ELECTRONIC ENG.**
- Frequency Modulation — Transistors

**APPLIED MATHEMATICS**
- Basic Practical and Theoretical Courses for beginners in Radio, TV, Telephones, Etc.
- B.E.E.B. Certificate
- F.M.G. Certificate
- Practical Radio, TV & Telecommunication Servicing

**PRACTICAL EQUIPMENT**
- The specialist Electronics Division of B.I.E.T.
- NOW offers you a real laboratory training at home with practical equipment. Ask for details.

You are bound to benefit from reading "ENGINEERING OPPORTUNITIES," and you should send for your copy now—FREE and without obligation.

**POST NOW!**

TO B.I.E.T., 453A ALDERMASTON COURT, ALDERMASTON, BERKSHIRE.

Please send me a FREE copy of "ENGINEERING OPPORTUNITIES." I am interested in (state subject, exam., or career).

NAME ________________________________

ADDRESS ________________________________

WRITE IF YOU PREFER NOT TO CUT THIS PAGE
HENRY'S RADIO LTD.

Build a quality 4-track tape recorder
To get the best out of your record-deck, use a MARRIOT TAPE RECORDER. The MARRIOT is a simple, high quality 4-track tape recorder which fits into the standard 6-in. cabinet. It also has been shown to give relief of the wear on your valuable tapes. The unit is easily accessible for cleaning and repair work. The instructions manual makes building easy.

MULLARD 1-WATT AMPLIFIER

Build yourself a quality radio
New printed circuit design with full power output. Fully rectified on both main and secondary, 7M4, 7M5, 20M5 valves. Transistors: Fitted 430, 440, 444 amplifier, 5900F, 5902F speaker, 5F5F speaker, Room Filling Power. Easy to build with full details. All local and continental stations. Complete detailed instructions.

Total cost £6.19.6. p.p. 4/-.

SEND FOR BROCHURE 2 TODAY.

HENRY'S RADIO Fully Illustrated Catalogues

ALL TYPES A B  
OF ELECTRONIC COMPONENTS TEST HIGHER FIDELITY & GENERAL AUDIO EQUIPMENT CATALOGUE

COMPREHENSIVE CLEAR CONCISE CATALOGUE

A Over 300 pages fully detailed and illustrated. Must have for all stereo enthusiasts. Order catalogues 1 & 2 today for £1.19.6.

B Stereo and high fidelity catalogue, 120 pages containing ideas and equipment for every application. Special low prices for all leading makes. Order catalogues 3 & 4 today for £1.19.6.

HIFI equipment to suit EVERYPOCKET

HIFI AUDIO EQUIPMENT CATALOGUE 5/- p.p. 1/-

VISIT OUR NEW HIFI CENTRE AT 329 EDGWARE ROAD, LONDON for all leading makes of - RECORD DECKS, SPEAKERS, AMPLIFIERS, MICROPHONES, TEST EQUIPMENT, ALL WITH DISCOUNTS - IT WILL PAY YOU TO BUY A VISIT! AUDIO SYSTEMS £44 - £200 TO SUIT SEND FOR ILLUSTRATED BROCHURE 16/17.

Two Demonstration Rooms

Electronic Musical Instruments

ELECTRONIC ORGANS
COMPLETE KITS FOR THE HOME CONSTRUCTOR

Send for Special Price List.  

SEND FOR BROCHURE 10 TODAY!

High Fidelity & Equipment Centre

303 EDGWARE ROAD. LONDON W.2.

Phone: 01-723 3159

High Fidelity & Equipment Centre
303 EDGWARE ROAD, LONDON W.2.
Phone: 01-723 3159