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Part 1

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IN THIS ISSUE

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<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
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<tbody>
<tr>
<td>T7 2G345B</td>
<td>100</td>
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<td>T6 2G344B</td>
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<td>T3 D1216 OC81D</td>
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SILICON RECTIFIERS—TESTED

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<tr>
<td>300A 10kV J3OA</td>
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<td>200A 10kV J2OA</td>
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<tr>
<td>150A 10kV J1OA</td>
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<tr>
<td>100A 10kV J0OA</td>
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<td>50A 10kV J0OA</td>
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LUCAS SILICON RECTIFIERS

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DIACS FOR USE WITH 82400

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<th>Type</th>
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<td>HD100</td>
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FULL RANGE OF ZENER DIODES

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<th>Voltage</th>
<th>Price</th>
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</thead>
<tbody>
<tr>
<td>3V-20V</td>
<td>1.50</td>
</tr>
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</table>

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<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
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<tr>
<td>BC507</td>
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<tr>
<td>BC517</td>
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Silicon Unilater. all switch 50p each

FET'S

<table>
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<tr>
<th>Type</th>
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<tr>
<td>2N3819</td>
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SILICON PHOTO TRANS.

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<tr>
<td>OC17</td>
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SILICON HIGH Voltage 250V N.O. T3 new/old

<table>
<thead>
<tr>
<th>Price</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>0.75</td>
<td>250V N.O. new/old</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
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<td>2N3904</td>
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ADJUSTABLE ADJUSTABLE TRANSISTOR MATCHING SET

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<th>Type</th>
<th>Price</th>
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<tbody>
<tr>
<td>T170B</td>
<td>0.50</td>
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<tr>
<th>Type</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>U200</td>
<td>0.50</td>
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</tbody>
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- Typical Total Harmonic distortion at 1 Watt less than 1%.

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<table>
<thead>
<tr>
<th>Type</th>
<th>Function</th>
<th>Qty</th>
<th>Price</th>
<th>Order No.</th>
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<tbody>
<tr>
<td><strong>BP300</strong></td>
<td>Expandable dual Input NAND</td>
<td>1-24</td>
<td>£2.85</td>
<td>U1C96</td>
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<tr>
<td><strong>BP300</strong></td>
<td>Expandable dual &amp; input NAND buffer</td>
<td>1-24</td>
<td>£2.75</td>
<td>U1C95</td>
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<tr>
<td><strong>BP300</strong></td>
<td>Dual Input expander</td>
<td>1-24</td>
<td>£2.75</td>
<td>U1C94</td>
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<tr>
<td><strong>BP900</strong></td>
<td>Expandable buffer inverter</td>
<td>1-24</td>
<td>£2.75</td>
<td>U1C93</td>
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<tr>
<td><strong>BP900</strong></td>
<td>Dual Input Expandable buffer without pull-up</td>
<td>1-24</td>
<td>£2.75</td>
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<tr>
<td><strong>BP900</strong></td>
<td>Quad. Input NAND</td>
<td>1-24</td>
<td>£2.75</td>
<td>U1C91</td>
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<tr>
<td><strong>BP900</strong></td>
<td>Dual Slave-slave J-K or RS</td>
<td>1-24</td>
<td>£2.75</td>
<td>U1C90</td>
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<tr>
<td><strong>BP900</strong></td>
<td>Movable</td>
<td>1-24</td>
<td>£2.75</td>
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<tr>
<td><strong>BP900</strong></td>
<td>Multiple Master-slave J-K</td>
<td>1-24</td>
<td>£2.75</td>
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<td><strong>BP900</strong></td>
<td>Multiple Master-slave J-K with separate clock</td>
<td>1-24</td>
<td>£2.75</td>
<td>U1C87</td>
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<tr>
<td><strong>BP900</strong></td>
<td>Multiple Master-slave J-K with Common Clock</td>
<td>1-24</td>
<td>£2.75</td>
<td>U1C86</td>
</tr>
</tbody>
</table>

Price includes VAT at 50p. per gross, unless otherwise stated.

**NUMERICAL INDICATOR TUBE TYPE GR116**

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<thead>
<tr>
<th>Type No.</th>
<th>Description</th>
<th>Order No.</th>
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<tr>
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<td>SL-20CT</td>
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<tr>
<td><strong>BP20C</strong></td>
<td>SL-20CT</td>
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| **BP70** | D-7070 | 1-12 | U1C30 |
| **BP70** | D-7070 | 1-12 | U1C30 |
| **BP70** | D-7070 | 1-12 | U1C30 |
| **BP70** | D-7070 | 1-12 | U1C30 |
| **BP70** | D-7070 | 1-12 | U1C30 |

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Manufactured Following out of date, no control, and packages units and part function but all of those from the manufacturer's are available rapidly specifications.

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Description</th>
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<td><strong>UC10</strong></td>
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| **UC10** | 12V 12V | 1-12 | U1C30 |
| **UC10** | 12V 12V | 1-12 | U1C30 |
| **UC10** | 12V 12V | 1-12 | U1C30 |
| **UC10** | 12V 12V | 1-12 | U1C30 |
| **UC10** | 12V 12V | 1-12 | U1C30 |

| **UC10** | 12V 12V | 1-12 | U1C30 |
| **UC10** | 12V 12V | 1-12 | U1C30 |
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B99 200 Mixed Capacitors. Approx.
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P4  250 Mixed Resistors. Approx.
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H4  40 Wire-wrap Resistors. Mixed
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H8  4 BY1127 Sil. Res.
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H9  2 OCF1/ Light Sensitive
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H12  50 NK155/35g Germ. diodes,
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H18  10 OCF1/75, unmarked black
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B84  100 Diodes DiO-7 glass
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B86  50 Sil PNPs from various
cat. IN441 and IN442 types
B88  50 Sil. Trans. NPN PNP
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H1  50 Germanium Specials Trans.
    PNP A.J. & R.S.
H16  40 BY324 Schottky Diodes
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H40  25 Mixed volts, 3.3 volt Zeners
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    1 amp. mixed volts

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2N3813 field effect Transistor. This is the 2N3813 in
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1 amp Miniature Plastic Diodes:
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59p 45p 40p
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40/50 per 500, 60 per 1,000.
500 each at 8p each, 100 each at 8p each.
OC177, Transistors, fully marked and tested.
500 each at 4p each, 500 each at 3p each.
2N3813 field effect Transistor. This is the 2N3813 in
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APRIL 1972
THE ‘BASS-BOOST’ PORTABLE

By

Sir DOUGLAS HALL, K.C.M.G., M.A. (Oxon.)

Employing the author’s ‘Spontaflex’ circuit design, this simple receiver incorporates 2 transistors only. Local station loudspeaker reception is provided on medium and long waves, an unusual feature being the inclusion of a positive feedback bass boost control.

It has often been pointed out in the pages of this magazine that many readers spend most of their listening time with one or other of the local stations. For this purpose the author favours the fairly large type of portable, since this can gain sensitivity and improved signal-to-noise ratio by the use of a reasonably sized frame aerial (which can give greater sensitivity than a normal sized ferrite rod) and also provide superior quality and acoustic output through the use of a reasonably sized loudspeaker. It is not always realised that a 2½in. speaker gives little or no response to fundamentals below about 200Hz, and that electrical output means little unless the size of the speaker is taken into account. It is, after all, acoustic output which reaches the ear. As a result of employing a frame aerial and a large speaker, a very simple circuit may be used to give excellent reproduction from local stations at a volume level which is perfectly adequate for domestic listening in a normal sitting room.

BASS BOOST CONTROL

The main feature of the receiver to be described is a bass boost control which really boosts the lower register and does not function by cutting down the higher audio spectrum, to give a rather muffled output, as happens with many tone controls. The bass boost circuit in itself makes a fairly low volume level much more acceptable. So often there is the temptation to turn up the volume in an attempt to get something in the way of bass.

However, when testing this receiver remember that the tone control does not function like the normal treble cut device which has an effect on all types of transmission. The control on this receiver has no effect at all on the higher audio frequencies. There must be some bass in the signal to be boosted. The flute is left alone; but the bass guitar is helped.

The circuit is shown in Fig. 1. L1 is the medium wave frame winding and L3 the medium wave reaction winding, feedback being taken from the emitter of TR1 and controlled by VR1. L2 and L4, respectively, are added in series with these two inductors when receiving long waves. Full medium and long wave bands are covered. In addition, the receiver will tune down to about 150 metres on the medium wave band, making local Top Band amateur transmissions available. The whole of the tuned circuit is applied to the input of TR1 which, as a ‘Spontaflex’ amplifier, functions as a common collector device at radio frequencies. D1 detects, and then TR1 acts as a common base amplifier at audio frequencies, with a much amplified signal appearing across VR3. This signal is then transformer coupled by T1 to the input of TR2. A high ratio transformer is needed in the T1 position to match the large output impedance of TR1 to the much lower input impedance of TR2. A normal interstage transformer will not work well here, and

www.americanradiohistory.com
Fig. 1. The circuit of the 'Bass Boost' portable receiver

**COMPONENTS**

**Resistors**
- R1 82Ω 10⁶ ohm, 1 watt
- VR1 5kΩ potentiometer, linear
- VR2 100kΩ potentiometer, wirewound
- VR3 250kΩ potentiometer, preset, slider type

**Capacitors**
- C1 250μF electrolytic, 4V wkg. (Mullard miniature)
- C2 0.01μF paper or plastic foil
- C3 500pF silvered mica
- C4 40μF electrolytic, 2.5V wkg. (Mullard miniature)
- C5 80μF electrolytic, 2.5V wkg. (Mullard miniature)
- C6 640μF electrolytic, 10V wkg.
- VC1 500pF variable, solid dielectric, Jackson "Dilecon"

**Inductors**
- L1, 2, 3, 4 Frame aerial (see text)
- L5 Choke (see text)
- T1 25:1 transformer type TT53 (Repanco)
- T2 Output transformer type LT700 (Eagle)

**Semiconductors**
- TR1 SF115
- TR2 BC169C
- D1 OA73

**Switch**
- S1(a)(b)(c) 3-pole 3-way, or 4-pole 3-way, miniature rotary

**Speaker**
- 3Ω speaker, 8in. by 5in.

**Battery**
- 9-volt battery type PP9 (Ever Ready)

**Miscellaneous**
- 12-way tagstrip
- 6-way tagstrip
- 2in. by ½in. dia. ferrite rod
- Battery connectors
- Slow-motion drive (optional)
- Plywood (see text)
- Hardboard (see text)
- Speaker fabric
- Fablon or Contact
- Knobs (as required)
readers should be careful not to be fooled off with a substitute for that specified in the Components List. Another unusual feature of the circuit is that the transformer is parallel-fed by VR3. This means that the direct collector current for TR1 is kept out of the primary winding so that only a few microamps of base current for TR2 pass through it, whereupon its inductance is maintained at a very high level. In addition, some damping is caused by VR3, and this helps the transformer to give similar treatment to all audio frequencies.

TR2 is a normal high amplification common emitter output device. Base bias for TR1 is taken from the emitter circuit of TR2, providing a complete negative feedback loop at d.c. with consequent excellent bias stability. C6 is the usual large capacitor across the battery supply.

The bass boost circuit works in the following manner. A varying direct voltage at the emitter of TR2 is out of phase with the corresponding voltage at the base of TR1, so that, as already mentioned, there is d.c. negative feedback. But the windings of T1 are so connected as to reverse the phase at a.c. and positive feedback of the audio signal is therefore possible. The presence of C5 means that the higher audio frequencies are bypassed to the negative supply line, but some impedance is offered to the lower audio frequencies, and the potentiometer formed by L5 and C1 feeds these back to the base of TR1. This potentiometer is itself frequency-dependent, favouring the lowest audio frequencies once again, and VR2 regulates the proportion of these which can be fed back. L5 must be home-wound. A standard r.f. choke would have too high a resistance and the resistive element would predominate at the low frequencies involved so that the impedance offered would be virtually identical at 100Hz and 1kHz. A suitable low resistance choke is made by close-winding 100 turns of 32 s.w.g. enamelled wire on a 2in. length of 3/16 in. ferrite rod. If necessary, a 2in. length can be snapped off from a longer rod by filing a shallow notch at the right point.

The components employed are all standard types. The 10k potentiometer specified for VR2 is available from Home Radio under Cat. No. VR85A. The SF115 quoted for TR1 can be obtained from Amatronix Ltd., 396 Selsdon Road, South Croydon, Surrey. The values of C1, C4 and C5 are important and these should be new and reliable components. Mullard miniature electrolytic capacitors are recommended here. The OA73 specified for DI gives better results in this circuit than more common diodes, and is available from Henry’s Radio Ltd. The PP9 battery should have a long life as current consumption is of the order of 8mA only.

Switch S1(a) (b) (c) is basically a miniature 3-pole 3-way component. It will probably be found easiest to obtain a 4-pole 3-way miniature switch, and to make no connections to one of the poles.

CONSTRUCTION

With this receiver it is suggested that the case be made first, as all components are moulded on the inside of its front. The case uses 1/2 in. plywood throughout, and Fig. 2 is largely self-explanatory. The dashed lines show how the various pieces are screwed together. The speaker aperture and the holes for the controls should be cut out before the case is assembled. The three lower control holes are 1/2in. diameter, but the uppermost control hole will have a diameter which depends upon whether or not the tuning capacitor, VC1, is fitted with a slow-motion tuning drive. This point is dealt with at the end of the article under the sub-heading 'Tuning Drive'.

A back is also required and this should be made of hardboard with a hole about 3 in. square cut in its centre and covered, on the inside, with speaker fabric. It should measure 12in. by 9in. and is held in place by screws passing into the edges of the frame aerial, which is next to be described. The case and its back may be covered with Fablon or Contact.
The frame aerial is shown in Fig 3. Cut two pieces of \(\frac{1}{8}\) in. plywood, 12 in. by 3 in., and cut slots in the narrow ends as shown in Fig. 3. Note that there are 9 slots in all at each end, and that the outside slots are \(\frac{1}{3}\) in. from the long edges in each case, with \(\frac{1}{3}\) in. spacing between each slot and the next except for a gap of \(\frac{1}{3}\) in. between the 7th and 8th pair of slots, counting from the bottom. Note also that, with one exception, these slots are single cuts made with a small hacksaw - a fret saw has too narrow a blade. The exception is the 8th from the bottom, which is in the form of a V to accommodate the 40 turns of the long wave winding. A second, exactly similar, piece of wood is cut and slotted, and then one of these two pieces has holes drilled in it as shown in Fig 3, using a \(\frac{1}{4}\) in. drill. In order that these holes should be accurately positioned it is an advantage to draw pencil lines between opposite slots.

Now cut two pieces of \(\frac{1}{8}\) in. plywood, 8\(\frac{1}{4}\) in. by 3 in., and screw the two slotted pieces to these as in Fig. 4. Note that the long pieces extend \(\frac{1}{4}\) in. beyond the shorter pieces at each end, to allow room for the windings. Position the screws between the lines of the slots so that their heads will not damage the windings. Next make sure that the frame will fit inside the case. It may be necessary to sand-paper the edges down a little.

Hold the completed frame with the 12 in. side having the small holes drilled in it at the top, and with hole No. 1 towards the hands and towards the left. Pass the end of a length of 32 s.w.g. enamelled wire through hole No. 1 and lock it in place with a matchstick, leaving a few inches for subsequent connection. Wind on 3 turns in the first set of slots (first from the bottom in Fig. 3) in an anti-clockwise direction and as indicated in Fig. 3, and then 3 turns in the next set of slots and so on until a total of 18 turns have been wound as a continuous winding in the first 6 sets of slots. Leave a few inches of wire for connection and pass the end through hole No. 2 locking the wire in position with a matchstick. 6 turns of the same gauge wire should now be wound in the next set of slots, starting at hole No. 3 and ending through hole No. 4. 40 turns of 38 s.w.g. enamelled wire are wound in the last set of slots, starting at hole No. 7 and ending at hole No. 8. All windings are anti-clockwise. Put the completed frame aerial on one side for the time being.

**MOUNTING COMPONENTS**

Components may now be mounted, but if a slow motion tuning drive is to be fitted, as described at the end of the article, this should be done before any component other than VCI is fitted into place.

Take a 12-way tagstrip. The prototype uses a 12-way section cut from an R.S. Components (formerly Radiospares) standard size 18-way tagboard, as this has large tags which are very convenient, but a normal 12-way tagstrip could be used instead, if desired. The R.S. Components tagboard just mentioned is available from Home Radio under Cat. No. BTS10. Mount the wire are wound in the last set of slots, starting at hole No. 7 and ending at hole No. 8. All windings are anti-clockwise. Put the completed frame aerial on one side for the time being.

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Next take up a 6-way tagstrip and mount T2 and C6 to it as shown in Fig. 6. The mounting lugs of T2 are soldered to two of the tags, as indicated, and its four leads connect to the remaining four tags. No connection is made to the centre-tap of T2 primary, this being the white lead between the red and green leads. The bare end of this lead may be cut off and the lead folded neatly out of the way. Take care not to confuse this lead with the white lead from the secondary, which appears on the same side of the transformer as the black lead. The white lead from the secondary is used in the circuit.

Mount VC1, VR1, VR2 and S1 in the case, as shown in Fig. 6. Also, mount the 12-way tagstrip by passing wood-screws through its two end tag holes, with spacing washers between the strip and the plywood. The 6-way tagstrip, with T2 and C6 fitted to it as illustrated, is also mounted. If any of its tags are secured to the plywood these should, preferably, be the second from the top and the second, or third, from the bottom. Next mount T1, as shown.

