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Further information is contained in Publication No. TD TPC 5—available on request.
SEPTEMBER 1960

417 Editorial Comment
418 Transistor V.H.F/F.M. Receiver—2  By R. V. Harvey
423 Medical Electronics at Olympia
426 Converting to Stereo
427 S.B.A.C. Exhibitors
427 Short-wave Conditions
428 World of Wireless
430 Personalities
431 News from the Industry
433 Letters to the Editor
436 National Radio Show Guide
451 The Genius of A. D. Blumlein  By M. G. Scroggie
457 Quarter-wave Transformers  By "Cathode Ray"
461 Transistor Inverters and Converters—2  By M. D. Berlock and H. Jefferson
465 How Precise is your Attenuator?  By H. Stern
467 Technical Notebook
468 Elements of Electronic Circuits—17  By J. M. Peters
469 Conferences and Exhibitions
470 Random Radiations  By "Diallist"
472 Unbiased  By "Free Grid"

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The National Radio Show

ONCE again the annual exhibition of the British domestic radio and television receiver manufacturers opens its doors at Earls Court and we are to experience the bustle and excitement, the sights and sounds, both familiar and unexpected, which combine to create the special atmosphere which is associated with this annual event. True things are not as hectic as they are remembered in the early and middle 1930s when the pace of technical development from the primitive to the sophisticated was at its hottest, and we shall not lack the depressive cynicism of those blasé individuals who pretend to find nothing new—"The mixture as before, old boy." But let no one mistake stability for stagnation. A little probing behind the familiar facade has never yet failed to produce more than enough to fill the time of the technically minded visitor with interesting food for thought.

To get the best out of an exhibition in the limited time at one's disposal it should be tackled rather like an examination paper. One should go first for the obvious questions (and here we hope that a study of the guide to the stands given elsewhere in this issue will enable readers to decide their individual priorities); then in the time that remains one makes sure that the manufacturers’ stands which have not so far been visited do not spring some last-minute surprises. It is not unknown for manufacturers to withhold information until the opening day, or even to surprise themselves by last minute brainwaves!

Among things we shall look for first are the new transistor v.h.f./f.m. battery sets to see how they compare with the "no-compromise" B.B.C. design now being described in this journal. We shall be interested in the picture quality of 405 lines as displayed on 21-in tubes and how far set makers have been successful in solving the now vital problem of ensuring correct interlace. And, of course, transistors which will be shown in embryo and in their multifarious applications in ways which cannot fail to add something to the knowledge of every visitor, layman, or professional. High-quality sound reproduction enthusiasts will make for the Audio Hall, where they may expect to find new pick-ups of phenomenally light construction and tape recorders with yet wider frequency range and extended playing time. Stereo, after its somewhat strident introduction last year, has now settled into its rightful place as an important but not the only contributory element in the search for a system of realistic sound reproduction.

One of the most valuable aspects of the Show is the opportunity which it affords of a glimpse behind the scenes of the sources of broadcast entertainment, to acquaint or remind us of the scale and complexity of the vast fabric of transmission and studio production necessary to put the shortest camera shot on our screens or the briefest news item on our loudspeakers. This is too often taken for granted, as are the lengthy processes of evolving new receiver designs and getting them into quantity production.

The "sideshows" as they are somewhat unkindly referred to by those engaged in the mainstream of the industry, also play an important part. The Services, both civil and military, give us an insight into those aspects of their work which increasingly involve electronics and communications and which they hope will attract the up-and-coming younger generation whose first interest in such things was perhaps stimulated by tinkering with a simple home-built receiver. We particularly commend the enterprise of B.R.E.M.A. and the R.T.R.A. in staging an exhibit to show the public the why and how of radio and television receiver servicing and to attract the best technical talent to a challenging and important career.

