Q MULTIPLIER UNIT

Also featured
550-25 Metre Superhet ★ Windscreen Wiper Delay Unit ★ Shorted Turn Tester

www.americanradiohistory.com
Television Sets, Receivers and Short Wave Transmitters are expensive to acquire and you no doubt highly prize your installation. Apart from the value of your Set, you might be held responsible should injury be caused by a fault in the Set, or injury or damage by your Aerial collapsing.

A “Scottish” special policy for Television Sets, Receivers and Short Wave Transmitters provides the following cover:

(a) Loss or damage to installation (including in the case of Television Sets the Cathode Ray Tube) by Fire, Explosion, Lightning, Theft or Accidental External Means at any private dwelling-house.

(b) (i) Legal Liability for bodily injury to Third Parties or damage to their property arising out of the breakage or collapse of the Aerial Fittings or Mast, or through any defect in the Set. Indemnity £10,000 any one accident.

(ii) Damage to your property or that of your landlord arising out of the breakage or collapse of the Aerial Fittings or Mast, but not exceeding £500.

Why not BE PRUDENT AND INSURE your installation—it is well worthwhile AT THE VERY LOW COST INVOLVED. If you write to the Corporation’s Office a proposal will be submitted for completion.

Write for full details, quoting reference 5304, to:—

THE MANAGER
SCOTTISH INSURANCE CORPORATION LTD.,
66–67 CORNHILL, LONDON E.C.3
## BI-PAK SEMICONDUCTORS

### QUALITY-TESTED VALUE PAKS ▪ BARGAINS

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
</table>
| 207  | Trans. 2N1225 Germ. PNP | 10/-
| 256  | Trans. OC74/90/91 | 10/-
| 106  | White Spot AF Trans. | 10/-
| 151  | Red Spot AF Trans. | 10/-
| 575  | Silicon Rects. 1A 100-400 PIV | 10/-
| 206  | A 10 Silicon Rects. 100 PIV | 10/-
| 202  | OCL40 Trans. NPN Switching | 10/-
| 262  | A SCR 100 PIV | 10/-
| 303  | Sil. Trans. 2N5033 PNP | 10/-
| 402  | Zener Diodes 1500V | 5/-
| 200  | 200 Mils Sil. Trans. NPN 60/15V | 5/-
| 304  | Zener Diodes 400mW 5V, 10V | 5/-
| 432  | High Current Trans. OC4 2N6 | 5/-
| 525  | Power Transistor OSC1 2N339 | 5/-
| 526  | Silicon Rects. 400 PIV 500mA | 5/-
| 527  | AC176 Trans. Mullard Type | 5/-
| 620  | Power Trans. TOC2 100V | 5/-
| 621  | OA202 Sil. Diode Sub-min. | 5/-
| 622  | Low Noise Trans. NPN 2N290 | 5/-
| 623  | Sil. Trans. NPN VCB 100ZT6 | 5/-
| 624  | OA18 Diodes | 5/-
| 625  | OC72 Transistors Mullard Type | 5/-
| 626  | OC7/7 Transistors Mullard Type | 5/-
| 627  | Metal Alloy Transistors Mullard Type | 5/-
| 628  | Sil. Rects. 400 PIV 500mA | 5/-
| 629  | GET884 Trans. Epoxy OC14 | 5/-
| 630  | 2N708 Sil. Trans. 100 Mils NPN | 5/-
| 631  | 5T41/45 Germ. Trans. PNP Epoxy | 5/-
| 632  | GT51 LFO Low Noise Germ. Trans. PNP | 5/-
| 633  | 5N914 Sil. Rects. 75 PIV | 5/-
| 634  | OA45 Germ. Diode Epoxy | 5/-
| 635  | NPN Germ. Trans. NKT731 Epoxy | 5/-
| 636  | AC10 | 5/-
| 637  | 2N222 Power Trans. Germ. | 5/-
| 638  | OC125 Power Trans. Germ. | 5/-
| 639  | 4A125 Power Trans. Germ. | 5/-
| 640  | 4A128 Trans. PNP High Gain | 5/-
| 641  | 2N137 PNP Transistor for NPN | 5/-
| 642  | 3N107 PNP Switching Trans. | 5/-
| 643  | 4DG214H Germ./Diodes Rev. OA31 | 5/-
| 644  | AF16 Mullard Type Trans. | 5/-
| 645  | 12 Assorted Germ. Diodes Marked | 5/-
| 646  | AC141 5 120 - 1200 Ohm | 5/-
| 647  | ORP61 Photo-conductive cell | 5/-

### FREE

One 10% off Pack of your own choice free with orders valued £4 or over.

### TESTED DEVICES

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
</table>
| AC25 | 3 12K770 Series | 5/-
| AC176 | 5.6 OC44 | 1/9
| AF19 | 10 - OC45 | 1/9
| AF2/3 | 10 - 2N664 | 3/-
| BC107 | 5 - ST141 | 4/-
| BC103 | 5 - 2N5055 | 4/-
| BC109 | 5 - 2N697 | 4/-
| BCY13 | 6 - 2N106 | 4/-
| BCY4 | 6 - 2N924 | 4/-
| BCY24 | 6 - 2N92 | 4/-
| BF350 | 7.6 2N5050 | 5/-
| BF351 | 7.6 2N9120 | 5/-
| BF352 | 7.6 2N3050 | 5/-
| MAT100 | 3 - 2N303 | 4/-
| NK773 | 4/-

### TRANSISTOR MANUAI BY G.E.

#### CIRCUITS, APPLICATIONS, CHARACTERISTICS, THEORY

747 PAGES

### INTEGRATED CIRCUITS

#### THEORIES, RATING, TO-3, TO-5, TO-9

8/6 OUR ADVERTISED STOCK BY BI-PAK SEMICONDUCTORS 500 CHESHAM HOUSE, 150 REGENT STREET, LONDON, W.1.

### THE RADIO CONSTRUCTOR

#### ANNUAL SUBSCRIPTIONS to this magazine

may be obtained direct from the publishers

or through your newsagent

ONLY 42/- per year, post free

Please send remittance with name and address and commencing issue required to:

DATA PUBLICATIONS LTD 57 MAIDA VALE LONDON W9

SEPTEMBER 1968

69

www.americanradiohistory.com
NEW! PORTABLE SOLID-STATE VOM
A thousand and one uses . . . plus lowest cost
IM-17 Kit £13.12.0 pp. 6/-
Solid state circuitry FET input. 4 Silicon transistor, 1 diode. A.C. voltage ranges. D.C. voltage ranges. 0.1 ohm ranges. 20k ohm input d.c. 1M ohm input on a.c. 4¼ in. 200μA meter. Battery powered. Rugged Polypropylene case, self cover and handle. Space for storage of test leads. Easy circuit board construction.

Just right for the householder, hobbyist, boaters, model builders. Amateur radio den and TV service engineer.

INSTRUMENTS

3" LOW-PRICED SERVICE OSCILLOSCOPE. Model OS-2. Compact size 5" x 7½ x 12" deep. Wt. only 9½ lb. "Y" bandwidth 2Hz-3MHz 53dB. Sensitivity 100mV/cm. T/B 20Hz-200kHz in four ranges, fitted mu-metal CRT Shield. Modern functional styling.
Kit £23.18.0 Ready-to-Use £31.18.0 p.p. 9/-

5" GEN-PURPOSE OSCILLOSCOPE. Model IM-13U. A unique model with professional specification and styling. "Y" bandwidth 3MHz-4.5 MHz 53dB. 5½ B 10 Hz-500 kHz.
Kit £35.17.6 Ready-to-Use £45.15.0 p.p. 7/-

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

AUDIO SIGNAL GENERATOR. Model AG-9U. 10 Hz to 100 kHz, switch selected. Distortion less than 0.1%, 10V sine wave output metered in volts and dB's.
Kit £23.15.6 Ready-to-Use £31.15.0 p.p. 9/-

VALVE VOLTMETER. Model V-7AU. 7 voltage ranges d.c. volts to 1,500. A.C. to 1,500 r.m.s. and 4,000 peak to peak. Resistance 0.1Ω to 10MQ with internal battery. D.C. input resistance 11MΩ. dB measurement, has centre-zero scale. Complete with test prods. leads and standardiing battery.
Kit £13.18.6 Ready-to-Use £19.18.6 p.p. 6/-

MULTIMETER. Model MM-1U. Ranges 0-1.5V to 1,500V a.c. and d.c.; 150μA to 15A d.c.; 0.02 to 20MQ. 4½ 50μA meter.
Kit £12.18.0 Ready-to-Use £18.11.6 p.p. 6/-

R.F. SIGNAL GENERATOR. Model RF-1U. Up to 100 MHz fundamental and 200 MHz on harmonics. Up to 100μV output.
Kit £13.18.0 Rdy-to-Use £20.8.0 p.p. 6/-

VISIT THE HEATHKIT CENTRES
GLOUCESTER Bristol Road Tel. 29451
LONDON 233 Tottenham Ct. Rd. Tel. 01-636 7349
BIRMINGHAM 17-18 St. Martin Hse, Bull Ring Tel. 021-643 4386

LATEST! PORTABLE STEREO RECORD PLAYER, SRP-1
Kit £28.6.0 incl. P.T. p.p. 10/-
Ready-to-Use £35.4.0 incl. P.T. p.p. 10/-

Automatic playing of 16, 33, 45 and 78 rpm records. All transistor—cool instant operation. Dual LP/78 stylus. Plays mono or stereo records. Suitcase portability. Detachable speaker enclosure for best stereo effect. Two 8in x 5in. special loudspeakers. For 220-250V a.c. mains operation. Overall cabinet size 15¾ x 3½ x 10¾in.
Compact, economical mono and stereo record playing for the whole Family—plays anything from the Beatles to Bartok. All solid-state circuitry gives room filling volume.

ENJOY YOURSELF AND SAVE MONEY
HEATHKIT for Britain's Best in Electronic kits

Complete your motoring pleasure with this outstanding CAR RADIO, Model CR-1

Will give you superb LW and MW entertainment wherever you drive. Tastefully styled to harmonise with any car colour scheme. Available for your convenience in two separate parts, RF Amp. Kit £11.15.0 inc. P.T. IF/AF Amp. Kit £11.15.0.

Total Price Kit (excl. Loudspeaker) £12.18.6 incl. P.T. p.p. 9/-.
8" x 5" Loudspeaker £1.16.1 incl. P.T.

TRANSISTOR RADIOS
OXFORD LUXURY PORTABLE. Model UXR-2. Specially designed for use as a domestic or personal portable receiver. Covers L. and M. Wave bands. 7 transistor, 3 diode, circuit. 7¾ x 4½" loudspeaker for big set sound. Heathkit now offer choice of Brown or Black real leather case. Excellent value at only Kit £15.10.0 incl. P.T. p.p. 6/-.

Total Price Kit (excl. Loudspeaker) £28.6.0 incl. P.T. p.p. 6/.

STereo TRANSISTOR FM TUNER
(Mono version also available) 14 transistor, 5 diode circuit. Tuning range 86-106 MHz. Designed to match the AA-22U Amplifier. Available in separate units, can be built for a total price.

TFM-1S Kit (Stereo) £25.2.6 incl. P.T. p.p. 6/-
TFM-IM Kit (Mono) £21.3.6 incl. P.T. p.p. 6/-

Cabinet extra £2.5.0.

SEE HOW EASY-IT-IS TO BUILD
ANY HEATHKIT MODEL YOURSELF
Full details of manual only purchase scheme in latest catalogue. Remember all Heathkit models are fully guaranteed.
LATEST! STEREO AMPLIFIER, TSA-12
12 x 12 watts output.
Kit £30.10.0 less cabinet p.p. 10/6
Cabinet £2.5.0 extra
Ready-to-Use £38.0.0 incl. cabinet p.p. 10/6
FOR THIS SPECIFICATION
• 17 transistors, 6 diode circuit • ±1dB, 16 to 50,000 Hz at 12 watts per channel into 8 ohms • Output suitable for 8 or 15 ohm loudspeakers • 3 stereo inputs for Gram, Radio and Aux. • Modern low silhouette styling • Attractive aluminium, golden anodised front panel • Handsome assembled and finished walnut veneered cabinet available • Matches Heathkit models TFM-1 and AFM-2 transistor tuners.

FULL SPECIFICATION SHEET AVAILABLE

LATEST! STEREO TAPE RECORDER, STR-1
Fully portable—own speakers
Kit £58.0.0 incl. P.T. p.p. 10/6
Ready-to-Use £70.6.0 incl. P.T. p.p. 10/6
FOR THIS SPECIFICATION
• 1 track stereo or mono record and playback at 7±, 3± and 1± ips • Sound-on-sound and sound-with-sound capabilities • Stereo record, stereo playback, mono record and playback on either channel • 18 transistor circuit for cool, instant and dependable operation • Moving coil record level indicator • Digital counter with thumbwheel zero reset • Stereo microphone and auxiliary inputs and controls, speaker/headphone and external amplifier outputs • Front panel mounted for easy access • Push-button controls for operational modes • Built-in stereo power amplifier giving 4 watts rms per channel • Two high efficiency 8" x 5" speakers • Operates on 230V a.c. supply.

Versatile recording facilities. So easy to build—so easy to use.

FULL SPECIFICATION SHEET AVAILABLE

WORLD LEADER IN QUALITY KITSETS
The instruction manual shows you how to build the model.

SHORTWAVE 4 BAND RECEIVER, GR-64E
Offers you the exciting world of Shortwave

Kit £22.9.0 pp 9/-. Ready to use £29.9.0 pp 9/-

SPEAKER SYSTEMS
HI-FI SPEAKER SYSTEM, Model SSU-1

AVON MINI SPEAKER SYSTEM
6½" Bass, 3¼" Treble speakers and crossover unit. Kit £5.2.0 incl. P.T. Beautiful Walnut veneered fully-finished cabinet, £8.18.0. Total price Kit £14.0.0 incl. P.T. p.p. 10/6 Ready to use £18.18.0 pp 10/6

FREE! CATALOGUE
Describes these and many more kits and ready-to-use models for Stereo/Hi-Fi, Domestic Radio, Record Players, Tape Recorder, Amateur Radio, Shortwave, Test, Educational, Home and Hobby. Save money with Heathkit models. Mail coupon or write to Daystrom Ltd., Gloucester. Tel: 29451.

DAYSROM LTD., Dept. RC-9
GLOUCESTER Tel. 29451
□ Enclosed is £_____ plus packing and carriage.
□ Please send model (s) _______
□ Please send FREE Heathkit Catalogue.
Name__________________________ (Please Print)
Address________________________
City__________________________

Prices and specifications subject to change without notice.
The Sinclair IC-10 is the World’s first monolithic integrated circuit high fidelity power amplifier and pre-amplifier. The circuit itself, which has an output power of 10 Watts, is a chip of silicon only a twentieth of an inch square by one hundredth of an inch thick. This tiny chip contains 13 transistors (including two power types), 2 diodes, 1 zenor diode and 18 resistors, all of which are 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.

Monolithic I.C’s. were originally developed for use in computer and space applications where their extraordinary toughness and reliability were even more important than their minute size. These same advantages make them ideal for linear applications such as audio amplifiers, but hitherto they have been confined to low power applications. The IC-10 thus represents a very exciting advance. Not only is it far 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, the IC-10 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. So we are able to sell the IC-10 at a price far below that of the components for a conventional amplifier of comparable power. At the same time, we give a 5 year unconditional guarantee on each IC-10 knowing that every unit will work as perfectly as the original and do so for a lifetime.
10 WATT MONOLITHIC INTEGRATED CIRCUIT AMPLIFIER

Specifications
- Power 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: 5 mV
- Input impedance: Adjustable externally up to 2.5 M ohms for above sensitivity

Circuit Description
The circuit diagram of the 1C-10 is shown on the right. The first three transistors are used in the pre-amp and the remaining 10 in the power amplifier. The output stage operates in class AB with closely controlled quiescent current which is independent of temperature. A high level of overall negative feedback is used round both sections and the amplifier is completely free from cross-over distortion at all supply voltages. Thus battery operation is eminently satisfactory.

Construction
The monolithic I.C. chip is bonded onto a gold plated area on the heat sink bar which runs through the package. Wires are then welded between the I.C. and the tops of the pins which are also gold plated in this region. Finally the complete assembly is encapsulated in solid plastic which completely protects the circuit. The final device is so rugged that it can be dropped thirty feet on to concrete without any effect on performance. The circuit will also work perfectly at all temperatures from well below zero to above the boiling point of water.

Other Sinclair Products
Micromatic—the world's smallest personal radio. Kit, complete 49/6. Built and tested 59/6. Q.14 low priced hi-fi speaker, 8 ohms/14 watts loading £7 19s. 6d. PZ.4 stabilised power pack, giving 18 V.d.c. at 1.5A, 99/6.

Applications
Each 1C-10 is sold with a very comprehensive manual giving circuit and wiring diagrams for a large number of applications in addition to high fidelity uses. These include public address, loud-hailers, use in cars, inter-com, stabilised power supplies, electronic organs, oscillators, watt meters, tape recorders, solar cell amplifier, radio receivers.

The transistors in the 1C-10 have cut off frequencies greater than 500 MHz so the pre-amp section can be used as an R.F. or I.F. amplifier making it possible to build complete radio receivers without any additional transistors.

SINCLAIR 1C-10
The complete IC-10 with the manual and 5 year guarantee costs just £5.96

SINCLAIR GUARANTEE
Should you not be completely satisfied with your purchase when you receive it from us, your money will be refunded in full at once and without question. Full service facilities available to all purchasers.

SINCLAIR RADIONICS LIMITED
22 NEWMARKET ROAD, CAMBRIDGE
Telephone 0CA3-52731

To: SINCLAIR RADIONICS LIMITED, 22 NEWMARKET ROAD, CAMBRIDGE.
Please send POST FREE

NAME
ADDRESS

For which I enclose cash/cheque/money order.

RC.968

SEPTEMBER 1968

www.americanradiohistory.com
AERIAL EQUIPMENT

TWIN FEEDER. 300 ohm twin ribbon feeder similar K25, 8d. per yard. Post on above feeders and cable, 2/- any length.

COPPER WIRE. 14G, H/D, 140 ft., 30/-; 200 ft., 16/- Post and packing 3/2. Lengths are only approx. Actually sold by weight.

FEEDER SPREADERS. 6" Ceramic type F.S., lOd. each. Postage 2/6 up to 12.

CERAMIC CENTRE PIECE for dipoles, Type AT, 1/6 each, P. & P. 1/6.

2 METRE BEAM, 5 ELEMENT W.S. YAGI. Complete in box with 1" to 2½" masthead bracket. Price £3.7.0. Carriage 5/-.

SUPER AERAXIAL. 70/80 ohm coax. 300 watt very low loss, 2/3 per yard. 50 ohm 300 watt, 2/6 per yard. P. & P. 2/6.

TOUGH POLYTHENE LINE, type ML1 (100lb.), 2d. per yd. or 12/6 per 100 yds. Type ML2 (220lb.), 4d. per yd. or 25/- per 100 yds., ML4 (400lb.), 6d. per yd. ideal for Guys, L.W. Supports, Halyards, etc. Postage 1/6 on all line.

CALLERS PLEASE NOTE

Our NEW Hours of Business

Mon, Tues, Wed, Fri & Sat
9.00 a.m. — 5.30 p.m.

Special

LATE SHOPPING NIGHT
THURSDAY
9.00 a.m. — 8.00 p.m.

NEW BOXED VALVES
3/6 each, 4 for 10/- P. & P. 2/–

TYPES
6N7GT 65SF7 6AB7 6SH7 X22
6AC7 6F7 6SK7 955 Z21
955A

ABSORPTION WAVEMETERS, 3.00 to 35.00 Mc/s in 3 Switched Bands. 3.5, 7, 14, 21 and 28 Mc/s. Ham Bands marked on scale. Complete with Indicator bulb. A MUST for any Ham Shack. ONLY 25/- EACH. P. & P. 1/6.

SHORT WAVE KIT, 1 valve only, 45/–. Phones, Ant. and Batteries 40/- extra if required. Ideal for junior operator.

VARIABLE CONDENSERS. All with ceramic end plate, ball bearings and ganging extension. 50 pF 5/9; 100 pF 6/6; 160 pF 7/6; 240 pF 8/6 and 300 pF 10/6. P. & P. 2/-.


The Widest Range in the Midlands
★ HIRE PURCHASE
★ PART EXCHANGE
Chas. H. YOUNG Ltd.

At your service G2AK, G3LAY, G3VFV
Please print your address. No. C.O.D. under £1.

phone 021-236 1635

170-172 Corporation Street,
Birmingham 4

THE MODERN BOOK CO

Colour Television. Pal System by G. N. Patchett. 40s. Postage 1s.

Inter GEC Transistor Manual. 7th Ed. 21/-.
Postage 1/-

Transistor Pocket Book. By R. G. Hibberd. 25/-.
Postage 1/-

Beginner's Guide to Transistors. By J. A. Reddihough. 15/-.
Postage 1/-

Rapid Servicing of Transistor Equipment. By G. J. King. 30/–.
Postage 1/-

Basic Theory & Application of Transistors. By US Dept of Army. 12/-.
Postage 1/-

Service Valve & Semiconductor Equivalents. Compiled by G. R. Jessop. 5/-.
Postage 6d.

Postage 6d.

Practical Television Circuits. A Newnes Pub. 30/-.
Postage 1/-

Radio Valve Data. 8th Ed. Compiled by "WW". 9/6d.
Postage 1/-

Mullard Data Book 1968. 3/6d. Postage 6d.

Postage 6d.

Postage 6d.

8/6d. Postage 6d.

Questions & Answers Audio. By C. Brown. 8/6d.
Postage 6d.

Postage 1/-

Questions & Answers Radio & Television. By H. W. Hellyer. 8/6d.
Postage 6d.

Transistors for Technical Colleges. By L. Barnes. 25/-.
Postage 1/-

World Radio TV Handbook 1968. 42/-.
Postage 1/-

FET Circuits. By R. P. Turner. 25/-.
Postage 1/-

We have the Finest Selection of English and American Radio Books in the Country

19-21 PRAED STREET (Dept RC) LONDON W2

Telephone PADdington 4185
**BI-PRE-PAK LIMITED**

**SEPTEMBER 1968**

**THE VALUE OF 10/- WITH ORDERS**

PACKS OF YOUR OWN CHOICE UP TO

All tested and guaranteed transistors—unmarked.

TRANSISTORS ONLY 1/- EACH

**FOR AMATEURS, PROFESSIONALS, FACTORIES, ORGAN BUILDERS, AND THOSE PEOPLE THAT JUST USE LARGE QUANTITIES OF TRANSISTORS.**

**EXCITING NEW PAKS**

**FOR AMATEURS, PROFESSIONALS, FACTORIES, ORGAN BUILDERS, AND THOSE PEOPLE THAT JUST USE LARGE QUANTITIES OF TRANSISTORS.**

**FREE!**

PACKS OF YOUR OWN CHOICE UP TO THE VALUE OF 10/- WITH ORDERS OVER £4

**TRANSISTORS ONLY 1/- EACH**

**SILICON**

**PLANAR**

**N.P.N.**

**P.P.N.**

All these types available

2N300 2N706 2S131 2S103 2N696 2N1613 2S733 BFY10

2S501 2N706A 2S512 2S104 2N697 2N1711 2N726 2S731

2N2411 2N3011 2S102 2N2220 2N1607 2N1893 2N2484 2S732

All tested and guaranteed transistors—unmarked.

Manufacturers over runs for the new PRE-PAK range.

**NEW UNMARKED UNTESTED PAKS**

- 25 BSYS6A NPN Silicon TRANSISTORS 10/-
- 10 1000 PIV 1 amp. Min. Silicon DIODES 10/-
- 25 BSYS6-97 NPN Silicon TRANSISTORS 10/-
- 10 10 Watt Silicon All Voltages ZENERS 10/-
- 25 BSYS500-1-2 NPN Silicon TRANSISTORS 10/-
- 10 4 amp. Stud. Silicon RECTIFIERS 10/-
- 25 BC107-8-9 NPN Silicon TRANSISTORS 10/-
- 40 1N914-6 GHz OA200/202 Sub. Min. Silicon DIODES 10/-
- 150 Min. Germ. High Quality DIODES 10/-
- 25 2N706 A NPN Silicon TRANSISTORS 10/-

**PRE-PAK, N.505 POWER TRANSISTOR EQUIVALENT TO NKT301**

- FREE CATALOGUE AND LISTS FOR:—
- **ZENER DIODES**
- **TRANSISTORS, RECTIFIERS**
- **FULL PRE-PAK LISTS**
- **& SUBSTITUTION CHART**

**MINIMUM ORDER 10/- CASH WITH ORDER PLEASE. Add 1/- post and packing per order, OVERSEAS ADD EXTRA FOR AIRMAIL.**

**THERE IS ONLY ONE BI-PRE-PAK LTD**

BEWARE OF IMITATIONS

**FREE! A WRITTEN GUARANTEE WITH ALL OUR SEMICONDUCTORS**

**BI-PRE-PAK LTD**

DEPT. A, 222-224 WEST ROAD, WESTCLIFF-ON-SEA, ESSEX

TELEPHONE: SOUTHEND (0702) 46344

<table>
<thead>
<tr>
<th>TRANSISTORS</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2N300</td>
<td>1/-</td>
</tr>
<tr>
<td>2N706</td>
<td>1/-</td>
</tr>
<tr>
<td>2S131</td>
<td>1/-</td>
</tr>
<tr>
<td>2S103</td>
<td>1/-</td>
</tr>
<tr>
<td>2N696</td>
<td>1/-</td>
</tr>
<tr>
<td>2N1613</td>
<td>1/-</td>
</tr>
<tr>
<td>2S733</td>
<td>1/-</td>
</tr>
<tr>
<td>2S501</td>
<td>1/-</td>
</tr>
<tr>
<td>2N706A</td>
<td>1/-</td>
</tr>
<tr>
<td>2S512</td>
<td>1/-</td>
</tr>
<tr>
<td>2S104</td>
<td>1/-</td>
</tr>
<tr>
<td>2N697</td>
<td>1/-</td>
</tr>
<tr>
<td>2N1711</td>
<td>1/-</td>
</tr>
<tr>
<td>2N726</td>
<td>1/-</td>
</tr>
<tr>
<td>2S731</td>
<td>1/-</td>
</tr>
<tr>
<td>2N2411</td>
<td>1/-</td>
</tr>
<tr>
<td>2N3011</td>
<td>1/-</td>
</tr>
<tr>
<td>2S102</td>
<td>1/-</td>
</tr>
<tr>
<td>2N2220</td>
<td>1/-</td>
</tr>
<tr>
<td>2N1607</td>
<td>1/-</td>
</tr>
<tr>
<td>2N1893</td>
<td>1/-</td>
</tr>
<tr>
<td>2N2484</td>
<td>1/-</td>
</tr>
<tr>
<td>2S732</td>
<td>1/-</td>
</tr>
</tbody>
</table>

**PRE-PAK**

Selection from our lists

<table>
<thead>
<tr>
<th>No.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>50 Unmarked Trans. Untested</td>
</tr>
<tr>
<td>B2</td>
<td>4 Photo Cells Inc. Book of Instructions</td>
</tr>
<tr>
<td>B6</td>
<td>17 Red Spot AF Transistors</td>
</tr>
<tr>
<td>B6A</td>
<td>17 White Spot RF Transistors</td>
</tr>
<tr>
<td>B9</td>
<td>1 ORP 12 Light Sensitive Cell</td>
</tr>
<tr>
<td>B63</td>
<td>25SiL Trans. 400 Mc/s</td>
</tr>
<tr>
<td>B64</td>
<td>40 NPN-5</td>
</tr>
<tr>
<td>B65</td>
<td>NPNTo18</td>
</tr>
<tr>
<td>B66</td>
<td>NPN/PNP</td>
</tr>
<tr>
<td>B68</td>
<td>10 Top Hat Recs. 750 M/A 100-800 PIV</td>
</tr>
<tr>
<td>B69</td>
<td>20 Diodes. Gld-Bnd. Germ Sil. Planar</td>
</tr>
<tr>
<td>B74</td>
<td>6 Gld-Bnd. Diodes. 2-OA9, 3-OAS</td>
</tr>
<tr>
<td>B75</td>
<td>3 Comp. Set. 2G37, 2G381, 2G339A</td>
</tr>
<tr>
<td>C2</td>
<td>1 Unijunction Transistor 2N2150</td>
</tr>
<tr>
<td>C26</td>
<td>3 Texas Power Transistors 2S012A</td>
</tr>
<tr>
<td>C32</td>
<td>6 Top Hat Recs. IS100 Type</td>
</tr>
<tr>
<td>A1</td>
<td>7 Silicon Rectifiers BY100 Type</td>
</tr>
<tr>
<td>A3</td>
<td>25 Mixed Marked and Tested Transistors</td>
</tr>
<tr>
<td>A21</td>
<td>5 Power Transistors 1-AD149/1-DC26 and 3 others</td>
</tr>
</tbody>
</table>

**BRAND NEW PAK JUST RELEASED!!!**

**REPLACES OUR VERY POPULAR B39 PAK**

Short Lead Components, all Brand New and Factory Marked, mounted on Printed Circuit Panels. Approximately:

- **80 TRANSISTORS AND DIODES**
- **50 HIGH TOLERANCE RESISTORS**
- **20 VARIOUS CAPACITORS**

Please state when ordering Pak. P.1 2/6 Post and Packaging with this pack.