A word is necessary about the TT53 transformer used for T1. New versions of this component have
Fig. 7. How the alternative versions of the transformer specified for T1 are connected up and mounted. The transformer in (a) has flexible lead-outs whilst that in (b) has connecting spills.

flexible leads as shown in Fig 7(a), and if one of these transformers is used it should be cemented to the case, upside down so that the leads are uppermost, and connected as shown. But earlier examples of the TT53 had solid spills, and the colour marking was different. It may be that some readers will have one of these older components in their spares box, or may buy one from old stock. They are equally suitable and, indeed, one is used in the prototype, but connections are different and are as shown in Fig. 7(b). It will be found that the transformers fitted with spills are rather delicate, as twisting a spill can easily break the very fine internal wire used for the large winding. The wiest course is to cut a piece of thin Paxolin, and carefully pass the four spills through four suitably drilled holes, bending them over and round the edge of the Paxolin, as shown, to hold the transformer firm. Flexible leads are then soldered to the exposed ends of the spills, which need not be touched again. Colour coding of these earlier transformers is by drops of paint on the short extensions of the spills on the top side of the component, and these short coloured extensions will be uppermost when the Paxolin panel is screwed to the case. In most cases, of course, the constructor will buy an up-to-date component and fit it as shown in Fig. 7(a). Note that the solder tag which carries the common connections from C4 and T1 primary and secondary is secured under a wood-screw. In Fig. 7(b) this is one of the two wood-screws holding the Paxolin panel in position.

Wire up the remaining small components shown in Fig. 6. Choke L5 is mounted vertically, its lower end being cemented to a close-fitting grommet, which in turn, is cemented to the plywood. Also fit the speaker, over a piece of fabric, and wire it up.

Push the frame aerial into position so that its leads are close to S1 and wire these up as shown by the numbered arrows in Fig. 6. A little cement will hold the frame in position, but do not use this until the receiver has been tested and found in order, as there always may have been a slip in winding the aerial! Arrange a means of holding the PP9 battery in position. A small shelf may be used or, as in the case of the prototype, two small hooks and a large rubber band.

SETTING UP

The only setting-up process involves the preset control VR3, this being adjusted to allow the whole of the track of the bass boost control, VR2, to provide useful control. First set VR3 with all its resistance in circuit, its slider then being fully to the left, as seen in Fig. 5. Set VR2 fully clockwise to its maximum boost position, and switch on. Adjust VC1 and VR1 to a station, this being preferably a fairly strong local transmission but not so powerful as to cause overloading. Next, advance the setting of VR1 until a whistle denotes radio frequency oscillation. If the whistle cannot be obtained, advance the slider of VR3 a little to the right until oscillation is achieved. Now advance the slider of VR3 further to the right until a position is reached where a low note audio oscillation is superimposed on the whistle, then bring it back slightly. If the low note oscillation does not occur when the slider of VR2 has been advanced about two-thirds of the way from the left, something
is wrong, and the fault should be looked for. Never advance the slider of VR3 more than nine-tenths of its way over, since a large current will then flow. The usual optimum position will be at about the half-way point. The object is to adjust VR3 so that VR2 will produce maximum bass boost, without oscillation or distortion, when very near to, or at, its maximum position.

TUNING DRIVE

As suggested earlier, it is a useful, though by no means essential, refinement to fit a slow-motion tuning drive to VC1. This will not be necessary for local stations, but it will be found that after dark the range of the receiver is quite good, and three or four Continental stations will probably come in at fair volume plus many more at 'bedside' volume. It is for these that a slow-motion drive is useful. But the author would emphasise that this is essentially a local station receiver. Apart from other considerations, the bass boost control is less effective on very weak signals.

With the prototype, the author used a Jackson cord drive spindle type G (Home Radio Cat. No. DL34). A few turns of Sellotape were wrapped around this, after which a grommet with a ½ in. hole was passed over. The Sellotape ensures that the grommet is held firmly on the spindle. The bush of the spindle is then fitted to the panel of the receiver in a position which causes the grommet to press hard against a large diameter knob fitted to VC1, the knob having a diameter of 3½ in. in the prototype. Rotating the cord drive spindle then causes the large diameter knob to turn, and a simple but effective slow-motion drive results.

If this method is employed, the added spindle should be mounted before any components other than VC1 have been fitted to the case, or the drilling and subsequent work involved may cause damage, particularly to T1. Many readers will do without a slow-motion drive, and others will fit a commercially made type of their own choice. A ball-drive, for example, could be used, VC1 being fitted to a small sub-panel behind the front panel of the receiver.

A wavelength scale, marked with available stations, may be fitted, and the other controls suitably marked. A final touch is given by the provision of a carrying handle, which can be purchased from a 'D.I.Y.' shop.

CAN ANYONE HELP?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time.

- Electroniques Coils Type SL/T, SL/U and SL/Y.—E. Warner, 44 Thorndale Ave., Larne, Co. Antrim, N. Ireland — would like to purchase or be advised of any supplier retaining these coils.
- Receiver Type R1475, Power Unit Type R360 and Tuning Unit Type 131.—C. Astbury, 16 Eaton Avenue, Handbridge, Chester, CH4 7HS — manual or any other information.
- “Eddystone” Rx Type 840A, “Murphy” 700 Series TV Converter.—F. Payne, 15 Wood Crescent, Holts’ Estate, Oldham, Lancs. — manual or any other information — loan or purchase.
- Airmec Televet-877.—D. Wigley, 4 Sellons Avenue, Harlesden, London, N.W.10 — manual required, loan or purchase.
- Simon SP5 Recorder.—R. W. Bolton, 569C Garratt Lane, Earlsfield, London, SW18 4SR — manual or servicing instructions, loan or purchase.
- BC221 — AF Frequency Meter.—J. R. Owen, 40 Kingslea Road, Withington, Manchester, M20 9UA — Alignment instructions, also circuit diagrams and alignment details for the wavemeter D Mk II.
- RSC A10 30 Watt Hi-Fi Amplifier.—L. V. Flynn, 18 Ireton Street, Belfast, BT7 1LH — circuit manual — loan or purchase.
- November 1965 issue of The Radio Constructor (now out of print).—F. Hill, 19 Leith Road, Sale, Cheshire, M33 2LR — loan or purchase.
- Capacitor Analyser (Solar) Type CB-24.—R. Kirk, 22 Barncraig Street, Buckhaven, Fife — circuit or any information.
- June 1969 issue The Radio Constructor (now out of print) required by:—C. S. Bailey, 19 Fallows Green, Harpenden, Herts, and also by G. J. Knock, 31 Northmead, Ledbury, Herefordshire.
THE PEGASUS BOOK OF ELECTRONIC EXPERIMENTS. By F. G. Rayer, A.I.E.R.E., G30GR.
190 pages, 5 x 7½in. Published by Dobson Books, Ltd. Price 95p.

One of the main points that is, rightly, given emphasis in this book is that all the experiments described are completely safe because the only supplies required are those given by 1½ volt cells and 9 volt batteries. None of the experiments involves connection to the mains. It may be added that valves appear nowhere in the book; where active devices are required these are all low-cost transistors.

The book commences with chapters on circuits and components, on the measurement of voltage, current and resistance, and on semiconductors. Then follow a wide range of suggested experiments, these taking in radio reception, audio amplifiers and output circuits, pick-ups, microphones and audio oscillators. Next come experiments dealing with transistors as switches, with control by light and with analogue and digital computer methods. Two final chapters describe miscellaneous experiments and the book concludes with a useful index.

The Pegasus Book of Electronic Experiments' can be recommended to the beginner of any age-group who wishes to become acquainted, by practical experience, with the elements of electronics. All details are dealt with in simple terms and only the essential theory is provided. Particularly interesting are the chapters dealing with analogue and digital computer experiments, as these provide an imaginative introduction to the field of elementary computer operation and of binary notation.

223 pages, 5 ½ x 8 ½in. Published by IPC Electrical-Electronic Year Books Limited. Price £1.

The fourth edition of this annual publication follows the basic style of previous editions in listing details and giving illustrations of the latest table, car and portable radios, colour and monochrome television receivers, radiograms, record players and unit audio equipment. Tape recorders, which were grouped in the preceding editions as either battery or mains powered, are now categorised as reel-to-reel recorders or cassette recorders. The tape recorders and unit audio equipments included are those which do not exceed a price range of approximately £150 (those which do being dealt with in the sister publication 'Hi-Fi Year Book'). The edition also includes radio and television v.h.f. and u.h.f. transmitter guides.

The purpose of 'Radio and Television Year Book' is two-fold. Firstly, it assembles data on all the available domestic radio, television and audio equipment together in one handy volume, enabling the reader to make comparisons, to contact manufacturers for literature and to make a selection for purchasing through his dealer. Secondly, this same dealer also has the same complete list, to which he can refer when customers enquire about lines he does not normally stock. The information provided in the book includes details and specifications of models with prices and suppliers' or makers' names, as well as addresses and telephone numbers, all of which are intended to make ordering easy.

The book is available through booksellers or by post (in which case add 15p) from IPC Business Press (Sales and Distribution) Ltd., P.O. Box 147, 40 Bowling Green Lane, London, EC1P 1DB.

628 pages, 5 ½ x 8 ½in. Published by Iliffe Books. Price £4.75.

This 8th Edition of what is virtually a standard work on its subject has been completely revised and reset, and the book now uses SI (Système Internationale) units throughout. The author points out in his preface that 'possessors of previous editions may need to be convinced that it is going to be worth while getting this one', then proceeds to state that transistors had made only a rather tentative appearance in instrumentation when the last edition was written. This present edition deals fully with the uses of transistors in laboratory equipment.

The book commences with chapters dealing with the basic requirements of a laboratory, including the home laboratory of the amateur, then carries on to the fundamental principles of measurement and to power and signal sources. The following chapters discuss indicators (meters, oscilloscopes, etc.), standards, composite apparatus and the choice and care of equipment. The next three chapters deal with measurements; of circuit parameters, of signals and of equipment characteristics. The first of the final two chapters which complete the book covers the procedure of dealing with results obtained from laboratory measurements, whilst the last provides a very detailed reference section. There is also a comprehensive index.

M. G. Scroggie's light style makes the book eminently readable without in any way detracting from its accuracy and conciseness. The 8th Edition of 'Radio and Electronic Laboratory Handbook' can be fully recommended to anyone who deals with laboratory work, be he student, amateur experimenter or professional engineer.

APRIL 1972

529
"SAFEBLOC" SALES STILL INCREASING

Thirteen years ago a completely new concept was introduced to the British market by Rendar Instruments Ltd., the electronic component manufacturers in Burgess Hill (Victoria Road), Sussex.

This was a small, boxed-in device with a lid which provided an absolutely safe and quick connection to the mains for 2-core and 3-core bare-ended flexible leads.

The product was marketed under the name "Safebloc", and immediately found a ready acceptance by the larger industrial users on their factory testing lines.

More recently, Safebloc has been adopted by smaller users — shops and stores find it invaluable for the demonstration of all kinds of electrical apparatus, and it has even found its way onto the work benches of individual handymen and repair shops.

Among its advantages is the matter of time saving, as there is no need to fit a plug before the test or demonstration. The safety factor is also appreciated, as it is quite impossible for any current to pass while the lid is open.

Readers are advised to ask for Safebloc from their local stockist, but alternatively they can order it direct from the Rendar factory as a mail order operation.

MINISTRY OF DEFENCE MAKES LARGE AWARD

The Ministry of Defence has awarded Lieutenant "Benny" Goodman, Royal Signals, one thousand pounds for inventing the VHF Radio Applique Unit, now known in the Royal Signals as the "Goodman Box".

"Benny", who is the son of Mrs. Gertrude Goodman of 20, Upper Shalmsford Street, Chartham, Canterbury, conceived the idea some fourteen months ago while serving as a Warrant Officer at the School of Signals. He was listening to a lecture on "Signals in Germany" where the speaker complained about interference by unwanted signals over Very High Frequency nets. He immediately constructed pilot models which were tested and modified by the Combat Development and Trials Wing of the School of Signals. Royal Electrical and Mechanical Engineers then produced the first units for field tests and they are now in regular service.

"Benny" is a fourth generation soldier whose father, grandfather and great grandfather served in the Royal Engineers. He enlisted in boys service in 1948 and has seen service in Korea, the Far East, the United Kingdom and Germany.

To cap it all this is not his first award for his radio engineering genius. He was awarded the British Empire Medal in the New Years Honours List for his design of a Radio Control Monitor Unit.

Technical Details

The Goodman Box is used on VHF nets. Its primary use is at rebroadcast stations where it prevents unwanted voice signals from "triggering" the station. Subsidiary but no less important uses at VHF stations are an indication of the strength of a received signal, a means of testing co-axial feeder continuity and the provision of a transmitter power output test.
NEW GIANT LOOKS INTO SPACE  PYE POCKETFONE AT ABBEY

A NEW radio telescope, which should be the largest of its kind in the world, is to be financed by Britain’s Science Research Council, at a cost of £250,000. A BBC science programme explained why it was necessary.

To see deeper and deeper into space, it is necessary to use larger and thus more sensitive radio telescopes because the farther away the source is, the weaker the signal. There are 10,000 radio sources known, but many more cannot yet be distinguished because of the limitations of present equipment.

Behind the new radio telescope is Sir Bernard Lovell, director of Britain’s Jodrell Bank Radio Astronomy Observatory. For 13 years the Mark I radio telescope was the largest fully steerable dish-type in the world – some 80 metres in diameter.

Recently the Germans completed one measuring 100 metres – now the new British telescope, to be called the Mark V, should be 115 metres in diameter. The dish itself will be almost four times as heavy as the German dish, weighing 7,000 tons.

IN BRIEF

- The British Amateur Electronics Club are hoping to form a group in the London area. Readers interested should write to D. A. Barry, 55 Cromwell Road, Stevenage, Herts.

- Newmarket Transistors Ltd., have issued a statement of policy regarding their intention to continue the manufacture and supply of a wide range of germanium devices. The reason for the policy statement is the decreasing number of sources of supply.

- A new general purpose closed-circuit television camera, incorporating an intrinsically weatherproof casing and other purpose-designed features to simplify operation, installation and maintenance, has been introduced by EMI. Known as the ‘Surveyor’, this rugged and versatile 625/525-line camera provides comprehensive operational facilities which makes it suitable for a wide range of applications.

- The latest issue of the FR Electronics Reed Switch Catalogue, containing details of the complete range of 37 different reed switches, is now available. Details from FR Electronics, Wimborne, Dorset, BH21 2BJ.

- The Annual Dinner and Dance of the Derby and District Amateur Radio Society (founded 1911), is to be held on Saturday 15th April at the Derbyshire Yeoman, Kingsway, Derby. Details of the Society may be obtained from the Honorary Secretary, F. C. Ward, G2CVV, 5 Uplands Avenue, Littleover, Derby.

Westminster Abbey, home of much that is part of Britain’s heritage, has recently begun using the most modern communications aid – two-way pocket radios.

The system, supplied and installed by Pye Telecommunications Ltd., comprises a base station and 9 two-way radios and has just completed various acceptance tests.

Pye Telecommunications supplies such equipment to the Police, the public authorities such as Water Boards, Gas and Electricity Boards, and to commercial users such as oil refineries, large factories, warehouses, etc.

“Madam would you mind turning your T.V. set off—it’s interfering with my drill!”
Adding a transistor to a regulated supply circuit can provide continuous monitoring of output current, thereby preventing excessive current in the load.

**SIMPLE RESISTOR LIMITING**

Simple resistor limiting was shown in the last note to give appreciable protection of a regulator against short-circuit. It is less useful in protecting the load since the short-circuit load current can be many times the normal load current (150mA as against 30mA in the example considered last month).

The only alternative left is to sense the load current and 'take avoiding action'. Two forms are possible: (a) switching action that disables the supply at some critical current, (b) continuous monitoring and feedback to exercise the same controlling action on current as already exists for voltage. It is the latter that we shall consider now, noting first that the current need not be controlled to a high accuracy while minimizing of wasted power is important.

**CONTINUOUS MONITORING**

The additional components are enclosed by the dotted lines in the diagram. When the current in Rs is small, the p.d. developed across it is insufficient to bring TR2 into conduction and the circuit behaves exactly as before, though with a small voltage being lost in Rs. As the load current increases, the p.d. across Rs rises towards about 0.5V, the point at which TR2 begins significant conduction. (This assumes that TR2 is a silicon transistor). In so doing TR2 withdraws current from the bias section of the regulator until eventually a point is reached where there is insufficient current for the zener diode to maintain a stable voltage. Any further decrease in load resistance now results in a very small increase in load current since TR2 is biased at the level where its current doubles for each increase in Vbe of 20mV or so, i.e. the load voltage might be halved by a change of load resistance that only allowed the load current to increase by a few per cent.

In practice the effect from the onset of limiting to a complete short-circuit might consist of a current change of less than 10%.

The stability of the current limit condition is clearly dependent on that of the transistor Vbe. This changes with temperature, but in such a direction that the short-circuit current actually falls as the temperature rises. Even so the change is not likely to exceed 10% in the conditions met by the average experimenter, though this is not true if the regulator were to be used in a 'hot-spot' as part of a car electronic system. Better regulation at the expense of greater wasted power can be achieved by adding a Zener diode to the current control loop.

In commercial regulators the same basic method is used, though TR2 might be replaced by a complete amplifying circuit with separate reference voltage to set the desired current. In our example the required value of Rs can be estimated by dividing the expected Vbe value by the current limit required. With the 30mA maximum current figure used in the previous example, R2 would be 0.5V/30mA or about 16Ω. Making Rs a variable resistor of say 50Ω would allow control of the current limit to suit different loads.

**NOTES**

Two forms are possible: (a) switching action that disables the supply at some critical current, (b) continuous monitoring and feedback to exercise the same controlling action on current as already exists for voltage. It is the latter that we shall consider now, noting first that the current need not be controlled to a high accuracy while minimizing of wasted power is important.
Novel Alignment Aid

by G. A. FRENCH

During servicing work it is occasionally necessary to align the r.f. and i.f. stages of small transistor portable radios with the aid of a modulated signal generator. Whilst it is possible to achieve quite accurate alignment by listening to the audio output from the speaker of the receiver, best results are obtained by using an output meter. This is because small increases in volume level, to which the ear is not normally very sensitive, are readily discernible in a meter. In practice the output meter can consist of a testmeter, switched to an a.c. volts range, which is connected across the speaker of the receiver. The alignment, incidentally, should always be carried out with the receiver volume control at its maximum setting, and with just sufficient output from the signal generator to give a comfortably audible output from the receiver.

Unfortunately, it is difficult to connect a testmeter to the speaker of some transistor radios, this being due to the fact that the speaker connections are positioned beneath the printed circuit board of the set. Alternatively, the speaker connections may only be available in the form of two small sections of foil in the copper pattern, to which testmeter clips cannot be reliably applied. The alignment aid to be described in this article offers a novel means of causing the audio output of a receiver to be coupled to a measuring instrument without the necessity of making any direct connection to the receiver whatsoever. The aid also enables the audio output to be reproduced in a pair of headphones, a facility which can be of occasional advantage in a noisy workshop.