The Radio Show has served for nearly forty years as the focal point of the radio industry where potential customers can see under one roof the choice available to them, where manufacturers and their dealers can do business and where those interested in technical development can take stock, conveniently and at first hand, of the march of events. The Show will lose much of its value if it is not comprehensive and we view with misgiving the decision of one of the large firms, Pye, to hold a separate exhibition this year outside Earls Court. It may be true, as they say, that the Radio Show offers limited scope for a sufficiently comprehensive display of the Group's diverse activities, but that could equally well be said of A.E.I. and many other great firms who are nevertheless content to support the Show and to let us see those sections of their interests which impinge on broadcast entertainment. We hope that any unusual circumstances which may have influenced Pye's decision this year may be circumvented and that next year we shall be sure of finding all the important firms, both great and small, once again under the same roof.

Wireless World, September 1960
Transistor V.H.F./F.M. Receiver

By R. V. Harvey*, B.Sc., A.M.I.E.E.

A GENERAL view of the receiver chassis is shown in the photograph. The i.f. amplifier occupies about 11 inches along the centre of a brass channel $20 \times 3 \times 1\text{in}$; the r.f. and a.f. circuits are housed in separate units at each end. The left-hand knob is the on-off/a.f.-gain control; the right-hand knob controls the tuning and is coupled to the scale pointer by a cord drive using flying pulleys to obtain the expanded tuning scale as shown in Fig. 2; this layout is convenient for the size of cabinet chosen but these units could be disposed in a more compact form if desired, provided that no liberties are taken with the circuit layout. In particular, the i.f. unit has a maximum gain of 90 dB and is unscreened; any reduction in the spacing of two inches per stage would necessitate some additional screening.

R.F. Unit.—Fig. 3 shows the layout of the r.f. circuits. The unit chassis measures $4\frac{1}{2} \times 2\frac{1}{2} \times \frac{7}{8}\text{in}$ and is supported $\frac{7}{8}\text{in}$ above the main chassis by four brass pillars; this gives sufficient clearance for the $2\frac{1}{2}$-in diameter tuning-drive drum. The tuning coils are wound with the earthy ends uppermost to enable the coupling coils to be added subsequently. The r.f. input coil is wound in a left-hand sense for convenience, and the earth return for the coil and input capacitor is a tag on the input socket. The oscillator transistor is placed close to the tuning capacitor with its base lead adjacent to the oscillator coil, to which it is tapped at the first turn via a 3000-pF ceramic-disc capacitor. The tag on the frame of the tuning capacitor is used as the earth connection for the oscillator coil, the internal screen of the transistor and the collector-decoupling capacitor. A feed-through capacitor in the centre of the chassis supplies the collector and base circuits; the base-feed choke is detailed in the coil winding data.

The i.f. output tags project through holes in the main chassis and are connected directly to the i.f. input coil and the only earth point for the whole mixer is between the tags. The circuit diagram, Fig. 1, shows an extra pair of capacitors and a centre-tapped choke between the oscillator coupling coils and the mixer diode. This latter circuit may be added at a later stage if required but normally it will not be necessary and it has therefore been omitted from the layout. The tuning-capacitor swing is restricted to $150^\circ$ by two diametrically-opposed studs, $\frac{3}{8}\text{in}$ in diameter, fixed to the tuning drum, which engage with a similar stud projecting from the frame bar of the capacitor. The r.f. unit has a screening cover. This may be omitted if the wiring is kept close to the chassis but there will then be an increase in both oscillator radiation and i.f. break-through. To prevent microphony due to movement of the oscillator circuit, a liberal application of polystyrene cement to the coils and the mixer crystals is recommended, and the transistor should be fixed to the chassis with a suitable adhesive. The coaxial input socket is connected to a socket at the rear of the cabinet by a coaxial lead; an internal dipole, made by splitting

*B.B.C. Research Department.

2. Construction and Alignment

Fig. 2. Arrangement of tuning drive and dial with jockey pulleys to double scale length.

Wireless World, September 1960
back some twin flex for about two feet and pinning it round the inside of the cabinet back, may be plugged in if desired.