Make a Rev. Counter for your Car. The "FACHO BLOCK". This encapsulated block will turn any 0-1mA meter into a perfectly linear and accurate rev. counter for any car. State 4 or 6 cylinder. 20/- each

**FREE CATALOGUE AND LISTS FOR:—**

- **ZENER DIODES**
- **TRANSISTORS, RECTIFIERS**
- **FULL PRE-PAK LISTS & SUBSTITUTION CHART**

Minimum Order 10/- Cash with Order Please. Add 1/- Post and Packing per Order. Overseas Add Extra For Airmail.

www.americanradiohistory.com
Ordering Components is FUN

A bargain at 7'6 plus 3p & p.

with THIS Catalogue in your hands!

Ever had trouble locating a particular piece for your project? Ever wasted time thumbing through confusing price lists? Ever been foot-weary and frustrated tramping round the shops?

Sigh no more. Just sink into an armchair and enjoy life with a Home Radio Catalogue! Pick your parts. Grab your pen. Make for a letter-box. Your chosen items will be with you almost before you can get back to that armchair!

This Catalogue really is a must if you're interested in Radio and Electronics. It has 256 pages, over 7,000 items listed, over 1,300 illustrations. With each catalogue we supply a Bargain List, a Book Mark giving Electronic Abbreviations, an Order Form and an Addressed Envelope. All this for only 7'6 plus 3p post and packing. By the way, every catalogue contains 5 vouchers, each worth 1p when used as directed. Send the coupon today with your cheque or P.O. for 10'6.

Please write your Name and Address in block capitals

NAME
ADDRESS

Home Radio (Mitcham) Ltd., Dept. RC, 187 London Rd., Mitcham CR4 2YQ
Vol. 22 No. 2

Published Monthly (1st of Month)
First Published 1947

Editorial and Advertising Offices
57 MAIDA VALE LONDON W9

Telephone
CUNningham 6141

© Data Publications Ltd., 1968. Contents may only be reproduced after obtaining prior permission from the Editor. Short abstracts or references are allowable provided acknowledgement of source is given.

Annual Subscription 42s. (U.S.A. and Canada $5) including postage. Remittances should be made payable to "Data Publications Ltd". Overseas readers please pay by cheque or International Money Order.

Queries. We regret that we are unable to answer queries other than those arising from articles appearing in this magazine nor can we advise on modifications to equipment described. Queries should be submitted in writing and accompanied by a stamped addressed envelope for reply.

Correspondence should be addressed to the Editor, Advertising Manager, Subscription Manager or the Publishers as appropriate.

Opinions expressed by contributors are not necessarily those of the Editor or proprietors.

Production.—Lithography.

Three-Band 550–25 Metre Transportable Superhet
by F. G. Rayer, G3OGR

Two-Voltage Power Supply
(Suggested Circuit No. 213)
by G. A. French

News and Comment
by A. N. Drew

Shorted Turn Tester
by A. N. Drew

A Description of Electrowriter Instruments
by L. Saxham

Radio Constructors Data Sheet No. 13
(Parallel-R, Series-C Table)

Recent Publications
by P. Williams

High Performance T.R.F. Tuner Unit
by J. Morley

Q-Multiplier and Audio Filter Units
by L. Saxham

“Amateur” Coil Construction
by A. S. Carpenter, G3TYJ

Suggestions for Your ‘Easy-View’ Diary
by J. Vella

The Radio Constructor’s ‘Easy-View’ Diary
by J. Vella

Meter Coil Resistance Measurement
by P. A. Graves

Solid State Windscreen Wiper Delay Unit
by J. Vella

Understanding Radio
(Mixer Functioning)
by W. G. Morley

Courses of Instruction
by Recorder

In Your Workshop

Radio Topics
Three-Band 550–25 Metre Transportable Superhet

by

F. G. RAYER, G3OGR

This is an easy-to-build 3-valve receiver offering continuous coverage from 550 to 25 metres. Alignment and wave-band switching problems are minimised by the use of a ferrite rod aerial and a panel-mounted r.f. trimmer.

By using a ferrite rod aerial wound for three bands and an extending telescopic aerial this receiver gives very good results without an external aerial. Coverage is approximately 550 to 25 metres, without gaps, as follows:

- **Band 1**: 1,500–550 kc/s, or 200–550 metres, the usual "medium wave" band.
- **Band 2**: 4.5–1.5 Mc/s, or about 65–200 metres, thus including shipping, 80m and 160m amateur bands, and other short wave transmissions.
- **Band 3**: 12–4.5 Mc/s, or about 25–65 metres, for most long distance and general s.w. reception.

**THE CIRCUIT**

$L_1$, $L_2$ and $L_3$, shown in Fig. 1, are aerial coils, and the panel trimmer $VC_3$ allows the aerial circuit to be peaked up for maximum efficiency on all frequencies. The tuning drive is automatic 2-speed, and the scales are calibrated in frequencies. This gives convenient and easy tuning.

The oscillator stage is provided by the triode section of $V_1$, the appropriate coils (indicated as $L_4$ in Fig. 1) being...
switched in by $S_{10}$ and $S_{16}$. There are three oscillator coils but, for simplicity of presentation, only one is shown in Fig. 1, the remaining coils having similar switching connections. Each oscillator coil is provided with its own integral trimmer, indicated as $C_{x}$, but requires an external fixed padding capacitor. The latter are listed as $C_{P1}$, $C_{P2}$ and $C_{P3}$. With the OS9 coil (1,500–550 kc/s) the black tag connects to chassis and the yellow tag to the padding capacitor, as shown in Fig. 1. The OS10 (4.5–1.5 Mc/s) and OS11 (12–4.5 Mc/s) coils have their black and yellow tags connected together, both being returned to chassis via the appropriate padding capacitor. These different methods of connection are clearly illustrated in the wiring diagram, which is discussed later.

The use of a ferrite rod aerial coil which has no coupling windings makes wavechange switching very straightforward. Some other parts of the circuit have also been simplified, without loss of efficiency. $V_1$ and $V_2$ have no cathode bias because there is no voltage delay on the a.g.c. circuit at $V_2$ diode, so bias is produced for $V_1$ and $V_2$ at virtually all signal levels. A small standing bias is also provided by "contact potential" in $V_2$ diode. A.G.C. is applied to $V_1$ via $R_1$, $V_1$ and $V_2$ have a common screen-grid supply by way of $R_4$, $C_6$ being the bypass capacitor.

The output stage gives excellent volume for a speaker.

<table>
<thead>
<tr>
<th>Resistors (All fixed values $\frac{1}{4}$ watt 10% unless otherwise stated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_1$</td>
</tr>
<tr>
<td>$R_2$</td>
</tr>
<tr>
<td>$R_3$</td>
</tr>
<tr>
<td>$R_4$</td>
</tr>
<tr>
<td>$R_5$</td>
</tr>
<tr>
<td>$R_6$</td>
</tr>
<tr>
<td>$R_7$</td>
</tr>
<tr>
<td>$R_8$</td>
</tr>
<tr>
<td>$R_9$</td>
</tr>
<tr>
<td>$R_{10}$</td>
</tr>
<tr>
<td>$R_{11}$</td>
</tr>
<tr>
<td>$R_{12}$</td>
</tr>
<tr>
<td>$R_{13}$</td>
</tr>
<tr>
<td>$V_{R1}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Capacitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>$C_1$</td>
</tr>
<tr>
<td>$C_2$</td>
</tr>
<tr>
<td>$C_3$</td>
</tr>
<tr>
<td>$C_4$</td>
</tr>
<tr>
<td>$C_5$</td>
</tr>
<tr>
<td>$C_6$</td>
</tr>
<tr>
<td>$C_7$</td>
</tr>
<tr>
<td>$C_8$</td>
</tr>
<tr>
<td>$C_9$</td>
</tr>
<tr>
<td>$C_{10}$</td>
</tr>
<tr>
<td>$C_{11}$</td>
</tr>
<tr>
<td>$C_{12}$</td>
</tr>
<tr>
<td>$C_{13}$</td>
</tr>
<tr>
<td>$C_{14}$</td>
</tr>
<tr>
<td>$C_{15}$</td>
</tr>
<tr>
<td>$C_{P1}$</td>
</tr>
<tr>
<td>$C_{P2}$</td>
</tr>
<tr>
<td>$C_{P3}$</td>
</tr>
<tr>
<td>$V_{C12}$</td>
</tr>
<tr>
<td>$V_{C3}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inductors</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_1$, $L_2$, $L_3$</td>
</tr>
<tr>
<td>$L_4$</td>
</tr>
<tr>
<td>$L_{FT1}$</td>
</tr>
<tr>
<td>$L_{FT2}$</td>
</tr>
<tr>
<td>$T_1$</td>
</tr>
<tr>
<td>$T_2$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Valves</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_1$</td>
</tr>
<tr>
<td>$V_2$</td>
</tr>
<tr>
<td>$V_3$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Switches</th>
</tr>
</thead>
<tbody>
<tr>
<td>$S_1$</td>
</tr>
<tr>
<td>$S_2$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rectifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D_1$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Jack</th>
</tr>
</thead>
<tbody>
<tr>
<td>$J_{K1}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Miscellaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow motion dial type SMD2 (Electroniques)</td>
</tr>
<tr>
<td>3 knobs</td>
</tr>
<tr>
<td>3 B9A valveholders</td>
</tr>
<tr>
<td>Ferrite rod 5in by $\frac{3}{4}$in diameter, Cat. No. FR3 (Home Radio)</td>
</tr>
<tr>
<td>Telescopic aerial, 36in extended or as desired</td>
</tr>
<tr>
<td>3-way tagstrip</td>
</tr>
<tr>
<td>Chassis, 10 x 5 x 2in</td>
</tr>
<tr>
<td>Panel, 10 x 6in</td>
</tr>
</tbody>
</table>

SEPTEMBER 1968
Fig. 2. The components and wiring above the chassis. The ferrite rod is secured on two vertical strips of Paxolin or similar material.
but phones can be plugged in for personal listening, if desired.

A simplified power section incorporates $T_2$, which offers full isolation from the mains, and half-wave rectification is given by $D_1$ and $C_{15}$. Additional smoothing for the screen-grid of $V_3$ and earlier stages is provided by $R_{10}$ and $C_6$. $C_7$ is a radio frequency bypass capacitor. $V_3$ requires only about 170 to 200V maximum for good results, and the actual working h.t. voltage, at about 175V, is lower than in most mains equipment. The performance is good even with an h.t. voltage of 150 or less.

**PREPARING CHASSIS AND PANEL**

The positions of valveholders and other items can be taken from Fig. 2, which also indicates the panel dimensions of 10 by 6½in. Valveholder and i.f. transformer orientation may be found from Fig. 3. All three valveholders have solder tags for chassis connections under their securing nuts. Each i.f. transformer requires seven holes—four to clear the tags, two for 6BA mounting bolts, and a central hole so that the lower core can be reached with a trimming tool.

Not shown in Fig. 2 are the holes in the chassis required for the leads to $T_1$ primary and secondary, the 6.3V and h.t. secondary leads from $T_2$, and the $T_2$ mains and switching leads to $S_2$. The positions of these holes depend somewhat on the dimensions and construction of the particular transformers employed and should be marked out and drilled accordingly. All chassis holes for the passage of wires should have rubber or p.v.c. grommets fitted to prevent lead insulation being in contact with the metal of the chassis.

The front panel is secured in place by the mounting nuts for the underchassis controls and jack (see Fig. 3 for positioning). For free, smooth tuning, the drive and ganged capacitor need to be lined up accurately. If necessary, $V_{C12}$ can be moved a little by elongating the chassis holes with a small file, or drilling large holes and placing washers each side.

A tagstrip anchors the three cores of the mains lead, green being Earth (to chassis). Neutral (N) connects to the transformer primary, whilst Line (L) connects to the primary via the switch, $S_2$. If a 13A mains plug is used, this may be fitted with a 2A fuse. The mains transformer will, normally, have taps in the primary for different mains voltages. If the transformer has insulated lead-outs for connection instead of tags, the primary tap lead-outs not required should be carefully taped up to ensure that there is no risk of these short-circuiting to the chassis or other components.

The tag positioning for $T_1$ and $T_2$ shown in Fig. 2 corresponds to the transformers used in the prototype. Other components may have different tag positioning (or may have lead-outs) and this point should, of course, be borne in mind when connecting these transformers into circuit. No specific make or type number is quoted for the two transformers as these should be generally available from a number of suppliers. A suitable transformer for $T_2$, is, for instance, available from Henry's Radio, Ltd.

The 6.3V winding of $T_2$ connects to chassis and all heaters. The h.t. secondary is connected to chassis and the rectifier, $D_1$. Mains and h.t. leads which pass through the chassis should be well insulated.

The primary of $T_1$ connects to the positive terminal of $C_{15}$ and pin 6 of $V_3$. The secondary is connected to the panel jack for speaker or phones.

Bolts secure the telescopic aerial to an insulated block, which is in turn fixed to the chassis. If transportable working is not wanted, a wire aerial can be connected instead of the telescopic aerial.

**FERRITE ROD WINDING**

The ferrite rod is 8in long and ½in in diameter. Two strips of Paxolin or other insulating material ¾in wide are cut and a notch to receive the rod is filed in the top of each. Small brackets mount the strips vertically. Elastic or string through a small hole holds the rod in place.

Gummed paper, or thin card coated with glue, is wound on the rod, making tubes for $L_1$, $L_2$ and $L_3$. These should be free to slide along the rod. The tube for $L_1$ is ¾in long, that for $L_2$ ½in long, and that for $L_3$ 1in long.

When the tubes are dry, coat each thinly with clear Bostik or a similar adhesive immediately before winding. During winding, each tube is placed on the rod itself, or on
Fig. 3. Wiring below the chassis. Connections from the oscillator, coils to the wavechanger switch are given in Fig. 4.
an object of similar diameter.

$L_1$ is 9 turns of 26 s.w.g. enamelled wire, wound side-by-side, the tapping for $C_1$ being 2 turns from the end which joins $L_2$. $L_2$ is similarly wound with 26 s.w.g. wire, but has 16 turns. $L_3$ is 60 turns of 32 s.w.g. silk covered wire, wound side-by-side.

Turns must be so wound that beginning at the VC end of $L_1$, and continuing through $L_2$ and $L_3$ results in all turns being in the same direction.

With $L_1$ tube flush with the end of the rod, and $L_2$ tube $\frac{3}{4}$ in away (see Fig. 2) trimming on the short wave bands should fall within the range of the panel control VC3. This also applies on medium waves, with $L_3$ almost at the other end of the rod, as in Fig. 2. Further adjustment, to compensate for the variations in inductance to be expected with home-wound coils can easily be made as described later.

The heaters require just under 1.5A and, as already stated, suitable small transformers are readily available. For h.t. purposes, a 45mA 220V winding does well. When the heaters have reached full temperature, about 180V should be found across $C_{15}$, and a meter in the h.t. line immediately after $C_{35}$ should indicate about 40mA. Some variation in h.t. voltage is not important, but if it exceeds 200V it is preferable that $R_{13}$ be increased in value to reduce the voltage. The actual voltage depends on $T_2$ secondary resistance and the rectifier, as well as $R_{13}$.

As an incidental note, a 250V 30mA transformer has also been tried out and found satisfactory. In this case $R_{13}$ was increased in value until h.t. current was 30mA, the h.t. line then being near 160V.

UNDER THE CHASSIS

Fig. 3 shows components and connections, and a few points here need explanation.

The oscillator coils OS9, OS10 and OS11 fit in $\frac{3}{4}$ in diameter holes and each has its own trimmer, $C_T$, incorporated. These trimmers are adjusted from below with a screwdriver. The cores are rotated with a trimming tool from above the chassis. The coils are placed so that black and yellow lead tags take up the positions shown in Fig. 3.

Each coil has its own padder capacitor, 270pF (CP1) for OS9, 1,000pF (CP2) for OS10, and 3,000pF (CP3) for OS11. The OS9 padder connects between yellow and black, the latter going to chassis. But, as already mentioned, the OS10 and OS11 coils have black and yellow tags joined, padders connecting from here to chassis.

When black and yellow tags have been wired as in Fig. 3, blue and green tags are connected to the switch as illustrated in Fig. 4. The leads to the OS10 and OS11 coils need to be short and direct. Switch $S_1$ is shown as 3-pole 3-way, but a 4-pole 3-way component with one section unused may be employed instead, if this is easier to obtain. In this latter case confirm, by visual inspection or with a continuity meter, the group of fixed contact tags which appear in each switch section.

Bandchange switching is actually very straightforward, but if any doubt is felt about this part of the circuit it is wise to initially wire in the OS9 coil only, with $L_1$, $L_2$ and $L_3$ in series connected across $C_{35}$. Assuming that normal medium-wave reception is then obtained, the remaining oscillator coils can be connected up. This will help avoid errors in switch wiring.

The switch section, $S_{1(0)}$, short-circuits $L_3$, or $L_2$ and $L_3$, for the higher frequency bands. $L_1$, $L_2$ and $L_3$ are all in use, in series, for the medium-wave band.

Junction L1/L2
Junction L2/L3

Fig. 4. The wiring to switch $S_1$. Leads to the OS10 and OS11 coils should be kept short and direct.
The intermediate frequency transformers, IFT₁ and IFT₂, have numbered tags positioned as in Fig. 3. All tags must clear the chassis. Short pieces of sleeving may be placed on the tags to ensure this point, if desired.

The connections identified as "MC" are to solder tags bolted tightly to the chassis at the positions indicated. Many of these are provided under valveholder securing nuts.

Capacitor C₁₂ should be a good, reliable component, as even very slight leakage here will upset bias conditions for the output stage. The rectifier is a contact-cooled type, bolted direct to the chassis.

SPEAKER AND PHONES

The speaker should have an impedance of 2 to 3Ω, and it needs a cabinet or baffle for satisfactory reproduction. A 3½ in, 5 in or larger speaker is better than a very small unit.

If phones are employed, there is an impedance mismatch, but T₁ still isolates the phones from h.t. circuits. The mismatch is less with low-impedance phones, and is usually disregarded because V₃ can supply very much more power than is normally required for headphones. A small, external low/high matching transformer between receiver and phones will improve matching, but the extra volume is usually of no advantage and can actually be a nuisance.

(It should be noted that, if the receiver is operated without a speaker or low impedance phones it is possible for high a.f. voltages to appear across T₁ primary, with a risk of damage to this component. The volume control should, in consequence, be kept at a low setting if T₁ secondary is not loaded by a speaker or low impedance phones. Alternatively, a 10Ω ½ watt resistor may be permanently connected across the tags of JK₁. This will ensure adequate loading under all conditions and will cause negligible reduction in a.f. output.—Editor.)

I.F. ALIGNMENT

For maximum sensitivity, the top and bottom cores of both IFT₁ and IFT₂ may need adjusting. Tune in any weak transmission which can be trimmed for maximum volume with VC₃. Then with the correct type of insulated tool carefully rotate each i.f. transformer core for maximum volume.

If a signal generator is to hand, this can be used in the customary manner. Place VR₁ near maximum volume, and reduce the generator output as needed for a low volume output from the speaker.

AERIAL AND OSCILLATOR

Provided VC₃ can be turned to a position which gives a quite sharp peak in volume, and is not then fully open or fully closed, maximum efficiency is obtained. However, some adjustment of the oscillator coils and trimmers (and possibly aerial coils) will allow most suitable band coverage, and will result in VC₃ having to be touched only occasionally for optimum reception of weak signals. VC₃ also compensates for changes in loading, such as is given by extending the aerial.

The medium wave band is most easily dealt with. Set the ganged tuning capacitor nearly fully open and rotate the OS9 coil trimmer to tune in a station near 200m (such as Luxembourg on 208m). Rotating VC₃ should bring volume up as described. Then tune towards the low frequency end of the band (VC₁, nearly closed) and move L₃ along the rod for best volume. If a known station or signal generator shows coverage is wrong, adjust the OS9 coil to correct this, and move L₃ as necessary for best results.

The same methods are used for Bands 2 and 3, but adjustments are more critical. If L₁ and L₂ are wound exactly as described, slight adjustment of the OS10 and OS11 cores and trimmers should provide suitable tuning coverage, with VC₃ capable of being peaked up for maximum sensitivity throughout each range.

The settings of VC₃ provide a guide to the adjustments needed in the oscillator circuit. If VC₃ needs to be nearly fully closed for best results, with VC₁,₂ nearly open, the oscillator trimmer C₇ of that range is at too high

THE RADIO CONSTRUCTOR
capacitance. At the low frequency end of a band, the necessity to have VC₃ nearly closed shows that the oscillator coil core for that band is too far in.

**DIAL CALIBRATION**

Blank scales on the dial are most easily calibrated by putting on the half cursor provided with the drive, so that pencil marks can be made along its edge. A signal generator is very convenient, because it can be set to various frequencies which are then tuned in and marked on the scale. Failing this, spot frequencies on various bands can be located by listening, and then marked. The dial is afterwards taken off and finished neatly in ink or ball-point pen. A different colour for each band is helpful. The dial is then replaced, using the cursor having a centre line.

The blank scales have a numbered section, and this may be used to log transmissions, or to transfer readings to a graph. The latter will then provide readings for frequencies where no known stations are found, so that the dial can be completed without a signal generator.

---

**SUGGESTED CIRCUIT No. 214**

**Two-Voltage Power Supply**

by G. A. FRENCH

In equipment run from the A.C. mains it is quite often desirable to power one or more of the stages at a potential which is approximately half the full supply voltage available from the rectifier. Typical instances are given in amateur transmitters, where the p.a. stage may be fed from the full rectified h.t. supply voltage whilst the v.f.o. and early modulation stages are run from a subsidiary supply at reduced voltage. Similar conditions can also exist in an a.f. amplifier whose power output stage requires a higher supply voltage than the preamplifier stages. In a communications superhet receiver it may, again, be desirable to have a reduced supply voltage available for application to a voltage stabiliser and, thence, to the local oscillator. Other applications of the same type will suggest themselves to the reader.

A common approach towards obtaining the reduced supply voltage is to incorporate a dropping resistor from the main rectified supply or, where better regulation is required, to connect a fixed potentiometer across the main supply rails, and take the reduced voltage from the junction of the two resistors which form this potentiometer. Both these approaches are, however, wasteful of rectified supply current. Also, if high voltages and/or currents are involved, it may be necessary to employ high wattage resistors to provide the reduced voltage, with consequent heat dissipation and loss of chassis space.

It is possible to obtain a reduced rectified supply voltage, at about half the voltage of the main supply, without employing any of the circuit devices just mentioned at all. Furthermore, this can be achieved at almost negligible cost in components. The only requirements are that a bridge rectifier be employed to give the full supply voltage, and that the mains transformer secondary feeding the bridge rectifier be provided with a centre-tap.

**BASIC CIRCUIT**

The circuit in Fig. 1 demonstrates the basic technique employed. T₁ is a mains transformer, and its full secondary connects to the bridge rectifier given by D₁ to D₄. This functions in normal fashion and a rectified voltage appears across reservoir capacitor C₂. The voltage on the upper plate of C₂ appears at the "+2" output terminal (assuming no external load) its potential above chassis is equal to the peak value of the alternating voltage across the full secondary of T₁.

The circuit of Fig. 1, as described so far, represents a conventional bridge rectifier supply. However, Fig. 1 also shows an auxiliary circuit, this comprising capacitor C₁ together with a...
connection into a centre-tap in the mains transformer secondary. As will now be explained, the rectified voltage across 

C₁ is exactly half the rectified voltage across C₂.

Let us consider circuit operation at an instant in the a.c. cycle when the upper end of T₁ secondary is at peak positive potential. Diodes D₂ and D₃ in the bridge circuit are then conducting, the latter diode virtually connecting the lower end of T₁ secondary direct to chassis. Hence the peak positive voltage appears at the centre-tap of the secondary and is applied to the upper plate of capacitor C₁.

On the alternate half-cycle peak it is the lower end of T₁ secondary which is at positive peak potential whilst, this time, diodes D₄ and D₁ are conducting. Diode D₁ effectively connects the upper end of the secondary to chassis, and the centre-tap once more has a potential which is half the peak positive potential above chassis. Again, this potential is applied to the upper plate of capacitor C₁.

Thus, on alternate peaks, capacitor C₁ is caused to charge up to half the peak voltage across the mains transformer secondary. If a load is connected across C₁, causing the "+1" output voltage to drop below half the peak voltage across T₁ secondary, diodes D₁ and D₄ will conduct before voltage peaks, and will charge C₁ in the normal manner associated with a full-wave rectifier. If a further load is connected between the "+2" output and chassis, these two diodes will also commence to conduct as soon as the voltage from T₁ secondary exceeds that across C₂. With loads connected, therefore, both C₁ and C₂ receive charging pulses every half-cycle, those for C₁ being via the full-wave rectifier given by D₁ and D₄ and those for C₂ being via the bridge rectifier given by D₁, D₂, D₃ and D₄.