ALIGNMENT AID

The alignment aid consists basically of nothing other than a small 3Ω loudspeaker and a valve speaker transformer. These are wired up as shown in Fig. 1, in which the transformer functions as a step-up component, i.e. the winding with the lower inductance is connected to the speaker.

To use the device, the speaker is placed over the loudspeaker aperture of the receiver being aligned, as shown in Fig. 2. This provides a tight acoustic coupling between the speaker in the receiver and the speaker employed in the aid, and the latter can be held in position, if necessary, by a loop of elastic cord passed over the receiver cabinet. For convenience, the speaker in the aid circuit may be coupled to its transformer by way of some 4 or 5ft. of 2-core flex.

The speaker in the aid functions as a microphone, the voltage produced across its voice coil being stepped up by the speaker transformer. If the reader is fortunate enough to possess a sensitive valve or f.e.t. voltmeter with a diode probe, or an oscilloscope, the output from the speaker transformer may then be connected direct to this, whereupon a reliable comparative measure of the audio output of the radio becomes immediately available for alignment purposes. Signal voltages to be expected at low receiver output levels are of the order of 0.5 volt, although these will of course be

![Fig. 1. The basic circuit employed in the alignment aid](image)

![Fig. 2. The front of the speaker of Fig. 1 is placed over the speaker aperture in the receiver being aligned. It may be held in place by a loop of elastic cord](image)
dependent upon the sensitivity of the speaker which is used as a microphone and the step-up ratio of the transformer to which it connects.

If neither a valve or f.c.t. voltmeter nor an oscilloscope are available, visual indications of audio output from the receiver may be obtained by means of the circuit given in Fig. 3. Despite its simplicity this arrangement gives quite usable comparative indications of audio output from the receiver, but at low volume levels it is necessary to work to an indication in the 0-100µA meter of about 3 to 5µA only. It will be found that 'exaggerated' peak readings are given at these low meter deflections since the signal amplitude from the speaker transformer is then just passing the level at which forward conduction in the series germanium diode commences. There is no advantage, incidentally, in using a bridge rectifier instead of a single series diode to rectify the a.f. from the transformer. If a bridge rectifier were used the output from the speaker transformer would have to overcome the forward conduction level of two diodes in series instead of one before meter deflection commenced. With the circuit of Fig. 3, a fairly high output level from the receiver produces meter readings that are well past half-scale deflection.

As a further point, the output from the receiver can be made audible in a pair of 2,000Ω headphones connected to the speaker transformer as shown in Fig. 4. The sound level offered by these headphones is of the same order as is given by holding the ear about a foot away from the receiver loudspeaker itself. The fact that the headphones mask external noise can be an asset for some servicing applications.

If it were decided to combine the circuits of Figs. 3 and 4, these could be made up in the form shown in Fig. 5, in which the transformer, the diode, the meter and a jack socket for the headphones, are all fitted in a small insulated box which connects to the speaker via 2-core flex. The headphones should not be plugged in when it is desired to use the meter, as they will cause a reduction in the sensitivity of the circuit. On the other hand, the meter circuit does not significantly reduce the output fed to the headphones.

**PRACTICAL POINTS**

It will be appreciated that the circuits just discussed have the advantage of using components (with the possible exception of the 0-100µA meter) which are almost certain to be continually on hand in a service workshop. Indeed, either of the circuits of Figs. 1, 3 or 4 could be temporarily wired up for a particular servicing task and then just as quickly disassembled again.

A small loudspeaker having a light cone is best for use in the alignment aid as this should, in general, be most sensitive as a microphone. If several speakers are to hand these could be tried individually to see which gives best results. A piece of thin speaker fabric may be fitted over the front of the speaker to prevent possible damage to its cone.

The speaker transformer should, preferably, have a high ratio, since meter readings increase as the ratio increases. The author used a small Elstone transformer type MO/T (Home Radio Cat. No. TU12) for checking the circuit. This component offers step-up ratios of 1:33, 1:55, and 1:90 when employed in the manner required here, the best performance being given with the 1:90 ratio. The speaker was a 3Ω unit with a cone diameter of about 3in.

The germanium diode employed in Figs. 3 and 5 can be any type, but it will be of advantage to select a diode which exhibits a low forward voltage. It may be found that the base-emitter or base-collector junction of a germanium transistor offers a better performance in this respect than does a standard diode. The author obtained slightly increased sensitivity with the base-emitter junction of an ACY19 (no connection being made to the collector) as compared with a number of point-contact diodes.

The sensitivity of the alignment aid is, to some extent, dependent upon the audio frequency reproduced by the receiver loudspeaker. Sensitivity is adequate for alignment purposes when the signal generator is modulated by a 1kHz tone, and it becomes increased if the modulation is at 400Hz. Bearing in mind the frequency response of small speakers, as would be used in the aid, such a performance is that which would be expected.
Sensitivity Measurement of Portable Receivers

by

C. F. Dorey

How to measure the sensitivity of ferrite rod receivers

To carry out the sensitivity measurement to be described, the receiver must be placed in the field of a loop radiator, at a point where the field strength can be simply calculated in terms of the voltage applied.

LOOP CURRENT

The field strength due to a vertically mounted square loop of 30 cm. side, at a point 1 metre from the loop along its axis, can be expressed in terms of current in the loop, or the applied voltage if the loop is fed through a high resistance.

If the total resistance is 1,000Ω, the field strength at 1 metre distance is given by

\[ F = \frac{5150 \text{ V}}{\text{µV/metre}} \] where V is the applied e.m.f. in volts.

This holds good up to about 20 MHz.

The loop can be made of metal curtain rail mounted on a wooden block of the type used to mount domestic electric sockets and switches.

In the author’s case plastic covered curtain rail was used, because the loop is therefore insulated and has a non-tarnishable finish. The H-section type of curtain rail gives strength to the loop so that it is self-supporting.

The length, nominally 120 cm. total, was cut slightly short to leave a small gap in the bottom at the feed point. The ends were secured to the wooden block by two 6BA screws in each side, with a solder tag placed under the one nearest the end on each side. The resistor, made up of 910Ω and 15Ω in series, or any other values totalling 925Ω (for a 75Ω generator), were connected between one solder tag and the inner conductor of a coaxial lead about 6 feet in length. The screen of the coaxial lead was connected to the other solder tag. The resistors and a clamp for the lead fitted into the wiring recess in the wooden block, and were covered by a base plate of hardboard.

MEASUREMENT

The measurement should be made in the following manner. The receiver should be positioned, as shown in the diagram, with the mid-point of its aerial rod 1 metre from the loop radiator, and along its axis. An output meter should be used, as in a normal sensitivity measurement, to indicate when the standard output of 50mW is being achieved as the level of the modulated output of the signal generator is adjusted. The receiver should be rotated and aligned for maximum output at a fixed low signal level before making the actual sensitivity measurement, and the surrounding area should be as free as possible from metal objects which could cause distortion of the field.

When the signal generator output voltage giving the standard output has been noted, the corresponding field strength may be calculated. A moderately good 6-transistor portable would have a sensitivity of 500 µV/metrew at 1 MHz for an output of 50mW.

REFERENCE

**TRANSPARENT IN-FLEX FUSEHOLDER**

The new Bulgin transparent fuseholder. This is designed to be inserted in a flexible lead.

A. F. Bulgin and Co. Ltd., announce a new in-flex fuseholder in their popular F.180 series. This, the F.180/Clear, is shown in the accompanying illustration and is moulded in a transparent plastic material. As with the previous types the new fuseholder can be inserted in a flexible lead, the latter being connected to the two end terminals of the fuseholder.

The advantage of the clear fuseholder is that the fuse and cable terminations are clearly visible, thereby effecting an obvious saving in time when looking for a blown fuse or faulty connection. The fuseholder is rated at 250 volts maximum and has a length of slightly less than 2½in. The previous opaque fuseholders were types F.180/Red and F.180/Black; further details may be obtained from A. F. Bulgin and Co. Ltd., Bye-Pass Road, Barking, Essex.

**IMPROVED SOLDER FEED**

For use with most hand-held electric soldering irons, the Mark 2 ANEXTRA has been improved since the original was announced. The method of attaching to a soldering iron now incorporates two "V" notches and two adjustable nylon straps which provide a much more firm fixing between the iron and ANEXTRA.

The prime object of leaving one hand free to hold the job is thus enhanced and quantity production has enabled the list price to be reduced to £3.75 direct from the makers; or s.a.e. for leaflet, ANEXTRA LTD., Chiltern Works, Rear of 77/78 Chiltern View Road, Uxbridge, Middlesex, England.

**NEW PANEL FIXING SCREW**

Vero Electronics Limited have just introduced a new style of front panel fixing screw. The screw is still for use with existing ½ UNF fixings but has a smaller head for the neater appearance and is also supplied with a black cup washer to protect the panel itself and further enhance the overall appearance. Head and washer dimensions are such that any standard size panels can be mounted together without interference from the adjoining screws. Two lengths are available one for single panel thickness and one for double panel thickness. Vero Electronics Ltd., Industrial Estate, Chancellors Ford, Hampshire SO5 3ZR.

**AERIAL CHANGEOVER RELAY**

The Series 951 Co-axial Relay from Magnetic Devices for aerial switching at frequencies in the order of 450 megacycles is ideally suitable for HF 2-way radio. This small fast operating relay with a single pole changeover contact enclosed in a silver plated brass housing may also be used in applications where exceptionally low inter-contact capacitance is required. The relay is designed for use with UR 43 co-axial cable and is competitively priced. Coils can be wound for operation up to 100 volts D.C. For further information please contact Magnetic Devices Limited, Newmarket, Suffolk.
Subtraction Computing Circuit

By

D. SNAITH

This simple analogue computing device enables one number to be subtracted from another. The circuit is capable of handling negative as well as positive difference figures.

Elementary analogue computing devices can be readily assembled by the home constructor. Whilst no pretensions are made concerning their ultimate practical usefulness, they are nevertheless of value in demonstrating basic theory. They are also capable of impressing non-technical friends and of making instructive educational toys for children.

The writer published a circuit for a simple analogue computing device capable of addition in a recent issue.* The computing circuit now to be described is capable of performing a subtraction, and can cope with the case where the answer is a negative quantity. The principle of operation is different from that used in the previous circuit.

Battery Circuit

A battery-operated version of the circuit is shown in Fig. 1. Here, the three batteries, B1, B2 and B3, are assumed to offer equal voltages, which can conveniently be 9 volts nominal. S2(a)(b)(c) is a 3-pole 2-way rotary switch, which functions as the on-off switch for the device. For the present discussion we shall assume that it is turned to the ‘on’ position, and all of its three sections are closed.

The three potentiometers are linear components and are scaled from 0 to 100 in terms of resistance. Thus, if the pointer of one potentiometer is set to 50, the slider of that potentiometer is exactly central on its track. The numbers selected by VR1, VR2 and VR3 can be expressed as A, B and C respectively whereupon, when the circuit is balanced as indicated by a zero reading in the central-zero meter, the scale readings satisfy the equation:

\[ A - B = C \]

The circuit will also satisfy the consequent equations:

\[ A - C = B \]
\[ A = B + C \]

Resistor R1 is merely a current limiting resistor and limits the maximum current which can flow in the meter.

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Fig. 1. The circuit of the computing device. The three potentiometers should, preferably, be good quality wirewound types.

(with 9 volt batteries) to about 2mA. The meter should be able to pass this current without damage. S1, whose function will be described later, must be a break-before-make type, such as a toggle switch.

Let us now take an example of the circuit in operation. We shall refer to the voltage offered by each battery as E volts. Potentiometer VR1 is set to 80 on its scale, whereupon its slider taps off a potential that is, with respect to the lower common rail, equal to 0.8E volts. Potentiometer VR2 is set to 20 on its scale, with the result that its slider taps off a voltage that is 0.2E volts negative of that on the slider of VR1. Since the latter is 0.8E volts positive of the lower common rail, the potential on VR2 slider is positive of the common rail by 0.8E minus 0.2E, or 0.6E volts. If VR3 is next adjusted for a null reading in meter M1 this will occur when VR3 slider taps off 0.6E volts positive with respect to the lower common rail. The requisite voltage is given when VR3 pointer indicates 60 on its scale.

In operating the device we initially set VR1 to the first figure and VR2 to the figure we wished to subtract from that figure. We then adjusted VR3 for a null reading in the meter, whereupon its pointer indicated the result of subtracting the second figure from the first.

What happens if the second figure is larger than the first so that the result of the subtraction is a negative quantity? In this case we bring changeover switch S1 into operation and proceed as in the following example, in which we subtract 90 from 70.

First, VR1 is set to 70, whereupon its slider becomes 0.7E volts positive of the lower common rail. We next set VR2 to 90, with the result that it slider is 0.9E volts negative of the slider of VR1. The slider of VR2 is, then, 0.2E volts negative of the lower common rail.

We cannot balance the circuit with S1 at 'Positive' and so we change it over to the 'Negative' position. The upper end of VR3 track is now E volts negative of the lower common rail, and balance will be given when its slider taps off 0.2E volts relative to the common rail. This is given when its pointer indicates 20 on its scale. The device tells us therefore that the process of subtracting 90 from 70 yields an answer of — 20. The figure 20 is indicated on the scale of VR3 and the fact that it is a negative quantity is shown by the position of S1.

CALIBRATION

The only possible disadvantage with the circuit of Fig. 1 is that it necessitates that all three batteries offer the same voltage. This is not too difficult to arrange, however, since all three batteries can be purchased at the same time from a single retailer, whereupon they should all be in a common batch from the factory. Their terminal voltages should then remain the same as they age. If any differences in voltage do occur they will in any case be indicated by obviously inaccurate results from the computing device. There is, of course, little point in adding voltage stabilising components in a very simple circuit of this nature.

The potentiometers can be calibrated in terms of resistance. Take one of the potentiometers and first find its central track position and calibrate this as 50. Next find its 10 and 90 positions and calibrate these. The calibration points from 10 to 50 and 50 to 90 can then be made with the aid of a protractor, making the assumption that they are spaced out in linear fashion. Calibration from 0 to 10 and from 90 to 100 has to be carried out with resistance measurements, since practical potentiometers either reach zero resistance before the end of the slider travel or do not reach zero resistance at all. In this respect, much better results will be given by using good quality wirewound potentiometers rather than carbon track types.

Once one potentiometer has been calibrated, the remaining two can be calibrated from it by means of the circuit shown in Fig. 2. The potentiometer to be
calibrated is set up for zero reading in the meter and its scale given the same calibration marking as the first.

An alternative version of the circuit can use 2,000Ω headphones as the null indicating device. The output of an a.f. oscillator is coupled to three identical a.f. transformers, as illustrated in Fig. 3. The black dots shown alongside each transformer winding in the diagram indicate their phase relationships. This circuit has the disadvantage of incurring extra components, but has the compensation that the voltages applied to the three potentiometers must always be equal. Further, the ear is capable of detecting null indications at low intensity and the circuit will offer a greater resolution than is given by that of Fig. 1.

??HALF-A-DOZEN PUZZLERS ??

By P. MANNERS

Here are six unusual problems to try your hand at. They are all quite simple, although one or two are rather on the 'sneaky' side.

1. The junior service engineer was in a right old state. Whilst working on a portable transistor radio he had clumsily broken its ferrite aerial rod clean across the middle, and the two halves of this now hung decoratively on the coil wires, with one half bearing the medium wave coil and the other half bearing the long wave coil. No replacements for the rod were available, so what could he do to get the set working properly again?

2. The Professor rushed along to the Patents Office with his new rectifier circuit, which is reproduced in the diagram. At the cost of two extra rectifiers (which are cheap enough these days) this circuit provides a full-wave rectified output with only half the mains transformer secondary that would be required with a conventional 2-rectifier arrangement. On half-cycles when end A of the transformer secondary is negative, rectifier D1 prevents this end from going negative of chassis by any significant amount and virtually the full positive voltage at end B is passed via D2 to the reservoir capacitor C1. On alternate half-cycles, when end B of the secondary is negative, D3 similarly prevents this end from going negative of chassis, and it is the full positive voltage at end A which is now passed, via D4, to the reservoir capacitor. But the Patent Office very rudely told the Professor to get lost.

Why?

3. The Secret Service agent entered the Cypher Room, handing over to the duty officer the short length of recording tape he had that evening removed, at great personal risk, from the embassy of a Certain Power. The officer played it on a tape recorder and they heard the 1kHz dots and dashes of a signal in Morse. The agent (who luckily remembered Morse from his Boy Scout days) copied the message on a pad. It read: 'REEV EHT ROL EREH QFAO ERN EG'.'

Can you decipher the message?

4. Solve the following simultaneous equations for x and y.

\[ x^\circ C = y^\circ F \]

x shillings = y new pence

5. A home-constructor removed the can from a British-made 470kHz transistor i.f. transformer to see how it was connected internally. To his annoyance he accidentally broke a winding lead-out wire half an inch away from its tag at the bottom of the transformer. He became further incensed with himself when he found, after untwisting its rayon covering, that the wire was 5-strand Litz. He spent the next two hours in laboriously scraping the enamel from each strand with a razor blade, having to make several fresh starts as one or other of the strands broke whilst being scraped. Eventually, he was able to solder all the strands together, after which he ran a single thin tinned copper wire from their junction to the tag to which the wire had previously connected.

Had he wasted his time?

6. Finally, a nice easy one. You are required to design a tape playback system in which a loop of tape is continually drawn at 3\(\text{in.} \)per second past a single track record/playback head so that a programme may be originally recorded on it and then reproduced over and over again. The loop consists of 100 ft. of tape with its ends stuck together and you are allowed to exert all your ingenuity in the design of spools, tape routing and any other mechanical devices or techniques you may care to take advantage of. For that matter, the tape can be made to your requirements with magnetic coating on whatever area you suggest, and with any degree, within reason, of mechanical strength. You are, however, limited to a single track on the tape.

How can you arrange things for maximum length of programme, i.e. for maximum time, on replay, between the starts of successive programmes?