**I. F. Unit.**—Starting as close as possible to the r.f. unit, the brass channel is drilled for the six coil formers at 2-in spacing between centres. Following each coil a tag-board, \(1 \times 2 \frac{1}{2} \times \frac{1}{8}\) in, should be mounted under the chassis. The six tag-boards are fixed on \(\frac{1}{8}\) in spacers, and each carries six small turret terminals. The first four tag-boards carry the four i.f. transistors; the last two carry the limiter, discriminator and first a.f.-stage circuitry. Fig. 4 shows the layout of the first two i.f. stages and Fig. 5 shows the limiter and discriminator. At the end of the i.f. chassis there is a four-pin plug which engages with a socket on the a.f. unit. The pin connections used are:

1. A.F. output to gain control via C62.
2. Supply for oscillator from Zener diode.
4. Used as soldering tag for the Zener diode circuit which is mounted on the i.f. chassis for convenience. The earth connection between the two chassis is completed by bolting them together.

**A. F. Unit.**—The chassis measures \(5 \times 3 \times 1\) in and carries a vertical brass partition \(3\) in square. The output transistors are bolted to this partition with mica plates and nylon screws which are supplied with

---

**Fig. 3. Layout of r.f. unit. Coupling coils on T1 and T2 are shown, for clarity, as if 'lifted off' formers.**

**Fig. 4. First and second i.f. amplifier stages: wiring of the following stages is similar.**

**Fig. 5. Limiter, discriminator and first a.f. amplifier layout.**
each matched pair of transistors. The power-input plug, loudspeaker socket and the fuse are mounted at the rear of the chassis. A power plug of a polarized type must be used to prevent accidental reversal of the supply; the recommended batteries each require a polarized plug and these should be made up in a power lead with a flying socket connector for the input to the set. An exact layout for this unit is not given as it is not vital to the performance and is determined mainly by the dimensions of the capacitors used.

Alignment

Before switching on for the first time, it is advisable to check that the polarity of the supply and of the electrolytic capacitors is correct. During alignment, any changes to the connections of the circuit should be performed either with the power removed or after careful consideration of the consequences (which may be swift, ominously silent and expensive!).

A. F. Unit.—Disconnect the feedback network, R14C50, from the a.f. output and connect it to earth. Disconnect C52 from the gain control. R41 and R42 must then be adjusted so that the quiescent current in the output transistors is between 5 and 10 mA. These currents are best measured by connecting a meter of 1000-ohms resistance across the one-ohm emitter resistors, R44 and R59 and adjusting for between 5 and 10µA.

Connect a tone source of 6.8-kΩ impedance to the "live" end of the gain control through an 8-µF blocking capacitor, and an oscilloscope across a 15-ohm resistor in place of the loudspeaker. If the transformer secondary windings are correctly connected, an input e.m.f. of 70 mV r.m.s. should produce an output of 11 volts peak-to-peak and an increase of input above this should produce a symmetrical flattening of peaks. If there is noticeable cross-over distortion at low input levels, this may be minimized by a further adjustment to R59 and R41. Reconnect the feedback network; if the transformer primary sense is correct the gain will fall by 16 to 18 dB.

I. F. Amplifier and Discriminator.—Disconnect the a.g.c. line from C40 and connect it to a potential divider consisting of 10 kΩ from the supply and 1.5 kΩ to chassis. Short-circuit L9, replace C69 by a 100-pF capacitor and connect the junction of this and R19 to an oscilloscope via a 10-kΩ resistor. Connect a f.m. signal generator, using a 0.01-µF isolating capacitor, to the collector of V5. Set C53 to half-capacitance and tune L50, L7 and T4 for maximum response at 10.7 Mc/s. Increase C53 in stages, adjusting L6 and L7 until the response curve is just over-coupled and adjustment of either L6 or L7 produces a tilt of the response symmetrical about the centre frequency. Transfer the signal generator connection to the base of V4, set C22 half way and tune L33, L4 and L8 for maximum at 10.7 Mc/s. Increase C53 in stages till the response shows 1-dB peaks at 10.7 Mc/s ±60 kc/s, as shown in Fig. 6, and responds to adjustment of L5 and L7 by a symmetrical tilt. At each adjustment, vary the input level to ensure that the last i.f. stage, V7, is not overloading. Replace C10, insert a 1-mA meter in series with R7, and measure the response point by point and compare with Fig. 6.