If C₁ and C₂ were omitted from the circuit, both outputs would consist of successive positive half-cycles, as given by full-wave rectification without a reservoir capacitor. The average voltage at the "+2" output would then be 0.9 times the secondary r.m.s. voltage. Should C₁ alone be omitted, the "+2" output becomes the peak value associated with a reservoir capacitor whilst the average output at the "+1" terminal continues at 0.45 times the secondary r.m.s. voltage. On the other hand, if C₂ alone is omitted, the average voltage on the "+2" output terminal is higher than 0.9 times secondary r.m.s. voltage because C₁ imparts some of its charge to the bridge circuit on each successive half-cycle. This last fact is applicable should it be intended to have the bridge rectifier output feed into a choke input filter instead of a reservoir capacitor. In such a case the full-wave output at the secondary centre-tap should also feed into a choke input (or resistor input) filter.

All the four diodes require a p.i.v. rating of greater than 1.4 times the r.m.s. voltage across the entire transformer secondary. This is, of course, the same rating as for normal bridge operation. The forward current in D₂ and D₄ is that flowing in the "+2" output and reservoir circuit only. The forward current in D₁ and D₃, and the current in the mains transformer secondary, is the sum of the currents in both the "+1" and "+2" outputs and reservoir circuits. Reservoir capacitors C₁ and C₂ require the values associated with the class or work for which the power supply is intended. Smoothing filters are not shown in Fig. 1 and these may be provided after the output terminals, as required.

The neat circuit trick of taking a half-output voltage from a centre-tap in the mains transformer secondary is not original to the writer, and acknowledgement is due to the German amateur radio journal Das DL-QTC in which the first saw this technique.

APPLICATIONS

The circuit of Fig. 1 may be employed at any transformer secondary voltage, and the fact that the two outputs are positive of chassis makes it especially attractive for valve equipment. For fairly high output voltages, T₁ could be a transformer having an h.t. secondary voltage of, say 200–200, whereupon 400 volts r.m.s. becomes applied to the bridge. For lower power work the Radiospares mains transformer with a secondary voltage of 125–0–125 at 25mA (Home Radio Cat. No. TM39) is attractive. This last transformer could use an inexpensive contact-cooled bridge h.t. rectifier for D₁ to D₄.

Fig. 2 shows the same circuit as Fig. 1, but with output polarities reversed. This has been achieved by simply reversing the diodes and the two capacitors. The negative outputs may be more attractive for work with transistors, whereupon T₁ can have a low voltage centre-tapped secondary. Heater transformer secondaries can be improvised here or use made of a specific low voltage transformer such as the Electroniques Code No. P.9004, which has a secondary voltage of 6–0–6 at 80mA. Such low voltage secondaries can also be used to give positive outputs employing the circuit of Fig. 1.

A slightly different configuration is shown in Fig. 3. Here, the reservoir capacitor for the bridge circuit (previously C₂) is now given by C₃ and C₄ in series, whilst the half output voltage reservoir capacitor (previously C₁) is now given by C₃ on its own. In this circuit each capacitor requires a working voltage of half the "+2" output, and this is an advantage if the "+2" voltage is high, as can occur with a transmitter. The two outputs in Fig. 3


This circuit was that given in Das DL-QTC.
are positive of chassis. They may be made negative by transferring the chassis connection to the positive plate of $C_4$, whereupon a full negative voltage becomes available at the negative plate of $C_3$, with half the output voltage available at the centre output terminal.

A final point is that it is important to ensure, in all three circuits, that the secondary centre-tap is a true centre-tap, and to avoid using a mains transformer whose secondary has a tap which is some way from the winding centre. Such a circumstance would occur if a transformer with a secondary having a tap near the centre (but not intended as a centre-tap) were pressed into service. If the secondary tap is too far removed from the winding centre, relatively heavy charge and discharge currents can flow in the half output voltage reservoir on successive half-cycles, and may cause this component to become overheated.
We visited the amateur radio station, GB2LO, operated by the Radio Society of Great Britain during the 1968 City of London Festival at a site in front of the Daily Mirror Building in Holborn.

Arriving in the early morning before the station was officially open, gave the writer the opportunity of chatting with Sylvia Margolis, the energetic Public Relations Officer of the R.S.G.B., about this new venture. There is no doubt that the kindness of the Daily Mirror and the Festival authorities in helping and allowing the R.S.G.B. to operate GB2LO gave the society a unique opportunity to present amateur radio to the public at large. Sylvia Margolis was obviously determined that the society should take full advantage of this opening.

One or two points she made about the way to present an attractive image of amateur radio to the public are, we think, worth passing on.

Firstly, the station must be operated in a manner that will interest the man in the street, therefore it would be a mistake to use c.w. Also the public are not particularly attracted by a conversation between the operator and a local amateur (after all they may feel they can do the same by inserting 6d. in a telephone coin box), but they will probably be keenly interested in hearing a contact being made with an amateur thousands of miles away. The operators must be presentable in appearance, and a general impression of friendly efficiency given.

The foregoing considerations may seem elementary but they can be easily overlooked.

There was no doubt in the mind of the writer, as he made his way across Holborn Circus through the gathering spectators listening to the station’s p.a. system, that this new venture was a success, not to be measured solely in the number of new adherents gained to the hobby but also in the increase of public interest in the ideals and needs of amateur radio.

Another venture in publicity for amateur radio, in Canada this time, can also be reported upon.

During a recent visit to Winnipeg, Manitoba, one of our editorial team was agreeably surprised to find a demonstration of amateur radio being staged by local radio amateurs in one of Winnipeg’s largest shopping centres known as The Mall. He lost no time in introducing himself as a British radio amateur and was able to learn at first hand a little about the hobby in that part of Canada.

The countryside around is, for the most part, flat wheat growing country extending right to the horizon without an obstruction of any sort. It was not surprising therefore to learn that much of the local activity was on v.h.f. V.H.F. mobile operation is extremely popular and is their equivalent of our Raynet, particularly so as it is very common for farmsteads and small communities to be cut off by snow in winter time. Dx working on the lower frequencies was losing its popularity due to TVI caused by the many TV channels in use.

Private aircraft are a favourite form of transport and amateur radio v.h.f. mobile activity is used by those amateurs owning such aircraft. There are a growing number of flying enthusiasts in Winnipeg and they were also staging a publicity drive at the same shopping centre. To judge from the crowds making enquiries at both stands it appears that both private flying and amateur radio are likely to have considerable support in the near future.

Finally we come to amateur radio’s showpiece in this country, the International Radio Engineering and Communications Exhibition to be held at the Royal Horticultural New Hall, Greycoat Street, Westminster, London, S.W.1. from 2nd to 5th October, 1968. Here are some preliminary details:

For the first time the Diplomatic Wireless Service will be exhibiting, showing some of their latest communication equipment. They will also be responsible for the centre stage presentation.

An innovation will be a series of four lectures on ‘Communication Equipment’, ‘Single Side Band (s.s.b.)’, ‘Aerials’, and ‘Communication Research and Developments’. These will take place on the Thursday and Friday, with Saturday being reserved for all the Armed Forces general meetings.

A Manufacturers’ Silver Plaque will again be awarded outright to any new outstanding communication equipment displayed for the first time.

The Radio Society of Great Britain will feature the Radio Emergency Network (RAEN) at work, and the latest constructed Mobile Operations Room will be on display for the first time.

There will be a competition for home-constructed equipment for which silver trophies will be awarded, also the Organiser’s Silver Plaque for 1968 and additional prizes.

The opening will be supported by the Armed and Radio Services, and international invitations to the Exhibition will be on a wider scale than ever before.
THE ROYAL TELEVISION SOCIETY

Formed in 1927, The Royal Television Society has for over 41 years played a major part in acting as a discussion ground in many aspects of television. Now a new sphere of activity – the field of educational technology – is being added to the Society’s work.

A special Royal Television Society seminar entitled ‘Television in Educational Technology – what is its role?’ is being held in London on October 11th 1968 at 3 p.m. The seminar will include the following speakers: Guthrie Moir (Rediffusion Television Ltd.), Professor J. Black (UGC Committee on Educational Technology), J. C. Wykes (ILEA), G. Sattin (Eothen Films), Dr. R. C. G. Williams (ICETT), Dr. Gerald Vaughan (Guy’s Hospital), E. Stones (Birmingham University).

Admission is free to both members and non-members of the Royal Television Society. Applications for tickets should be made to The Secretary, The Royal Television Society, 166 Shaftesbury Avenue, London, W.C.2. Tel: 01–836 3350/3788.

An Educational Television and Technology Committee has been set up to plan the first year’s activities. The chairman is Dr. P. D. Whitaker (University of Birmingham) and the other committee members are: M. H. Cox (ABC Television), J. Gilman (BBC), B. Groombridge (ITA), G. Moir (Rediffusion Television Ltd.), T. Neil (Thomson Foundation Television College), J. Ware (Ware MacGregor Partnership), D. Whittle (David Whittle Associates), Professor R. Warwick (Guy’s Hospital Medical School), J. M. Wright (ICETT).

Membership of the Royal Television Society will now be open to educationalists, lecturers, professors, teachers, educational television organisers, administrators, local education officers, Service instructors, industrial training officers and students.

The aim is to enable common problems of educational technology to be discussed in the open and neutral forum which the Society can provide. Educationalists, programme producers, engineers and administrators will, for the first time, have an all-enhancing professional Society.

The full facilities of the London secretariat of the Society and its eight centres in Bristol, Cardiff, Devon and Cornwall, Leicester, Manchester, Midlands, Northern Ireland and Nottingham, will be available to further the aims of the new members.

All enquiries to:
The Royal Television Society.

SEPTEMBER 1968

TELEPHONING BY LIGHT BEAM

A portable telephone recently produced by Britain’s Associated Electrical Industries uses a beam of light instead of wires. In a BBC scientific programme, Noel Ernst of A.E.I. explained that this new short-range communications system will be very useful on building sites, making it possible to speak to the top of a building from the ground without having to lay cables. It can also be used in surveying, enabling surveyors to speak to each other across a river without the expense of a radio telephone and the formalities of a frequency allocation. Technically, the new system is a modulated light source, the filament of a lamp being modulated by the voice. At present the range is just over a mile but research engineers hope to extend this very soon.

COLOUR CODING OF FLEXIBLE CABLES

H.M. Government have decided to make regulations under the Consumer Protection Act requiring the core colours of three-core flexible cords fitted to domestic electrical appliances, when offered for sale in Great Britain, to comply with the following international coding recently agreed by most of the countries in Europe:

Green-and-yellow striped core Earth
Brown core . . . . . . Live
Light blue core . . . . Neutral

Up to a date to be specified in the new statutory regulations, it will be admissible as an alternative to offer for sale appliances having cords in accordance with the British coding at present specified in the IEE Wiring Regulations.

MICROELECTRONIC DEPT.

“We’re on to something BIG here Dodsworth!”

www.americanradiohistory.com
HAVING CONSTRUCTED SEVERAL COILS WHICH PROVED unsatisfactory due to short-circuits between turns, the writer decided to make a simple shorted turn tester. The result is described in this article and has proved to be both reliable and sensitive in use.

CIRCUIT DETAILS
The circuit of the tester is given in Fig. 1. In this diagram, TR₁ is an oscillator for which the tuned circuit is given by L₁ and the series combination of C₁ and C₂. Coil L₁ is wound on one end of a ferrite rod, over which are passed the coils to be tested.

The supply to TR₁ is stabilised by zener diode D₁, whilst control of oscillation is provided by R₅. This potentiometer is set up such that TR₁ is just oscillating.

The oscillator voltage at TR₁ collector is passed, via C₃, to TR₂, which functions as an emitter follower. This transistor is inserted in the circuit to minimise the load on the oscillator. The output from TR₂ is next passed to TR₃, which amplifies as a common emitter transistor.

The signal appearing at TR₃ collector is next applied to diodes D₂ and D₃, these being connected in a voltage doubler circuit. The rectified voltage from these diodes is

Fig. 1. The circuit of the shorted turns tester
COMPONENTS

**Resistors**

(All fixed values $\frac{1}{4}$ watt 10%)

<table>
<thead>
<tr>
<th>R</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R_1</td>
<td>15kΩ</td>
</tr>
<tr>
<td>R_2</td>
<td>1.5kΩ</td>
</tr>
<tr>
<td>R_3</td>
<td>1kΩ</td>
</tr>
<tr>
<td>R_4</td>
<td>470Ω</td>
</tr>
<tr>
<td>R_5</td>
<td>1kΩ</td>
</tr>
<tr>
<td>R_6</td>
<td>1kΩ potentiometer, linear</td>
</tr>
<tr>
<td>R_7</td>
<td>47kΩ</td>
</tr>
<tr>
<td>R_8</td>
<td>100Ω</td>
</tr>
<tr>
<td>R_9</td>
<td>1kΩ</td>
</tr>
<tr>
<td>R_{10}</td>
<td>470Ω</td>
</tr>
<tr>
<td>R_{11}</td>
<td>5.6kΩ</td>
</tr>
<tr>
<td>R_{12}</td>
<td>560Ω</td>
</tr>
<tr>
<td>R_{13}</td>
<td>see text</td>
</tr>
<tr>
<td>R_{14}</td>
<td>820Ω</td>
</tr>
</tbody>
</table>

**Capacitors**

<table>
<thead>
<tr>
<th>C</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_1</td>
<td>0.068µF paper or plastic foil</td>
</tr>
<tr>
<td>C_2</td>
<td>0.0068µF paper or plastic foil</td>
</tr>
<tr>
<td>C_3</td>
<td>0.1µF paper or plastic foil</td>
</tr>
<tr>
<td>C_4</td>
<td>1µF electrolytic, 6V wkg.</td>
</tr>
<tr>
<td>C_5</td>
<td>100µF electrolytic, 10V wkg.</td>
</tr>
<tr>
<td>C_6</td>
<td>1µF electrolytic, 6V wkg.</td>
</tr>
</tbody>
</table>

**Inductor**

| L_1 | see text |

**Semiconductors**

| TR_1 | 2N3702 |
| TR_2 | AF117  |
| TR_3 | AF117  |
| TR_4 | AF117  |
| D_1  | 5.6 volt zener (OAZ201, etc.) |
| D_2  | OA81 or similar |
| D_3  | OA81 or similar |

**Meter**

| M_1  | 0–100µA to 0–1mA moving-coil |

**Switch**

| S_1  | s.p.s.t. on-off |

**Miscellaneous**

| Ferrite rod, 3in x $\frac{1}{4}$in dia. |
| 9-volt battery |
| Knob (for R_5) |

finally applied to TR_4, which feeds the meter.

When TR_1 is oscillating the rectified voltage from D_2 and D_3 causes TR_4 to pass a relatively high collector current. When TR_1 ceases to oscillate (as would occur if a shorted turn were placed over the ferrite rod) there is no rectified voltage from D_2 and D_3, and TR_4 passes negligible current.

COMPONENTS

In the writer's version, TR_1 was a 2N3702, whilst TR_2, TR_3 and TR_4 were AF117's. However, these last three transistors may be any p.n.p. types, silicon or germanium (provided, in the case of germanium, that they exhibit low leakage current). The transistor in the TR_1 position must be silicon because, with germanium transistors, varying junction temperatures cause backlash in the control exerted by R_3 to become excessive. The writer used a 2N3702 here, but any other similar silicon type should be quite satisfactory. All the transistor types specified in the diagram were used because they happened to be on hand. The shield lead-outs of the AF117's were left unconnected.

D_1 is a 5.6 volt zener diode, and the maximum current it could be called upon to pass in the circuit is of the order of 7mA. Any small zener diode, such as the OAZ201, may be used here. D_2 and D_3 are germanium diodes.

It must be possible for potentiometer R_5 to cause the oscillator to stop running as its slider is advanced since, otherwise, the tester cannot be brought to its most sensitive condition. With some transistors in the TR_1 position it may be necessary to adjust the value of R_4 to enable R_5 to cover the required range. An alternative method of controlling the oscillator could consist of connecting a potentiometer of around 1kΩ across the zener diode, the supply for TR_1 being taken from its slider. This idea has not been tried by the writer, but is presented as a basis for experiment.

The meter M_1 may have any full-scale deflection between 100µA and 1mA. Resistor R_{14} has to be found experimentally, and it should have a value which prevents the meter from reading more than f.s.d. when the oscillator is running at full amplitude. The meter current should be a few microamps only with the oscillator stopped. In some cases it may be helpful to adjust the value of R_{14} to ensure that a wide difference in readings is given for the two oscillator conditions.

THE COIL

Coil L_1 uses the basic construction shown in Fig. 2. It consists of 3,800 turns of 30 s.w.g. enamelled wire pile-wound at one end of a $\frac{3}{4}$in ferrite rod 3in long. The coil should be positioned well away from metal objects, which will give the same effect as a shorted turn. The writer's tester is assembled in an Eddystone diecast box measuring $4\frac{3}{8} \times 2\frac{3}{8} \times 1$in, with the coil mounted externally in a plastic housing which gives good clearance from the metal case. The protruding section of the ferrite rod is protected by a Paxolin tube.

In use, the tester is switched on and the oscillator is set

---

www.americanradiohistory.com
so that it is only just running, whereupon the meter should read about half-scale. Placing a shorted turn over the protruding end of the ferrite rod will result in the meter reading falling sharply.

The accuracy to which the oscillator is adjusted determines the sensitivity of the instrument, which is more than adequate for normal purposes. The writer’s unit has been in use for quite some time and it was found that its operation was quickly mastered, the sensitivity being such that it can detect a sixpenny piece held $\frac{1}{2}$ in from the end of the ferrite rod.

(Editors Note. If $M_1$ is a 0–100 $\mu$A meter, start with a value of around $90k\Omega$ for $R_1$, reducing as required for the final reading. For a 0–1mA meter, a suitable starting value for $R_{13}$ is around $9k\Omega$.)

---

A DESCRIPTION OF ELECTROWRITER INSTRUMENTS

The Electrowriter can be briefly described in the following way:—One writes with a ball-point pen on regular paper as on a note pad, and as the pen is moved, the remote receiver(s) instantaneously and faithfully reproduces the copy, as it is written. No extraneous power supplies are required. The instruments are self-contained and fully transistorised.

Electrowriter instruments can be attached to a telephone system, permitting alternate written messages and voice service. Messages between electrowriter stations will pass automatically through a dial exchange, in the same manner as telephone calls.

Electrowriter instruments can also be used in any combination over G.P.O. leased or customer-owned lines of any distance with or without associated telephone sets.

Unlike true facsimile equipment that can be referred to as reproducing equipment (photo-scanned reproduction) of original data, the Electrowriter is an electro-mechanical pantograph, giving the facility that one can write to other points by remote control. This is done by creating two frequencies transmitted down a pair of wires compositely, one of which is governed by a horizontal movement and the other by vertical movement, thus giving a true analogue device, unlike a teleprinter which relies upon single pulses, (therefore a digital device).

A receiving unit has a mechanical response to a varying frequency on the line. The input is filtered in such a way that it splits the composite signal into two distinct frequencies each of which is then able to operate the vertical and horizontal pantograph motors, which in turn operates the pen. The action of the pen nib is achieved by the frequency modulation of one channel. This is then detected and converted into pure d.c. to operate a solenoid which, by mechanical linkages causes the pen to touch paper. This sequence of events is touched off at the transmitter, by the operation of a gravity switch within the stylus and thereafter by a spring loaded plunger which operates the pen-down mechanism.

The receiving machine is inactive until a signal appears at the input, thus operating a squelch relay and bringing the whole machine into the receive condition. As both vertical and horizontal frequencies 1310–1490 c/s/2060–2340 c/s are within the voice bandwidth, it is then obvious that whenever voice reception is possible this system will operate. Therefore we now have a machine which can transmit written messages or sketches to any point, however distant, over telephone or radio circuits.

Appropriate signal lamps are provided to indicate power on, transmit or receive conditions, and busy line conditions.

The Electrowriter is considered to be one of the most viable methods of communications for both industry and commerce available on world markets today. Electrowriter instruments are manufactured by Modern Telephones (Great Britain) Ltd. – a member of the Shipton Automation Group.
## PARALLEL-R, SERIES - C TABLE

The Table gives the total resistance of two resistors in parallel, or the total capacitance of two capacitors in series, for 20% preferred values from 1 to 100. Use appropriate multipliers: thus, 3.3MΩ in parallel with 15MΩ gives 2.7MΩ, or 47pF in series with 22pF gives 15pF. All results to 2 significant figures.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>1.5</th>
<th>2.2</th>
<th>3.3</th>
<th>4.7</th>
<th>6.8</th>
<th>10</th>
<th>15</th>
<th>22</th>
<th>33</th>
<th>47</th>
<th>68</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.50</td>
<td>0.60</td>
<td>0.69</td>
<td>0.77</td>
<td>0.82</td>
<td>0.87</td>
<td>0.91</td>
<td>0.94</td>
<td>0.96</td>
<td>0.97</td>
<td>0.98</td>
<td>0.99</td>
<td>0.99</td>
</tr>
<tr>
<td>1.5</td>
<td>0.60</td>
<td>0.75</td>
<td>0.89</td>
<td>1.0</td>
<td>1.1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
<td>1.4</td>
<td>1.4</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>2.2</td>
<td>0.69</td>
<td>0.89</td>
<td>1.1</td>
<td>1.3</td>
<td>1.5</td>
<td>1.7</td>
<td>1.8</td>
<td>1.9</td>
<td>2.0</td>
<td>2.1</td>
<td>2.1</td>
<td>2.1</td>
<td>2.2</td>
</tr>
<tr>
<td>3.3</td>
<td>0.77</td>
<td>1.0</td>
<td>1.3</td>
<td>1.7</td>
<td>1.9</td>
<td>2.2</td>
<td>2.5</td>
<td>2.7</td>
<td>2.9</td>
<td>3.0</td>
<td>3.1</td>
<td>3.1</td>
<td>3.2</td>
</tr>
<tr>
<td>4.7</td>
<td>0.82</td>
<td>1.1</td>
<td>1.5</td>
<td>1.9</td>
<td>2.4</td>
<td>2.8</td>
<td>3.2</td>
<td>3.6</td>
<td>3.9</td>
<td>4.1</td>
<td>4.3</td>
<td>4.4</td>
<td>4.5</td>
</tr>
<tr>
<td>6.8</td>
<td>0.87</td>
<td>1.2</td>
<td>1.7</td>
<td>2.2</td>
<td>2.8</td>
<td>3.4</td>
<td>4.0</td>
<td>4.7</td>
<td>5.2</td>
<td>5.6</td>
<td>5.9</td>
<td>6.2</td>
<td>6.4</td>
</tr>
<tr>
<td>10</td>
<td>0.91</td>
<td>1.3</td>
<td>1.8</td>
<td>2.5</td>
<td>3.2</td>
<td>4.0</td>
<td>5.0</td>
<td>6.0</td>
<td>6.9</td>
<td>7.7</td>
<td>8.2</td>
<td>8.7</td>
<td>9.1</td>
</tr>
<tr>
<td>15</td>
<td>0.94</td>
<td>1.4</td>
<td>1.9</td>
<td>2.7</td>
<td>3.6</td>
<td>4.7</td>
<td>6.0</td>
<td>7.5</td>
<td>8.9</td>
<td>11</td>
<td>13</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>22</td>
<td>0.96</td>
<td>1.4</td>
<td>2.0</td>
<td>2.9</td>
<td>3.9</td>
<td>5.2</td>
<td>6.9</td>
<td>8.9</td>
<td>11</td>
<td>13</td>
<td>15</td>
<td>19</td>
<td>22</td>
</tr>
<tr>
<td>33</td>
<td>0.97</td>
<td>1.4</td>
<td>2.1</td>
<td>3.0</td>
<td>4.1</td>
<td>5.6</td>
<td>7.7</td>
<td>10</td>
<td>13</td>
<td>17</td>
<td>19</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td>47</td>
<td>0.98</td>
<td>1.5</td>
<td>2.1</td>
<td>3.1</td>
<td>4.3</td>
<td>5.9</td>
<td>8.2</td>
<td>11</td>
<td>15</td>
<td>19</td>
<td>24</td>
<td>28</td>
<td>32</td>
</tr>
<tr>
<td>68</td>
<td>0.99</td>
<td>1.5</td>
<td>2.1</td>
<td>3.1</td>
<td>4.4</td>
<td>6.2</td>
<td>8.7</td>
<td>12</td>
<td>17</td>
<td>22</td>
<td>28</td>
<td>34</td>
<td>40</td>
</tr>
<tr>
<td>100</td>
<td>0.99</td>
<td>1.5</td>
<td>2.2</td>
<td>3.2</td>
<td>4.5</td>
<td>6.4</td>
<td>9.1</td>
<td>13</td>
<td>18</td>
<td>25</td>
<td>32</td>
<td>40</td>
<td>50</td>
</tr>
</tbody>
</table>
RECENT PUBLICATIONS


More than 180 individual circuit diagrams appear in this book, each being accompanied by sufficient text to enable any home constructor of reasonable experience and ability to build the circuit and bring it into operation. Layout and mechanical assembly diagrams are provided where essential, but in most cases it is the circuits themselves which tell the story. Some circuits are for a single or double stage, whilst others are for a complete equipment.

There is an exceptionally wide range of subjects, these including aerial matching units, receiver pre-amplifiers, converters, i.f. filters, detectors, noise limiters, transmitters, modulators, amplifiers, power supplies and test gear. The variety is so great, indeed, that it is impossible to attempt a complete list here. Suffice it to say that, as one reads through the book, one encounters such things as f.m. modulators, s.s.b. modulators, an electronic key, grid dip oscillators, a varactor tripler for 432 Mc/s, and two reflectometers. As is to be expected, some of the circuits will provide most assistance to the amateur transmitting enthusiast but the book will still be of considerable interest to the home constructor and experimenter as well. In either field it certainly offers excellent value for money.

This is the second edition of "Amateur Radio Circuits Book", and is an enlarged and revised version of the first, 1964, edition. It may, if desired, be obtained direct from R.S.G.B. Headquarters, 28 Little Russell Street, London, W.C.1., at 11s. 6d. post paid.

RADIOISOTOPE EXPERIMENTS FOR SCHOOLS AND COLLEGES. By J. B. Dance, M.Sc. 212 pages, 5 x 7½in. Published by Pergamon Press, Ltd. Price 27s. 6d. (hard cover) or 17s. 6d. ("Flexi-cover").

The author of this book is well known to regular readers of The Radio Constructor, and we have in the past published a number of articles from his pen on the general subject of radioactivity. In the present work, Mr. Dance devotes himself mainly to the student, teacher and lecturer; although anybody interested in radioisotope work can profit from the book.