Answers are given on page 568
SECOND A.F. INPUT

by

S. L. THOMAS

This unusual method of adding a further input to a valve a.f. amplifier has the advantage of providing fully independent a.f. mixing.

It is sometimes necessary to apply a second input to an existing a.f. amplifier. If the second input signal is at fairly low impedance, of the order of 20kΩ or less, and if the amplifier employs valves in a simple circuit without extensive n.f.b. and does not have a 'live' chassis, the dodge to be described in this short article works excellently and causes virtually no alteration in the existing operation of the amplifier. Also the additional components required are inexpensive and take up little space.

THE MODIFICATION

The added a.f. input should be applied to the voltage amplifier valve in the amplifier which immediately precedes the output stage, or to the voltage amplifier valve which immediately precedes the phase-splitter stage should the amplifier have push-pull output. The main provisos are that the cathode circuit of the voltage amplifier valve should not have a negative feedback connection made to it and that the valve should not be inside a negative feedback loop. The circuit should not be applied to earlier voltage amplifier valves as it could cause the appearance of hum.

The existing circuit for the voltage amplifying valve will be basically that shown in Fig. 1. Here, R1 is the grid resistor and it may, in some cases, consist of the amplifier volume control. R2 is the anode load resistor and R3 and C1 are the cathode bias components.

To add the extra a.f. input, the circuit of Fig. 1 is modified to that shown in Fig. 2. R3 and C1 have been removed, and are replaced by a p.n.p. transistor, TR1. R5 is a skeleton preset potentiometer and it is adjusted such that the voltage on the cathode of the valve with respect to chassis is the same as it was when the previous cathode bias components were installed. The second a.f. input is applied to the added volume control R4, this being mounted at any convenient point on the amplifier panel. The signal voltage tapped off by the slider of this component is passed to the base of TR1 via C3. TR1 functions as an emitter follower and applies the signal to the cathode of the valve. The valve then amplifies this second signal in the same manner as it does that applied to its grid. Either the original signal or the added signal may be amplified by the valve or they may both be amplified together, whereupon the overall circuit becomes capable of mixing the two signals in any proportion. Variations in volume level adjustment to one signal do not alter the volume level of the other, as can occur with some simple a.f. mixing arrangements in which both signals are applied to a single grid.

The absence of the cathode bypass capacitor may result in the valve giving slightly lower amplification to the signal applied to its grid. There is a possibility also that the removal of the cathode bypass capacitor may result in an increase in the hum level in the output of the amplifier, but it has been the writer's experience that any increase in audible hum level is negligible when the amplifier drives a speaker which does not have an extended bass response. It is best to check this point before obtaining the components for the modification by temporarily disconnecting the bypass capacitor and retaining the cathode bias resistor in circuit on its own. If the hum level is then objectionable the modification should not be proceeded with.
The valve shown in Figs. 1 and 2 is a triode. The same modified cathode circuit may be employed if the valve is a voltage amplifier pentode, provided that the remarks just given concerning hum are borne in mind.

Transistor TRI should be a germanium type having a medium gain figure, and one of the earlier devices, such as the OC44, will function adequately here.

Before installing the transistor circuit first check the voltage dropped across the cathode bias resistor and make a note of it. Then remove the cathode bias resistor and bypass capacitor and install the new cathode components shown in Fig. 2. Connect a voltmeter between chassis and the cathode of the valve and adjust R5 so that it inserts about 50kΩ into circuit. This is given when its slider is about one-fifth of the way along the track from the end connected to chassis. Switch on the amplifier, allow it to warm up and then adjust R5 until the voltage on the valve cathode with respect to chassis is the same as was given when the previous cathode bias components were in circuit.

The added a.f. input is now ready for use. A point which has not so far been mentioned is that, in most cases, the a.f.-carrying leads in the added circuitry will need to be screened. If C3 and R5 are mounted close to TR1, this will necessitate the use of screened wire between C3 and R4 and between R4 and the second input terminal. The screening of the wire connects to chassis.

The added a.f. input must not, of course, be fitted to amplifiers having a chassis which connects to one side of the mains (as occurs, for instance, with the a.f. amplifier stages of a television receiver) since the external connections to the added circuit will be ‘live’ and can give rise to dangerous shock. The amplifier should have a double-wound mains transformer giving complete isolation from the mains supply.
V.H.F. WAVEMETER

By

F. G. RAYER, Assoc.I.E.R.E., G30GR

A simple absorption wavemeter covering the range 120 to 180 MHz can be readily assembled, as is demonstrated in this short article. In addition to general usage the wavemeter may be employed to set up the 'Easy' 2 Metre Receiver' described in last month's issue.

WITH A HOME-CONSTRUCTED RECEIVER DESIGNED for v.h.f. use, individual differences in wiring, the exact dimensions of tuning coils and similar factors influence frequency coverage quite considerably. In the case of the 'Easy' 2 Metre Receiver' described last month a pre-set trimmer is also provided, and its position naturally has a large effect on the band of frequencies covered by the panel-mounted variable tuning capacitor.

ABSORPTION WAVEMETER

In some circumstances, factors of this nature can cause difficulty in actually finding the 144–146MHz band. If necessary, this can be overcome by making the v.h.f. absorption wavemeter shown in the accompanying diagram. If the specified variable capacitor is employed, and the wire loop is made as described, scale readings should be duplicated with sufficient accuracy to bring the receiver tuning range into the 144–146MHz region. It should be emphasised that the specified capacitor must be used. This is a Jackson 15pF type C804 component and is available from Home Radio (under Cat. No. VC26D) or from Henry's Radio. Also, the loop has to be made exactly as described, and it is necessary to use the scale quoted in the Components List.

First, study the accompanying diagram and physically examine the tuning capacitor so that the final shape of the loop can be visualised. Then, take a 5 in. length of 20 s.w.g. tinned copper wire, and carefully straighten it. Place a 1p coin flat on the table and bend the wire round it (or use any other circular object 13/16 in. diameter). When the wire is released it should spring out to form a loop 1 in. from centre to centre of the wire, as in the diagram. Bend 1 in. at right angles for soldering to the capacitor fixed plates at stud F, and 4 in. at 45 degrees for soldering at tag M. Run a 4 in. length of 1mm. insulated sleeving over the wire, then solder the loop at stud F and tag M.

15pF variable capacitor, type C804 (Jackson Bros.)
3in. aluminium scale, Cat. No. DL72 (Home Radio)
Pointer knob, Cat. No. KN9 (Home Radio)
5in. of 20 s.w.g. tinned copper wire
4in. of 1mm. sleeving

Fit the 3in. diameter dial to the capacitor bush so that it is 5/16in. from the front of the capacitor body and secure it with nuts. Turn the capacitor so that it is fully closed, put the pointer knob at 100 on the scale, and tighten the grub-screw.

Frequencies, read against the dial, are shown in the accompanying Table.
To use the wavemeter with the ‘‘Easy’’ 2 Metre Receiver, set VCl of the receiver about half closed. Advance regeneration until the hiss described in the article is apparent. Hold the wavemeter by the metal dial, and bring its loop to about 1 in. from L3 of the receiver, and in line with it. Rotate the wavemeter knob to the point which causes the receiver to go out of oscillation, as shown by the hiss stopping, and read the frequency from the wavemeter dial. If the frequency is too low, reduce the capacitance of TC2. If the frequency is too high, increase capacitance in TC2.

The metal scale of the wavemeter is held by the user and this is in electrical contact with the loop. Because of the sleeving which covers it, there is no risk of shock if the loop should touch a high voltage point inside the receiver, but such a shock would occur if the metalwork of the capacitor were to touch such a point.

The wavemeter may be employed to check other equipment operating at or near 2 metres provided that the coil in the tuned circuit concerned is not screened and that the absorption effect of the wavemeter can be perceived as a loss in tuned circuit efficiency.

---

**TABLE**

<table>
<thead>
<tr>
<th>Dial Reading</th>
<th>Frequency</th>
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<tr>
<td>30</td>
<td>180MHz</td>
</tr>
<tr>
<td>36</td>
<td>170MHz</td>
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<tr>
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</tr>
<tr>
<td>100</td>
<td>120MHz</td>
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**CATELOGUES**

**CELECTRON-E**

Newly introduced is the Clectron-E catalogue, this comprising 97 pages of which 93 give details, with illustrations, of radio and electronic components as are used by the home-constructed, experimenter and service engineer.

Most of the parts offered are those supplied by R.S. Components, Ltd., (formerly Radiospares) and it is stated in the catalogue that all components specified in the popular electronics magazines and periodicals as ‘Radiospares’ are available from Clectron-E. The items listed range from cabinet feet to integrated circuits and cover a wide range from amateur to professional applications.

The catalogue is available from Clectron-E, P.O. Box No. 1, Llantwit Major, Glamorgan, CF6 9YN, at 25p post free.

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**CHROMASONIC ELECTRONICS**

Chromasonic Electronics announce the appearance of their 1972 catalogue. This lists a very wide range of products, covering semiconductors, integrated circuits and virtually all parts required by the home-constructor down to nuts and bolts. Also included in the catalogue is the complete range of Mullard colour TV integrated circuits, together with a selection of those made by Plessey for the same application.

The companies whose products are retailed by Chromasonic Electronics include Siemens, Ferranti, Eddystone, Fairchild, ITT, Motorola, Signetics, Telefunken and R.S. Components. With respect to the last, the catalogue states that all R.S. Components parts can be supplied; if the items required are not specifically marked in the catalogue, a quotation will be given.

The catalogue is available from Chromasonic Electronics, 56 Fortis Green Road, London, N10 3HN, at 20p post free.

APRIL 1972
The sawtooth generator described in this article is capable of producing an almost perfectly linear voltage sweep. It will find many applications in the radio, TV and electronic fields. Due to the provision of access to the internal circuitry via the terminations on the back of the unit it is also capable of performing many other functions besides waveform generation, and some of these are detailed in the section dealing with applications at the end of Part 2. A special feature of the design is the long sweep times available (over 600 seconds with suitable external components). The internally selected ranges give a sweep repetition coverage from 20kHz down to 1 sweep in 70 seconds in three overlapping ranges.

The unit was originally designed by the author as an improvement in the method of testing and setting-up pen recorders, many of which are in use in the University department where he works. It became evident after the construction of the first prototype that the versatility of the unit could be extended if a number of minor component changes were made. These changes were mainly to increase the range of repetition rates that the unit could provide and also to shorten the interval between sweeps.

The final circuit and component values selected are presented in this article. It should be pointed out that the setting-up process (to be described in Part 2) requires an oscilloscope and a testmeter having a sensitivity of 20,000 ohms per volt and the ability to read currents of the order of 85 to 90µA.

SWEEP GENERATOR

The first section of the circuit to be discussed is the voltage sweep generator. This is really the most important part since, without a means of generating a linear voltage rise with time, there would be little justification for the title of this article!

The method used to generate this voltage makes use of a property of the bipolar transistor whereby the collector current is relatively independent of the collector-emitter voltage over a substantial range in the region beyond the collector 'knee'. See Fig 2. In order to explain the action of this stage, it has been redrawn in a simplified form in Fig. 1.

In Fig. 1 it can be seen that we have a transistor (TR2) connected as an emitter follower. Its base is fed from a constant voltage provided by the zener diode ZD2, and its collector is returned to a negative potential via the charging capacitor Cc and the discharge circuit. The action of the circuit depends upon the fact that a bipolar transistor is a charge carrier limited device; this means that for a given base-emitter
The circuit operation and intensive design. Constructional be published next month.

When a potential is applied between collector and emitter (Vce) these charge carriers will be swept towards the collector under the influence of the electric field thus created. If this potential is above the ‘knee’, all the charge carriers in the base will be drawn to the collector. It follows therefore that since we have only injected a certain number of carriers into the base we cannot, no matter how high we make Vce (within reason), draw out more than we put in.

In practice, of course, nothing is quite so simple, and the collector will in fact tend to draw out a certain number of carriers from the emitter directly, thus causing the collector current to vary slightly with changes in Vce. This change in collector current (Ic) can be reduced by operating the transistor in the emitter follower mode as shown. In operation, the current in the emitter-collector circuit flows through Re and develops a voltage across it which is only slightly less than the input voltage, Vin, and the difference voltage will equal the base-emitter voltage (Vbe) for the transistor used. Since Vin is fixed it follows that any change in collector current will cause a change in the voltage across Re and therefore will also cause Vbe to change, this last change causing the collector current to alter in such a way that it opposes the initial variation.

An example would be given, for instance, if the collector current tended to fall by say 1mA. This would cause the voltage across Re to fall and Vbe to increase, whereupon transistor action would cause the collector current to rise and therefore cancel out the initiating change. In practice, of course, it would not completely cancel out and there would be some slight alteration in Ic. Just how big a change there would be can be gathered from Fig. 2 where it will be seen that if TR2 has a high d.c. current gain it will not need much of a change in the voltage across Re to cause a large current compensation, whereas if the d.c. current gain is low the voltage across Re can change by a relatively large amount before even a reasonable correction takes place. The change in the voltage across Re is caused by changes in Vce which occur under operating conditions.

TR2 must have a very high gain, as high as can be reasonably provided by a single transistor. In the prototype it was found that a gain of 150 was the lowest acceptable, and preferably TR2 should be a high gain type. The transistor specified is a 2N4062, which has a minimum gain of 180.

In operation, the collector current flows into the charging capacitor Cc, which initially has zero voltage.
The voltage across \( R_9 \) passed the resistor is 15 volts. The voltage reached before discharge which, in the complete unit, is about 6.5 volts. The voltage across \( C_c \) is applied to a Schmitt trigger, and when it reaches the trigger level the discharge of \( C_c \) is initiated whereupon the circuit resets to its initial condition ready for the next sweep.

**THE SCHMITT TRIGGER**

The circuit of the Schmitt trigger is shown in simplified form in Fig. 3 and it consists of two transistors (TR4 and TR5) arranged to form a monostable multivibrator. The d.c. feedback loop is created by returning the emitters to a common resistor (\( R_9 \)) and the a.c. loop by way of the ‘dwell’ capacitor \( C_{dt} \).

![Fig. 3. The basic circuit, without ‘refinements’ of the Schmitt trigger](image)

In operation, TR5 is biased into full conduction by the resistor \( R_{10} \), which is returned to the positive 15 volt supply rail. The collector-emitter voltage \( V_{ce} \) is equal to the saturation voltage of the device and the potential \( V_{out} \) is low. TR4, on the other hand, is cut off since its base is held near the negative common rail by the voltage from \( C_c \) (of Fig 1) whilst its emitter is at the higher positive potential developed across \( R_9 \) due to conduction in TR5.

When the input voltage, \( V_{in} \), rises above the voltage across \( R_9 \) plus the \( V_{be} \) for TR4, this transistor begins to conduct. Its \( V_{ce} \) tends to fall and this change is passed on to the base of TR5 via \( C_{dt} \), which causes the \( V_{be} \) of TR5 to fall and to bring TR5 out of conduction. The voltage across \( R_9 \) now begins to fall and this causes the \( V_{be} \) of TR4 to increase, thus causing a still larger collector current to flow and lowering its \( V_{ce} \) still more. The action is cumulative and results in the transistors changing over, with TR4 fully on and TR5 cut off. This state lasts for a time determined by the time constant of \( C_{dt} \) and \( R_{10} \). During this time, the voltage at the junction of \( C_{dt} \), \( R_{10} \) and the base of TR5 will be initially below the negative common rail due to the charge held by \( C_{dt} \). \( C_{dt} \) now discharges and the potential on the base of TR5 rises. When this potential reaches the voltage across \( R_9 \) plus the \( V_{be} \) of TR5, this transistor starts to conduct, thereby raising the voltage across \( R_9 \). This rising voltage tends to cut off TR4, and the circuit reverts to its original state.

**DISCHARGE CIRCUIT**

To examine the discharge section we now turn to the complete circuit, this being given in Fig. 5. The discharge section is given by a transistor (TR3) in series with the resistor \( R_4 \). The combination is connected across the charging capacitor (\( C_c \)) which in Fig. 5 is the capacitance selected by \( S_3(a) \). The base of TR3 is fed from the collector of TR5 in the Schmitt trigger via a 10 volt zener diode, ZD3, and is also connected to its own emitter via the resistor \( R_5 \). This latter component prevents any leakage current between collector and base (\( Ib_{co} \)) from causing unwanted conduction in TR3.

In operation, when TR5 comes out of conduction the output voltage at its collector rises above the zener voltage of ZD3; this causes base current to flow and turns TR3 on, thereby connecting \( R_4 \) across the charging capacitor and discharging it. TR3 will remain in conduction until the Schmitt trigger resets at the end of the ‘dwell’ period.

**OUTPUT SECTION**

The output section is also shown in Fig. 5, and it consists of a Darlington amplifier transistor, TR6, connected as an emitter follower which acts as a buffer between the charging circuit and the low impedance output circuit given by potentiometers \( V_{R2} \) and \( P_4 \). The Darlington transistor was chosen for its high input impedance (in the present case, over 7M\( \Omega \)). This is due to the high d.c. current gain of this type. For the transistor used (a G.E. 2N5308) the gain...
ranges from 7,000 to 10,000 times. The input impedance is approximately equal to the emitter resistor value multiplied by the gain, and it follows that an input impedance of at least some 7MΩ may be expected when the value of the emitter resistor is 1kΩ.

Another reason for choosing this type of transistor is that the input impedance tends to rise with increasing collector current, a factor which helps to offset the loading effect that would occur if an ordinary bipolar transistor had been used.

**COMPLETE CIRCUIT**

As already stated, the complete circuit is shown in Fig. 5. Also, a block diagram is given in Fig. 4.

It can be seen that the circuit of Fig. 5 contains several additional components which were not shown in the simplified circuits so far discussed. The most important of these is the diode and resistor circuit comprising D6, D7, R6 and R7, which forms a clamp circuit to provide TR4 with an input voltage during the reset or ‘dwell’ period of the Schmitt trigger. If the clamp circuit were omitted, TR4 would have no input voltage during this time, the Schmitt trigger would reset early, Cc would recover the small amount of charge lost, and the cycle would recur indefinitely.

Below the clamp level (3.5 volts) diode D6 isolates the charging circuit from the potential at the junction of R6 and R7, and D7 in conjunction with D6 performs the same function when the voltage on the charging capacitor rises above the clamp level. The way in which the circuit functions may be described more fully in the following manner.