To align the discriminator, transfer the oscilloscope to the a.f. output (top of C15). With the f.m. signal generator set to the centre of the i.f. pass-band, 10.7 Mc/s, and deviated ±200 kc/s, set C45 to half way and tune L4 and L19 to obtain a symmetrical response of the general shape of Fig. 7. Adjust the discriminator coupling in stages by moving L9 along the coil former until with further adjustments to L9 and L19, the response is symmetrical and linear over ±120 kc/s. Insert a microammeter between R14 and R25 and, for constant current in R15, measure the discriminator load current, point by point, over the frequency range ±200 kc/s and compare with Fig. 7.

Limiting and Third-Harmonic Filter.—Remove the short-circuit from the third-harmonic filter, L6 C41, and re-tune the limiter transformer, T3; a maximum current in R16 set the input level to make this current 200 µA. Connect the oscilloscope via a 100-kΩ resistor to the junction of V9 and R25. Apply 100% amplitude modulation to the signal and display the amplitude response of the limiter. The reader should refer to J. G. Spencer's article* for curves showing limiting characteristics in various conditions. Lm must be adjusted to give a curve with a top as flat as possible, consistent with the knee of the curve occurring at a low value of instantaneous input. If the knee shows at less than 70% modulation or more than 80%, the discriminator coupling capacitor C26 should be decreased or increased accordingly. This last adjustment is a matter of compromise in that a greater absolute sensitivity can be obtained by increasing C41 at the expense of a lower a.m.-handling capacity by the limiter. The procedure for aligning the discriminator should be checked after completing the limiter and coupling adjustments; the a.g.c. line is then re-connected.

The above alignment may, if desired, be performed at an input frequency of 90 Mc/s after adjusting the r.f. circuits.

R.F., Oscillator and Mixer Circuits.—Break the earth connection between Pin 2 of T3 and chassis.

---


Fig. 6. Overall frequency response preceding limiter.
insert a 0.01-\mu F disc capacitor and connect across it a 1-mA meter to measure the mixer current. Set the tuning capacitor to half-mesh, remove the dust core from T1 and set the core of T2 so that it protrudes \( \frac{1}{4} \) in. from the top of the former. Adjust R1 to give maximum mixer current; this should be at least 150 \( \mu A \), at a collector current in V3 of about 1 mA. Insert the core into T1 from the top until a dip occurs in the mixer current reading, then unscrew the core three turns. Connect a f.m. signal generator to the aerial socket and set its output to 1 mV at 91 Mc/s. Adjust T2 core until the signal is heard and then set T1 for maximum limiter-load current. The tuning range should be adjusted in this way so that at 87 Mc/s the capacitor is at 160° and at 100 Mc/s it is at 10° from minimum capacitance.

**Resistors**

The resistors used in the original receiver were 10% \( \frac{1}{2} \) W Erie Type 16, except R4, R5 and R6.

- R1* 56kΩ R15, 20, 12, R24, 29 8.2kΩ
- R2 2.2kΩ 21, 27, \{ 6.8kΩ
- R3 100Ω 25, 26 100kΩ
- R4 150Ω R16 5.6kΩ
- R5, 8, 31 3.3kΩ R17 1.5kΩ
- R6, 9, 13 4.7kΩ R18, 39, 41\* 560Ω
- R7, 10, 14 1.8kΩ \{ 41* 680Ω
- R11, 33 22kΩ R19, 22 10kΩ
- R12 15kΩ R23, 30, 36 1kΩ

*Adjust on test, see alignment instructions.