"Radioisotope Experiments for Schools and Colleges" gives a description of all matters dealing with radioactivity, introducing the experiments referred to in the title when the preceding explanatory text has given the reader sufficient information to appreciate their usefulness. Careful stress is placed upon the health factor and the special precautions which have to be observed when working with radioisotopes in educational establishments. A feature which will be of particular help to the teacher is that suitable manufacturers are quoted for particular items of equipment, and that attention is drawn to the Government regulations involved in handling radioactive materials.

This is a very useful book which well deserves to become a standard text-book in its field.

TAPE RECORDING. By C. N. G. Matthews. 128 pages, 5½ x 8½in. Published by Museum Press, Ltd. Price 20s.

This book, intended more for the lay owner of a tape recorder than for the veteran electronic or recording engineer, deals simply and concisely with all the main requirements which have to be observed if optimum results are to be obtained with a recorder under domestic conditions. The first seven chapters give a clear general description of the electrical and magnetic processes involved in recording and reproduction, starting with the nature of sound and working through to equalising circuits. A following chapter then discusses microphones and loudspeakers.

The next three chapters give lucid advice on tape recorder operation, the subjects dealt with including story dramatisation (with a sample script for a play), sound effects, tape splicing, editing, "trick effects" such as the deletion or transposing of words and phrases, and recording production. These are followed by a chapter on elementary tape recorder servicing and a final short chapter describing specific commercially available recorders.

"Tape Recording" offers plenty of useful common-sense advice for the newcomer as well as for the more experienced user who wishes to learn more about the possibilities offered by his machine.

STEREO HANDBOOK. By G. W. Schanz. 135 pages, 8½ x 5½in. Distributed by Iliffe Books Ltd. Price 16s.

This book is in the Philips Paperback series, and has been translated from the German by J. V. Randeraat. Whilst it covers no new ground it does provide, within two covers, a detailed summation of all the more important principles of stereophony. It is aimed mainly at the technician and the stereo enthusiast, and the approach is essentially non-mathematical.

Subjects covered at the start of the book include stereo sound fundamentals, room acoustics, and stereo recording and reproduction. A long section of the book then deals with stereophonic transmission and reception, giving particular emphasis to the pilot tone system. The remainder of the book describes the testing of stereo a.f. equipment and decoders, with a final chapter devoted to test equipment.
A report on the stations - both amateur and broadcast - that may be logged by the s.w.l. on the various short wave bands; compiled by a Dx'er whose QTH is located near the S. Suffolk coast.

**Amateur Bands**
With the sunspot cycle at its near maximum, there is plenty of Dx to be heard by those who can spare the time for operating. As usual, 14Mc/s s.s.b. produced the most varied selection of Dx as may be seen below.

### 21 Mc/s
- CW: PY2DN, 2OU, 2RT, TA2BK and 5Z4LE. These were logged in one short session on this band.
- 14 Mc/s
  - CW: CR6AI, 6AL, CX10P, 2AM, JA5VQ, PY1CNQ, 6ABD, 7APS, 7NJ, VK7RX, Z56JK, SS6: CP6HJ, CR6HN, 6LI, EL8J, HI3ELJ, HK0BK, HK3RQ, 5BFA, HV3SJ (Vatican), KZ5NH, LU6AH, MP4DAT, OD5BFA, PY1H1X, 2ALI, 4AH, YVK2, TG7KJ, 9AG, TI2RSL, ZW, VK3AUH, 3JM, 3JS, 4LA, 6DF, 7WH, WP7NP, YS1PQM, YV1EC, 5AA, 5AMP, 6EX, 6GL, XE4PW, 4A1MZ, 1IT, 5Z5KL and 9L1KZ.

### 7 Mc/s
Very little time is spent on this band by the writer except for the occasional Sunday morning sessions listening to the semi-locals. The commercial intruders continue to provide unabated QRM but despite this, Dx is there for those who operate at night or early mornings - especially on c.w. One late night session on c.w. did provide W4RAE and PY1DDY.

### 1-8 Mc/s
Among other considerations, Dx is relative to the band in use and Top Band can provide some very good results - especially when summer static is absent.

#### CW
- GI3A0B, 30QR, 3PDN, GM3FSV, 30XX, GW3REQ, 3UMB, 3VLP, 8PG, OH2Z, OK1ARZ, 110K, 11SK, 15M, 2AOP, 2MW, 2OU, 3CIT/1, OL1AJM, 1AKG, 4AJF, 6AIU. SSB: GW3BAC, 3MSY, 3TMH, 3UDJ, 3UMB, 3UTD, 3VLP, 3YF, PA0PN.

### Broadcast Bands
Like the amateur bands, some of these frequencies have shown a marked tendency to produce Dx signals of late. This is particularly so if one is interested in the smaller powered S. American stations that are very often difficult to log. For these stations, a listening watch should be kept during the small hours. An example of this was the reception of HGWE1 on 4685kc/s at 0230 with station identification "R. Nacional Espejo la primera y mas potente emisora del pais". Situated in Quito, Ecuador, this station verifies by QSL card.

- QSO: 0414
- YVQN Ondas Portenas, Venezuela, with Ident. and Latin American music.

---

**September 1968**

---

### Now Hear This

- **7010 2245**
  - Thai TV Co., Bangkok - with programme in vernacular. SINPO 33343.
  - Bangkok, capital of Thailand, is a seaport on the Menam river some 20 miles inland. Main exports are rice, tea and teak.

---

### Last Look Round

**Reader** - "What's all this SINPO 33343 business"? **Answer** - "We'll be dealing with this as the Topic next time round - November issue.

---

"You fool—not a model—a module."
DESIGNING WITH INTEGRATED CIRCUITS

by

P. WILLIAMS

One of the difficulties of employing integrated circuits in home-constructor applications is, of course, the fact that each integrated circuit type is intended for its own specific purpose only. In this article our contributor discusses an approach which enables integrated circuits to be used for functions other than that for which they were designed, and describes experiments carried out with the Fairchild µL900 buffer amplifier. It must be emphasised that some of the techniques described here may result in the risk of damage to the device concerned, and that they should only be used by readers who understand the principles involved and are prepared to accept the risk.

Perhaps the title of this article is a misnomer since only one integrated circuit is to be considered. What it is hoped will emerge is an attitude of mind that gets most out of i.c.'s—if at all possible more than the manufacturer put in. To do this it is not enough to merely read the manufacturer's data sheet since this gives only the information that is important for the original task. In addition, the other parameters of the circuit must be scrutinised for clues to alternative applications. It may be that going just outside a manufacturing limiting value in a controlled manner gives a valuable characteristic that can be used.

A good example, for single devices, is the use of the base-emitter junction of planar transistors as reference diodes. The specification will normally give a maximum value of reverse V_{be} below which the leakage current will not exceed a given figure. Forcing a somewhat larger current through the p-n junction in the appropriate (reverse) direction results in a stable voltage usually some 20–50% above the limit rating. No damage is done provided the current is limited by some series resistance chosen in conjunction with the supply voltage. Thus, as was just suggested, the device is being used in a controlled manner outside one of its limits. A strong word of warning is necessary here: if, due to exceeding a rating, damage is done to a circuit don’t blame the manufacturer—or the writer.

Interested readers will find a great deal of information from the makers of operational amplifiers on the many and diverse functions they can perform by combining such amplifiers with suitable input and feedback networks. The i.e. versions are still relatively expensive (a dangerous statement likely to be outdated before publication) so this has been taken as the excuse for tackling a digital circuit instead.

It should be realised that the emphasis throughout this article is on novel applications of a circuit designed for a single basic function. In every case a better result could be obtained from a specifically designed unit, whether conventional or i.e. Any choice would then revolve around the usual questions of cost, simplicity, flexibility, etc. For the individual designer the benefits from unorthodox approaches are the stretching of the mind and the increasing familiarity with the limitations of his chosen circuits. In the writer’s opinion, these outweigh the extra effort involved in the initial design.

Integrated Buffer Circuit

Consider the circuit shown in Fig. 1. It is a buffer circuit type µL900, part of a series intended for logic operation from a supply voltage of 3.6V. The manufacturers specify such characteristics as noise immunity, speed, fan-out capability, etc., for such circuits. Looking at it through the eyes of, say, an intelligent student without prior knowledge of its intended function, we would see a common emitter input stage driving an emitter follower. The emitter follower has a transistor as load, also controlled by the input, whose
current demand falls as the input voltage falls, i.e. as the output voltage rises. More current will be released for any external load, just when it is most needed, and we might reasonably expect a slightly lower output impedance than from the emitter follower alone. Because there are two similar transistors in parallel at the input, the input impedance and current gain will both be roughly halved. All these points we might expect an unprejudiced observer to deduce. If, instead, we consider the reactions of a circuit designer, then we move forward to possible applications.

Naturally a designer working on digital circuits will recognise it as a circuit eminently suited for "buffering" the output of say, a flip-flop for feeding into multiple gates. Someone used to analogue circuits, either from the audio or video fields, would probably see it immediately as a "d.c. feedback pair", only minus the feedback and plus an extra transistor. Such is the ability of the mind to recognise familiar patterns in the presence of unfamiliar detail. A typical example of the basic circuit is shown in Fig. 2, and most manufacturers of integrated circuits have used similar designs to produce wide-band amplifiers. Equally the circuit has always found favour with audio designers, its applications ranging from tape-head preamplifiers to audio mixers.

Video Amplifier

To take the more obvious of the linear applications first, the μL900 is illustrated again in Fig. 3 with the appropriate coupling and feedback elements. Under the conditions in Fig. 3 the circuit can offer a power gain of 16dB and a frequency response as shown in Figs. 4 (a) and (b). The original intention was that it should form part of a matched 75Ω video distribution system, but the presence of a limiting 100Ω resistor in the collector of TR₂, which is not accessible, reduces the maximum efficiency for such loads.

None-the-less, the very wide bandwidth makes it an attractive circuit for low-power video and pulse amplifiers. Bandwidth can be traded in for gain in the usual way by decreasing the negative feedback. It would not be easy to construct a discrete-components version without degrading the high frequency performance through stray capacitance (and possibly series inductance?). Thus, at quite low cost we have a wide-band amplifier with a very respectable performance.

The video amplifier was checked at a supply potential of 10V without apparent damage to the integrated circuit. An r.f. bypass capacitor was connected directly across the supply leads to the circuit. (To reiterate the statement in the introduction to this article, readers employing the integrated circuit at supply voltages higher than those specified by the manufacturer must be prepared to accept the risk of possible damage to the device.—EDITOR).

Voltage Regulator

A very different aspect of the circuit is used to make it perform its second suggested function, that of a voltage regulator. The base-emitter voltage of TR₁ is proportional to the natural logarithm of its collector current over wide ranges of current. To a first approximation this current will have a linear dependence on supply voltage and so the base potential of TR₁ changes much more slowly than the supply. Unfortunately, the impedance at the base of TR₁ is not particularly low and no appreciable power can be withdrawn. Fig. 5 indicates how a potential divider network ensures that the output voltage is a direct multiple of this base-emitter voltage provided that the divider current is much greater than the base current of TR₁, then, \[ V_{out} \approx \frac{R_2 + R_1}{R_1} V_{be} \]

By the chosen ratio of resistors in this chain we may obtain any output voltage down to \( V_{be} \) as a minimum and somewhat less than supply voltage as a maximum. (For the author's experiments, \( R_2 \) was the internal 1kΩ resistor in the i.e.). The output impedance is now that of the augmented emitter follower previously described, further appreciably enhanced by the negative voltage feedback due to the potential divider. Temperature drift remains an important feature of the circuit's imperfections, and will again be determined primarily by that of the base-emitter voltage of TR₁. This is close to \(-2\,\text{mV/°C}\) in 600mV, i.e. a little over \(-0.3\%/°C\). Used in typical laboratory environment with temperature swings less than 10°C, the change in

SEPTEMBER 1968
output voltage will be about 3%. This is not good but may be acceptable for some applications. In summary we have a circuit which reduces input voltage swings by at least a factor of ten, has a low output impedance and moderate temperature stability.

Improving Performance

This performance is sufficiently encouraging to make an attempt at improvement worthwhile. Ideally, we would like to be able to tackle each of the limiting features in a way that produces no interaction with the others, e.g. to bring the output impedance close to zero without degrading the temperature characteristics. Fortunately there are well-known techniques, which compensate for such variations. The methods adopted are summarised below but it should be noted at the outset that exact compensation is possible at only one combination of the other variables. For example once the output impedance has been set to zero, then a change in supply voltage or temperature will spoil the precise compensation. Similarly each set of compensating elements are valid for only one setting of output voltage. Since it is the $V_{be}$ of TR1 that is the effective reference voltage for this regulator then a simple method for compensating for the fall in output voltage due to increasing load current is shown in Fig. 6. As the load current increases so does the voltage drop across $R_3$. The voltage across $R_1$ must equal the sum of the above voltage plus that of the $V_{be}$ of TR1 and hence can be held constant by adjusting the value of $R_3$ to compensate for the natural fall in $V_{be}$ with rising load current.

A similar method is adopted to correct for supply induced variations in the output, as indicated in Fig. 7. As the supply voltage increases so does the current injected into $R_1$ via $R_4$. There is thus less required via $R_2$, the voltage across which will fall slightly, and this fall can be adjusted to cancel the natural increase in all the circuit p.d.'s due to the increasing supply. To test the effectiveness

---

**Fig. 3.** The μL900 used as a video amplifier. (Note that terminal 1 is commoned to terminal 5.) This offers a power gain of 16dB with a bandwidth of greater than 25 Mc/s.

---

**Fig. 4(a).** Power gain versus frequency for the circuit of Fig. 3 when source resistance is 220Ω.

(b). Greater bandwidth at less gain is given for a source resistance of 470Ω.

---

**Fig. 5.** The basic form of voltage regulator, in which the base-emitter voltage of TR1 in the integrated circuit acts as the reference voltage.
of these methods the circuit was set up as in Fig. 7 using the internal 1kΩ resistor for R2. One possible use for the circuit is to provide a stabilised supply for other integrated circuits in the same range at their nominal operating voltage of 3.6V. The integrated circuit under test was taken well outside its normal operating conditions in doing this, with supply voltages ranging from 7 to 10V and load currents from 2 to 20mA at an output set to 4V.

This last figure corresponds to the manufacturer's maximum rated value of supply voltage for correct operation in the original switching applications (3.6V ±10%). There was no sign of any damage to the unit tested, though the temperature must have been fairly high at maximum output, since there was a small but noticeable fall in output voltage continuing for some time after the application of the maximum supply voltage. With careful adjustment of the resistors, R1, R3 and R4, the output was held to within ±1% for the above range (i.e. 4V output at 2 to 20mA with supply voltage varying from 7 to 10V). For the particular µL900 used in this experiment, R4 was 8.7kΩ, R1 was 142Ω and R3 was 0.4Ω.

To verify that this stability was achievable for other values of output, R1 was reduced for outputs of 2V and 1V respectively, with a correspondingly lower value of supply. Using the same load currents and adjusting R3 and R4 to suit, the stability was again kept to similar limits. At an output of 1V the minimum supply voltage was as little as 4V even at the maximum output current of 20mA, which would drop 2V across the internal T2 collector resistor. This supply voltage is less than that required for the lowest voltage Zener diode commonly available (3.3V) and the temperature dependence. Even under laboratory conditions, the figure quoted earlier of —0.3%/°C is going to dominate over the other sources of output change, making the benefits of precise compensation illusory. A considerable improvement is obtained by placing a germanium diode, in the forward conducting direction, in series with R3. This has a temperature drift of comparable magnitude to that of the Vb of T1, and the resulting drift of current in R1 is likely to be about +0.1%/°C. When R2 is much larger than R1, it is this change in current that will dominate the overall voltage drift at the output. For R2 at zero, the drift will be that of the base-emitter voltage of TR1, i.e. —0.3%/°C. Clearly, there will be some intermediate ratio of R1:R2 at which the drift is close to zero, and this appears to be for R2 between three and four times R1. Unfortunately at the time of testing this circuit it was not possible to do an accurate temperature run and the above estimate has to stand for the time being. An additional factor which can be made use of is that the internal 1kΩ resistor has a small positive temperature coefficient. Used as part or all of R1 it could provide a means of getting near-zero temperature drifts at any value of output voltage; using a diode as above for temperature compensation would work exactly for only one ratio R1:R2 and hence for only one value of output voltage. In summary, the drift in output voltage with temperature can probably be reduced to +0.1%/°C with little difficulty and may be adjustable to zero in some cases.

Different Functions

The two applications described in this article have, perhaps, been covered in rather more detail than they warrant intrinsically. Nevertheless, it is hoped that the article has shown how simple i.c.'s may be used to perform functions quite different from those for which they were designed. Thus, a circuit described by its manufacturer as a buffer circuit for logic systems has become a video amplifier and a voltage regulator. To take Lewis Carroll's advice through Humpty Dumpty: "When I use a word, it means just what I choose it to mean—neither more nor less".

THE RADIO CONSTRUCTOR

We regret that the May, June, July and August issues were published late due to reasons arising from the sudden cessation of business of the old-established firm who had printed this magazine for more than 20 years — see Note on inside back cover of the May 1968 issue.

Regular readers will have noticed that we are gradually bringing the publication date forward and we hope that we will shortly be on sale on the 1st of each month again — the due date.
HIGH PERFORMANCE T.R.F. TUNER UNIT

by

J. MORLEY

The simple medium and long wave tuner unit incorporates an unusual r.f. amplifier circuit to obtain a high level of selectivity and sensitivity

The main disadvantage of simple "straight" receivers is their lack of selectivity. The inherent low input impedance of a transistor in the normal common emitter configuration loads the preceding tuned circuit and reduces the effective “Q” of its coil. The result is poor selectivity and, at worst, the overlap of signals. Tertiary windings on the coils help but are not, at any rate in the writer’s experience, a successful answer to the problem.

LONG-TAILED PAIR

In order to produce a simple high performance tuner that could really separate stations without the use of field effect transistors, the writer looked again at the long-tailed pair configuration. Its basic use in the present application is illustrated in Fig. 1.

In this diagram the first transistor, because of current feedback, has a reasonably high input impedance—enough, anyway, not to drastically load the type of coils the writer would use. The second transistor is effectively in grounded base, being driven by the common emitters, and the output impedance would also be reasonably high.

With these factors in mind some experiments were carried out, these culminating in the complete tuner unit circuit shown in Fig. 2. Here, TR1 and TR2 are the long-tailed pair, these appearing between standard Denco Miniature Dual Purpose Transistor coils. The coils are Range 1T for long waves and Range 2T for medium waves, and may be plugged into B9A valveholders as required. The numbers alongside the windings in the circuit diagram indicate the valve pins to which connections should be made. The two coils should be screened from each other.

The coils are tuned by the 2-gang capacitor C1C2, with trimmers C3 and C4. Normally the trimmers may be set up for best results at the high frequency end of the medium wave band.

The output from the second tuned circuit is fed into transistor TR3, which is biased back on the lower part of its characteristic curve to work as a detector in rather a similar manner to the old anode-bend type. The a.f. output is obtained via L11.

In practice, the circuit works extremely well, with very effective selectivity and good audio quality.

Before concluding, some points need to be made concerning components. An OC170 is specified for TR3, and it was found that this was the only type that would function as an efficient detector with the component values given for the circuit. Its shield lead-out can be left unconnected.

It may be found of advantage to experiment with R5 to meet the requirements of specific transistors in the long-tailed pair. The value of R5 may be raised or lowered until the selectivity and sensitivity are at best proportions. TR1 and TR2 may be OC44, GET874 or OC170. If the last, the shield lead-outs, should preferably, be connected to chassis.

The value specified for C11 is applicable if the tuner output feeds into a subsequent transistor stage. If the following amplifier has a high impedance input, as would occur with a valve amplifier, C11 may have a value of 0.05µF.

![Fig. 1. The basic long-tailed pair r.f. amplifier](image_url)
Fig. 2. The complete a.m. tuner incorporating the long tailed pair, TR₃ is the detector.

Resistors
(All ½ watt 10%)

| R₁  | 47kΩ     |
| R₂  | 5.6kΩ    |
| R₃  | 47kΩ     |
| R₄  | 5.6kΩ    |
| R₅  | 270Ω (see text) |
| R₆  | 33kΩ     |
| R₇  | 470Ω     |
| R₈  | 2.2MΩ    |
| R₉  | 1kΩ      |

Capacitors

| C₁, ₂ | 2-gang variable, 310 + 310pF |
| C₃   | 30pF, trimmer |
| C₄   | 30pF, trimmer |
| C₅   | 0.1μF      |
| C₆   | 0.1μF      |
| C₇   | 100μF electrolytic, 6V wkg. |

Inductors

| L₁   | Miniature Dual Purpose Transistor Coil, Blue, Range 1T and 2T (Denco) |
| L₂   | Miniature Dual Purpose Transistor Coil, Yellow, Range 1T and 2T (Denco) |

Transistors

| TR₁, TR₂ | GET 874, OC 44 or OC 170 |
| TR₃      | OC 170 |

Switch

| S₁ | s.p.s.t. on-off |

Battery

9-volt battery

DIRECT BROADCASTING FROM SATELLITES

IEE Colloquium, Savoy Place, 4 November 1968

The Institution of Electrical Engineers are planning a one-day colloquium on the subject of direct broadcasting from satellites, to be held at Savoy Place on Monday 4 November 1968.

The scope of the meeting will cover the general problems of terrestrial broadcasting and the possible advantages of broadcasting from space, discussion of possible frequency bands, required field strength and power from the space vehicle. Satellite-aerial stabilisation, probable size of spacecraft, performance of aerial systems, power supplies and problems of space-vehicle transmitter design will also be discussed.

On the receiving-equipment side, it is hoped to cover modulation systems, low-cost domestic aerials, head amplifiers and local oscillators.
Q-MULTIPLIER
AND AUDIO FILTER
UNITS

by
L. SAXHAM

It is a relatively easy task to improve the selectivity of the lower priced communications and broadcast type of superhet, and this article describes the two simple units which are designed to this end. The Q-Multiplier enhances the i.f. selectivity, and the audio filter unit assists in selecting the desired signal from heavy background noise and interference. Both units can be added to an existing receiver, which requires only slight modification.

RECENTLY REQUIRING A GENERAL-COVERAGE COMMUNICATION receiver, the writer decided to invest a modest sum in one of the medium priced equipments currently available on the market. The receiver selected was the Trio 9R-59D. From the literature provided, it appeared that this receiver was ideal for short wave listening over both the amateur and broadcast bands. For a single conversion superhet the selectivity figures quoted (±5 kc/s at -60dB; ±1.3 kc/s at -6dB) are quite good, this being mainly due to the use of two mechanical filters in the i.f. stages. Excellent in all other respects, the writer decided that an improvement in the selectivity characteristic would greatly enhance the performance of this receiver.

---

Fig. 1. The circuit of the Q Multiplier
To achieve this end, two simple units were constructed and the receiver slightly modified, the end result being a much improved selectivity response. The modifications to the receiver are simple and are capable of being carried out even by the beginner. No originality is claimed for the circuits published here although they may be new to many beginners—for whom this article has mainly been written. One of the units is a Q-multiplier, and this may be added to any valve superhet whose chassis is isolated from the mains supply by a double-wound mains transformer. This unit must not be used with receivers whose chassis is connected to one side of the mains. The second unit is a very simple switched audio filter, and is merely plugged into the headphone output jack of the receiver.

Since some readers may also have a Trio 9R-59D receiver, brief instructions for adding the Q-multiplier to this particular set are included. However, as was just stated, the Q-multiplier may be added to any valve superhet having an isolated chassis.

Q-MULTIPLIER

Details of this simple unit, shown in circuit form in Fig. 1, were, to the best of the writer's knowledge, introduced into this country many years ago. Although differing slightly with respect to the components used, the principle of operation remains the same. Articles dealing with the problem of obtaining an increased i.f. selectivity response had also appeared in the American radio press.\(^2\)

In the circuit of Fig. 1, one half of a double-triode 12AX7 has been used, and the unit tunes across the i.f. pass-band of the receiver when the i.f. stages are accepting the signal selected by the operator. In some more complex versions of the Q-multiplier, a second triode (which could be the remaining half of a 12AX7) is connected into an additional circuit that will reject an unwanted signal. However, the writer has found by experience that the reject facility takes rather a long time to set up correctly, and feels that this fact outweighs any advantages it may have for normal operating purposes. In the circuit of Fig. 1, therefore, only the accept application is incorporated.


**COMPONENTS**

| Resistors (All fixed values \(\frac{1}{2}\) watt 10\% types) |
|--------------------------|--------------------------|
| \(R_1\) 33kΩ            | \(R_2\) 2MΩ             |
| \(R_3\) 10kΩ            | \(R_4\) 5kΩ pot. linear track |
| Valve \(V_1\) 12AX7     |                          |
| Valveholder B9A with skirt and screening can | |
| Chassis 6 x 2\(\frac{1}{2}\) x 2in deep | |
| (H. L. Smith & Co., Ltd.) | |
| Switch \(S_{1(a),(b)}\) 2-pole, 2-way | |

**Inductors**

- \(L_1\) Coil type QL10 (Electroniques)
- \(L_2\) Coil type QL4 (Electroniques)
- \(RFC_1\) 2.4mH choke, type CH1 (H. L. Smith & Co., Ltd.)

**Capacitors**

- \(C_1\) 1,000pF silver-mica, 2\%
- \(C_2\) 1,000pF silver-mica, 2\%
- \(C_3\) 8μF, electrolytic, 450V wkg.
- \(C_4\) 100pF, variable, Jackson Bros, type C804
- \(C_5\) 1,000pF silver-mica, 2\%
- \(C_6\) 3,000pF silver-mica, 2\%
- \(C_7\) 500pF silver-mica

**Cabinet**

Eddystone die-cast box, 7\(\frac{3}{4}\) x 4\(\frac{1}{4}\) x 2\(\frac{1}{4}\)in. (Home Radio Ltd., Cat. No: E845)

**Miscellaneous**

Knob, 2 tagstrips (4-way, end tags earthed), nuts and bolts, connecting wire, coaxial cable, coaxial plug and socket, etc.
In use, the unit is connected to the receiver power supply, or to a separate power pack where this is not considered desirable, and the anode of the receiver frequency changer valve wired to the input socket of the Q-multiplier via a short length of coaxial cable. After some adjustment of both the Q-multiplier and the receiver first i.f. transformer, an extremely high degree of selectivity is obtained by virtue of the positive feedback employed between the anode and the grid of the 12AX7. Operators of a "straight" or t.r.f. receiver will have noted the high degree of selectivity and sensitivity obtained when the reaction control of such a receiver has been adjusted such that it is in its most sensitive state. The operation of the Q-multiplier is very similar in these respects, it being adjusted such that the Q-multiplier valve is just below the oscillation point. The Q-multiplier tuned circuit then offers a very high impedance at its resonant frequency and a relatively low impedance at neighbouring frequencies, with the result that only the signal at the resonant frequency remains unattenuated. The selectivity offered is very much greater than is possible with normal i.f. transformer stages.