When the circuit starts operating, the negative (anode) side of D6 is near the negative common rail potential due to the charging circuit, in which Cc initially has zero volts across it. D7 will be forward biased and the potential on the positive (cathode) side of D6 will equal the clamp voltage less the forward voltage drop of D7. When the voltage across the
charging capacitor selected by S3(a) rises above the clamp voltage plus the forward voltage drop in D6, this diode becomes conductive and the junction of D6, D7 and TR4 base also starts to rise, reverse-biasing D7. When the level at TR4 base exceeds the predetermined threshold level (set by the value of R9 and the current through it) the Schmitt trigger changes state; this causes the discharge circuit to operate as described earlier, whereupon the negative side of D6 drops nearly to the potential of the negative common rail, thereby reverse-biasing it once more. Since TR4 emitter potential is now going negative its base also falls in potential and D7 conducts, thus passing current into TR4 and keeping it turned on during the 'dwell' period of the Schmitt trigger. When the 'dwell' period ends the circuits returns to its original state.

A second and almost equally important addition to the circuit is the diode and resistor combination given by D8 and R11. The function of this circuit is to protect the base-emitter junction of TR5 from the high reverse voltage which is present when the voltage across Cdt is applied to it during the 'dwell' period. The resistor shunts the base to the emitter and the diode becomes reverse-biased, thereby preventing the base from going further negative. If the circuit were omitted, TR5 base could receive a negative voltage of about 9 volts, which is above the recommended reverse Vbe rating for this transistor. Although TR5 would not be harmed by this (it would tend to go into zener breakdown) the current which flowed would certainly upset the circuit's performance.

REFINEMENTS

Having discussed the operation of the circuits that go to make up the complete unit in their basic form, we can now turn to the 'refinements', so to speak. These will be dealt with starting at the sweep generator circuit. In this circuit it can be seen that in place of Rl in Fig. 1, we have two potentiometers, VR1 and P2. These are, respectively, the charge current control, which varies the charging rate of Cc and hence the repetition frequency of the unit, and a range limiting control which sets the maximum current that can flow when VR1 is at minimum resistance.

Another addition is P1. This control adjusts the minimum current that can flow when VR1 is at maximum resistance. Full details of the adjustment of these two components will be given in the setting-up instructions in Part 2. VR1 and P2 are wired as variable resistors. In the completed unit P2 is connected so that a clockwise rotation when viewed from the adjustment end causes the current to increase. VR1 is wired so that an anti-clockwise rotation seen from the shaft side of the control causes the current to increase. VR1 is a logarithmic type and this gives a reasonably linear scale to the current control since I is, by Ohm's law, inversely proportional to R. This tends to offset the 'cramping' effect that would occur if a linear potentiometer were used instead. P1 is wired in the same sense as P2 and is connected as a normal potentiometer.

R3 is returned to the negative common rail via the additional components PB1 and S2. These controls provide a means of halting the sweep at any level within its range, and operate in the following manner. If S2 is left in the closed position ('Repeat'), the circuit will operate as in the simplified manner described when Fig. 1 was discussed. If, however, S2 is left open ('Manual/External Sweep') the base supply to TR2 is removed and the sweep will hold at whatever level it has reached for as long as S2 is left in this position. In practice, the voltage across Cc will fall slowly, due to the slight discharge current through the base of TR6 and also through the capacitor's own leakage resistance. Electrolytic types (C3 for example) are usually the worst in this respect and C3 must therefore be chosen to have a low leakage level, preferably less than 5µA at the voltage used (6.5 volts) in the circuit. If, whilst S2 is in the open position, the button PB1 is depressed (to give 'Manual Sweep') the voltage across Cc will start to rise once more. This will also happen if Terminal A is earthed to the negative supply rail via Terminal G by an external circuit. This facility will be discussed further, in Part 2, in the section dealing with applications.

Turning now to the range selector switch, S3(a)(b), it can be seen that S3(a) selects different values of charging capacitance for each of the three internal ranges. S3(b) selects compatible values of 'dwell' capacitance (Cdt). An additional position on each switch section selects the 'External Component' terminals. Terminals B and C are for an external charging capacitor, and Terminals D and E are for an external 'dwell' capacitor. A further point to be mentioned whilst dealing with this part of the circuit is that the value of the discharge resistor R4 is so chosen in conjunction with the 'dwell' period that it does not completely discharge Cc during this time, but leaves a sufficient voltage on it to overcome the input offset voltage of TR6. This only applies to the internal sweep ranges. An idea of the voltage appearing across Cc under typical working conditions is given in Fig. 6.

Dealing with the Schmitt trigger circuit, PB2 is a reset button which, when depressed, causes the circuit to revert to its 'dwell' state. This may also be brought about by externally linking Terminals E and G by a suitable switch, or by feeding a positive-going voltage not exceeding 4 volts peak to Terminal E.

Potentiometer P3 is wired as a variable resistor in the collector circuit of TR5, and acts as a threshold control for the Schmitt trigger. It varies the current flowing through R9 and, consequently, the voltage across it, thus changing the trigger voltage by a small amount.

THE RADIO CONSTRUCTOR
The generator as seen from the rear

P3 is normally adjusted on the fastest repetition range, Range 3, in order to set the working point of the circuit for best results at high frequencies. The circuit is capable of triggering in an unstable manner at these frequencies, but the effect is not serious and is fully compensated for by this control.

The output circuit is provided with two ranges selected by S4, these being an uncalibrated range of approximately 0–5.5 volts on Range 2, and a preset range on Range 1 which may be set anywhere within these values (the author’s version gives 0–1 volt on this range). Both outputs connect to the output potentiometer VR2 and thence to the output Terminal F. Diode D9 between the base and emitter of TR6 prevent reverse voltages being applied, as could happen if TR6 were supplying a capacitive load when reset occurs. D9 shunts the charge from the capacitive load to the negative common rail via TR3. In normal operation D9 is reverse biased.

**POWER SUPPLY**

The power supply section is shown in Fig. 7. It has a conventional circuit employing a series pass transistor TR1, and a zener diode, ZD1, as the reference element. A bridge rectifier is used, made up of four Texas Instruments 1N2069 silicon diodes, although any four diodes of suitable rating will do as will shortly be discussed. A slightly unusual feature is that the mains input is fed to the 230 volt tap in the primary of T1 for mains voltages of 240 volts, this being done to ensure that if the mains voltage were to fall slightly the input to TR1 would still be high enough to keep TR1 above the ‘knee’ of its collector characteristic. R1 provides surge limiting at switch-on, and D5 prevents the base-emitter junction of TR1 becoming reverse-biased due to the charge retained in C2 when the circuit is switched off. As will become evident next month, when constructional details will be given, the components in Fig. 7 marked with an asterisk are mounted on the main circuit board of the unit.

![Fig. 7. The circuit of the power supply. Components marked with an asterisk appear on the main circuit board](image-url)
**COMPONENTS**

The components employed in the unit are shown in the accompanying Components List and, where these are of a specialised nature, will now be dealt with. The reasons for the choice of some of the parts will become more apparent in Part 2. The more experienced constructor who, by slight re-arrangement of panel dimensions, etc., wishes to use alternative switches and other components which may be on hand, is advised to wait until next month’s issue in order to see what is involved here.

The fixed resistors are 5% ± watt high stability types. In the prototype, the four pre-set potentiometers, P1 to P4 inclusive, are Plessey type MP ‘Dealer’ potentiometers, 6BA fixing, and are available from Electronic Component Supplies (Windsor) Ltd., Thames Avenue, Windsor, Berkshire, on a cash with order basis. VR1 and VR2 are moulded track low-noise potentiometers and are available from a number of suppliers including Home Radio (Cat. No. VR18B for VR1 and Cat. No. VR18D for VR2). It is essential that these two potentiometers be moulded track types.

Of the capacitors, C1 is an A.H. Hunt wire-ended component having dimensions of 2 in. by 1 in. diameter and is available from Home Radio under Cat. No. 2CG19. Other capacitors of the same value and similar size could, of course, be used. In the prototype, C2 and C3 were Mullard C437AR/E1000 wire-ended miniature aluminium capacitors, but the constructor may find this type difficult to obtain. An alternative with the same dimensions (but which may be supplied with two tags at one end instead of wire ends) is available from Home Radio under Cat. No. 2DL29. For optimum results C3 must have a very low leakage current, of not more than 10µA at 10 volts. This is very much lower than the rated maximum leakage current for the capacitor specified but it is found, in general, that Mullard miniature electrolytics have extremely low leakage currents. It is advisable to choose, for C3, the capacitor of the two purchased which exhibits the lower leakage current, bearing in mind that a significant period will elapse before the capacitor exhibits its final

### Resistors

(All fixed values ± watt 5% high stability. See text concerning potentiometers.)

<table>
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<th>R1</th>
<th>22Ω</th>
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<tr>
<td>R2</td>
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<td>P3</td>
<td>470Ω preset potentiometer</td>
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<td>P4</td>
<td>2.2kΩ preset potentiometer</td>
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<td>VR1</td>
<td>25kΩ potentiometer, log</td>
</tr>
<tr>
<td>VR2</td>
<td>1kΩ potentiometer, linear</td>
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</table>

### Capacitors

(See text for alternative types)

- **C1** 1,000µF electrolytic, 25V.Wkg.
- **C2** 1,000µF electrolytic, 16V.Wkg., Mullard C437AR/E1000
- **C3** 1,000µF electrolytic, 16V.Wkg., Mullard C437AR/E1000
- **C4** 10µF polyester, 63V.Wkg.
- **C5** 0.1µF polyester, 250V.Wkg.
- **C6** 330pF silvered mica
- **C7** 0.022µF polyester, 250V.Wkg.
- **C8** 32µF miniature electrolytic, 15V.Wkg.

### Transformer

- **T1** R.S. Components Standard Filament Transformer, Secondary 16.3V at 0.3A, Cat. No. TH5A (Home Radio)

### Semiconductors

- **TR1** 2N3405
- **TR2** 2N4062
- **TR3** 2N3704
- **TR4** 2N3711
- **TR5** 2N3711
- **TR6** 2N5308

### Diodes

- **ZD1** 15 volt 5% zener diode 400mW
- **ZD2** 5.1 volt 5% zener diode 400mW
- **ZD3** 10 volt 5% zener diode 400mW

### Switches

(See text for suitable types)

- **S1** s.p.s.t. miniature toggle
- **S2** s.p.s.t. miniature toggle
- **S3** 3-pole 4-way miniature rotary
- **S4** s.p.d.t. miniature toggle

### Neon

- **NE1** Miniature panel neon assembly with integral resistor

### ‘Lektrokit’ Chassis Parts

1-off LK111 Chassis Plate No. 1
1-off LK161 Chassis Plate No. 6
2-off LK211 Chassis Rails, Short
2-off LK301 Side Plates No. 1
1-off LK431 Front Plate No. 1, Short
1-off LK521 Cover, Short
2-off LK531 Cover, Short (Plain)
10-off LK2021 Insulator, Lead-through, No. 1
4-off LK2411 Rubber Feet

### Terminals

(See text for suitable types)

- 1-off Red
- 1-off White
- 1-off Yellow
- 2-off Blue
- 2-off Black

### Miscellaneous

- Mains 3-way connector assembly, Cat. No. P.360 (Home Radio) 2-off knobs, Cat. No. KN85B (Home Radio)
- 1-off knob, Cat. No. KN87B (Home Radio)
- 6BA binder head screws and full nuts.
- 4BA screws and full nuts.

550 THE RADIO CONSTRUCTOR

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leakage current after the voltage has been applied. This is particularly true if the capacitor has been on the shelf for a long time.

Capacitor C4 in the prototype was an R.S. Components (formerly Radiospares) side wire polyester type with a working voltage of 63 volts. Its length is 1\(\text{in}\). and its width is 3\(\text{in}\). This is not available directly from R.S. Components, who do not supply to individual constructors, nor through the usual mail order houses (although it may be ordered from R.S. Components by a retailer) and is rather expensive. An electrolytic capacitor of 15 V.Wkg or more could be employed instead, provided it had a very low leakage current. A tantalum capacitor would be best in this respect. C5 was an R.S. Components 0.1\(\mu\)F 250 V.Wkg polyester capacitor. The Mullard 0.1\(\mu\)F 125 V.Wkg polyester capacitor (Home Radio Cat. No. 2EH07) is a little larger, but is a satisfactory alternative. C7 was an R.S. Components 250 V.Wkg polyester capacitor, and may be replaced by a Mullard 125 V.Wkg polyester capacitor of the same value (Home Radio Cat. No. 2EH03). C8 is a sub-miniature component and may be a Mullard 32\(\mu\)F 40 V.Wkg miniature electrolytic capacitor (Home Radio Cat. No. 2CH39). It should preferably have a low leakage current, of not more than 50\(\mu\)A. It should be noted, however, that the value specified for C8 is higher than is required to give the same sweep-to-flyback ratio as on the other ranges, this being due to the fact that the author required this range for use with a chart recorder. If the unit is not required for such a function, C8 could be reduced to 2\(\mu\)F.

Transformer T1 was also an R.S. Components part, and this is available from Home Radio, as indicated in the Components List.

The Lektrokit chassis parts can all be obtained from Home Radio, under the same Cat. Nos. as the Lektrokit part numbers.

The terminals were R.S. Components insulated types in the colours and quantities shown. Suitable alternatives are the Home Radio Cat. No. PK12C (Red and Black) and PK12CA (White, Yellow and Blue).

Switches S1, 2 and 4 were R.S. Components miniature single pole changeover types. An alternative is the sub-miniature 2-pole 2-way toggle switch Type 9 available from Henry's Radio. Another R.S. Components part, the panel neon lamp assembly, may alternatively be Home Radio Cat. No. D841/250V Red. Further R.S. Components parts are the push-buttons PB1 and PB2, which were miniature push-to-make in the prototype. A suitable substitute is the push-button available from Home Radio under Cat. No. WS89. S3 is a standard 3-pole 4-way miniature rotary switch, one of the poles being unused.

Of the semiconductors, TR2 to TR5 inclusive are generally available. TR1 and TR6 may be obtained from Electrovalue, 28 St. Judes Road, Englefield Green, Egham, Surrey, but it should be pointed out that there might be a waiting time for delivery of TR6. Diodes D5 to D9 inclusive are also obtainable from Electrovalue.

Rectifier diodes D1 to D4 inclusive were 1N2069 in the prototype but any silicon rectifier rated at 1 amp with a p.i.v. of 50 volts or more, such as the 1N4001, could be used instead.

ZD1 may be any 400 mW 15 volt 5% zener diode, such as the BZY88C15. ZD2 can be a BZYC5V1, whilst ZD3 may be a BZYC10. These diodes, or equivalent types, are generally available.

*(To be concluded)*

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APRIL 1972
A MODERN HOMODYNE RECEIVER

Part 2

By

G. W. SHORT

In this concluding article our contributor deals with the construction of his homodyne receiver. Also described is a suitable a.f. amplifier, together with details showing how this amplifier and the homodyne receiver may be assembled to form a complete receiver with loudspeaker output.

COMPLETE CIRCUIT

The complete circuit of a modern homodyne receiver on the lines discussed last month is shown in Fig. 4. This is basically a two-stage r.f. amplifier, tuned at the input only, and driving a double-diode detector, D3, D4, which acts as a demodulator when the receiver is made to behave as a homodyne. A single a.f. stage completes the circuit as shown here, but of course a separate power amplifier must be used for loudspeaker reception.

In Fig. 4 the aerial tuned circuit is given by C1, C2 and whatever inductance is selected by wave-change switch S1. L1 and L2 are medium and short wave coils on a ferrite aerial rod offering, with a 500pF tuning capacitor, ranges of 500 to 2,000kHz and 3.5 to 10MHz respectively. When S1 is set to the 'L.W.' position, loading coil L3 is inserted in series with L1, whereupon the range covered is 150 to 500kHz. Similarly, setting S1 to 'S.W.1.' causes loading coil L4 to be inserted in series with the ferrite rod short wave coil, L2, whereupon the range covered is 1.6 to 5MHz. CI is a 'fine tuner' with a capacitance of 5pF, and is helpful for final tuning of short wave signals. The aerial tuned circuit arrangements are discussed in more detail later.

The r.f. amplifier (TR1, TR2) calls for a little explanation. A junction f.e.t. is used in the input stage. This produces little r.f. gain in itself, but simplifies the band-switching by making it possible to dispense with the usual tapping on the input coil and to connect the whole aerial tuned circuit directly to the amplifier. Most of the actual gain comes from TR2.

COMPONENTS

Resistors
(All fixed values ± watt 10% or closer tolerance)
R1 220kΩ
R2 1kΩ
R3 1kΩ
RV4 500Ω potentiometer, pre-set, miniature skeleton
R5 1kΩ
R6 10kΩ
RV7 10kΩ potentiometer, log. with metal case (see text)
R8 10kΩ
R9 10kΩ
RV10 25kΩ potentiometer, log
R11 10kΩ
R12 2.7MΩ
R13 180Ω

Capacitors
C1 5pF variable
C2 365 or 500pF, variable
C3 2.5µF electrolytic, 6V. Wkg.
C4 0.01µF metallised polyester
C5 0.01µF metallised polyester
C6 0.01µF metallised polyester
C7 0.01µF metallised polyester
C8 0.1µF metallised polyester
C9 0.1µF metallised polyester
C10 0.01µF metallised polyester
C11 125µF electrolytic, 10V. Wkg.
C12 10µF electrolytic, 10V Wkg.*

Inductors
L1, L2 Medium and short wave ferrite aerial assembly (Amatronix)
L3 2.5mH r.f. choke type CH1 (Repanco)
L4 Short wave loading coil (see text)

Semiconductors
TR1 2N3819
TR2 AF239
TR3 BC169C
D1–D4 OA90

Switches
S1 1-pole 4-way, rotary
S2 d.p.s.t., slide switch

Loudspeaker
LS1 75Ω or 80Ω loudspeaker†
†Required only when a.f. amplifier of Fig. 7 is used.