In Fig. 1, C1 and L1 correct the detuning of the first i.f. stage introduced by the coaxial cable connecting to the frequency changer anode, with the result that, when S1(a)(b) is set to Off, the receiver functions in the same manner as before. With S1(a)(b) in the On position h.t. is applied to the valve circuit via RFC1, whilst the receiver i.f. stage is coupled into the tuned circuit given by L2 in combination with C4, C5 and C6. The triode appears in a Colpitts oscillator configuration. However, R3 and R4 provide degeneration in the cathode circuit and the valve can be maintained just short of the oscillating condition by suitable adjustment of R4. When the unit is correctly set up, C3 tunes across the i.f. pass-band, enabling the required signal to be picked out from those being handled by the receiver i.f. amplifier.

In the writer's installation, where the Q-multiplier is used in conjunction with a 9R-59D receiver, the unit functions at the receiver i.f. of 455 kc/s. However, the inductors specified for L1 and L2 are satisfactory for intermediate frequencies ranging from this figure up to 470 kc/s and the unit can, in consequence, be employed with other receivers having these intermediate frequencies. Alternative coils are also available from Electroniques for intermediate frequencies outside the range just mentioned and these are listed in the accompanying Table. They may be employed in the circuit of Fig. 1 without alteration of component values apart from C5 and C6.

C3 is a bypass capacitor and ensures that there is no interaction between the Q-multiplier circuit and any other circuit sharing the same h.t. supply. The value specified for R1 is suitable when the h.t. input is around 160 volts (as occurred in the writer's case). R1 may be increased in value, if desired, for higher input voltages. The required value is not very critical, and all that is necessary is to ensure that the voltage at the triode anode is of the order of 150 volts when R4 is inserting maximum resistance.

It will be noted that S1(b), in the Off position, connects the lower end of R1 to chassis. This is a desirable circuit feature and it ensures that C3 discharges rapidly after switching off. The reason for this method of connection is that it is possible for the Q-multiplier, if just below oscillation point with S1(a) in the On position, to go into oscillation when S1(a) is set to Off and removes the input loading from L2 and its associated capacitors. This oscillation may continue for a short period if C3 is not quickly discharged, and it can cause interference with received signals.

The value specified for R3 is, at 10kΩ, somewhat higher than that usually encountered in Q-multiplier circuits of this type, but this value was found necessary to ensure that oscillation occurred with R4 at about
Coils (with Electroniques type numbers) for Q-multiplier operation at different intermediate frequencies.

<table>
<thead>
<tr>
<th>Freq.</th>
<th>L₁ Type No.</th>
<th>L₂ Type No.</th>
<th>C₅</th>
<th>C₆</th>
</tr>
</thead>
<tbody>
<tr>
<td>85 kc/s</td>
<td>—</td>
<td>1.0–2.0mH</td>
<td>QL9</td>
<td>2500pF</td>
</tr>
<tr>
<td>100 kc/s</td>
<td>—</td>
<td>1.0–2.0mH</td>
<td>QL9</td>
<td>1800pF</td>
</tr>
<tr>
<td>239 kc/s</td>
<td>4.0–8.0mH</td>
<td>250–500µH</td>
<td>QL6</td>
<td>1200pF</td>
</tr>
<tr>
<td>460 kc/s</td>
<td>1.5–3.0mH</td>
<td>120–150µH</td>
<td>QL4</td>
<td>1000pF</td>
</tr>
<tr>
<td>600 kc/s</td>
<td>1.0–2.0mH</td>
<td>90–140µH</td>
<td>QL4</td>
<td>900pF</td>
</tr>
<tr>
<td>735 kc/s</td>
<td>0.7–1.4mH</td>
<td>70–100µH</td>
<td>QL3</td>
<td>750pF</td>
</tr>
<tr>
<td>915 kc/s</td>
<td>250–500µH</td>
<td>60–90µH</td>
<td>QL3</td>
<td>500pF</td>
</tr>
<tr>
<td>1.6 Mc/s</td>
<td>50–100µH</td>
<td>40–60µH</td>
<td>QL2</td>
<td>250pF</td>
</tr>
</tbody>
</table>

The centre of its travel. It is assumed that this effect is due to high i.f. impedances in the 9R-59D receiver, which uses mechanical i.f. filters, these high impedances presenting only a low loading on the Q-multiplier tuned circuit. If it is found, in units built up to the design and which couple into conventional i.f. transformer circuits, that oscillation does not occur at any setting of R₄, the value of R₃ may be reduced until oscillation is given at a convenient point in the travel of this potentiometer. Normally, it should not be necessary to have R₃ lower than 5kΩ.

An important point concerns C₁, C₂, C₅, C₆ and C₇. It is essential that these capacitors be silver-mica types. Do not use ceramic components here because, apart from possible difficulties due to frequency drift with temperature change, the larger value ceramic capacitors are normally offered at very wide tolerances on value.

A final point concerns the unused triode of the 12AX7. The electrodes of this triode may be earthed by connecting pins 6, 7 and 8 to chassis.

CONSTRUCTION

As may be seen from the illustration, the unit is fitted in an Eddystone die-cast aluminium case, a small chassis being secured to the front panel by means of the nuts and threaded bushes of S₁, C₄ and R₄. Two 4-way tagstrips have been used, one being utilised for the power input and the other for securing the components R₂, C₅, C₆ and one end of the r.f.c. mounted around the valveholder.

The rear of the die-cast case should have an entry for the power supply, suitably fitted with a rubber grommet, and for the coaxial cable input. The rear of the case should also have three jin holes drilled through to provide ventilation, these being made at the top of the panel. As shown, the unit has been fitted with four rubber feet, but this is not, of course, essential. Looking at the unit shown here, the left-hand control is switch S₁, the variable tuning control C₄ is in the centre and the feedback control R₄ is to the right.

The unit is delightfully simple to construct and no layout has been included here, this not being critical with respect to performance.

ADJUSTMENTS

Some readers may prefer to have the Q-multiplier permanently wired, via coaxial cable, to the anode of

Above chassis view showing the layout of the main components. L₁ at left and L₂ at the right-hand positions.
the frequency changer, whilst others may wish to have the Q-multiplier capable of being plugged in, when required, by way of a socket on the receiver. In the latter case a short length of coaxial cable is needed to couple the frequency changer anode to a coaxial socket on the rear of the receiver chassis, the braiding being earthed at both ends. The first i.f. transformer will then have to be re-trimmed to take up the added capacitance resulting from this cable. Obviously, the cable should be kept as short as possible. Note that this i.f. re-trimming is only to cater for the coaxial cable added inside the receiver chassis and that it is not intended to take up the capacitance in the external coaxial lead to the Q-multiplier when the latter is plugged in. The external self-capacitance is corrected for by C1 and L1 in the Q-multiplier unit.

For the permanent connection into the receiver, the coaxial cable to the Q-multiplier is wired to the frequency changer anode and a nearby chassis point, and no re-trimming of the first i.f. transformer is required.

To set up the Q-multiplier the receiver should initially, for the permanent connection, have the centre conductor of the coaxial cable close to but disconnected from the anode of the frequency changer valve. For the plug-in connection, the receiver should initially have its internal coaxial cable fitted and adjusted for, but without the Q-multiplier plugged into the socket. The receiver should be set to receive a.m. transmissions. Tune in a steady signal on the receiver, using a signal generator connected to the aerial input via a 0.01µF capacitor if such a test instrument is available. The aerial should be disconnected from the receiver if the signal generator is used. The frequency used by the writer for this procedure was 3.9 Mc/s although any frequency that can be accurately read from the receiver dial may be used. If a signal generator is not available then a steady broadcast transmission should be tuned in, one that is not suffering from fading and causing variations in the S-Meter readings. Set the receiver r.f. gain at maximum. Note the S-meter reading.

For the permanent connection, next switch off the receiver, quickly solder the coaxial centre lead to the frequency changer anode, and switch on again. For the plug-in connection, simply plug the coaxial lead from the Q-multiplier into the rear socket. Apply power to the Q-multiplier. It will be appreciated, of course, that both the receiver and the multiplier unit must be thoroughly warmed up and not subject to frequency drift prior to proceeding further with the adjustments.

With the unit connected to the receiver, a serious drop in signal strength will be noted on the S-Meter. In the writer’s case this was approximately 2 S-points. Using a hexagonal-ended trimming tool, and with S1(a),b set to off, adjust the core of L1 until the S-Meter returns to its former reading, or as near to this reading as possible. Providing the coaxial cable connecting the receiver to the unit is short, adjustment of L1 should largely balance out the capacitance of the cable thereby allowing the S-Meter to return to its earlier reading. The writer found that, due to the length of coaxial cable involved in the present case, a net loss of half an S-point was apparent. Note this second S-Meter reading.

Switch the Multiplier On with R4 set at the minimum position (maximum resistance) and with C4 at exactly half-capacitance. Using the trimming tool, adjust the core of L2 until it is at exact resonance with the signal, causing the S-Meter to return to its former reading. Slowly advance R4 until oscillation occurs. Slightly back off R4 until the oscillations just cease, ensuring that L2 is finally adjusted such that, with C4 at mid-position, exact resonance is still maintained. The receiver is now at its most sensitive and selective condition.

CHECKING THE PERFORMANCE

To check the performance obtained with the Q-
COMPONENTS

Capacitors

C₁ 0.01μF
C₂ 0.004μF
C₃ 0.001μF
C₄ 300pF
C₅ 100pF

Switch
S₁ single-pole 6-way, miniature rotary (see text)

Plug
P₁ Jack plug, Igranic (H. L. Smith & Co., Ltd.)

Socket
J₁ Jack socket, Igranic (H. L. Smith & Co., Ltd.)

Miscellaneous
Knob, 2-oz tobacco tin or similar, connecting wire, etc.

multiplier at its most sensitive condition, and using the signal generator set to 3.9 Mc/s as previously described, the following results were obtained. This practical check may be carried out by any reader, incidentally, and a broadcast transmission can be used if a signal generator is not available.

Note the bandspread dial reading, it being assumed here that this dial is capable of being read to fine limits. Tune the bandspread dial above the signal frequency until the signal is inaudible and note the reading, return the bandspread dial to the limits of audibility at the lower frequency side and again note the reading.

Switch the Q-multiplier out of circuit and repeat the above test, noting the bandspread dial readings at the two limits of audibility and compare the results of the two tests. It will be found that selectivity is improved enormously with the Q-multiplier in circuit, and Fig. 2 shows the results obtained by the writer. From this it will be seen that without the Q-multiplier in circuit the injected signal was audible over a 4 kc/s limit whilst, with the unit in circuit, this was reduced to a total of 2 kc/s, thus representing an improvement in selectivity of 100%.

In operation, it will be found that with the Q-multiplier in its most sensitive condition a.m. or s.s.b. signals will exhibit a "boomy" response due to the elimination of the sidebands, this being a feature of high selectivity. The effect may be counteracted by slightly detuning C₄ or, if less selectivity is required, by slightly backing off R₄. By using the simple audio filter described later, however, an acceptable balance may be readily obtained.

Additionally, the Q-multiplier may be made to function as a b.f.o. by causing the multiplier circuit to gently oscillate, whereupon c.w. and s.s.b. signals may be received. The s.s.b. signals may be easily resolved by slight variation of C₄.

MODIFICATIONS TO THE 9R-59D RECEIVER

To accommodate the Q-multiplier unit, this receiver may be easily modified both for the supply of power and the inclusion of a coaxial socket on the chassis rear apron.

Fig. 3 (a) shows the octal socket mounted on the rear apron of the receiver chassis prior to modification, both this and a mating plug being included for remote operation when using the receiver with a transmitter. This facility is not required in the present instance, whereupon the plug and socket provide an ideal power outlet, after modification, for the added unit. Fig. 3 (b) shows the octal socket after modification. Tags 1, 2 and 3 are connected together, as also are tags 4, 5 and 8. Tag 7 is connected, via a short length of p.v.c. covered wire to pin 4 of V₁. The aerial wire (tag 8) is completely removed.

Fig. 3 (c) shows the plug before modification and it will be noted here that pins 1 and 3, and 4 and 5 are already connected together by the manufacturer. It was decided not to remove these jumper wires—hence the
of this length of coaxial cable should be connected at one end to the chassis tag at the coaxial socket and, at the other end, to the nearby chassis tag alongside the coiilpack.

The matching transformer to the first i.f. mechanical filter should now be adjusted to take up the self-capacitance added by this coaxial cable.

**AUDIO FILTER UNIT**

Fig. 4 shows the simple audio filter unit referred to at the beginning of this article and which may be used in conjunction with the Q-multiplier to assist in selecting the desired signal from those adjacent to it. The unit costs very little in terms of cash outlay and time spent in construction, and yet it provides quite a remarkable attenuation of unwanted audio frequencies.

In Fig. 4, plug $P_1$ is inserted into the headphone jack of the receiver. Its sleeve connects to the corresponding contact of socket $J_1$ whilst its tip connects to the arm of $S_1$, a single-pole 6-way switch. The headphones are then plugged into socket $J_1$.

When $S_1$ is switched to position 1, the receiver output connects direct to socket $J_1$ and the filter unit has no effect on the signal passed to the headphones. On positions 2 to 6 the switch connects in series capacitors of increasingly lower value, these ranging from $C_1$ at 0.01μF to $C_5$ at 10μF. The capacitors apply increasing degrees of low frequency attenuation and it will in many cases be found that the subjective effect is to give the required signal greater clarity, particularly when some classes of background interference are in evidence. The bass-cut introduced by capacitors $C_1$ to $C_5$ also counteracts the attenuation of the higher audio frequencies resulting from use of the Q-multiplier.

The switch is set to the position which offers the best results for the particular signal being received. It may be found necessary to increase audio gain for switch positions 4, 5 and 6. The unit is, of course, external for a coaxial socket (American pattern) for use when to the set and will not affect reproduction via the receiver loudspeaker.

As may be seen from the accompanying photographs, the writer's audio filter unit is fitted in a 2-oz tobacco tin. This is secured to the operating bench at a convenient position. The capacitors may be ceramic, paper or plastic foil, or silver-mica. It may be found difficult to obtain a single-pole 6-way miniature rotary switch for $S_1$, as 6-way components of this type are usually available in double-pole. A double-pole 6-way switch may be used instead with no connections made to one pole and, as may be seen from the photograph, such a switch is employed in the writer's filter unit.

The unit is intended for use with high impedance headphones.

---

**NORTHERN AUDIO FAIR**

The Northern Audio Fair will be held on Friday, Saturday and Sunday September 20th to 22nd 1968, from 1100 to 2100 hrs, at the Hotel Majestic (Rooms 158-160, on the 1st Floor) Harrogate, Yorkshire.

Among other exhibitors, Daystrom Ltd (Heathkit) will be displaying their latest audio equipments and demonstrations of Heathkit hi-fi stereo amplifiers, tuners, receivers and speaker systems. Also on display will be stereo record players and tape recorders.
In the early days of radio rather cumbersome coils and components were required for the reception of programmes. Large outdoor aerials were also in fashion, since the now familiar ferrite rod aerial had not been invented. Little of this early equipment remains, the trend towards miniaturisation continuing unabated.

Large outdoor aerials and bulky coils are still in use however and—ignoring public and commercial undertakings—these exist mainly at radio amateur stations. This does not mean that radio amateurs are out of touch with modern trends; many are in fact well ahead of the times. A very great deal of the short wave "communication" of today is the outcome of work done by the keen radio amateurs of yesterday!

Since licensed radio amateurs are permitted to transmit as well as to receive, their need for large aerials is obvious, for it would indeed be difficult to put a respectable signal into, say, the States via a small ferrite rod aerial! But even with a large aerial it may not be possible to get good contacts, because the G.P.O. sets a limit to the transmitter input power that radio amateurs may use. Nevertheless, many amateur stations consistently work distant stations using quite low power, this being of the order of 30 to 40 watts or so.

If low power signals are to "get out" it is essential for the aerial to be correctly designed; additionally the transmitter and aerial impedances must be carefully matched lest precious power be wasted. A resonant aerial system is also essential for any serious receiving purposes that may be contemplated and confers a degree of readability which would otherwise be lost.

The "shack" end of an aerial feeder can be 1000Ω or more, whilst the actual impedance required by the transmitter or receiver may be only 70 to 100Ω. Fortunately, the aerial and the equipment may be matched correctly by employing a special aerial matching unit, or a.m.u.
Basically, an a.m.u. consists of some form of coil and capacitor combination, and this is a particularly common application requiring the use of large coils.

Six popular amateur bands in regular use are: 1.8–2.0 Mc/s (Top Band-160 metres), 3.5–3.8 Mc/s (80 metres), 7.0–7.1 Mc/s (40 metres), 14.0–14.35 Mc/s (20 metres), 21.0–21.45 Mc/s (15 metres) and, when conditions permit, 28.0–29.7 Mc/s (10 metres). It is possible to operate on each of these bands via a single aerial through a suitable a.m.u. Although a single switched coil and capacitor combination could be used in the a.m.u., separate plug-in coils for each band, tailored to suit, are much preferred in order to minimise losses. Normal receiver-type coils cannot be used in transmitter-to-aerial couplings, and since commercially produced types hardly exist it is both necessary and instructive to construct them.

The coils employed in an a.m.u. are normally air-cored, and a fairly thick gauge of wire should be used. Long narrow coils are, incidentally, unsuitable, and tend to behave more like chokes.

The frequency coverage and “goodness” of a newly constructed coil and capacitor combination, when unconnected to an external circuit, may be found by bringing a reliably calibrated grid-dip oscillator (g.d.o.) nearby, as in Fig. 1. When the g.d.o. coil is tuned to the resonant frequency of the coil and capacitor a sharp kick of the g.d.o. meter needle will be noted. With a poorly made coil the g.d.o. needs to be brought quite close but a “good” coil will give an indication when the g.d.o. is as much as 10 to 12in distant. Experience with a particular g.d.o. will soon enable one to use it for estimating the efficiency of a coil and capacitor combination.

**A PRACTICAL AERIAL MATCHING UNIT**

The circuit diagram of a thoroughly practical unit for use with a single feed line aerial is given in Fig. 2 (a). This can be easily constructed on a chassis measuring about 8 by 4in. The transmitter or receiver is connected to socket SK₁, and the aerial is plugged in at socket SK₂. Coils L₁ and L₂ are a combined plug-in assembly to be described. Inter-coil coupling is electrically variable due to C₁ and C₂, which may be a 470 + 470pF (nominal) twin-gang capacitor with both sections in parallel. Capacitor C₂ (150pF max) tunes coil L₂ to the operating frequency; the vanes of this capacitor should be adequately spaced if used with a transmitter to avoid flashover.

To accommodate the coil unit a four-pin socket is required but if a tapped coil is used, as is sometimes beneficial, a five-pin item is needed; see Fig. 2 (b). Band changing usually means coil changing too, together with readjustment of the a.m.u. tuning capacitors to positions previously noted; these will be found at the setting up stage.

**PRACTICAL A.M.U. COIL CONSTRUCTION**

Experience has shown that the use of available commercial plug-in type coil former-base units can be rather a costly venture. There are various inexpensive alternatives, and for the coil socket a valve base may be utilised. Suitable bases can be obtained from discarded or obsolete valves. The obsolete valve types 77 and 78 are, for example, ideal because they are on the UX6 base which has no centre spigot. Unwanted valves such as the 6K7, etc., on the International Octal base may also be used, although the central locating spigot limits the types of coil assembly which may be fitted to the base.

Valves selected for demolishing should be placed, one at a time, in a strong plastic bag. Holding the base through the bag the glass bulb is then tapped smartly with a hammer. The remaining debris is soon cleared away, and the connecting wires removed by holding a hot soldering iron against each pin in turn.

Valve bases with or without centre spigots may have a slot cut as shown in Fig. 3 (a). These then accept the edge of a flat “former” of the type illustrated in Fig. 4. Bases

(Continued on page 113)
HOW TO MAKE FULL USE OF YOUR DIARY

Underline the dates of both personal and radio events in which you are interested or concerned, as shown in the illustration below, and enter brief details of these in the Diary Notes. A list of forthcoming events of radio interest taking place during the fourth quarter (October to December inclusive) is shown alongside. Detach your Diary from the magazine and affix to the workshop wall. An Easy-View diary for the next quarter (January to March 1969 inclusive) will be published in the December issue.

SUGGESTIONS FOR YOUR EASY-VIEW DIARY

OCTOBER

- 2-5 RSGB International Radio Engineering & Communications Exhibition
- 5-6 RSGB Third 432Mc/s (Open) Contest
- 5-6 VK/ZL Oceanic Phone Contest
- 5-6 ISWL Amateur Bands CW Listeners Contest
- 12-13 RSGB 28Mc/s Phone Contest
- 12-13 RSGB Second 1296Mc/s (Open) Contest
- 12-13 VK/ZL Oceanic CW Contest
- 13 S. Coast R/Control Gala, R.A.F. Tangmere
- 19-20 11th Jamboree on the Air
- 26-27 RSGB 7Mc/s CW Contest
- 26-27 CQ WW DX Phone Contest

NOVEMBER

- 2-3 Okinawa (KR6) Contest
- 2-3 ISWL Amateur Bands AM Contest
- 5-16 Do-it-Yourself Exhibition (City Hall, Manchester)
- 9-10 OK CW Dx Contest
- 9-10 RSGB 7Mc/s Phone Contest
- 9-11 ARRL SS Phone Contest
- 11 RSGB Seventh 144Mc/s SSB Contest
- 16-17 RSGB Second 1-8Mc/s Contest
- 16-18 ARRL SS CW Contest
- 23-24 CQ WW DX CW Contest

DECEMBER

- 1 RSGB Fourth 7Mc/s CW Contest
without centre spigots may alternatively be cut as in Fig. 3 (b), whereupon they may be fitted with coil formers of the type shown in Fig. 6.

Dealing first with the flat "formers", these consist of rectangles of Perspex \( \frac{3}{4} \) in thick. See Fig. 4. Four rows of small holes just large enough to take the wire thickness to be used may be drilled centrally along lines "A" and "B". Coil \( L_1 \) will occupy rows B and coil \( L_2 \) will occupy rows A. To wind such coils neatly, commence with the inner coil, and place the required number of turns plus two on a \( \frac{3}{2} \) in diameter dummy former. Release the winding to obtain a loose spiral then feed this carefully through the Perspex holes using a screw-like action. One turn at each end will then be pulled out to form connecting wires and the remainder can be secured with polystyrene cement.

The edge of the Perspex "former" is next fitted to the slot in the valve base, as in Fig. 5, and secured with Durofix or a similar adhesive. It will be seen from Fig. 4 that there is an extra \( \frac{3}{4} \) in between one edge and the adjacent row of A holes, and this is the edge which fits into the valve base slot. The slot should, of course, be cut to take the Perspex comfortably. The coil ends are finally taken down to the appropriate valve base pins and soldered.

Valve bases cut as in Fig. 3 (b) may take the coil assembly shown, in exploded form, in Fig. 6. An unusual but effective and inexpensive former material is given by oddments of modern plastic drain water pipe, obtained as a "Marley" product from Do-it-Yourself stores. This is available in diameters of approximately \( \frac{3}{4} \) in (for \( L_1 \)) and \( \frac{5}{8} \) in (for \( L_2 \)). Each coil former, after winding, is secured to a circular Paxolin cheek of \( 3 \) in diameter with Durofix or similar, the cheek then being fixed centrally on the valve base with the aid of a 6BA nut and bolt. Suitably positioned holes are previously drilled in the formers and Paxolin cheek to allow coil ends to pass through to the pins.

COIL WINDINGS

Details of suitable windings for \( L_1 \) and \( L_2 \) for the various bands are given in Table I, these applying primarily to the coil former assembly of Fig. 6. The coil wire is \( 22 \) s.w.g. and the turns should be spaced by wire thickness. The same number of turns may be used for coils fitted to the Perspex flat "formers" but in this case it will be difficult to achieve the same close turn spacing. A slightly increased turn spacing is, however, quite permissible.

As a further guide Table II gives details of frequency coverages, using the same wire guage and turn spacing, but for a coil former diameter of \( \frac{5}{8} \) in, tuned with a 150pF variable capacitor. No external connection was made to the tuned circuit when making up this Table.

THE A.M.U. IN USE

Setting up the a.m.u. for use with a receiver is a simple
operation. The correct coil for the band in question is fitted, and C₁ and C₂ are set up for best signal strength, either as shown by the receiver S-meter or as perceived aurally.

Those with transmitters will be familiar with the use of a standing wave ratio indicator, and an instrument of this type may be inserted between the transmitter and the a.m.u., as illustrated in Fig. 7. Interconnections are made with coaxial cable. With the appropriate coil plugged in a trial position is set for C₁ and C₂ and an attempt made to load the transmitter with the s.w.r. indicator set to indicate “Reverse”. Initially the s.w.r. indicator will show a reading on its meter whereupon C₂ is adjusted to lower the reading. Capacitor C₁ is also adjusted together with minor adjustments to the transmitter until, eventually, settings are found which permit of a full scale “Forward” reading on the s.w.r. indicator and a zero “Reverse” reading. In stubborn cases an aerial tapping connection on coil L₂ will do the trick. See Fig. 2 (b). Thereafter it is but necessary to fit scales and pointer knobs to the a.m.u. for subsequent ease of operation.

CONCLUSION

It may be seen, in conclusion, that the construction of a simple aerial matching unit is clearly not too tedious a task. It is certainly a rewarding one. When the prototype was used with a 50W c.w. rig to a Windom aerial many pleasant QSO’s were enjoyed, despite heavy QRM.

A simple aerial based on Windom principles is given by a horizontal long wire cut for the lowest frequency band required (132ft for 3.5–3.8 Mc/s, or 67ft for 7.0–7.1 Mc/s).

<table>
<thead>
<tr>
<th>TABLE I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turns</td>
</tr>
<tr>
<td>L₁</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turns</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>30</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>

Fig. 7. Using the a.m.u. with a transmitter and an s.w.r. indicator for optimum matching to the aerial

A single wire feeder some 45ft in length is then connected one third of the way along the flat “top”. The feeder should run off at right angles for at least 16ft, preferably more, in relation to the horizontal “top”. Don’t forget that a good earth is a “must” at the station end!

MARCONI SUPPLY FIRST SOLID-STATE TV EQUIPMENT

The Marconi Company has received an order from Switzerland for colour and monochrome television transmission equipment to be installed in a Postes, Telegraphes et Telephones (P.T.T.) broadcasting station in Bantiger, near Bern. The £185,000 order, won against fierce European competition, includes four of the recently announced Marconi solid-state u.h.f. drive units, believed to be the first broadcast transmitting equipment employing transistor technology to be supplied to Switzerland.

The Marconi B7311 u.h.f. drive unit is used with the Company’s latest range of television transmitters, and puts them among the most modern, reliable and compact systems to be found anywhere in the world. It is already being supplied with thirty-five Marconi transmitters currently on order from stations in Britain and Scandinavia requiring colour transmission facilities.

The additional equipment for the contract includes four vapour-cooled 10kW Band IV/V television transmitter amplifiers, type B7315, four combining unit assemblies, type B8144, and two paralleling units.

Marconi will install the equipment in the Bantiger station at the end of this year.

THE RADIO CONSTRUCTOR
A DILEMMA FACING MOST CONSTRUCTORS at one time or another is that of having a sensitive moving-coil meter whose coil resistance is unknown. This resistance cannot be measured by the usual methods—using a resistance meter or bridge—as these could pass an excessive current through the coil, causing the meter needle to wrap itself round the end-stop!

CURRENT SHARING

The problem can, however, be readily overcome by employing a technique which takes advantage of the fact that the meter whose resistance is to be measured is itself capable of indicating the current which flows through it.

To start, consider the circuit shown in Fig. 1, in which a constant current, I, flows through the resistor R. If a second resistor having the same value as R is connected in parallel with R, as in Fig. 2, the fixed current I divides equally between the two resistors. The current flow through R is then one-half of its previous value. Conversely, if R were unknown and the second resistor is a variable component which is adjusted until the current in R falls to half its previous value, then the resistance in the variable resistor is equal to R.

With a moving-coil meter, the deflection of its needle is directly proportional to the current flowing through it. We can, therefore, pass a fixed current through the meter which causes it to read full-scale deflection, then connect a variable resistor across the meter and adjust it until the meter reading is half its full-scale value. The resistance of the variable resistor is then equal to that of the meter.

TEST RIG

This principle was employed recently by the author when it was found necessary to find the actual resistance of a batch of 50μA meters, each of which had a nominal resistance of 800Ω. A simple test rig was made up, using the circuit of Fig. 3. Here, both R1 and VR1 have values of 100kΩ, the latter being adjusted to cause 50μA to flow from the 9-volt battery. VR2 has a resistance of 1kΩ and can be switched across the meter under test by means of S2. Since the values of R1 and VR1 are very much higher than the meter resistance, the current which flows from the battery can be considered as being constant regardless of whether S2 is open or closed.

VR2 is fitted with a pointer and scale and is initially calibrated by opening S2 and connecting a resistance meter (Avo or similar) across its terminals. Graduations can then be marked on the scale at 100Ω intervals, with intermediate graduations over the range (in this case around 800Ω) where it would be required to obtain more precise measurements.

To use the rig, S1 and S2 are opened, and VR1 and VR2 adjusted to insert maximum resistance. The meter is con-
Solid State Windscreen 
Wiper Delay Unit

by J. VELLA

In our August 1967 issue we published "Windscreen Wiper Programmer" by T. J. Daborn, this unit allowing the windscreen wipers of a car to operate once every 2 to 30 seconds as desired under conditions of light rain or drizzle. The circuit described here carries out a similar function, but it incorporates a thyristor (silicon controlled rectifier) to control the motor instead of a relay, as in the previous design. It is intended for use in cars with 12 volt systems.

The Circuit to be described, which can only be used with windscreen wipers having the self-parking facility, gives a delay which can be continuously varied from 2 seconds to about 45 seconds. The delay unit can be instantly overruled by switching on the manual wiper switch.

Thyristor Operation

If a thyristor is connected as shown in Fig. 1 a gate current flows. If $R_2$ is slowly reduced in value the gate current increases until eventually the thyristor fires and conducts heavily, the anode current being limited only by $R_1$. The thyristor continues to conduct irrespective of what happens to its gate drive, and it can only be returned to its non-conductive state either by removal or by reversal of the supply. The minimum gate current (and hence the maximum value of $R_2$) needed to initiate conduction varies even between thyristors of the same type, and the final circuit (Fig. 2) has been designed to deal with a wide spread in this characteristic. In the prototype the minimum gate current was 13mA, corresponding to a value in gate resistance ($R_2$ of Fig. 1) of 980Ω, when the supply was 17V.

The Circuit

In the circuit given in Fig. 2, $C_1$ charges via $R_1$ and $RV_1$. As the charge on $C_1$ starts to build up, $TR_1$ draws a base current and becomes more conductive, allowing a gate current to flow in the thyristor. This gate current increases with the charge on $C_1$. Due to the presence of $R_3$ in the emitter circuit of $TR_1$, capacitor $C_1$ can charge to a high voltage before collector current is sufficient to fire the thyristor.

Once the thyristor has fired the wiper motor starts. Also, the diode $D_1$, now being forward biased, allows $C_1$ to discharge very rapidly through it and the limiter resistor $R_4$. The first few degrees of wiper movement close the self park switch, short-circuiting the thyristor and thereby returning it to its non-conducting state.

When the wipe has been completed the self park switch opens, causing an extremely high back voltage to appear momentarily across the motor. This back e.m.f. is quenched in the protective diode $D_2$. Without $D_2$ the steep wave-form of the back voltage not only refires the thyristor but also welds the slider of $RV_1$ to its track!

The length of delay is controlled by $RV_2$. This component is fitted with on-off switch $S_1$ and has a log track, which tends to spread out the working range over most of the slider movement. The potentiometer is connected so that it inserts more resistance in circuit, and hence increases the delay, as its knob is turned clockwise.

Tolerances and Construction

Components are not particularly critical. Any medium gain p.n.p.
A dilemma facing most constructors at one time or another is that of having a sensitive moving-coil meter whose coil resistance is unknown. This resistance cannot be measured by the usual methods—using a resistance meter or bridge—as these could pass an excessive current through the coil, causing the meter needle to wrap itself round the end-stop!

**CURRENT SHARING**

The problem can, however, be readily overcome by employing a technique which takes advantage of the fact that the meter whose resistance is to be measured is itself capable of indicating the current which flows through it.

To start, consider the circuit shown in Fig. 1, in which a constant current, $I$, flows through the resistor $R$. If a second resistor having the same value as $R$ is connected in parallel with $R$, as in Fig. 2, the fixed current $I$ divides equally between the two resistors. The current flow through $R$ is then one-half of its previous value. Conversely, if $R$ were unknown and the second resistor is a variable component which is adjusted until the current in $R$ falls to half its previous value, then the resistance in the variable resistor is equal to $R$.

With a moving-coil meter, the deflection of its needle is directly proportional to the current flowing through it. We can, therefore, pass a fixed current through the meter which causes it to read full-scale deflection, then connect a variable resistor across the meter and adjust it until the meter reading is half its full-scale value. The resistance of the variable resistor is then equal to that of the meter.

**TEST RIG**

This principle was employed recently by the author when it was found necessary to find the actual resistance of a batch of 50μA meters, each of which had a nominal resistance of 800Ω. A simple test rig was made up, using the circuit of Fig. 3. Here, both $R_1$ and $VR_1$ have values of 100kΩ, the latter being adjusted to cause 50μA to flow from the 9-volt battery. $VR_2$ has a resistance of 1kΩ and can be switched across the meter under test by means of $S_2$. Since the values of $R_1$ and $VR_1$ are very much higher than the meter resistance, the current which flows from the battery can be considered as being constant regardless of whether $S_2$ is open or closed.

$VR_2$ is fitted with a pointer and scale and is initially calibrated by opening $S_2$ and connecting a resistance meter (Avo or similar) across its terminals. Graduations can then be marked on the scale at 100Ω intervals, with intermediate graduations over the range (in this case around 800Ω) where it would be required to obtain more precise measurements.

To use the rig, $S_1$ and $S_2$ are opened, and $VR_1$ and $VR_2$ adjusted to insert maximum resistance. The meter is con-
Solid State Windscreen Wiper Delay Unit

by J. VELLA

In our August 1967 issue we published “Windscreen Wiper Programmer” by T. J. Daborn, this unit allowing the windscreen wipers of a car to operate once every 2 to 30 seconds as desired under conditions of light rain or drizzle. The circuit described here carries out a similar function, but it incorporates a thyristor (silicon controlled rectifier) to control the motor instead of a relay, as in the previous design. It is intended for use in cars with 12 volt systems.

The circuit to be described, which can only be used with windscreen wipers having the self-parking facility, gives a delay which can be continuously varied from 2 seconds to about 45 seconds. The delay unit can be instantly overruled by switching on the manual wiper switch.

THYRISTOR OPERATION

If a thyristor is connected as shown in Fig. 1 a gate current flows. If $R_2$ is slowly reduced in value the gate current increases until eventually the thyristor fires and conducts heavily, the anode current being limited only by $R_1$. The thyristor continues to conduct irrespective of what happens to its gate drive, and it can only be returned to its non-conductive state either by removal or by reversal of the supply. The minimum gate current (and hence the maximum value of $R_2$) needed to initiate conduction varies even between thyristors of the same type, and the final circuit (Fig. 2) has been designed to deal with a wide spread in this characteristic.

In the prototype the minimum gate current was 13mA, corresponding to a value in gate resistance ($R_2$ of Fig. 1) of 980Ω, when the supply was 17V.

THE CIRCUIT

In the circuit given in Fig. 2, $C_1$ charges via $R_1$ and $RV_1$. As the charge on $C_1$ starts to build up, $TR_1$ draws a base current and becomes more conductive, allowing a gate current to flow in the thyristor. This gate current increases with the charge on $C_1$. Due to the presence of $R_3$ in the emitter circuit of $TR_1$, capacitor $C_1$ can charge to a high voltage before collector current is sufficient to fire the thyristor.

Once the thyristor has fired the wiper motor starts. Also, the diode $D_1$, now being forward biased, allows $C_1$ to discharge very rapidly through it and the limiter resistor $R_1$. The first few degrees of wiper movement close the self park switch, short-circuiting the thyristor and thereby returning it to its non-conducting state.

When the wipe has been completed the self park switch opens, causing an extremely high back voltage to appear momentarily across the motor. This back e.m.f. is quenched in the protective diode $D_2$. Without $D_2$ the steep waveform of the back voltage not only refires the thyristor but also welds the slider of $RV_1$ to its track!

The length of delay is controlled by $RV_1$. This component is fitted with on-off switch $S_1$ and has a log track, which tends to spread out the working range over most of the slider movement. The potentiometer is connected so that it inserts more resistance in circuit, and hence increases the delay, as its knob is turned clockwise.

TOLERANCES AND CONSTRUCTION

Components are not particularly critical. Any medium gain p.n.p. transistor is suitable. A medium value of $R_2$ is best, and $RV_1$ will have to be set to suit. $RV_1$ is a 5KΩ potentiometer, which is adjustable with a value of 5000Ω. $S_1$ is an on-off switch. The supply is 12V, and the motor is a 6V, 0.30A motor. A resistor of suitable value has to be chosen for the motor. A 100Ω resistor is suitable for the motor.

THE RADIO CONSTRUCTOR
transistor capable of a collector current of at least 20mA will do for TR₁. Using an OC81, it was not found necessary to mount it on a heat sink. Both the DD4520 and IS420 quoted in the Components List have maximum forward currents of 10A. The p.i.v. of the DD4520 is 50V and that of the IS420 is 100V. The writer obtained all his semiconductors from Bi-Pak Semiconductors.

The starting current of the wiper motor can be as high as 7A. The thyristor that is used must handle at least 10A—allowing for a stalled motor. The BTY87-100R can handle 12A maximum and has a p.i.v. of 100V.

The maximum delay given varies with the ambient temperature. It can be as high as 65 seconds at 70°F, falling to 35 seconds at 115°F. Under normal driving conditions 10 to 15 seconds is typical of what is usually required. The longer delays are very useful when driving in fog or fine drizzle.

The unit may be fitted anywhere in the car (apart from the engine compartment) and preferably reasonably close to the manual switch. The thyristor can be mounted on a few square inches of aluminium, this being insulated from metal parts of the car body if the car does not have a positive earth. If the car is positive earth the stud end of the thyristor, being the anode, can be bolted directly on to the car. D₂, which should be insulated from earth, does not have to be mounted on a heat sink.

At the time of writing the prototype has been in use for some months and has stood up well to bad weather. On one occasion it worked non-stop for a period of 4 hours. All components are operated well within their ratings.

## Knight-Kit LC-1

### Code Oscillator

Learning morse on the Knight LC-1 code oscillator, one of the many instructional devices which can be easily assembled from the "Knight-Kit" range of construction kits now being marketed in the UK and Europe exclusively by Electroniques (prop STC Ltd.). Capable of being assembled by anyone, regardless of their technical knowledge, the LC-1 enables young and old alike to quickly learn the rhythmic tappings of the morse code, the key output being indicated by built-in lamp, speaker or earphones.
In last month's article in this series we examined two mixer valve circuits of the type commonly encountered in domestic superhet receivers. The first of these employed a grid leak mixer, with which both the signal and oscillator frequencies are applied to the single control grid of a triode or pentode by way of a grid capacitor and grid resistor. Mixer circuits of this type are used at frequencies above some 40 Mc/s or so, and we examined a typical f.m. receiver circuit in which the valve also functioned as local oscillator. We next turned to mixer circuits of the type used in receivers for the long, medium and short wave bands. These employ mixer valves which have two control grids screened from each other, the signal frequency being applied to one grid and the oscillator frequency to the other. We saw how the difference frequency is actually produced in such mixers and also considered a practical circuit incorporating the ECH81 triode heptode.

We now proceed to further factors relating to mixer functioning.

**CONVERSION CONDUCTANCE**

The function of a mixer valve differs from that of an ordinary amplifying valve because the required output at its anode is at a different frequency to the signal applied to its grid. We can assess the usefulness of a normal amplifying valve by quoting its mutual conductance, i.e. the change in anode current resulting from a change in grid voltage. It will be recalled that mutual conductance is expressed in milliamps per volt.

A similar measure of usefulness is employed with a mixer valve and it is referred to as its conversion conductance. Conversion conductance is the relation between the anode current at the intermediate frequency to the grid voltage at the signal frequency. The similarity of this quantity with mutual conductance is clear, the main difference being that conversion conductance applies to specific alternating frequencies at anode and grid, whereas mutual conductance may be determined under d.c. conditions. With mutual conductance it is understood that the anode voltage is constant. The same is assumed for conversion conductance, the condition being expressed by the statement that the anode load (through which the current at intermediate frequency flows) has zero impedance. It is more difficult to measure conversion conductance than mutual conductance and the process requires fairly complex laboratory equipment. Like mutual conductance, conversion conductance may be expressed in milliamps per volt although, since most conversion conductance values are lower than 1mA per volt, it is usually more convenient to work in microamps per volt. The symbol for conversion conductance is $g_c$, and it is sometimes alternatively described as conversion transconductance.

The conversion conductance of a mixer valve varies, as is to be expected, with anode voltage and, if applicable, with screen grid voltage. In a mixer having two control grids it varies, again, with the bias applied to the signal grid. A particularly important factor is that it also varies (and very widely) with the amplitude of the local oscillator signal applied to the mixer. In consequence of this last factor, it is standard practice for valve manufacturers to issue curves for their products which show conversion conductance plotted against oscillation amplitude at the...
mixer grid. We have not yet discussed how oscillation amplitude may be measured, and so we must next digress a little and examine this particular point in detail.

Fig. 1 (a) shows the grid of a mixer to which is applied a signal from a separate local oscillator. It is assumed that the oscillator signal is provided by a coupling winding (which couples to the oscillator tuned circuit) because this shows the external circuit paths from grid to cathode most clearly. A standard grid capacitor and grid resistor input circuit is employed. If we wished to measure the amplitude of the oscillator signal it would appear that all we need to do is to connect a suitable a.c. voltmeter between the grid and chassis, as in Fig. 1 (b). In practice, unfortunately, this approach is not always entirely convenient, because it is necessary to use a voltmeter having a very high impedance between its terminals (otherwise it will cause the oscillator amplitude to drop) and to ensure that its connecting leads do not upset conditions elsewhere in the circuit. A much easier method of measuring oscillator signal amplitude is to insert a current reading meter in series between the lower end of the grid resistor and chassis, as in Fig. 1 (c), this giving us what we can look upon, for the moment, as a circuit incorporating its own voltmeter. The grid of the valve rectifies in normal leaky-grid fashion by conducting on positive peaks of the applied oscillator signal, whereupon the subsequent d.c. voltmeter formed by the current reading meter and the grid resistor (which acts in the same way as a voltmeter series resistor) gives an indication of the average negative voltage appearing at the grid. Since this voltage is negative with respect to chassis, it is necessary for the negative terminal of the current reading meter to be the one which connects to the grid resistor. Obviously, if oscillation amplitude increases so also will the reading in the meter, whereupon the latter gives an indication of that amplitude. This is a much more convenient method of indicating oscillation amplitude that is that of Fig. 1 (b), because all that is required is the insertion of a simple low-cost instrument into a part of the circuit which is already at low r.f. potential. The resistance of the meter will be very much smaller than that of the grid resistor, and inserting it into the circuit causes negligible disturbance of r.f. conditions. Even if any serious risk of such circuit disturbance exists, as is feasible if for instance the meter were connected by long leads, this can be completely eradicated by adding a bypass capacitor (of around 0.05μF for normal r.f. work) close to the grid resistor as shown in Fig. 1 (d).

We have described the combination of grid resistor and series current reading meter in Fig. 1 (c) as a d.c. voltmeter, because looking upon the circuit in this light when it is first encountered makes it easier to appreciate why the meter reading is proportional to oscillation amplitude, and why it is the negative terminal of the current reading meter which connects to the grid resistor. If we wished we could, indeed, calibrate the meter in terms of oscillation voltage amplitude. With a little further consideration, however, we may see that there is no necessity to provide such a calibration. It so happens that the meter indicates, on its existing scale, the average grid current resulting from the oscillator signal!

This last point may be a little puzzling to the beginner, particularly when it seems very clear from Fig. 1 (c) that the meter is patently not in series with the grid circuit in
any way. What occurs, however, is that the grid current which flows on the positive peaks of the oscillator signal causes the grid capacitor to become charged. Over the rest of the cycle the capacitor then discharges via the meter because, since the valve grid is not then conductive, no other discharge path is available for it.

Let us suppose that the grid of the valve in Fig. 1 (c) is taken out of circuit for a period. The meter will then give a zero indication because any current it passes on positive half-cycles is balanced out by the current it passes on negative half-cycles. If we reintroduce the grid this equilibrium is upset. A current then flows into the grid capacitor on positive peaks and flows from it through the meter over the remainder of the cycle. Thus the meter indicates, albeit at second hand, the average value of the current which has upset the equilibrium, and this current can only be the average grid current of the valve.

CHARACTERISTIC CURVE

Our digression, by way of the explanation illustrated in Figs. 1 (a) to 1 (d), shows us that a very simple method of determining the oscillator signal amplitude applied to a mixer grid is to insert a current reading meter at the chassis end of the grid resistor. We can then work in terms of the average grid current that this indicates. It is also necessary to specify the value of the grid resistor. With mixers of the type employed in long, medium and short wave receivers the average grid current is usually of the order of hundreds of microamps, whereupon the grid current meter could, in practice, be a 0–1mA instrument.

Mixers intended for higher frequencies usually run at lower grid current figures and a more sensitive instrument is required.

We may next return to our earlier statement that valve manufacturers issue curves for their products showing conversion conductance plotted against oscillation amplitude, and we can now also see that the latter may be expressed in terms of grid current.* A typical example of a conversion conductance-grid current curve is given in Fig. 2, this being taken from Mullard information for the ECH81. The corresponding circuit conditions for the valve are shown in Fig. 3. Note that, in Fig. 2, all the factors which may affect conversion conductance are firmly specified. Thus, the anode and h.t. potentials are specified as 250 volts, and the signal grid bias (Vg1) as –2 volts. The screen grid potential is not quoted in volts. Instead, the screen grid dropping resistor (Rg2 + g4) is stated to be 22kΩ. This represents the same conditions of screen grid supply as occur in a practical frequency changer circuit. (Since g2 and g4 carry out the same function as the screen grid in a pentode, it is common practice to refer to the two grids collectively as the “screen grid”). As the triode grid (g1) and the heptode oscillator grid (g3) are connected together externally they are treated as one item, and the grid resistor is referred to as Rg1 + g3. This is specified as 47kΩ.

The horizontal axis of the curve of Fig. 2 is graduated in grid current (Ig1 + g3) from zero to 400μA, and the vertical axis in conversion conductance from zero to 800μA per volt.

The most apparent feature of the curve of Fig. 2 is the abrupt rise in conversion conductance for grid current from zero to around 150μA. Above 150μA the curve flattens out, reaching a “broad” peak at around 250μA grid current, then dropping slowly above this figure. If we had to design an efficient frequency changer circuit around the ECH81 our first aim would be to ensure that the local oscillator circuit always provided a grid current which was comfortably above the 150μA figure. The drop in conversion conductance below 150μA grid current is so marked, in comparison with the rest of the curve, that working on this part of the curve should be avoided if at all possible. A sensible practical approach would be to aim for a grid current of around 200 to 275μA, and this would give a reasonable amount “in hand” for subsequent valve aging and the like. In order to keep well above the 150μA point it might, at first sight, be thought desirable to work at higher grid current up to 400μA or even more, since the drop in conversion conductance at these figures is

---

* Some v.h.f. triode and pentode mixer valves do, however, have oscillator amplitude expressed in r.m.s. voltage, this usually being done if the valve can operate as a mixer with a small resistor in the cathode circuit. If such a valve is operated with the cathode connected directly to chassis the r.m.s. oscillator voltage is the grid current multiplied by the grid resistor value (which gives the peak value from Ohm’s Law) times 0.7.
obviously not high. However, too high a grid current can result in the oscillator harmonics having appreciable amplitude, whereupon they become more liable to produce intermediate frequency signals with strong interfering aerial signals. In receivers having simple signal frequency tuning circuits, excessive oscillator harmonic amplitude can cause interference in the form of "whistles" on some transmissions.

A factor which complicates oscillator circuit design is given in superhets covering fairly wide frequency bands in a single sweep of the tuning capacitor, as occurs in long, medium and short wave receivers of the domestic type. It is often difficult to maintain a reasonably constant oscillator amplitude over all of a single band, it being found that grid current is usually lower at the low frequency end where the oscillator tuned circuit is least efficient. Nevertheless, it should still be possible to keep the grid current within the top broad part of the conversion conductance curve (say from 175 to 300μA in Fig. 2) at all settings of the tuning capacitor. The conversion conductance-grid current curve of Fig. 2 is typical in shape to that for virtually all standard mixer valves, whether these be of the grid leak type with a single control grid or like the ECH81 with two control grids. The conversion conductance curves for all these similarly exhibit the same sharp rise from zero to a broad peak, followed by a gradual fall for higher grid currents. Naturally, the actual grid current figures will be different for valves other than the ECH81 and the manufacturers' literature has to be consulted accordingly.

For grid leak mixers, either self-oscillating or running with a separate local oscillator, grid current measurement is carried out as in Fig. 4. In both cases the oscillator should be designed to offer the optimum grid current, as shown from the valve manufacturers' curves, in the same way as with the ECH81 just discussed.

**NEXT MONTH**

In next month's article we shall conclude on the subject of the superhet mixer and shall carry on to the i.f. amplifier.

---

### CATALOGUE RECEIVED

**ELECTRONIQUES (S.T.C.) LTD.**

Electroniques have now published the second edition of their Hobbies Manual. This new and entirely revised 1968 issue containing 960 pages is divided into twelve sections and is twice as large as the old edition.

There is a full range of kits for the practical man who enjoys the satisfaction of building his own high performance equipment but lacks the experience to design it himself. For the electronics enthusiast who prefers to build and design his own circuits there is an extensive components section incorporating both commercial and professional grade products. Every item listed is fully detailed and specified together with photographs and drawings where appropriate.

For those preferring to purchase ready-built equipment there are the Audio and Hi Fi, Shortwave Listening, Home and Hobby, Motoring and Amateur Radio sections from which to choose. Kits can be supplied assembled at extra cost. Other sections include books, test equipment, Hallicrafters receivers and a separate valves and semiconductors section with many new devices.

The new Manual has a much increased product range and now includes microscopes, telescopes, hi fi, tape recorders, car radios, seat belts, engine tuning kits as well as all the products previously available. In the components sections there are many new additions such as a new range of RCA American receiving valves and a much wider range of transistors including FET's. The index covers 20 pages.

As in the previous edition there are numerous pages of technical data, abacs, formulae, designs and hints of practical use to the constructor.

Although the price this year is 16/6d. this has been offset by vouchers valued at £25 which could save the cost of the Manual many times over when purchasing the goods listed in it.

The Hobbies Manual (price 16/6d.) is available from Electroniques Dealers throughout the country, or direct from Electroniques, Edinburgh Way, Harlow, Essex.

**SEPTEMBER 1968**

---

www.americanradiohistory.com
COURSES OF INSTRUCTION

COVENTRY TECHNICAL COLLEGE
Butts, Coventry, CV1 3GD.

A course in preparation for the Radio Amateurs' Examination (C. & G. 55) held by the City and Guilds of London Institute will be offered at this College for the next session beginning in September 1968.

Attendance will be on Wednesday evenings from 7.00 until 9.00 p.m. Tuition in Morse Code will be available, as an extension of the course after the examination in May 1969 until the session ends, in July, without further fee.

Enrolment will be during the period 9th to 12th September the course fee being £2 0s. 0d.

The College has a well equipped transmitting station (call sign G3UVW) and students are encouraged to operate the station under the supervision of the Organiser, Mr. F. J. S. Chandler, G3HHM who will welcome enquiries from intending students.

SOUTHALL
Southall College of Technology, Department of Electrical Engineering, Section 47/48, Beaconsfield Road, Southall, Middlesex

Full-time Course in Basic Electronics

There is a rising demand for technicians to work in the fields of (a) automation and computer technology and (b) television, including colour. City and Guilds of London Courses 47 and 48 cater for these requirements, taking five years to reach final level. The courses are similar up to Intermediate level, i.e. for the first three years.

In view of the acute shortage of skilled personnel, a full-time course has been arranged. This will cover the requirements, for Intermediate, in nine months, September to May, and will lead to City and Guilds certificates.

The course includes extensive practical work and, on completion the students will be competent to carry out test procedures, using modern test gear, repair, or assist in the construction and modification of, electronic equipment, using circuit diagrams.

If required, final level courses, in either specialisation, are available on a part-time basis, i.e. one day per week.

The full-time course is ideal for school leavers, both boys and girls, also for those who wish to enter any branch of the electronics industry for the first time.

There are no fees for school leavers under 18, and for others the fee is £19. Overseas students, with ‘O’ level English or equivalent, may have to pay £170 if they have no U.K. residence qualification.

Enrolment on 11th September, 10-12.00 or 2-4.00 p.m.

BROMLEY
Radio Amateur Examination

You may wish to inform your readers that a class in preparation for the Radio Amateur Examination will be held at the Adult Education Centre, 28 Beckenham Road, Beckenham, Kent.

The class meets on Thursdays from 7.00 – 9.00 p.m., commencing 26th September 1968.

Fees are graded according to age.

Enquiries to: M. D. Bass, B.Sc., (G30JE), 42 Clevedon Road, London, S.E.20. A Morse class will be held in addition, if numbers are sufficient.

TUNBRIDGE WELLS
The West Kent College of Further Education, Tunbridge Wells, Kent, are running full-time courses in Radio and Television Servicing, and Electronics Servicing, to intermediate City and Guilds Certificate standard.

Courses commence 16th September 1968, and applications can be considered from students outside the County of Kent. Further details may be obtained from the Registrar, West Kent College of Further Education, St. John’s Road, Tunbridge Wells, Kent. (Tel: Tunbridge Wells 28276).