Battery
9-volt battery type PP9 (Ever Ready)

A. F. Amplifier
A.F. amplifier of Fig. 7 or suitable alternative

Miscellaneous
Slow-motion tuning drive 4 knobs
Transistor holder
Battery connectors
Material for panel, chassis and cabinet

THE RADIO CONSTRUCTOR
Fig. 4. The complete circuit of the modern homodyne receiver. This can receive a.m., c.w. and s.s.b. transmissions.
The inside rear of the complete receiver. The homodyne board is to the right of the tuning capacitor, and its screen and the transistor holder for TR1 can both be seen. The 1,000μF capacitor is to the immediate right of the homodyne board. The a.f. amplifier board appears between the battery and the front panel, being obscured here by the battery.

The limiter (D1, D2) is a simple back-to-back pair of diodes, driven by a high enough resistance (R6) to ensure good clipping and at the same time prevent the limiter from loading the input to the detector. The regeneration control is RV7, an ordinary carbon track potentiometer with a metal case which is earthed to 'keep the r.f. inside'.

At lowish frequencies the amplifier has 360° phase shift, because there are two inverting stages, and so the output is in phase with the input. This means that the feedback path should not introduce further phase shift, since this would begin to bring the feedback signal towards an out-of-phase condition, and give negative instead of positive feedback. For this reason the regenerative path on long and medium waves is completed via a resistor, R1, which introduces no phase shift. This resistor is given a high value to avoid damping the input tuned circuit excessively. On short waves there is an appreciable amount of phase shift in the amplifier, and the output is no longer in phase with the input. Above about 2MHz, therefore, feedback is taken increasingly by way of a small capacitance, given by Cx, which bypasses R1. It is convenient to use for Cx a twisted-wire capacitor, i.e. the capacitance is provided by two pieces of insulated connecting wire twisted together. The capacitance is then easily preset by twisting or untwisting to achieve the required condition of just enough feedback to enable the circuit to be brought into oscillation at all points in the tuning range.

The function of RV4 is to set up the current in TR2 for optimum results. In the prototype, this is given (with RV7 adjusted to give zero regeneration) when TR2 passes 3mA, as indicated by a drop of 3 volts across R5. However, it may be found desirable to experiment a little and try results with different values of current in TR2. RV4 should be initially set up for the 3mA current then, after experience with the receiver has been obtained, the effect of different currents in TR2 between the limits of 1 and 4mA can be checked. It is necessary to provide some means of adjustment here because the current taken by different specimens of 2N3819 in the TR1 position will vary. The voltage drop across R2 and hence the base voltage of TR2 is dependent upon the current drawn by TR1.

The audio frequency low-pass filter is a very simple RC affair whose components are C6, R9 and C7. The d.c. load for the detector/demodulator is R8. This resistor has been deliberately given a rather low value (10kΩ) for the type of detector used here. The effect is to increase the damping of the amplifier output as signal strength builds up, which is the right condition for smooth reaction.

Volume control RV10 is followed here by one stage of a.f. voltage amplification, TR3. It is intended that the a.f. output will be used to drive a conventional loudspeaker amplifier. It is, however, possible to use the audio output of TR3 for headphone reception, provided that sensitive high-impedance phones are used. (Rather greater volume will be obtained by connecting high-impedance magnetic phones in place of R11.)

The total current consumption of the receiver, with RV4 set for 3mA current in TR2, is of the order of 4mA. However, this is liable to vary a little with different specimens of the 2N3819.

FREQUENCY COVERAGE

It will be clear to experienced constructors that the circuit lends itself to the reception of any tuning range within reason by the simple process of switching in appropriate ferrite aerial coils.

Ordinary grades of ferrite are not much good above about 2MHz, but special h.f. rods are made which operate well up to about 20MHz. The prototype uses a special h.f. rod, 6½in. by ¾in. in diameter, which is suitable for medium and long waves as well as the short wave ranges covered. The ferrite rod coils (L1 and L2 in Fig. 4) are designed to be tuned by 365pF, but by using a 500pF tuning capacitor the coverage can be extended down to nearly 450kHz on medium waves, which makes it possible to use the receiver as part of the i.f. chain of a conventional superhet. When L3 is in circuit, as is given by setting S1 to ‘L.W.’, the receiver can also tune through the conventional superhet intermediate frequencies.

Short-wave coverage, as is given by L4 in its own right, is up to 2MHz with 365pF tuning and 3.1 to 10MHz with 500pF, but in both cases the high frequency limit depends entirely on the mechanical capacitance of the tuning capacitor and the circuit strays, and will usually extend well beyond the conservative 10 or 11MHz just quoted. At the high frequency end of the ‘S.W.2' band it is possible, in the London area at least, to receive a number of broadcasting stations. Towards the lower frequency end (employ a 500pF tuning capacitor) it is also possible to receive s.s.b. amateur transmissions on the 80 metre band.

The ferrite rod assembly, ready-wound with L1 and L2 fitted, is available from Amatronix Ltd, 39 Epsom Road, South Croydon, Surrey, CR2 0DE. The ferrite rod for the ‘S.W.1' loading coil, L4, is also available from this source. It consists of 20 turns close-wound of 22 s.w.g. enamelled wire on a ½ by ⅛in. piece of rod. Loading coil L3 is simply a Repanco r.f. choke type CH1.

CONSTRUCTION

The complete receiver, as illustrated in the photographs, consists of the homodyne receiver proper plus an additional a.f. amplifier feeding a small speaker. It is not necessary to use this particular a.f. amplifier, since the homodyne section will work into any suitable amplifier. The homodyne receiver is built on its own circuit board, this coupling by wires to the external components, which consist of S1 and the aerial connection at Cx, RV7 and RV10. The complete receiver could, if desired, be built on a smaller baseboard and with a smaller panel with the a.f. amplifier and speaker omitted. Other variations are...

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possible, provided that the homodyne circuit board layout is retained and connections to the external components are kept short.

In the photograph, published last month, which gave a top view into the receiver, the a.f. amplifying point is between the loudspeaker and the battery. The homodyne receiver board is between the amplifier board and the tuning capacitor, and it extends from the back of the front panel to the rear of the baseboard. The centre of the homodyne board is obscured by a screen, which lays over it horizontally. This particular version of the receiver uses the rear section of a 2-gang 500 + 500pF tuning capacitor, but a single-gang 500pF, or 365pF, capacitor could have been employed just as well.

A slow-motion tuning drive is essential and that used here is the Jackson Bros. type 4489, which has a ratio of 6:1 and is calibrated 0 - 100. Any similar slow-motion drive could, of course, be used. The wave-change switch is on the front of the tuning capacitor, and L3 and L4 are soldered to its tags. L3 being partly hidden, in the photograph, by L4. The ferrite aerial rod, with L1 and L2, is at the rear, and is mounted on a wooden support column, to which it is lashed with plastic sleeving passed through holes in the column. Thick wire is employed for all aerial tuned circuit connections, including in particular those which appear in the short wave circuits.

Also visible in the photograph is R1, which connects between the slider of RV7 and the fixed vanes tag of the tuning capacitor. Cx may be seen across this resistor. The insulated wire forming this capacitance is soldered to the resistor lead-out connecting to the tuning capacitor fixed vanes tag, its other end then being twisted several times round the resistor lead-out which connects to RV7.

The potentiometers visible in the photograph interior both have integral switches. This is an incidental point and is merely due to the fact that these components happened to be on hand. No connections are made to the switches.

The receiver has an aluminium front panel whose dimensions, together with control functions, are shown in Fig. 5. The baseboard is 5" particle board measuring 12in. by 4½in., and is covered on the top with aluminium foil which is wrapped over the front edge so as to make good contact with the panel. The tuning capacitor is 'earthed' to the foil via its four fixing feet.

After fixing the capacitor the exposed foil is covered with thin card to insulate it from the circuitry on the receiver and amplifier boards, the latter being made up on pieces of hardboard. 'Earth' connections are made by taking lengths of stranded tinned copper wire, with the strands spread out, between the foil and the card. These 'earths' are positioned so that when the circuit boards are screwed down to the baseboard the strands are sandwiched firmly in place.

Constructors who prefer to use conventional metal chassis for their projects can, of course, adapt the methods shown here for this type of construction. A metal panel, common to the chassis, will still be necessary, to counteract 'hand capacitance' effects.

The top, sides and back of the cabinet are made in one unit, using particle board for the sides, plywood for the top, and hardboard for the back, the assembly being strengthened by corner braces glued in place.

**RECEIVER CIRCUIT BOARD**

The r.f. amplifier has a gain of several hundred at the lower frequencies and it is necessary to construct it carefully to avoid unwanted feedback which, even if it does not cause instability, will spoil what should be a very smooth reaction control. Unwanted feedback can take place from the amplifier to the tuned circuit. This is avoided by a combination of screening and distance, the latter being satisfied by keeping the base of TR1 reasonably well spaced from the collector of TR2 and all associated components. In the receiver in the photographs the 'danger area' of the circuit board is in effect sandwiched between an 'earth plane', given by the aluminium foil covering the baseboard, and a top screening plate which is just a piece of tinplate closely covering TR2 and associated components, including the diodes. The screen appears in the component layout given in Fig. 6, between the dashed lines AB and CD. The screening plate is 'earthed' to the negative supply line by soldering it to two of the pins which support the negative line wiring. Note that the positioning of the circuit board relative to tuning components and regeneration potentiometer RV7 has been chosen so as to minimise stray couplings. The component layout also enables resistor R1, with its attendant capacitor Cx, to be suspended in the air, making as direct a connection as possible between RV7 and the tuning capacitor.

The receiver board measures 4½ by 2½in. and has the layout given in Fig. 6. It should be noted that the a.f. output coupling capacitor, C12, is omitted in the layout, since the loudspeaker amplifier used here already has an equivalent component. If in other designs incorporating the homodyne receiver it is desired to retain C12 on the board, this can be done by increasing the length of the board by ½in. to accommodate it.

Anchorage points to which components lead-outs may be soldered are made by driving in bright new domestic pins (plated type, available from stationers) into the board (which consists of hardboard) at each connection point. The heads are cut off, leaving about ½in. of stem projecting, and the pins are then tinned before wiring-up begins.

Constructors are advised not to depart from the layout shown, which has been designed for stability. The easiest method of construction is to trace the layout, lay the tracing over the circuit board, and drive pins through the junction points on the diagram. The diagram then forms an on-the-spot wiring guide.

Constructors who prefer to use perforated board should select a piece with 0.1in. hole pitch.
A transistor holder (Eagle type TS10) was used for the f.e.t. in the receiver in the photographs, the f.e.t. being plugged into this after soldering had been completed. This protects the f.e.t. from the possibility of high voltages on the soldering iron bit breaking down its internal gate insulation. However, the f.e.t. could be wired in directly if precautions are taken during soldering. A suitable precaution consists of making the soldering iron metalwork common with the negative line of the receiver (say, by earthing both to the same point) and keeping the receiver switched off whilst soldering.

If a mains power unit is used, make sure that the output is really smooth. If further a.f. stages are driven from the same supply watch out for audio feedback, which can cause the receiver to 'moan' as the reaction is turned to the critical point. A 1,000µF electrolytic capacitor across the 9 volt supply prevents this from occurring. In the present design such a capacitor is added externally to the boards, being connected between the negative line of the homodyne board and the positive line of the amplifier board. It appears in the amplifier circuit of Fig. 7.

A.F. AMPLIFIER

The a.f. amplifier employed in the overall receiver is, as already mentioned, not a part of the homodyne circuit proper, and any other a.f.
amplifier could be used instead. For completeness, nevertheless, the present amplifier will next be described.

The amplifier circuit is given in Fig. 7 and it has the advantage of offering a lower battery consumption, the quiescent current being approximately 0.8mA only. The input signal is applied to the base of the BC169C, whose collector couples to the base of the first 2N4289. This drives the BC168B and 2N4289 in the complementary Class B output stage. Two silicon 'bias diodes' (available, as is the BC168B, from Amatronix Ltd.) keep the output transistors conductive for the zero signal condition, and these couple to the speaker, which may be 75Ω or 80Ω. The speaker employed in the prototype was a 75Ω 2½in. unit (which is also available from Amatronix Ltd.). Feedback to the BC169C is taken from the junction of the 1kΩ and 100Ω resistors across the speaker, and it will be noted that this particular part of the circuit exhibits a considerable economy in components. It is desirable that the 250µF 16V capacitor be a Mullard miniature electrolytic component, as its internal series resistance was taken into account when the feedback component values were calculated. As already stated, the 1,000µF capacitor across the supply lines is only required to reduce the risk of feedback to the homodyne receiver. If the amplifier were used on its own for a different application the 1,000µF capacitor could, in most instances, be omitted.

In the present design the amplifier is assembled on a piece of hardboard measuring 2½ by 3¼ in. and uses domestic pins for anchorage points in the same manner as with the homodyne receiver board. Components are laid out along the board in roughly the same order as they appear in the circuit. The 1,000µF capacitor is not mounted on the amplifier board, but is external to both this board and the homodyne board. It appears between the homodyne board and the battery, and is clearly visible in the photographs showing the interior of the overall receiver.

**OPERATION**

Operating a homodyne takes a little getting used to. The background hiss and the howls during tuning-in may be rather off-putting at first, but do not be discouraged! You will be surprised at the stations it can pull in once you have learned to use it. Here are a few general tips and guide lines:

1. If the circuit is detuned a little, but not far enough to lose synchronisation, the audio output falls and becomes distorted. The best tuning point is usually nearer one edge of the locking band than the other.
2. Loss of sync. may occur momentarily during deep modulation troughs, giving a rasping quality. This is a sign that the circuit is slightly off tune or that a.f. signals are getting back into the r.f. amplifier.
3. Loss of sync. may occur if the signal fades. The best strategy is usually to let well alone until the signal fades up again.
4. It is an advantage to use the lowest practicable level of oscillation. If you have to increase the level to override a strong signal in the next channel turn up the reaction until the intelligible breakthrough turns into unintelligible 'monkey chatter'. This is as far as you need go. However, when receiving s.s.b. signals the question of synchronisation doesn’t arise, so in this case the best level of oscillation is set by other factors. First, the level must be at least high enough always to exceed the incoming signal, otherwise intelligibility will suffer. Secondly, it turns out with this receiver that it is possible so to set the regeneration that a useful increase in signal amplification can be had even with the receiver oscillating. On weak signals this is what dictates the maximum level which can usefully be set up. (If strong s.s.b. signals are being received you may as well turn the regeneration right up and so get the maximum selectivity from the outset).

As a final point, Fig. 8 shows received frequencies corresponding to the 0 – 100 scale of the slow-motion tuning drive employed with the prototype. It must be emphasised that this diagram, which applies to a 500pF tuning capacitor, is intended for guidance only, and it should not be assumed that receivers built up to the circuit will exhibit exactly the same frequency/scale relationship. Nevertheless, the diagram will still be of assistance since it gives the constructor an approximate idea of received frequencies on the four bands covered.

**Fig. 8. The frequencies received with the prototype, plotted against the 0 – 100 calibration of its slow-motion tuning drive**
in remote Nepal, the transmitter at Kathmandu is still currently operating on 5000kHz where, unfortunately, the frequency standard stations MSF at Teddington and IBF at Milan cause the reception of Radio Nepal to be somewhat marred to say the least. Apparently the Nepalese engineers have never heard of MSF or IBF!

According to the British Association of Dx'ers (BADX), the schedule of Radio Nepal is as follows – from 0120 to 0350, from 0720 to 0950 and from 1150 to 1550 on 5000kHz. The power is 100kW.

Radio Nepal has also been logged on 9603 by a BADX observer at 0145 with a programme of Indian music, although the frequency is subject to some variation at times. The times offering the best chance of reception for listeners here in the U.K. are from 0120 and from around 1500 onwards.

**NOW HEAR THESE**

- **Yemen**

  The Aden transmitter in the People's Democratic Republic of Yemen can be heard on 5060 (59.29m) 7.5kW around 2000, when it was logged with a programme of Arabic songs and music. The daily schedule, except Fridays, is from 0300 to 0530, from 1100 to 2200, but on Fridays a continuous programme is radiated from 0300 to 2200. The address is – P.O. Box 1264, G.P.O., Aden.

- **Morocco**

  The Voice of America station in Tangier operates a number of foreign language broadcasts on a multitude of channels from 5965 (30.29m) to 25880 (11.59m) but has recently (at the time of writing) popped up on another channel. The ‘out of band’ frequency of 5436 has been heard from 2035 with a programme of both Arabic music and English musical comedy music to 2057. This was followed by a short newscast in Arabic, the station signing-off with identification in English at 2100. It has also been logged by BADX from 1952 onwards when radiating a programme of English ‘pop’ records, time signal and news in Arabic at 2000.

- **Paraguay**

  The Paraguayan station mentioned in ‘SWN’ February issue, operating on the ‘out of band’ channel of 5273 was apparently conducting test transmissions with a low powered transmitter. It has been reported by BADX being heard from around 0020 to 0130 but on an irregular basis, a not unusual practice when transmitters are being tested. When in full operation, ZPAI Radio Nacional will have a power of 100kW.

- **Ecuador**

  HCRPI Radio Catholica, Quito, listed on 5055 with a power of 1kW has been heard testing a new transmitter (estimated at 25kW) on 5060 (59.29m) with station identification every four minutes or so, according to BADX.

**Burma**

According to BADX, Rangoon has vacated the listed 7120 channel for that of 7185 (41.75m) where it has been heard from 0030 to 0230, leaving the BBC transmitter on the former channel in the clear to S.E. Asian audiences.

XZK4 has a power of 50kW and, according to the published schedule, operates from 0030 to 0200 in Burmese and from 0200 to 0230 in English, the news being at 0200.

Other Burmese transmitters on the short waves are – XZK2 on 4725 (63.49m), XZK4 on 5040 (59.52m) and XZK5 on 9725 (30.85m), all 50kW. The address is – Burma Broadcasting Service, Prome Road, Kamayut P.O., Rangoon – if you are lucky enough to hear one of these stations. Reception of them here in the U.K. is rather difficult, especially where ordinary ‘domestic’ type receivers are in use.

**Nigeria**

This huge African country operates an External Service, a series of Local Services and a Commercial Service.