WALTHAMSTOW E.17
Marsh Street Youth Centre

Radio Amateurs' Examination Course

Course No. 2 is being organised for commencement early in September 1968. The topics covered will be suitable for anyone beginning radio studies, and will cover the material required for the Examination for the Transmitting Licence. It is hoped to make the Course an informal one with plenty of time for discussion and difficulty solving.

As well as being suitable for the R.A.E. the Course should be eminently suitable for anyone thinking of a refresher or study course on elementary radio and electronics.

Enquiries regarding the Course should be addressed to K. L. Smith, G3JIX, 82 Granville Road, Walthamstow E.17.
Readers will recall that, in last month's episode, Smithy introduced Dick to the intriguing world of fluidics, in which gate functions analogous to those given by electronic circuits are provided by devices which control the flow direction of a gas under pressure. This month Smithy completes the fluidics story by describing fluidic symbols, a fluidic oscillator and the general trend of fluidic development.

"Why, so I did," said Smithy, his face clearing. "Well, now, that's a promise I don't mind keeping, because I'm just as interested in fluidics as you are. We've certainly got nothing else to do for the time being so I'd be only too happy to pass on a little more on the subject."

Somewhat taken aback at Smithy's ready acceptance of his suggestion, Dick faltered momentarily then decisively carried his stool over to Smithy's bench. That worthy was already settling himself down and had pulled his note-pad towards him.

"How much," he asked, "do you remember from our last natter about fluidics?"

A monstrous frown appeared on Dick's brow as he concentrated his thoughts.

"Well," he said slowly, "you first started off by telling me about Coanda effect. You said that if a fluid, which could be liquid or gas, is pumped under pressure through the aperture of a nozzle into the open air it forms a jet which just goes straight outwards. But if you put a side wall close to the nozzle aperture the jet flows, instead, along the surface of that wall, a little bubble of air being trapped in the corner between the side wall and the nozzle surface."

"That's right," confirmed Smithy, busy with his pen on his note-pad. "What you've just described is the basic Coanda or wall attachment effect. I also told you how this effect enabled a fluidic flip-flop to be made up, like the one that I've just drawn here. (Fig. 1). The side walls in this flip-flop are symmetrical on either side of the nozzle aperture whereupon, when a gas is initially fed in under pressure at the supply port, it will choose the side wall to which it first becomes attached in random fashion. Thus, the supply has can initially pop out at either of the output ports, just as occurs with an electric flip-flop. But you can easily flip the jet over from the right hand output port to the left hand one, if you want to, by feeding in gas under pressure at the right hand control port. And vice versa."

"You also," put in Dick, "told me about jet deflection."

"True enough," agreed Smithy, "and that led us up to the fluidic monostable which could function as a NOR gate. In the fluidic monostable there is a vent coupling to one of the side walls, with the result that Coanda effect cannot take place at all on that particular wall. The vent is on the left in the monostable I've sketched out here (Fig. 2) and so, in the absence of control inputs, the output is always at the right hand output port. But the output shifts to the left hand output port if there is an input at either one of the two control ports or at both of them. Just what you need for an OR gate. Since an output at the right hand output port is the inverse of one at the left hand output port, this device can also function as a NOR gate."

STABILITY

"Right," said Dick eagerly, "let's now press on from there!"

"As you like," replied Smithy equably, "What do you want to deal with next?"
"For the moment," said Dick, "I want to get myself more fully at home with the basic operation of these gadgets. How stable, for instance, is a fluidic gate when it's operating on Coanda effect?"

"How do you mean?"

"How long does the jet remain attached to a wall after it's been initially held there by Coanda effect?"

"The Coanda effect continues indefinitely," replied Smithy, "provided that the correct supply pressure is maintained at the jet nozzle. The Coanda effect doesn't take place at all until the jet pressure achieves a certain critical figure which depends on nozzle dimensions, wall spacing, and so on. The effect is then present for all jet pressures above this up to some 40 times the initial critical pressure. In consequence, provided you can maintain jet pressure within this very wide range, Coanda effect causes the jet to stick like a limpet to the side wall that has been selected for it. I may add that typical nozzle aperture diameters for gas are of the order of 0.015 inch, and that complete devices of the type we've been considering up to now are made in flat rectangular packages about an inch long, three-quarters of an inch wide and a quarter of an inch deep. These dimensions exclude any projecting pipes which are fitted for interconnection.

"Fluidic devices are quite small, then."

"Oh yes," confirmed Smithy. "The coupling tubing between fluidic devices is quite small, too. It's only about an eighth to a quarter of an inch in diameter according to the manufacturer of the devices it's used with. Again, the supply pressure is quite low, being of the order of 10 lbs per square inch or so."

"The supply pressure," remarked Dick thoughtfully, "is very similar to the supply voltage which causes current to flow in an electronic system."

"True enough," agreed Smithy. "There are other similarities as well, too. For instance, there's a fairly well established set of symbols for fluidic devices, and these appear in circuits that are much the same as the ones you have in electronic circuits. The tubing which couples devices together is shown as lines in these circuits, in the same way as the wiring coupling electronic devices is drawn. The symbol for the bistable flip-flop we considered just now is drawn like this. (Fig. 3 (a)). The total symbol is enclosed in a circle, and you'll see there's a smaller circle at the bottom. This smaller circle represents the nozzle and is usually given the letter S for 'supply', or J for 'jet'. The two arrows pointing inwards are called C1 and C2 and represent the control inputs. The two output ports are called O1 and O2 respectively. If there were two control ports on either side of the bistable nozzle, the symbol could be drawn like this (Fig. 3 (b)). Note that there's a tendency to keep the odd numbers for the C and O elements on the left and the even numbers on the right, although not all manufacturers follow this convention. The monostable OR-NOR gate with two input controls which I drew just now is shown like this (Fig. 3 (c)) and I've written alongside it the logic equations which correspond to its action. The first equation means that you get an output O1 when either input C2 or input C4 or both together are present of not-C2 and not-C4. Don't bother your head about that second equation, though, unless you're keen enough on logic to appreciate that this corresponds to the NOR condition of the device by way of D. Morgan's Rules.

"As a matter of fact," said Dick, "I remember you nattering about De Morgan's Rules some time ago, and so I've got a pretty good idea about what you're getting at there."

"Fair enough," said Smithy laconically. "Before we go any further there's one important little point I want to clear up. Up to now, and particularly during our last session, I have referred to the fluid which flows in the devices as being a gas other than air. In actual practice, the fluid will normally be air itself, this being used both at the supply nozzles and in the control ports and channels. With air you'll still get all the effects I've described, including the trapped bubble at the corner of the nozzle surface and side wall which occurs with the Coanda effect. If air is the fluid this now becomes a bubble of air trapped by a jet of air, instead of a bubble of air trapped by a jet of gas. The main advantage of referring to gas in an initial explanation of fluidic devices is that you can then show the jet shaded in your diagrams in order to differentiate it more readily from the air around it! But, to reiterate, the jet and control inputs can all use ordinary air under pressure to carry out the functions I've described."

"I notice," remarked Dick, "that in all your sketches you've shown the channels through which the air travels as having gently curved sides."

"That's a very necessary feature of fluidics design," said Smithy. "There must be gradual bends and gradual changes in dimensions in the paths through which the fluid flows or you get vortexes appearing, and these can upset operation. A point I haven't mentioned is that manufacturers sometimes deliberately introduce vents or cavities along the output channels for the jet, this being done to reduce vortexes and to ease the problems of matching the output to the connecting tubing and to other devices. The techniques used here tend to vary from maker to maker and the presence of such vents or cavities doesn't affect the explanations of jet switching which I've just given you.

"Are there any really complicated fluidic devices?"

"Quite a few," replied Smithy. "You..."
can, for instance, get fluidic binary counters, Schmitt triggers, and the like. These are given by combining a number of individual devices and gates together and are often made up in a single unit which incorporates the interconnections in channels instead of using external tubing. Just like integrated circuits!"

"Phew," remarked Dick wonderingly. "Integrated fluidics!"

"Then again," continued Smithy, "you can have a fluidic proportional amplifier with two control ports on either side of the jet. The side walls are positioned so that this works entirely by jet deflection with no Coanda effect taking place at all, and the jet is deflected between the two output ports by the pressure in the control inputs. Now, here's another application which I find quite intriguing!"

Smithy drew again on his note pad. (Fig. 4)

"What's this?" he asked.

"Don't ask me," replied Dick helplessly. "I haven't a clue."

"It's an oscillator," replied Smithy. "The device is biased to output port O1 by having a vent to prevent Coanda effect on the left and right, just as in the monostable we looked at earlier on. Also, there's a fairly long external channel or length of tubing between output O1 and control port C1. The result is that, as soon as the supply jet first appears it goes out at O1 and carries on into the long external channel. After a period depending upon the length of the external channel, the output appears at C1 and deflects the jet over to O2. This continues until the pressure in the external channel drops, whereupon the jet reverts to O1 and the process repeats. The result is a continuous oscillation, together with a pulsating output from O2."

**SENSITIVE AMPLIFIER**

"Gosh," said Dick, "that's neat." Smithy nodded his head in agreement, then drew a further sketch on his note pad. (Fig. 5)

"Now here," he announced, "is something even neater. This is a fluidic circuit for a very sensitive digital amplifier which has been developed by the Plessey Company, and you'll see that the bottom stage consists of an oscillator similar to the one we've just looked at. It's function is to pass a pulsating supply to the stage above, which is a monostable having one input. This monostable is a bit different to the previous one we looked at, and Coanda effect can take place on both sides. However, the side walls are so dimensioned that the jet always has a slight bias towards initial attachment to the right hand wall. The function of the control input is to flip it over to the left, where it can similarly be held due to Coanda effect."

"Why," asked Dick, "does its supply come from the oscillating stage?"

"To answer that question," replied Smithy, "I must return to an earlier point I made. You'll remember I said that the Coanda effect is always present provided that the supply pressure in the nozzle is higher than a certain critical figure. Below that figure the jet simply goes straight outwards regardless of the presence of side walls at the nozzle aperture. Now, if the supply pressure is gradually increased from a low figure it will reach a certain pressure, just below the critical minimum figure needed for Coanda effect, where the jet is in an unstable condition and can be readily deflected by a very small control signal pressure. In our present instance, the supply for the monostable is the pulsating output from the oscillator, and this supply pressure falls below the minimum critical Coanda figure once each oscillator cycle, after which it rises above it. Therefore what happens is that, once in each oscillator cycle, the supply to the monostable goes through the sensitive region, just below the critical Coanda minimum, where the jet is capable of being deflected to the left by a very small control input. As the supply pressure increases up to and passes the..."
Coanda minimum figure the jet is already deflected to the left and it then stays there until the Coanda effect is momentarily lost once more at the end of the oscillator cycle. The process then repeats and the overall result is that only a very small control pressure is needed to keep the monostable output over to the left. With no control signal, the built-in bias in the monostable keeps the output over to the right. For the small fraction of the oscillator cycle when it offers an output below the sensitive region the monostable will offer an output from both output channels. But since, during this period, the pressure from the oscillator is very much lower than over the rest of the cycle the effect of such low pressure outputs is negligible.

"What's the third stage?"

"That's just a standard bistable having its own supply," said Smithy. "The outputs from the monostable are, in turn, derived from the oscillator output, so they're also of a pulsating nature. They couldn't be applied directly to other fluidic devices. They are, in consequence, fed to the bistable, which acts as a sort of buffer, or smoothing, amplifier. The bistable enables a smooth output to be provided that is suitable for feeding to other fluidic components."

"Well," said Dick, impressed, "that's a really cunning scheme."

"Isn't it?" confirmed Smithy. "Incidentally, all the three stages are integrated into one assembly having four ports only. The first is the supply port, which feeds both top and bottom stages, the second is the sensitive control port, and the two remaining ones are the output ports."

"What about the feedback channel for the oscillator? Doesn't that have to provide a pretty long path?"

"It does," said Smithy, "but it's still integrated into the combined unit, and it consists of a channel folded back on itself several times. Like this." (Fig. 6).

"Well, I've certainly learned a good bit this morning," remarked Dick. "Are there any other things I should know about fluidics?"

"Well," said Smithy, "at this elementary stage it's useful to know how a fluidic system couples into the external processing machinery which the system is to control. Quite a few established methods of automatic process control rely on pneumatics, whereupon a fluidic system could, theoretically, be coupled into these directly. Other methods of automatic process control rely on electrics or electronics, with the result that transducers are needed to convert electrical signals to fluidic signals and vice versa. A simple example of the first is a solenoid, or modified relay which, on being energised, opens or closes a valve and allows or prevents the passage of fluid. For a transducer in the reverse direction you can have a diaphragm-operated switch. This closes, or opens, according to whether or not pressure is applied to the diaphragm."

Smithy put his pen back in his pocket with an air of finality.

"And that," he continued, "pretty well gives you all the picture so far as elementary fluidic basics are concerned. I should mention though that, apart from industrial applications, there have also been some really advanced developments in fluidics recently, particularly in the aviation and missile field. One advantage of fluidics is that fluidic systems can work at high temperatures, whereupon they become very useful for control applications in aircraft jet engines and things like that. Again there's even a fluidic stepper motor which is rather similar to a uniselector. It has a rotor which moves round one position for each pulse of pressure applied to it, and it can be used to indicate the numerical output from a fluidic computing device."

THE VAN-MAN COMETH

"Blimey," said Dick. "Fluidics certainly seems to be hotting up! For the moment, though I think I'd prefer to stick to the simple stuff, and I've got just one more question I'd like to ask." "Fire away!"

"How quickly," asked Dick, "do fluidic systems operate?"

"As I said during our last discussion," replied Smithy, "they're much slower than the corresponding electronic devices which they replace. Switching time in a single fluidic device like the monostable and bistable we have been talking about is of the order of a thousandth of a second, and you can get complete systems running at quite a few hundred pulses per second. This will be speeded up with further development but, as things stand, the speed is still more than high enough for most automatic control applications. And, of course, these fluidic systems can function under conditions of temperature and vibration which would make electronic systems curl up completely. Again, it's claimed that the inherent simplicity and robustness of fluidic systems makes them less subject to failure. Here, though, some care has to be taken to ensure that impurities in the air passing through the system don't wear out or block up jet nozzles. If a system is used in a location where there's a great deal of impurity in the air, the air has to be filtered before application to the system. On the other hand you can't, at any rate, break down a fluidic device by connecting it up incorrectly, as you can with some electronic gadgets!"

"For someone like me," grinned Dick, "this is the best advantage of the lot! By the way, Smithy, a thought that occurs to me is that a keen amateur could have quite a bit of fun making up his own experimental fluidic systems."

"Indeed he could," agreed Smithy. "A useful approach would be to use water as the fluid, since this would work with much wider jet orifices than are needed for air, and it would be easier to see if the devices were operating properly. Hullo, that sounds like our van!"

And, in fact, the sound of the van engine had become fully audible in the Workshop. There was a sudden squeal of brakes, followed by a heavy metallic clangour.

"Hell's teeth," snorted Smithy. "He's done it again! I'm convinced he's got a grudge against that dustbin of ours."

But, five minutes later, Smithy completely forgot about the Workshop dustbin as he and Dick surveyed the

(Continued on page 129)
Virtually all our modern civilisation is based on an assumption.

We rely on electricity to light our homes, to run our radio and television receivers, to operate much of our hospital apparatus, to start and maintain our automobiles in motion, to provide communication and navigational information for our aircraft, and to run the computers which do our calculations for us. We have satellites poised over the earth re-transmitting signals sent to them from over the horizon, as well as space vehicles that are capable of sending us pictures of the surface of the moon. And, of course, we rely on electricity for very much more besides.

All this gigantic range of electrical and electronic equipment is wholly conceived, designed, developed, manufactured and operated on the basis of a single assumption: that an electric current consists of a flow of electrons.

Yet nobody has ever even seen an electron!

Theory and Practice

Every part of our work in electricity and electronics is based on the theory that a flow of electrons constitutes an electric current. Not only can we explain the operation of all our devices in terms of this theory but we also create new applications which similarly depend on the electron concept.

I raise this point because it is occasionally a beneficial exercise just to stop and think about the foundations on which our present knowledge and activities are based. The theory that electric current consists of electrons in motion is a jolly good one and has certainly never been disproved. But it's nothing more than a theory, despite the fact that all our experience tells us that it must be correct and that its accuracy has been confirmed by a myriad of practical examples. True enough, but could it still not be that it is a theory which has fitted all our experience up to the present time?

I am reminded, here, of the reliance placed by 18th century scientists on the theory of phlogiston. The phlogiston theory was introduced by Georg Ernst Stahl and it fitted the available knowledge of the time very comfortably. Stahl speculated the phlogiston was the inflamable "principle" that enabled combustible objects to burn. According to his theory, a combustible substance of "calx", or ash, together with phlogiston whereupon, when it was burned in air, the phlogiston escaped and the calx was left. A given quantity of air could only absorb a certain amount of phlogiston, after which it became "phlogisticated" and could not support further combustion.

The phlogiston theory sounds almost incredibly naïve to our 20th century minds, but it represented an excellent working hypothesis for its day and age. It lasted throughout the 18th century, during which time it provided a good basis for further experiment, investigation and scientific advance. Part of its success was due to the fact that it was too far from the truth as we see it today. If what we now call a combination with oxygen were described as a "loss of phlogiston," the phlogiston theory ties in fairly well with the facts. And it certainly agreed with the facts closely enough to facilitate the work that was then in progress.

There were some tricky bits, though. Just to show how men's thoughts can twist themselves to fit a particular circumstance, one of the facets of the phlogiston theory was that phlogiston imparted levity. That got round the awkward observation that some bodies were found to increase in weight after combustion. (This was due, of course, to the added oxygen.) The explanation for the increase in weight was that since, due to combustion, the body had lost the levity imparted to it by the phlogiston it previously held, it was bound to be heavier.

Phlogiston finally disappeared into the history, books when, later, Lavoisier showed that combustion was the combination of a substance with oxygen. But it had had a good and useful run till then.

Perhaps the day may dawn when someone, carrying out an electrical or electronic experiment somewhere, will find that his results don't quite agree with what is expected of well behaved electrons. This may lead to further experiments along the same lines until—who knows?—a completely new theory will be evolved to explain all the electrical phenomena that currently exist and to provide even more accurate and reliable guide-lines for the future.

Don't forget phlogiston—it's happened before!

Projector Lamp Life

In our last April issue we published an article, "Increasing Projector Lamp Life" by T. R. Balbirnie, which described how switch-on surges with slide projector...
ELECTRONIC COMPONENTS
Valves, transistors, capacitors, transformers, amplifiers, tuners, etc., etc.
765 HIGH ROAD, SEVEN KINGS (opp. Seven Kings Hotel) ILFORD, ESSEX Telephone: GOODmayes 1826

MARKET CENTRE
For Semiconductors
Prompt, efficient mail order service for Mullard, Newmarket, Texas, Sinclair, S.T.C., Fairchild Semiconductors. We also offer a comprehensive selection of miniature components for transistor circuitry. Catalogue 15.
L.S.T COMPONENTS
23 New Rd., Brentwood, Essex

BOURNEMOUTH
LARGEST HI-FI AND RADIO COMPONENT STORE IN THE SOUTH
FORRESTERS NATIONAL RADIO SUPPLIES LTD.
70-72 Holdenhurst Road
Bournemouth
Telephone 25232

Your Local Supplier
LONDON
ST. HELEN'S RADIO
Hi-Fi Equipment
Tape Recorders
Radio Receivers
Television

ST. HELEN'S GARDENS
LONDON W.10
Tel: 01-969 3657

ELECTRONIC
COMPONENTS

An automatic switching circuit which extends the life of slide projector lamps.

An automatic switching circuit which extends the life of slide projector lamps.

Bournemouh
LARGEST HI-FI AND
RADIO COMPONENT
STORE IN THE SOUTH

FORRESTERS NATIONAL
RADIO SUPPLIES LTD.
70-72 Holdenhurst Road
Bournemouth
Telephone 25232

128

The number of letters in each word of the sentence represents, in order, the first eight figures of \( \pi \).

Mr. Arnold states that he has been using this circuit for several years now, employing a Brimistor type CZ11. The 1510 silicon rectifier shown in the diagram has a p.i.v. of 800 and a maximum forward current of 0.5 ma. The value of the resistor in series with the rectifier will have to be found by experiment and it should be such that the relay operates when the voltage across the lamp approaches mains voltage. Most relays with fairly low energising current requirements should cope and the contacts should be capable of switching about 1.5 ma and have insulation suitable for mains voltages. The relay used by Mr. Arnold has two normally-open contact sets and these are wired in parallel. The working voltage of the 2\( \mu \)F electrolytic capacitor must be equal to or greater than the final voltage appearing across the relay coil after the relay contacts close. It might be wise to employ a working voltage of at least twice the relay energising voltage, since this will allow a safety margin for errors when initially finding the value needed in the series resistor.

For the record I may add that the CZ11 has a maximum operating current of 1.5 ma. There is a heavier thermistor in the Brimistor range, this being the CZ12, or CZ12A, with a maximum operating current of 2.5 ma.

Mr. A. Torrance, London, W.2., has sent us a similar circuit, and my thanks go to both these readers for passing the information on to us.

PI TO 30 PLACES
"May I have a large container of coffee?"

You may recall that this was the mnemonic for \( \pi \) that I passed on last May. The number of letters in each word of the sentence represents, in order, the first eight figures of \( \pi \).

I seem to have started something here, and D. J. Davies of Bromley, Kent, has now sent me the following letter which I reproduce here for the benefit of everyone.

You may recall that this was the mnemonic for \( \pi \), "is very interesting and useful. It reminds me of one I learnt many years ago giving 30 places of decimals and reads as follows.

Follow that!

COLOURED "FLOAT" GLASS
Living as we do in a world of continuing technological advance it is
becoming almost commonplace to hear about new and unusual applications which involve the use of electric current. Nevertheless, a very recent innovation in the manufacture of coloured plate glass is more than worthy of especial attention because so many unusual processes are involved. With the new technique it is possible to tint or colour plate glass whilst in the molten state by merely closing a switch.

To obtain the background to this new production method it is first of all necessary to gain a basic understanding of the manufacture of “Float” glass, as developed by Pilkington Brothers of St. Helens, England. In the “Float” process, a stream of molten glass leaving the furnace is distributed over a bath of molten tin which, being very much denser than molten glass and having an ideally flat and level surface, imparts a surface of equal flatness to the underside of the glass which flows over it. This glass then passes into a subsequent annealing furnace where it becomes sufficiently rigid to be transferred to rollers, for final cooling and cutting up, without being marked. Thus, “Float” glass is produced in a fully transparent form and does not require the subsequent grinding and polishing operations needed with previous methods of glass manufacture.

Coloured or tinted glass has, up to now, been uneconomic to produce by the “Float” process (or, indeed, by earlier methods of manufacture) because of the necessity of melting an excessive amount of glass carrying the desired colour before starting each colour run. Now, however, colours and tints can be introduced to “Float” glass by adding a molten metal above the glass after it has been formed and as it continues along over the molten tin. Both metals are in intimate contact with the glass, and an electric current is passed through the path given by the upper metal, the glass itself and the tin underneath, whereupon ions of the upper metal migrate into the upper surface of the glass to produce the desired colour effect. Don’t forget that glass, when hot enough, is quite capable of passing electricity, as was demonstrated in the short article “Making Glass Conduct” which appeared in our May 1966 issue. The depth and hue of the colour can be varied by suitable choice of the upper metal and the current which flows.

Three colours in the range grey-bronze to copper-bronze are already available. These are produced by a concentration of exceptionally fine particles of the upper metal just inside the glass surface, where they are impervious to abrasion or chemical action. Apart from decorative effects, the colouring can also be designed to eliminate glare and to filter out heat rays. Typical applications currently envisaged are coloured plate glass windows for shops, houses and other buildings, with tinted safety glass for cars as a particularly promising outlet.

The main advantage with the new process is its ease of use on the production flow line. As little as a mile of coloured glass can be started, with no interruption to production, merely by closing a switch. When sufficient coloured glass has been produced the current is cut off, and the standard transparent material appears once more.

Modern manufacturing methods are always a source of interest, but this is one of the most intriguing I’ve heard of for quite a while. I am indebted for the main details, incidentally, to the Journal (No. 77) of the Tin Research Institute, Fraser Road, Greenford, Middlesex.

stock of television and radio receivers with which the van-driver had presented them. All, it may be remarked, intended to operate by courtesy of the ubiquitous electron rather than by pumping puffs of air through piping.

With a little sigh, Smithy dismissed the world of fluidics and returned to his more accustomed environment. Electronics was not, of course, without its own particular fascination, but it had been pleasant to dwell for a short while on a new and allied science which had so many intriguing points of similarity.

ACKNOWLEDGEMENTS
Some of the information given in the last two episodes of “In Your Workshop” is taken from technical literature by Aviation Electric Limited, Montreal, Canada (whose U.K. factors are Bendix Electronics Limited, High Church Street, New Basford, Nottingham) and Electrolux Limited, Pallion Trading Estate, Sunderland, Co. Durham (who handle Corning fluidic devices). Another source has been Component Technology, (Vol. 2, No. 6) published by The Plessey Company Limited, Ilford, Essex, who also manufacture fluidic devices and systems.

—-
THE COMPLETELY NEW 1968 ELECTRONIQUES MANUAL

12 HOBBIES SECTIONS PLUS OVER 12,000 COMPONENTS AND SPECIAL VOUCHER OFFERS COULD SAVE YOU £25 IF YOU BUY THE MANUAL NOW!

The 1968 Hobbies Manual now contains
KNIGHTKITS—a famous American range of electronic easy-to-build kits. HALLICRAFTERS—the Number One name in communication equipment and radios. BOOKS—over 140 titles. AUDIO and HI-FI—a wide, wide range including famous names like Goodman, Sinclair, Sonotone, Acos, Discatron, etc., etc. HOME AND HOBBY—something for every member of the family—microscopes, telescopes, radio controlled equipment, garage door openers, experimental and educational kits, etc. MOTORSING—a special section with money-saving engine tuning kits, radios, seat belts, a car warning cleaner and many other useful accessories. SHORT WAVE LISTENING—exciting kits and finished equipment for world-wide reception. TEST EQUIPMENT AND TOOLS—a very wide range including multimeters, oscilloscopes, signal generators, soldering irons, cutters, pliers, breadboarding kits, etc., etc.

COMPONENTS—over 12,000 items from more than 100 manufacturers. The most comprehensive range available from a single source—now bigger than ever before.

AMATEUR RADIO—the best of receivers, transceivers, aerials, aerial rotators, aerials, Qollapx modules and lots more.

ELECTRONIQUES PRODUCTS—boxes and assembly systems, transistor and valve Ham and General Coverage tuners, crystal filter I.F. amplifiers, oscillators and other modules for effortless high performance. And finally, SEMICONDUCTORS AND VALVES—a new section of famous brand names like STC, RCA Newmarket and Brimar.

Enclosed is a cheque/postal order for £16 (which includes the £1 pp) made payable to Electroniquesto Prop. STC Ltd. Please rush me my 960-page copy of the new 1968 Hobbies Manual.