The External Service operates in English from 0530 to 0730, from 1350 to 1700 and from 1800 to 1930 on 7275 (41.24m) to West Africa; on 15185 (19.76m) to N. Africa, Europe and Mediterranean and on 15120 to E. Africa and the Middle East. From 1130 to 1200 on 7275 to West Africa, 15185 to East Africa and the Middle East, on 15120 to Central and South Africa. From 1800 to 1930 on 7275 to West Africa, on 11925 (25.16m) to North Africa, Europe and the Mediterranean and on 15185 to Central and South Africa. The newscasts are at 0600, 0700, 1330, 1630, 1830 and at 1900.

One Nigerian station that can often be heard is the transmitter at Benin City, capital of the Mid-West region of the country, once an African kingdom and famous for its bronze work. Listen on 4932 (60.83m) for this 10kW transmitter from around 2000 onwards. The schedule of Benin City is from 0430 to 1245 and from 1350 to 2305. Listeners in the U.K. should listen from around 2000 onwards.

**Bangla Desh**

Radio Bangla Desh has been changing frequencies virtually from day to day according to BADX. A recent monitored channel was that of 15553 (19.28m) where it opens with the news in Bengali at 1230, followed by the news in English at 1235 and the remainder of the programme consisting of music and talks in English. The announced channel of 15520 appears to be silent.

‘Bandspread’, the official journal of the British Association of Dx'ers, reports the following recent recordings of Radio Bangla Desh. On 9440 (31.77m), 9856 (30.44m), 9980 (30.34m) and now on 15553. The foregoing frequencies are those reported since Bangla
Desh gained independence. The programme closes with a request for views on programmes to be sent to The Director, Radio Bangla Desh, Dacca. ‘Jai Bangla’ ended the programme, no anthem was heard.

**CURRENT SCHEDULES**

- **USSR**
  
  English broadcasts from Radio Kiev for Europe can be heard on Mondays, Thursdays and Saturdays from 1930 to 2000 on 5920 (50.68m) 50kW and on 7120 (42.13m) 100kW. To North America from 0030 to 0100 on Tuesdays, Fridays and Sundays on 7120, 7130 (42.08m), 7150 (41.96m), 9660 (31.06m) and on 11850 (25.32m). From 0430 to 0500 on 7130, 9480 (31.65m), 9610 (31.22m) and on 9760 (30.74m).

  The English schedule of Radio Vinnitsia is from 2230 and 2300 on 7310 (41.04m), 9450 (31.75m), 9610 (31.22m), 9750 (30.77m), 9810 (30.57m), 11930 (25.15m) and on 12050 (24.90m) all 100kW.

- **MONGOLIA**
  
  Radio Ulan Bator now broadcasts in English from 1220 to 1250 on 15545 (19.43m) and on 17785 (16.87m) and from 2200 to 2230 on 9540 (31.45m) and 11860 (25.30m), all 50kW except the latter channel which is 25kW.

- **INDIA**
  
  The current schedule of Radio Kashmir is from 0130 to 0230 and from 1130 to 1700 on 3277 (91.55m) 1 kW, from 0320 to 0430 and from 0600 to 1100 on 7270 (41.75m) 7.5kW.

  Delhi can be heard with a programme directed to the U.K. at 2045 when identification is made and followed by “Press Review”. Listen on 9525 (31.50m) 100/250kW.

- **VENEZUELA**
  
  Radio Nacional de Venezuela operates on 9550 (31.41m), 11725 (25.59m) and 17840 (16.82m). According to station announcements, it is carrying out tests on 11725 (25.59m), 11750 (25.53m), 11770 (25.49m), 11970 (25.06m), 15390 (19.49m), 15400 (19.48m) and on 17840 (18.82m).

  According to BADX, the 11725 channel has been logged on 0130 with Latin American music and station identifications, some of them in English, and requesting reception reports. The 17840 channel has also been heard.

- **PROGRAMMES IN ENGLISH**

  In the past two issues of this journal we have featured some programmes in the English language that can be heard on the short waves, mostly for the benefit of beginner listeners. Here are a few more such programmes logged recently, the times GMT being listed first as usual.

  **1950 7225kHz** (41.52m) 18/120kW, Bucharest, Roumania, with newscast of world events and Roumanian affairs.

  **2200 6200kHz** (48.39m) 50/500kW, Tirana, Albania, home news and the Albanian view of events in Europe.

  **2200 6270kHz** (47.84m) 120/240kW, Peking, China, programme about Chinese surgery and acu-puncture.

  **2215 9695kHz** (30.94m) 250kW, Johannesburg, South Africa, world news and events in the Republic.

- **READERS LOG**

  J. V. Moss of Rayleigh, Essex, continues to do sterling work on his Meridian 10 transistor portable superhet. With a 60ft long wire aerial and an aerial tuning unit he managed to hear such stations as —

  **7065 2030** Tirana, Albania, news in English.

  **9515 2200** Ankara, Turkey, English programme to Europe.

  **9525 1945** AIR (All India Radio) Delhi, programme in English.

  **9545 2045** Accra, Ghana, news in English to Europe.

  **9605 2100** Sackville, Canada, Radio Canada International with news in English.

  **9625 2050** Jerusalem, Israel, with news in English.

  **9645 2050** Vatican Radio with news in English.

  **9675 2000** Warsaw, Poland, news in English.

  **9805 2200** Cairo, U.A.R., programme in English.

  **11620 1945** AIR Delhi with news in English.

  **11710 2230** VOA (Voice of America) Monrovia, Liberia, identification at sign-off.

  **11710 2304** AIR Delhi, news in English.

  **11720 2207** Sackville, Canada, news in English.

  **11780 2000** HCJB, Quito, Ecuador, with programme in English.

  **11850 2030** Accra, Ghana, news in English to North America.

  **11900 2235** Johannesburg, S. Africa, with English programme.

  **11910 2015** ETLF Addis Ababa, Ethiopia, religious programme in English.

  **11920 1845** Abidjan, Ivory Coast, news and identification.

  **11950 1730** FEBA (Far East Broadcasting Association), Seychelles, with religious programme in English.

  **11970 2240** Johannesburg, S. Africa, with programme in English.

  The above represents only part of the JVM log, which just goes to show what can be achieved with a transistor portable, good show JVM!

**CLUB CORNER**

From time to time in ‘QSX’ I have brought to the notice of readers several British clubs that cater for the short wave listener, on this occasion however, I should like to draw attention to a European club.

The Cimbrer DX-Club, Box 27, Aars, Denmark, is one of the best clubs and issue a very creditable journal The Cimbrer DX-News, the last issue of which contained 19 pages in English and only 5 in Danish, which is approximately the usual ratio.

A postcard to the address given above will bring full details.

**LAST LOOK ROUND**

A correct period report to most of the powerful Broadcast stations, such as Radio Canada, Moscow, Prague, Voice of America, etc., especially where accompanied by an International Reply Coupon, will almost certainly bring forth a reply QSL card. However, there are many stations in the 1 to 10kW class, privately owned and mostly located in the South American continent, that do not as a general rule reply to such reports. In some cases, reports from outside the service area of the station are not required and in others, the cost factor is of some importance. Other stations QSL spasmodically for no apparent reason.

If a report has been sent and no reply received after a reasonable length of time has elapsed, a follow-up letter should be posted to the station concerned enquiring about the original communication and, better still, enclose a further report.

**APRIL 1972**
Electronics covers a wide field and takes in devices ranging from integrated circuits to what are, on the surface, nothing more than simple switches. This month, Smithy the Serviceman shows his able assistant Dick some of the unexpected applications that are offered by the magnetically operated dry reed switch.

![Diagram of dry reed switch](image)

Fig. 1 (a). The construction of the dry reed switch. The circular sections of the reeds provide a good seal to the glass at the ends of the capsule. The tinned end sections are flat.

(b). If a bar magnet is brought up to the dry reed switch, the reeds take up the magnetic polarities shown here.

(c). When the magnet field strength is sufficiently high, the two inside ends of the reeds are attracted together and cause the switch to close.

"Is that all?" queried Dick scornfully. "I'd have thought that a couple of bits of springy brass strip would have been enough for a job like that."

"I am not," stated Smithy disdainfully, "in the habit of making up switching devices which incorporate bits of springy brass strip."

"What have you used then?"

"A normally-open dry reed switch."

A gleam of interest came into Dick's eyes.

"A dry reed switch, eh? What makes it operate?"

"Two magnets," replied Smithy.

"One is fixed to the door whilst the other is mounted on the door frame and biases the dry reed switch from Form A to Form B operation."

Despite his irritation with his assistant, Smithy could not help but chuckle at the expression of utter incomprehension which now settled on that worthy's face. The Serviceman glanced at his watch.

"It looks," he grinned, "as though you haven't the faintest clue concerning what I'm talking about. I see that we've got a bit of time to spare from work, so turn off that job on your bench and bring your stool over here. I'll then give you some gen on these dry reed switches."

Dick needed no second bidding and in record time was seated alongside the Serviceman.
"Well now," said Smithy. "Let's start at the beginning. I should imagine that most people who play around with radio have, at one time or another, seen a dry reed switch. It consists of a glass capsule, normally filled with an inert gas, in which are fused two flat blades or reeds, these being positioned so that their ends overlap. The reeds are made of magnetic material, which is frequently a 50:50 alloy of nickel and iron, and their overlapping surfaces are coated with a high conductivity metal such as gold. In the most common form of the switch the reeds are separated from each other and this is the normally-open type, sometimes referred to as the Form A version."

Smithy pulled his note-pad towards him and sketched out the normally-open dry reed switch. (Fig. 1(a)).

"The type of inert gas used," he continued, "tends to vary with different switch designs, but if the overlapping areas of the reeds are coated with gold, as they are in most instances, the gas is usually hydrogen, or nitrogen with a little bit of hydrogen added. In some switches, though, the glass capsule is completely evacuated. This occurs with switches which are designed to handle high voltages."

"These normally-open switches," asked Dick, "all work in the same way, don't they? The contacts close when you apply a magnetic field to the capsule."

"That's right," confirmed Smithy. "And this field can be provided in practice by a bar magnet. If we position a bar magnet parallel to the dry reed switch, magnetic polarities are caused to appear in the reeds." Smithy added a bar magnet to his previous sketch and marked in the polarities. (Fig. 1(b)).

"Here we are," he went on. "The north pole of the magnet causes the outside end of the adjacent reed to exhibit a south pole and its inside end to exhibit a north pole. Similarly, the magnet south pole causes the outside end of the other reed to exhibit a north pole and its inside end to exhibit a south pole."

"This bit's easy," put in Dick. "Since the two inside ends of the reeds now have opposite magnetic polarities they become attracted to each other. If the magnetic field from the magnet is strong enough they come together. (Fig. 1(c))."

"They do, in fact," affirmed Smithy. "What's more, they come together with a snap action. One of the inherent properties of the dry reed switch is its snap action on contact closure. This action is easy enough to understand when you realise that, once the applied magnetic field is sufficiently strong to start the reed ends moving towards each other, the magnetic attraction between them increases as the space between them decreases."

"Let's go back to something you said a few moments ago," said Dick. "You mentioned that the ends of the reeds are usually coated with gold, yes?"

"Yes, I did," confirmed Smithy. "The contact coatings are silver and tungsten, as well as some of the more exotic metals such as rhodium, palladium or platinum. At the same time, the outside ends of the reeds, which project outside the glass capsule, are tinned during manufacture to enable soldered connections to be made to them later."

"Since you can cause a dry reed switch to operate with a magnet," commented Dick, "I assume that you can also make it operate by means of a coil."

"Oh, definitely," agreed Smithy. "If you fit the switch inside a coil, the reeds will become magnetised when a current is passed through the coil in just the same manner as when a bar magnet is brought up alongside them."

Smithy quickly drew a coil and dry reed switch assembly. (Figs. 2(a) and (b)).

"When a current flows through the coil," he went on, "the switch operates. A dry reed switch inside a coil forms a dry reed relay."

Dick absorbed this information.

"Does a dry reed relay," he asked next, "have an improved performance when compared with an ordinary type of relay?"

"In many applications it has," replied Smithy. "The great advantage of the dry reed relay is that its contacts are not exposed to contamination by the air as occurs with the contacts of ordinary relays, and so they cannot become dirty or oxidised. Provided its contacts are not over-run, a dry reed..."
relay offers a good performance after well over a million operations, and it can keep this up under conditions of really heavy atmospheric pollution. Another advantage with dry reed relays is their very quick operating time. The contacts of a small normally-open dry reed switch will close within 0.00001 second, and the application of the appropriate magnetic field. Yet a further advantage is the small size and absence of mechanical complexity. There’s none of this business of moving armatures and so on that you get with ordinary relays.

“What are the main applications for dry reed relays?”

“They were originally used,” said Smithy, “to replace ordinary relays in telephone exchanges, and were introduced for this purpose as long ago as the late 1930’s by Bell Telephone Laboratories in America. Nowadays they turn up all over the place, in computers, aircraft and marine equipment, and pretty well anywhere else where ordinary relays might otherwise be used. Incidentally, a dry reed relay need not contain just one dry reed switch inside a coil. You can have relays in which two, three or four dry reed switches are fitted inside a single coil. All of these operate when a current is passed through the coil. These multi-switch relay coils look something like this.”

Smithy tore the top sheet from his pad and sketched out the coils he had described. (Figs. 2(c), (d) and (e).)

**CONTACT RATINGS**

“What sort of currents can dry reed switches handle?”

“There’s a surprisingly high range of currents,” replied Smithy. “For resistive loads you can get small dry reed switches capable of switching from around 10mA up to an amp at low voltages, or switching lower currents at higher voltages. There are larger switch that too, and these can handle currents of 3 amps or more. Most of the dry reed switches that appear in the home-constructor market are in the smaller category. Physical sizes range from a capsule length of around a third of an inch to a capsule length of several inches.”

“This dry reed switch business,” remarked Dick, “covers quite a wide ground, doesn’t it?”

“It does, rather,” agreed Smithy. “The next thing I’d better do is give you some of the terms you’re liable to bump into when you’re dealing with these switches. I mentioned the normally-open or Form A type of switch just now. There is also a normally-closed or Form B type. This is often given by a Form A switch with a magnet positioned alongside it which holds it energised. To make the switch contacts open you have to apply a magnetic field which opposes that of the magnet. Thirdly, there is the changeover, or ‘Form C’ type.”

Smithy quickly sketched out a Form C dry reed switch. (Fig. 3.)

“There are several ways of making a changeover switch,” he resumed, “but the simplest consists of manufacturing it in such a manner that a long reed taking up most of the capsule length rests against a contact which is made of non-magnetic material. When the magnetic field is applied the reed is then attracted towards the other contact, which is made of magnetic material. Note, by the way, that the changeover action is of the break-before-make variety. There is a moment, during the changeover, when the moving reed is connected to neither of the two fixed contacts.”

“Is that important?”

“To a certain degree it is,” said Smithy, “because it differentiates the Form C changeover switch from the Form D changeover switch. In the Form D switch there is a momentary connection between the moving reed and both fixed contacts at an instant during the changeover.”

Dick frowned.

“I don’t get that,” he remarked. “Looking at the dry reed switch you’ve just drawn I can see that you can’t help but get an inherent break-before-make action during the changeover. In fact, I simply can’t visualise how the switch could give a momentary make between the two fixed contacts. The two fixed contacts would have to be so close together that they’d all be touching, anyway.”

“You don’t get the Form D action with a reed switch of the type we’ve been discussing up to now,” stated Smithy. “You get it with a different type, which I’ll be describing shortly. I only mentioned the Form D business so as to clear up all the Form functions at the same time.”

“Fair enough,” conceded Dick. “What other terms are there?”

“There are a few more essential ones,” replied Smithy. “To start off with, there is what is known as ‘pull-in’. ‘Pull-in’ applies to the case where there is just sufficient magnetic flux, or just sufficient current in the energising coil, to cause the dry reed switch to operate. The opposite term is ‘drop-out’ and this applies to the case where there is just sufficient magnetic flux, or current in the coil, to maintain the switch in the operated position after pull-in has occurred. As you may imagine, the drop-out value is lower than the pull-in value. Typically, it is about half that value, although that may be surprising, although the difference is much less. Another term is ‘flux unit’. This applies to the minimum magnetic flux required to cause pull-in to occur. The minimum flux required is expressed, in practice, most conveniently in terms of the ampere-turns in a coil surrounding the switch.”

“That seems to me to be rather a haphazard way of working,” commented Dick. “I would have thought that the size and shape of the coil could have quite an effect on the flux applied to the switch. Two coils of different shape could give you two different pull-in ampere-turn figures.”

“That could happen,” agreed Smithy. “When a specification for a dry reed switch is given in ampere-turns, it is assumed that these apply to a coil of ‘standard’ dimensions. In any case, any coil within reason, provided it is about the same length as the glass capsule, will give a pull-in ampere-turns figure that will be reasonably accurate. In practice, also, there’s a pretty wide variance in the ampere-turn pull-in figures of individual switches of the same type, because it is difficult to manufacture them to operate at precise pull-in figures. A typical pull-in ampere-turns specification for a small switch may be quoted as 60 to 100. In some instances the specification may merely state a minimum ampere-turn figure only, and leave it at that. Specifications also include a drop-out ampere-turn figure, and this may have a similarly wide tolerance. Incidentally, the terms ‘operate’ and ‘release’ may be used in specifications instead of ‘pull-in’ and ‘drop-out’.”

**LATCHING CONFIGURATION**

“It seems a pity,” mused Dick, “that the drop-out value for most of these dry reed relays is a lot lower than the
pull-in value. This could be something of a nuisance in some circuit designs.

"It's an unavoidable feature with a dry reed relay," he remarked. "And, in any case, you get the same effect with conventional relays. As a matter of interest, the difference between the pull-in and drop-out values can sometimes be put to good use. I'll show you a representative example, using magnets."

Smithy pulled his note-pad towards him and sketched out a normally-open dry reed switch and a bar magnet. (Fig. 4(a)).

"Now, this magnet I've drawn," he went on, "is so positioned that the magnetic field strength it applies to the switch is just half-way between the pull-in and drop-out values. Since the field is below the pull-in level, the switch stays open. We next bring another magnet up to the switch."

Smithy added the second magnet to his diagram. (Fig. 4(b)).

"As this second magnet approaches the switch," he went on, "it adds to the field strength given by the first magnet. The total field strength eventually passes pull-in level, whereupon the switch closes. If we take the second magnet away again, though, the switch remains closed because the field..."
strength from the first magnet is above the drop-out level. In other words you have a latching action. Once the dry reed switch is closed it stays closed."

"Blimey, that’s neat," exclaimed Dick, impressed. "Are there any other tricks like that using magnets?"

"Here’s another one," said Smithy, taking up his pen once more. (Fig. 4(c).) "Once again we have a magnet permanently alongside the switch, which is also of the normally-open type. In this case, however, the magnet is sufficiently close to the switch to produce pull-in, and so the switch is closed. This is an example of a Form A switch being changed, or biased, to Form B operation by means of a magnet. I’ll now add a second magnet, with opposite polarity, and bring it up to the switch." Smithy drew in the second magnet. (Fig. 4(d).)

"This second magnet," he continued, "produces an opposing field with the result that, as it approaches the switch, the field strength around the latter reduces until it reaches drop-out level. The switch then opens. It closes again after the second magnet is removed."

"That’s a crafty one," remarked Dick. "Simply by providing the first magnet, you get the switch to give a function that’s exactly opposite to its usual one."

"True," agreed Smithy. "Now I’ll show you a further example of what you can do with magnets. Let’s suppose that the first magnet is strong enough to provide a pull-in field when it is situated some distance away from the switch. If we now bring the second magnet up to the switch, the latter will drop out, as before. Should we continue to bring the second magnet up to the switch the field strength it applies will become greater than that offered by the first magnet by the pull-in value, and the switch will eventually become closed again."

Smithy drew out this latest set of operating conditions. (Fig. 4(e).)

"Well," said Dick, "you can certainly get these dry reed switches to carry out some interesting functions with magnets."

**OPERATION WITH COILS**

"These magnet set-ups," said Smithy, "have quite a few useful practical applications. They are also helpful in introducing the same modes of operation using energising coils."

Smithy drew out a further diagram. (Fig. 5(a).)

"It is possible," he said, "to fit two separate coils over a dry reed switch. For best results the two windings should both be adjacent to the length of the dry reed switch capsule, and they could be interwound or wound in successive layers on the coil bobbin. Let’s call them winding A and winding B, and say that a current in one produces the same field strength as does the same current in the other. Can you think of

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**Fig. 5 (a).** A dry reed switch may be inserted inside two windings. For clarity, the windings are shown here on either side of the switch. (b) The coils and dry reed switch provide an OR function (c) This arrangement constitutes an exclusive-OR gate (d) A combination which functions as an AND gate
anything we could do with these windings?"

Dick, staring at the drawing and scratching his head.

"Why, of course," he said, suddenly struck by inspiration, "we can do exactly the same things with these coils as we did with the two magnets. For instance, we could reproduce the latching operation by passing a current through winding A which is just midway between the drop-out and pull-in levels. If we pass a current through winding B in the same direction, so that its field strength adds to that given by winding A, we will be able to pass over the pull-in level and close the switch. The switch will then stay closed even after we remove the current in winding B. Another thing we can do is to set up a current above pull-in level in winding A and a gradually increasing current flowing in the opposite direction in winding B. This would give the same result as we got with the two magnets of opposite polarity. As the current in winding B increases, we will reach a stage where its field cancels out that due to winding A, and the switch will open."

"And," prompted Smithy gently, "if you continue to increase the current in winding B?"

"Let me see now," said Dick, frowning. "Oh yes, I see what you're driving at. If the current in winding B increases further, its field strength becomes greater than that due to winding A and the difference will be equal to pull-in level again. So the switch will close once more. It's the same as we had in the last example with the magnets."

"Exactly," confirmed Smithy. "Two windings also enable us to set up simple logic gates. I'll add some magnetic polarity letters to the two coils to indicate the polarity of the fields they produce.

Smithy added the letters to his diagram. (Fig. 5b.)

"Now," he said, "the currents applied to both windings here are in the same direction and are above pull-in level. The switch will close if the current is present in winding A, if it is present in winding B or if it is present in both together."

"Stap me," exclaimed Dick, "that's the same result as you get with an OR gate. The switch is closed for current in winding A or in B or in both."

"Good," commended Smithy, busy once more with his pen. (Fig. 5c.)

"Now, here's another one, in which the current in winding B flows in the opposite direction to that in winding A. Both currents are equal and both are above pull-in level. What happens here?"

"Let me see now," said Dick, looking closely at Smithy's diagram.

"This will be close for current in winding A and current in winding B. But if there's current in both windings their fields will cancel out and the switch will then open."

"That's right," stated Smithy. "This time you have an exclusive-OR gate. The switch closes for current in winding A, or for current in winding B, but not for current in both together. Finally, I'll show you an AND gate."

Smithy drew a further diagram. (Fig. 5d.)

"In this case," he said, "the same current flows in the same direction in both windings and results in a half pull-in value. Now, the switch will not close for current in winding A or for current in winding B, but it will close for current in winding A and current in winding B. This gives you an AND gate."

"There seems," remarked Dick, thoughtfully, "to be a bit of a snag here."

"How come?" said Dick, "what about drop-out after pull-in has taken place?" To act as a proper AND gate the switch should open again if the current is removed from either winding A or winding B. But you said earlier that the drop-out current for most dry Reed switches is usually half the pull-in value. There's a risk, therefore, that, after it has closed, the switch in the AND gate will remain closed if the current is removed from only one winding.

"That's perfectly right," agreed Smithy, "and you put your finger on a weakness of this circuit. You need to keep operating conditions controlled pretty tightly if you want reliable drop-out working, and you have to employ a switch whose drop-out level is only a little lower than the pull-in level. The AND gate circuit is by no means as positive in its action as are the two OR gates."

CONTACT BOUNCE

"That last gate reminds me of something," remarked Dick. "Does it matter very much if the current flowing in the coil of a dry Reed relay is considerably larger than the pull-in value?"

"It does, rather," replied Smithy. "An almost unavoidable effect with dry Reed switches is that you get contact bounce after closure. The contacts tend to open again several times for very small periods very shortly after they meet. Under proper operating conditions this contact bounce takes place within the first millisecond or so after closure. It doesn't matter very much in most of the circuits in which dry Reed relays are used, but it is obviously undesirable to have too much of it because of the resultant contact wear. Contact bounce is normally at its minimum when the energising current in the coil is kept at or below twice the pull-in value for the switch."

A thought occurred to Dick.

"There's another thing," he said. "Why are they called dry Reed switches? Why is the word 'dry' used?"

"Fun filled enough," said Smithy,
"That word 'dry' applies to two features of the switch. It applies because the dry reed switch can be reliably employed in dry circuits, and also because it differentiates it from the mercury-wetted version of the switch."

Dick sighed.

"Why," he asked mournfully, "don't I keep my big mouth shut? I should have known that the answer would be far more baffling than the question! All right then, Smithy, let's start off with the dry circuit bit. What's a dry circuit?"

"It's a switching circuit in which negligible current flows when the switching contacts close," explained Smithy. "You sometimes have an ordinary relay, in say a telephone exchange, the contacts of which only pass a low level audio signal. If those contacts are caused to close only very occasionally, they are liable to become slightly oxidised and offer a high resistance path. A wetting voltage is sometimes applied to circuits of this nature to overcome this problem. The wetting voltage is a direct voltage applied in series with the source of audio frequency and it breaks down the oxide film when the switching contacts close and allows them to offer a low resistance path to the audio signal. With a dry reed switch, whose contacts cannot oxidise, you don't need a wetting voltage."

"Oh, I see," said Dick brightly. "Well, that's the dry circuit part explained. Next, what's a mercury-wetted reed switch?"

"It's one," replied Smithy, "which is mounted vertically, and has a small reservoir of mercury inside the capsule at its base. Apart from this it looks much the same as the dry reed type. The mercury wets up the lower contact reed by capillary action, with the result that it is present at the junction of the two reeds. When these are open on drop-out the current they switch is carried by a little bead of mercury between the contact faces until the distance between the two contacts is too great to enable the mercury to stay in position, whereupon it breaks the circuit. The result is that break current stresses are kept away from the contact surfaces themselves and the switch is capable of controlling relatively high values of current without excessive contact wear. This type of switch doesn't suffer from contact bounce. In the changerover form, the long moving reed is the one in contact with the mercury reservoir, and it can be made to give the Form D operation I mentioned earlier."

"Dash it all," complained Dick. "That Form D business was the thing I was going to ask you about! All that's left now is the electric bell gadget you were playing around with at the beginning and which started all this loo off!"

"That's easy," replied Smithy cheerfully.

He tore a further sheet from his pad and drew out a circuit. (Fig. 6.)

"All there is here," he said, "is a normally-open dry reed switch mounted on the door frame with a magnet alongside it. Another magnet with opposing polarity is mounted on the door itself so that, when it is shut, the fields of the two magnets cancel out and the reed switch is open. When the door is opened the reed switch is subjected to the field from a single magnet only and it closes, thereby actuating a standard relay which in turn rings the bell. We've already discussed the manner in which these two magnets operate the switch. When you saw me raising and lowering my hand, I had the dry reed switch and one of the magnets lying on the bench and I was raising and lowering the other magnet to check the operation of the circuit."

A MEASURE OF DISTRUST

"Why," asked Dick, "did you include the ordinary relay? Couldn't the dry reed switch operate the bell directly?"

"A high current type could, probably," said Smithy, "although you have to be a bit careful with circuits containing electric bells as they sometimes draw surprisingly heavy currents and produce surprisingly high back-e.m.f. voltages. But the reed switch I happen to have is a low current type anyway, and so I put the bell circuit on to the contacts of an ordinary relay. The diode across its coil is merely to keep high back-e.m.f. voltages off the reed switch when the latter opens."

"You seem to have thought of pretty well everything there," commented Dick. "Nobody could accuse you of being incautious, Smithy."

"I believe in covering all the eventualities I can think of," grinned Smithy. "Besides, I know those characters in that shop of ours, and another reason for using that ordinary relay is that they wouldn't be above adding a few extra bells to this gadget after my back was turned. I wouldn't want to subject a dry reed switch to unexpected additional loads such as that."

And with this statement, reprehensible in its lack of trust in his fellow-men but at least demonstrating a knowledge of human frailty equal to that of electronic short-comings, Smithy brought the discussion to a close.
So far as I can recall, my first introduction to the use of acronyms occurred near the end of World War II when, in the R.A.F., I encountered the word RADAR (made up from Radio Detection And Ranging) which was then superseding the earlier 'radiolocation'.

In passing it may be mentioned that, some time after the war, the practice arose in the R.A.F. of calling the Station Warrant Officer the 'SWO-man', frequently preceded by the adjective 'abominable'. Such was the power of the W.R.A.F. in those far-off pre-Women's Lib. days that in one camp we even had a woman SWO-man.

MODERN USAGE

Nowadays these abbreviations are part of the daily scene, this being particularly the case in the higher echelons of electronics, and I'm beginning to think it's about time that those of us who work at the servicing bench or who carry out amateur construction at home had a belated attempt at similar hyperbole.

Most of us are familiar with the instance where a screen-grid or anode capacitor breaks down to chassis and results in cooking-up of the resistors in the h.t. supply circuit to that screen-grid or anode. What better description for this state of affairs can be given than Overheating Valve Electrode Network, or OVEN? At the same time, those infuriating faults which appear only on occasion richly deserve the description of the consequent Time Wasting Intermittent Tests, or TWIT. And does not the acronym BOMB adequately cover the beginning of multiple breakdown?

Personalities also lend themselves to these condensations. Very often the Fastidious, Lively, Interested Person (FLIP) is balanced out by his counterpart who exhibits Fundamental Lack Of Potential (FLOP). Also, those pop groups with their multi-kilowatt amplifiers must certainly dub as FAB the Fully Amplified Bass they produce. (Even if the subsequent overloading of their ear-drums might necessitate an early visit to the First-Aid Box).

But that's enough of acronyms for now, and we must turn our attention to more serious matters. Such as, for instance, future electronic possibilities, as typified by the Galvanic Radioactive Atomic Battery. And how does that GRAB you, my friends?

So far as I can recall, my first introduction to the use of acronyms occurred near the end of World War II when, in the R.A.F., I encountered the word RADAR (made up from Radio Detection And Ranging) which was then superseding the earlier 'radiolocation'.

In passing it may be mentioned that, some time after the war, the practice arose in the R.A.F. of calling the Station Warrant Officer the 'SWO-man', frequently preceded by the adjective 'abominable'. Such was the power of the W.R.A.F. in those far-off pre-Women's Lib. days that in one camp we even had a woman SWO-man.

MODERN USAGE

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METRICATION

As is reflected by the latest Constructor's Data Sheets which are appearing in this journal, metrification in the U.K. is proceeding at a greater speed than some of us realise. In the last two R.S. Components catalogues, for instance, nearly all component dimensions are given in millimetres instead of in inches. As most of you will already know, 'R.S. Components' is, of course, the new name for Radiospares.

Fortunately, the introduction of millimetres does not raise many problems in the home-constructor field, and it is possible for us to work with millimetres or inches with equal ease. An interesting fact is that one very large English firm, Mullard Limited, have been using millimetres for the dimensional specifications of their products for as long as I or anyone else can remember. British set-makers have been able, over the years, to fit Mullard components and valves into their otherwise inch-oriented systems without any trouble at all.

One point to watch out for when dealing with European drawings which are dimensioned in millimetres is that it is the Continental practice to denote a decimal point by means of a comma instead of by the full-stop that we use. This could cause some ambiguities because we have the habit of alternatively using the comma to separate the digits of a number in groups of three. Thus, to us the number 15,672 means fifteen thousand, six hundred and seventy-two. With the Continental approach that number means fifteen point six seven two. Quite a difference, as you will agree.

There are other factors in which Continental usage differs from ours, these appearing particularly in circuit diagrams. For instance, Continental circuit diagrams tend to express capacitance in units of nanofarads much more frequently than we do in the U.K. A nanofarad is equal to 1,000 picofarads or to one thousandth of a microfarad, and it has the abbreviation 'nF'. In a badly reproduced Continental circuit diagram an English person could mistakenly assume that units shown as 'nF' were actually 'mF' or microfarads; so this is another little point to look out for. Incidentally, the use of 'mF' instead of 'nF' to depict 'microfarad' is very bad practice but, regrettably, one encounters it every now and again.

Of the other discrepancies between the Continental approach in circuit diagrams and our own, the most common is the use of rectangles instead of 'wriggily lines' for resistors, and the use of small black circles to represent valve cathodes. These, however, are minor matters which those of us who have mastered 'la plume de ma tante' can take in our stride.

RESISTOR CHOKE FORMERS

This is a common practice to employ wire-ended carbon composition resistors as formers for home-wound r.f. chokes. Resistors of this nature offer a very convenient body on which such chokes can be wound, since they offer two lead-outs to which the choke terminations may be soldered. There are, however, one or two requirements which have to be satisfied if chokes wound in this manner are to perform satisfactorily in practice.

The first point to bear in mind is that the resistor is, obviously, connected in parallel with the choke. The resistor must in consequence have a high value, preferably at least 470kΩ. In some circuits it is required to have a choke with a fairly low value of resistance connected across it. In this instance the low value of resistance can be provided by the resistor on which the choke is wound.

Secondly, it is preferable that the resistor consist of a resistive carbon...
all the strands through' appeared reproduced produced wrong standard bridge rectifier.

A choke wound on a ring of copper spray would not present the requisite value of inductance, and you can avoid the risk of accidentally choosing a resistor which has had the copper spray treatment by only employing components with a tolerance of 10\%., or more.

LABORATORY HANDBOOK

I must next record the fact that the eighth edition of M. G. Scroggie's Radio and Electronic Laboratory Handbook (Hilfre Books, £4.75) has now been published. This book will be reviewed elsewhere in this journal but I do feel that a special mention is justified in these columns for what, over the last thirty years, has become one of the standard works in electronics. This eighth edition has been completely revised and reset, and it uses SI units throughout.

One of its greatest values is its complete practicability, and it even pays attention to the occasional desirability of checking out circuits by the 'bird's nest' approach, in which a few components are quickly soldered together without visible means of support. This informal technique, says Mr. Scroggie, 'sometimes saves time' but 'it should not be allowed to become a habit'. There are few of us who, when suddenly seized with an idea which involves up to half-a-dozen small components, have not in our eagerness at some time made a quick 'lash-up' to see if the scheme was workable, after which we wired up the components in a more durable and respectable manner later on.

But Radio and Electronic Laboratory Handbook goes far deeper into the science of electronics than this. It is a virtually indispensable reference work for anyone who is seriously interested in the art, and my copy now takes pride of place on my bookshelves.

?? HALF-A-DOZEN PUZZLERS ??

By

P. MANNERS

Here are the answers to the problems given on page 539

1. All the engineer had to do was to stick the two halves of the rod together with a good cold-setting adhesive! This is quite a permissible repair for ferrite aerial rods and was recommended by Mullard some years ago. The two broken parts should nest against each other accurately, and there should be a minimum of adhesive in the gap. A slight repositioning of the coils along the rod to obtain correct tracking may be needed after the adhesive has set.

2. The Professor's circuit is nothing other than a standard bridge rectifier.

3. The officer put the tape through the recorder the wrong way, with the result that the message was reproduced in reverse and asymmetric Morse characters appeared as different letters. Thus, L (---) was reproduced as F (---) and so on. With the tape placed in the correct direction the message is: 'WE ARE ONLY HERE FOR THE BEER'.

4. In the equations, x = 10 and y = 50. (10 C is equal to 50 F, and 10 shillings is equal to 50 new pence).

5. Undoubtedly. Present-day Litz wire uses 'solder-through' enamel on the individual strands and there is no need to scrape this off. It is merely necessary to apply a hot soldering iron and resin-coated solder, whereupon all the strands become at once soldered together!

6. Maximum programme length will be given by using tape with a magnetic coating on both sides and sticking it together to form a Moebius band, an example of which is shown in the diagram. A Moebius band differs from an ordinary band (such as is exemplified by a flat elastic band) insofar that one end of the tape is twisted through 180° before the ends are joined together. If a loop of this nature were drawn past the playback head the programme will be carried successively by the magnetic coatings on the alternate sides of the original tape and will be equivalent in length to that given by a normal tape loop 200 ft. long. A Moebius loop or band, it may be added, is a subject of topological interest since it has only one surface and only one edge. Also, Moebius loop tape playback systems have been promoted commercially.

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The appearance of a Moebius band or loop

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