NAME
ADDRESS

Send this coupon quoting the special limited-period offer to:
Electroniquesto Prop. STC Ltd., Edinburgh Way, Harlow, Essex

RADIO CONTROL FOR MODELS

SHIPS, BOATS and AIRCRAFT

By F. C. JUDD

With sections on servomechanisms by RAYMOND F. STOCK

More than 200 illustrations—circuits, working diagrams, photographs & tables. Each page is packed with information.

This book is basically an amalgamation of "Radio Control for Model Ships, Boats and Aircraft" and "Radio Control Mechanisms". Additional material has been added on Multi-Channel Operation; Transistorised Radio Control Receivers—Simple and Three-Channel; A Compact Efficiency Aerial; Decaux Battery Information; Licences, Conditions, etc.

To Data Publication Ltd., 57 Maida Vale, London, W.9

Please supply copy(ies) of your publication "RADIO CONTROL FOR MODELS" DATA BOOK No. 16.

I enclose cheque/crossed postal order for.

NAME
ADDRESS

Send this coupon quoting the special limited-period offer to:
Electroniquesto Prop. STC Ltd., Edinburgh Way, Harlow, Essex
AUTUMN SALE!

TIS43A Unipolar Unjunction 6/9d Including tax

2N3819 Texas First Matched Transistor 10/-

STOP

LOOKING FOR QUALITY VALUE & SERVICE? Write

TO: 5 CASE 1 AMP TYPE THYRISTOR REJECTS

SPIRA FAIRCHILD Logic

Power Supplies, etc. New, these cost £'s each. 10% yield good devices. Dirty cond. As CRS1/40 range. Not tested—mainly low 50% usable devices. Case type as AC126/8. Tested. Ideal complementary to 2N3707E (above). Large quantities sold.

Three Week Manufacturers' surplus. All tested and guaranteed. New. Ideal for power supplies, etc. 396 SELSDON ROAD, SOUTH CROYDON, SURREY, CR20DE.

FOR 'R.C.' CIRCUITS. July: Simple F.E.T. Voltmeter; 40468, 10/3; Electronic Stethoscope; use 2SB187 (2/6) for OC75. June: Luxembourg Booster; CA3011, 25/–; Mini 5W Hi Fi; use 2SB187 for 2G374, 2SB405 (6/–) for 2N1307, 2SD72 (6/–) for 2N1306. Also Photographer's Metronome. Feb: In Yr. Workshp. (Integrated a.f. trans. Reflex T.R.F.; 2 trans. & diode, 5/6; SW, spkr. op., 50/–. Mini Amplifier Packs: AX2, 300mW to 15 ohms, other loads usable (3–80 ohms); reversable polarity, 13/–. AX3, 1W to 8 ohm spkr., 25/–. All work from 9V, are economical and easy to make. Data supplied.

TRANSISTORS. All brand new with makers' markings. No 'seconds'. DISCOUNT PRICES (in brkts) for 5 OR MORE SAME TYPE. AD161/2 comp. pwr. pr., 15/6(12/8); BC107 3/11 (3/1); BC109 (hfe—450–900) 4/– (3/6); 2N2926 Green 3/– (2/6); 2N3707 5/– (4/3); 2N4058 5/6 (4/7). S.A.E. LIST. Mail order only. Cash with order. UK post free on orders over 10/–. Quick service. Discounts: 10% over £5; 15%, £10.

AMATRONIX LTD., (Dept. R.C.), 396 SELSDON ROAD, SOUTH CROYDON, SURREY, CR20DE.
Precision built radio components are an important contribution to the radio and communications industry. Be sure of the best and buy Jackson Precision Built Components.

**THE gang for the transistor radio**
**Robust. Lightweight. Reliable.**
2 gang 208/176 pF.
The right capacitance for full cover.
**Fully screened. Fitted with Trimmers.**
Price 12s. 6d.

It's reliable if it's made by JACKSON!

**00** Twin Gang
12/6 each

**It's reliable if it's made by JACKSON!**

JACKSON BROS. (LONDON) LTD.
(DEPT. R.C.), KINGSWAY-WADDON, CROYDON, CR9 4 DG
Phone: Croydon 2754-5 (01-688). Grams: Walfilco, Croydon

**HAIR DRYER**

Special Offer

Owing to the popularity of this offer, our stocks of Toltec Hair Dryers especially allocated for our special offer to readers of “The Radio Constructor”, as advertised in recent issues, are now nearly exhausted.

We regret therefore that we cannot guarantee to honour any coupons received after the 30th September 1968.

TOLTEC ELECTRONIC & TRADING CO. LTD.
HATTON HOUSE, HURST GREEN, ETCHINGHAM, SUSSEX

**MARCONI INSTRUMENTS LIMITED**

ST. ALBANS & LUTON

**ARE YOU A SKILLED AND EXPERIENCED ELECTRONICS TECHNICIAN?**
**HAVE YOU BEEN A WIRELESS OR RADAR FITTER IN THE ARMED FORCES?**
**CAN YOU DO A PROFESSIONAL REPAIR JOB ON A T.V.?**

If you can answer “YES” to at least one of these questions, then we should like to hear from you.

We need test and calibration engineers both at our Government Service Unit at Luton Airport and at our Production Units in St. Albans to work on a wide range of telecommunications measuring instruments, which includes F.M. and A.M. Signal Generators, R.F. Power Meters, Valve Voltmeters, Radar Test Sets, Digital Counters, Deviation Meters, Spectrum Analysers and White Noise Test Sets.

The work requires the understanding of the most modern and varied circuit techniques and embraces all frequencies up to U.H.F.

This is an opportunity to work for an expanding company with a world-wide reputation for technical progress in the design of test equipment. The posts are permanent and pensionable; they offer first-class conditions of service in a key export company of English Electric, including substantial superannuation and life assurance benefits. Financial assistance may be given with re-location expenses.

Write in confidence, stating briefly age, experience, qualifications and present salary, to:

The Recruitment Manager, Marconi Instruments Limited,
c/o Directorate of Personnel (RC 2890 H),
**SMALL ADVERTISEMENTS**

Rate: 9d. per word. Minimum charge 12/- Box No. 2/— extra.

Advertisements must be prepaid and all copy must be received by the 4th of the month for insertion in the following month's issue. The Publishers cannot be held liable in any way for printing errors or omissions, nor can they accept responsibility for the bona fides of advertisers. (Replies to Box numbers should be addressed to: Box No.—, The Radio Constructor, 57 Maid Vale, London, W.9.)

**SERVICE SHEETS.** Radio, Television, Tape Recorders 1925–1968, by return post, from 1s. with free fault-finding guide. Catalogue 6,000 models 2s. 6d. S.A.E. enquiries. —Hamilton Radio, 54c London Road, Bexhill, Sussex.

**FOR SALE.** Oscilloscopes—Galvanometers—Evershed and Vignolles Meggers—Relays—Uniselecter Switches—Solenoids. Also other items and components. Free list. Stamp please.—R. & E. Mart, Box 9 G.P.O., Tunbridge Wells, Kent.

**ILLUSTRATED CATALOGUE No. 17.** Manufacturers Surplus and New Electronic Components including Semiconductors. 3s.—Post Free. Arthur Sallis Ltd., 28 Gardner Street, Brighton.

**BRIGHTEN UP YOUR ADVERTISING!** Break the ice with a Service Sheets. Radio, Television, Tape Recorders—Extent to Space E. Burgess, 5s.—Box No. F316.

**CAR ELECTRONIC IGNITION SYSTEMS.** If you want to cut petrol consumption (up to 6 m.p.g. extra) and cut plug and point wear, these units do it. If you want more, you also get smoother and stronger pulling at low speeds and better sparks at high speeds. Unbelievable winter starting. Soon pays for itself. Guaranteed new and tested. Offered at only £12 (nearly half price). Only 3 connections. State earth point wear, these units do it. If you want more, you also get smoother and stronger pulling at low speeds and better sparks at high speeds. Unbelievable winter starting. Soon pays for itself. Guaranteed new and tested. Offered at only £12 (nearly half price). Only 3 connections. State earth please.—R. & E. Mart, Box 9 G.P.O., Tunbridge Wells, Kent.

**BOOKS FOR SALE.** Alfred Nobel E. Berggren £1, Radioisotope Laboratory Techniques R. A. Faires, 10s. Atomic Medicine Behrens, £1. Medical Radiation Biology Ellinger, 30s. Physics in Medical Radiology Russ, Clark & Pede, 7s. 6d. Disease & its Conquest Hollis, 7s. 6d. Earth's Envelope T. Vignolles—Relays—Uniselector Switches—Solid State Electronics. Also other items and components. Free list. Stamp please.—R. & E. Mart, Box 9 G.P.O., Tunbridge Wells, Kent.

**TECHNICAL TRAINING by I.C.S.**

First-class opportunities in Radio and Electronics await the I.C.S trained man. Let I.C.S train YOU for a well-paid post in this expanding field.

I.C.S courses offer the keen, ambitious man the opportunity to acquire quickly and easily, the specialized training so essential to success. Diploma courses in Radio/TV Engineering and Servicing, Electronics, Computers, etc. Expert coaching for:

- C. & G. TELECOMMUNICATION TECHNICIANS CERTS.
- C. & G. ELECTRONIC SERVICING
- R.T.E.R. RADIO AND TV SERVICING CERTIFICATE
- RADIO AMATEURS EXAMINATION
- P.M.G. CERTIFICATES IN RADIO TELEGRAPHY

Examination Students Coached until Successful.

**NEW SELF-BUILD RADIO COURSES**

Build your own High-fidelity receiver, transistor portable, signal generator, multi-test meter and professional-type valve voltmeter—all under expert guidance.

**POST THIS COUPON TODAY** and find out how I.C.S can help you in your career. Full details of all I.C.S courses in Radio, Television and Electronics will be sent to you by return mail.

MEMBER OF ASSOCIATION OF BRITISH CORRESPONDENCE COLLEGES.

**INTERNATIONAL CORRESPONDENCE SCHOOLS**

Dept. 248, Intersect House, Parkgate Road, London, S.W.11.

**NAME:**

**ADDRESS:** Block Capitals Please

---

**SMALL ADVERTISEMENTS**

**MEDIUM WAVE NEWS** Monthly during DX season—Details from: K. Brownless, 7 The Avenue, Clifton, York.

continued on page 134

**BENTLEY ACOUSTIC CORPORATION LTD.**

38 Chalcot Road, Chalcot Farm, LONDON, N.W.1.

Please forward all mail orders to Littlehampton

PHONE 0743

**SMALL ADVERTISEMENTS**

**MEDIUM WAVE NEWS** Monthly during DX season—Details from: K. Brownless, 7 The Avenue, Clifton, York.

continued on page 134

**BENTLEY ACOUSTIC CORPORATION LTD.**

38 Chalcot Road, Chalcot Farm, LONDON, N.W.1.

Please forward all mail orders to Littlehampton

PHONE 0743

Terms of business: Cash with order only. No C.O.D. Post/Packing 6d. per item. Orders over £5 post free. All orders despatched same day as received.

Complete catalogue including transistor section and components with terms of business 6d. Any parcel insured against damage in transit for £6 extra.

Business hours: 9 a.m. – 5.30 p.m. Saturdays 9 a.m. – 1 p.m.
NEW STYLE SELF-BINDER for "The Radio Constructor"
The "CORDEX" Patent Self-Binding Case will keep your issues in mint condition.
Copies can be inserted or removed with the greatest of ease. Rich maroon finish, gold lettering on spine.

Specially constructed Binding Cords are made from Super Linen of great strength, very hard twisted and twice doubled. They are attached to strong RUSTLESS Springs under tension, and the method adopted ensures PERMANENT RESILIENCE of the Cords. Any slack that may develop is immediately compensated for, and the Cords will always remain taut and strong. It is impossible to overstretch the springs, as a safety check-device is fitted to each.

PRICE 15/- Post Free
Available only from:—
Data Publications Ltd.
57 Maida Vale London W9

TECHNICAL DRAWINGS, Artwork, etc. Electronic and Radio Circuits a speciality. Moderate charges.—B. P. Meaney, 43 Forest Road, Worthing, Sussex.

JOIN THE INTERNATIONAL S.W. LEAGUE. Free Services to members including Q.S.L. Bureau, Amateur and Broadcast Translation. Technical and Identification Dept.—both Broadcast and Fixed Stations, DX Certificates, contests and activities for the SWL and transmitting members. Monthly magazine, Monitor, containing articles of general interest to Broadcast and Amateur SWLs, Transmitter Section and League affairs, etc. League supplies such as badges, headed notepaper and envelopes, QSL cards, etc., are available at reasonable cost. Send for League particulars. Membership including monthly magazine, etc. 35s. per annum.—Secretary, ISWL, 60 White Street, Derby.


FOR SALE. 20 watt motor generator, ex-Air Ministry, war surplus, 12V at 4A d.c. in, 480V at 0.04A out, £2. Radiation Monitor Ltd., utility geiger counter, £3. Soxhlet extractor, glass, with Liebig condenser to match, unused, £5. Box of weights, 0.1 to 50gm., 30s. All plus postage.—Box No. F330.


POSTAL ADVERTISING? This is the Holborn Service. Mailing lists, addressing, enclosing, wrapping, facsimile letters, automatic typing, copy service campaign planning, design and artwork, printing and stationery. Please ask for price list.—The Holborn Direct Mail Company, Capacity House, 2-6 Rothsay Street, Tower Bridge Road, London, S.E.1. Telephone: 01-407-1495.

ARE YOU A MOToring ENTHusiast? The Seven Fifty Motor Club caters for all types of motor sport—racing, rallies, hill climbs, etc. Monthly Bulletin free to members. For full details write to: The General Secretary, Colin Peck, "Dancer's End," St. Winifred's Road, Biggin Hill, Kent.

FOR SALE. Ex-Service clock, by Waltham Watch Co., 24 hr. dial, with Civil date dial. Seconds hand, 8-day. 3 inch diameter panel mounting. £5. Box No. F339.

WANTED TO PURCHASE. Denco coil turret, type CT7/B Urgently required to complete construction of receiver. N. G Edmunds, 16 Dawlish Drive, Styvechale, Coventry, Warwickshire.

MOTORISTS. Dimmed headlight conversion kit. All necessary parts plus full fitting instructions. Includes: Sealed relay, resistor, diode, brackets, connectors, etc. 12,6d. plus 1/6d. p. & p. Or instructions only, 2/- plus s.a.e. Box No. F342.


continued on page 135

THE RADIO CONSTRUCTOR
WANTED—RETAIL OUTLETS for new/surplus radio—
electronic spares. Excellent profits. Details from Box No.
F344.

PROPERTIES for sale and to let in London and suburbs.
Apply to Maggs & Stephens, Estate Agents, 229 Maida

DIGITAL CIRCUIT BLOCKS. M.E.L. 100 kHz range,
mostly new. Approximately 150 including 18 PS, OS;
20 FF; 55 gates; 54 amplifiers, EF. Offers? Box No. F345.

JAMSISTOR. Circuit of experimental jamsistor free with each
1 in. cube micro-transmitter at 50/-. (Superior to WO-11

ESSEX GARDENERS. Buy your bedding and rock plants,
shrubs, etc., also cacti from May's Nurseries, 608 Rayleigh
Road, Hutton, Brentwood, Essex. Callers only. Monday
to Saturday.

INNOVATION IN DX CLUBS ANNOUNCED! Formed in
October, 1965, the Radio New York Worldwide Listeners
Club now has 3,600 members in 86 countries! A unique club
offering shortwave listeners monthly magazines containing
listening tips and technical features, numbered wallet-sized
membership cards and gold 8½ in. by 11in. membership
certificates. Multi-lingual report forms available for cost of
postage. “We must be doing something right!” Find out . . .
join now!” Send 7s. 2d. (crossed domestic money order) for
one year’s membership to: The Radio New York Worldwide
Listeners Club, 485 Madison Avenue, New York 10022,
U.S.A.

FULL-TIME COURSE IN BASIC ELECTRONICS. A NINE
MONTH COURSE, starting September, for those wishing to
work in Radio, Television, Computers or Automatic Control.
The course leads to City and Guilds certificates and is ideal
for school leavers, for whom, in most cases, no fee is payable.
For details of this, or part time courses in Colour T.V., etc.,
write to Section 47/58 SOUTHALL COLLEGE OF TECH-
NOLOGY, Beaconsfield Road, Southall, Middlesex.

THE NEW JUPITER
TWO BAND TRANSMITTER

For the magnificent Jupiter two band transmis-
ter by F. G. Rayer G30GR which was described
in Radio Constructor June 1968, you can obtain
all your requirements from Electroniques.

Electroniques (Prop. STC) Limited,
Edinburgh Way, Harlow, Essex.

The “CORDEX” Patent Self-Binding Case
will keep your copies in mint condition.
Issues can be inserted or removed with
the greatest of ease. Rich maroon finish.
Specially constructed Binding Cords are
made from Super Linen of great strength,
very hard twisted and twice doubled. They
are attached to strong RUSTLESS Springs
under tension, and the method adopted
ensures PERMANENT RESILIENCE of the
Cords. Any slack that may develop is im-
mediately compensated for, and the Cords
will always remain taut and strong. It is
impossible to overstretch the springs, as a
safety check-device is fitted to each.

COLOURS: MAROON OR GREEN
(Please state choice)

PRICE 14/6 Post Free

Available only from:—

Data Publications Ltd.
57 Maida Vale London W9
CHASSIS and CASES by H. L. SMITH & CO. LTD. 287/9 Edgware Road London W2 TEL: 01-723 5891

ALUMINIUM, T'AOtO SILVER HAMMERED FINISH

<table>
<thead>
<tr>
<th>Type</th>
<th>Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>8 x 6 x 2&quot;</td>
<td>18/-</td>
</tr>
<tr>
<td></td>
<td>6 x 6 x 3&quot;</td>
<td>17/-</td>
</tr>
<tr>
<td></td>
<td>4 x 4 x 2&quot;</td>
<td>11/-</td>
</tr>
<tr>
<td></td>
<td>4 x 4 x 4&quot;</td>
<td>11/-</td>
</tr>
<tr>
<td>U</td>
<td>5 x 4 x 2 x 2&quot;</td>
<td>17/-</td>
</tr>
<tr>
<td></td>
<td>6 x 6 x 6&quot;</td>
<td>23/-</td>
</tr>
<tr>
<td>Y</td>
<td>5 x 7 x 9&quot;</td>
<td>24/-</td>
</tr>
<tr>
<td>Z</td>
<td>8 x 7 x 9&quot;</td>
<td>49/-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Size</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>4 x 4 x 4&quot;</td>
<td>11/-</td>
</tr>
<tr>
<td></td>
<td>4 x 4 x 4&quot;</td>
<td>11/-</td>
</tr>
<tr>
<td>U</td>
<td>8 x 7 x 9&quot;</td>
<td>23/-</td>
</tr>
<tr>
<td>Y</td>
<td>4 x 4 x 4&quot;</td>
<td>11/-</td>
</tr>
<tr>
<td>Z</td>
<td>8 x 6 x 6&quot;</td>
<td>23/-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type N</td>
<td>18/-</td>
</tr>
<tr>
<td>Type U</td>
<td>23/-</td>
</tr>
</tbody>
</table>

BLANK CHASSIS—Same day Service
Of over 20 different forms made up to YOUR SIZE.
(Maximum length 36", depth 5")

SEND FOR ILLUSTRATED LEAFLETS or order straight away, working out total area of material required (including waste) and referring to table below which is for four-sided chassis in 16 s.w.g. aluminium.

| N      | 176 sq. in. | 10/-  |
|       | 208 sq. in. | 11/-  |
|       | 304 sq. in. | 15/-  |
| U      | 80 sq. in.  | 6/-   |
| Y      | 168 sq. in. | 11/-  |
| Z      | 132 sq. in. | 9/-   |

Discounts for quantities. More than 20 different sizes kept in stock for callers.

FLANGES (1/ or 1/), 6d. per bend.

STRENGTHENED CORNERS, 1/- each corner.

PANELS
Any size up to 3ft at 6/- sq. ft. 16 s.w.g. (18 s.w.g. 5/-).

HIGH GLOSS METALLIC HAMMERED ENAMEL

'Makes fantastic difference to Panels' so say hundreds of enthusiastic users. 'Crackle' pattern appears like magic. Dries hard glossy finish. Scratch-proof, resists heat and liquid. Simply brush-on. No undercoat. Air dries 15 mins. Lt. & DK. Blue; Bronze; Silver; Green; Black. Send for details or send 6/- (plus 1/ for post.) for 1 sample tin, 3 cards to: "Yukan," 307a Edgware Road, London, W2.

YUKAN SELF-SPRAY
SO PROFESSIONAL THE YUKAN AEROSOL WAY—GET THE

- air drying GREY HAMMER OR BLACK WRINKLE (CRACKLE) finishes
- BRUSH OR SPRAY-ON QUICK DRYING
- DURALON SELF-SPRAY 3oz. can 5/-
- Other MATT self-spray 3oz. can 5/-
- Other SATIN self-spray 3oz. can 5/-
- Other GLOSS self-spray 3oz. can 5/-

Please enclose 1/- for each can.

Finnigan Speciality Paint Manufacturers, Dept. RC, Stocksfield, Northumberland.

WANTED
This and similar scrap relays. S.a.e. to "Lanco," 76 Sedgemoor Road, Willenhall, Coventry, Warwickshire.

BOUND VOLUME No. 20 of "The Radio Constructor" AUGUST 1966 to JULY 1967

Comprising 780 pages plus index

Bound Volume No. 21 (August 1967 to July 1968) will be available end of September

Special discount of 10/- for regular readers

As a further service to regular readers, it is no longer necessary to return the complete issues making up a volume, to qualify for the special discount.

Just cut the heading from each month’s contents page, including title and month of issue, and this will be sufficient evidence of readership to qualify for the discount.

Thus regular readers will still retain their old copies for workbench use, while having a splendid bound volume containing issues in mint condition.

PRICE 22/6 Postage 4/6

Limited Number of Volume 19 (August 1965–July 1966) still available. Same prices as above.

Available only from:
DATA PUBLICATIONS LTD., 57 MAIDA VALE, LONDON, W9

Please mention THE RADIO CONSTRUCTOR when writing to advertisers.
THE RADIO CONSTRUCTOR

Price 3/- each, postage 6d.
Annual Subscription 42/-, post free.
Cordex Self-Binders With title “The Radio Constructor” on spine, 15/-, post free.
With no title on spine 14/6, post free.

DATA BOOK SERIES

DB5  TV FAULT FINDING
     124 pages. Price 8/6, postage 8d.

DB6  THE RADIO AMATEUR OPERATOR'S HANDBOOK
     64 pages. Price 5/-, postage 5d.

DB14 SHORT WAVE RECEIVERS FOR THE BEGINNER
     72 pages. Price 6/-, postage 6d.

DB15 TWENTY SUGGESTED CIRCUITS
     48 pages. Price 3/6, postage 5d.

DB16 RADIO CONTROL FOR MODELS
     192 pages. Price 15/-, postage 9d.

DB17 UNDERSTANDING TELEVISION
     512 pages. Price 37/6, postage 3/-

PANEL-SIGNS TRANSFERS

Six sheets in each set
Set 3: WORDING—White
Set 4: WORDING—Black
Set 5: DIALS—Control Panels have a clear background
Set 6: DIALS—Control Panels have a black background
Price per set 4/6, postage 4d.

I enclose Postal Order/Cheque for .................................................. in payment for ..........................................................

NAME ...................................................................................................................

ADDRESS ...........................................................................................................

(Please use Block Capitals for both name and address)

Postal Orders should be crossed and made payable to Data Publications Ltd.
Overseas customers please pay by International Money Order
All publications are obtainable from your local bookseller

Data Publications Ltd., 57 Maida Vale, London W.9

www.americanradiohistory.com
SOLID STATE HIGH FIDELITY AUDIO EQUIPMENT
POWER AMPLIFIERS — PRE-AMPLIFIERS/CONTROL UNITS — POWER SUPPLIES
BRITISH MADE

NEW! 8-TRANSISTOR INTEGRATED 7 WATT AMPLIFIER AND PREAMPLIFIER—MA7
WITH FULL BASS—TREBLE AND VOLUME CONTROLS
A brilliant new design suitable for home or portable installations. Designed for use with magnetic and crystal/ceramic cartridges, radio tuners, microphones, tape head replay and auxiliary inputs. Output is for 3 to 10 ohm speakers. It favours the user in so many ways with fantastically powerful, with far greater adaptability, with freedom to operate it from batteries or mains power supply unit (the new PS20 is ideal for this), hi-fi installations, electronic guitars and organs, P.A. installations, intercom, systems, etc. This true 7 watt amplifier is supplied built, tested and guaranteed. For complete listening satisfaction.

FOR ONLY £8.10.0 P.P. 4/-
(Original Mains Unit PS20 62/6 p.p. 3/-)

FM STEREO DECODER
7 Mullard Transistors. Printed Circuit Design with Stereo Indicator. For use with any valve or transistor FM. Uses pot cores to Mullard design and ger, and silicon transistors. As used by B.B.C. and G.P.O.

COMPLETE KIT PRICE
£5.19.6
Ask for Brochure 4. P.P. 2/6

With a Martin Recordakit. TWO-TRACK. Deck Amplifier. Cabinet and speaker. Complete kits with MICROPHONE 7in. 1,200ft. tape, spare spool. Today's
Value £5.0 P.P. 22/6
36 gns.

*FOUR-TRACK. Deck Amplifier. Cabinet and speaker. Complete kits with MICROPHONE 7in. 1,200ft. tape, spare spool. Today's
Value £6.0 P.P. 22/6
39 gns.

Build a Quality Tape Recorder

SOLID STATE HIGH FIDELITY AUDIO EQUIPMENT
POWER AMPLIFIERS — PRE-AMPLIFIERS/CONTROL UNITS — POWER SUPPLIES
BRITISH MADE

MAYFAIR PORTABLE ELECTRONIC ORGAN
Designed by L.W. Roche
Deferred terms available.
COMPLETE KIT. Deposit £9.19.0
12 monthly payments of £3. TOTAL £11.19.0.
READY BUILT & TESTED. Deposit £5.8.0
12 monthly payments of £0.6. TOTAL £6.4.8.0.

TOTAL ORGAN COMPONENTS COST
GNS.

99

Send for Free List No. 36.

Send for Illustrated Brochures 16/17

CATALOGUE
The most COMPREHENSIVE — CONCISE — CLEAR — COMPONENTS CATALOGUE. Complete with 10/-worth discount vouchers FREE WITH EVERY COPY
* 32 pages of transistors and semi-conductor devices, valves and crystals.
* 200 pages of components and equipment.
* 65 pages of microphones, decks and Hi-Fi equipment.

Send Today 8/6 Post Paid

TWO STOP SHOPPING FOR ALL YOUR NEEDS
303 Edgware Road, London, W.2. Mail Order Dept. all types of Components, Organ Dept. (01) 723-1008/9
309 Edgware Road, London, W.2. High Fidelity Sales, P.A. and Test Equipment, Record Decks (01) 723-6963

www.americanradiohistory.com