The volume control is 5 kΩ log, or semilog, law potentiometer with switch. Resistors R4, R5 and R6 are one ohm in value and are made by winding a 134-inch in length of 26 s.w.g. insulated (double-cotton-covered) Eureka wire as a self-supporting coil.

**Fixed Capacitors**

Many of the capacitors listed below were chosen not only for a particular value of capacitance but for other features such as temperature coefficient or size. If it is desired to use a component produced, for instance, by another manufacturer, a careful check should be made to ensure that all

<table>
<thead>
<tr>
<th>Capacitor</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>100 pF</td>
<td>Erie N750/BD</td>
</tr>
<tr>
<td>C2, 16, 24, 29, 36</td>
<td>6.8 pF</td>
<td>Erie NPO/AD</td>
</tr>
<tr>
<td>C3, 12</td>
<td>18 pF</td>
<td>Erie N750/AD</td>
</tr>
<tr>
<td>C5, 6</td>
<td>470 pF</td>
<td>T.C.C. 101 SMP</td>
</tr>
<tr>
<td>C7, 10, 11, 15</td>
<td>3000 pF</td>
<td>Erie K7004/831</td>
</tr>
<tr>
<td>C8, 9</td>
<td>47 pF</td>
<td>Erie NPO/AD</td>
</tr>
<tr>
<td>C14</td>
<td>4700 pF</td>
<td>T.C.C. CH315/LT</td>
</tr>
<tr>
<td>C17, 18, 20, 23, 25, 27, 28, 30, 32, 35, 37, 38, 39, 48</td>
<td>0.01 µF</td>
<td>Erie K7004/811</td>
</tr>
</tbody>
</table>

**Variable Capacitors**

As with some of the fixed capacitors, special characteristics may have influenced the choice of the variable capacitors specified.

- C4, 13 Tuning capacitor. Wingrove and Rogers Type C28-142, 9/0.045in. 7 to 18 pF per section. Restricted to 150° swing by stops on drum.
- C22, 33 L.F. coupling. Wingrove and Rogers Type C32-01, 10/0.0075in. 2 to 11 pF.
- C42 Discriminator coupling. Wingrove and Rogers Type S50-01/2. 0.7 to 4 pF.

**Coil Data**

Unless otherwise stated, the wire used for winding is enamel insulated. Numbers in brackets indicate the connections shown on the circuit diagram given last month (Fig. 1) and correspond with the numbers given on the coil formers. Where capacitors are mentioned, they should be fitted inside the screening can.

<table>
<thead>
<tr>
<th>Capacitor</th>
<th>Value</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>C19, 21, 31, 34</td>
<td>330 pF</td>
<td>T.C.C. 101 SMP</td>
</tr>
<tr>
<td>C26</td>
<td>68 pF</td>
<td>T.C.C. 101 SMP</td>
</tr>
<tr>
<td>C40</td>
<td>8 µF</td>
<td>15V electrolytic, T.C.C. CE67B</td>
</tr>
<tr>
<td>C41</td>
<td>3.3 pF</td>
<td>Erie NPO/AD</td>
</tr>
<tr>
<td>C43, 44, 45</td>
<td>120 pF</td>
<td>T.C.C. 101 SMP</td>
</tr>
<tr>
<td>C46, 47</td>
<td>27 pF</td>
<td></td>
</tr>
<tr>
<td>C49*</td>
<td>0.01 µF</td>
<td></td>
</tr>
<tr>
<td>C50, 57, 60</td>
<td>1000 µF</td>
<td>25V electrolytic</td>
</tr>
<tr>
<td>C51</td>
<td>100 µF</td>
<td>6V electrolytic</td>
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<tr>
<td>C52</td>
<td>8 µF</td>
<td>15V electrolytic</td>
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<tr>
<td>C53, 56</td>
<td>1000 µF</td>
<td>6V electrolytic</td>
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<tr>
<td>C54</td>
<td>4 µV</td>
<td>12V electrolytic</td>
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<tr>
<td>C55</td>
<td>820 pF</td>
<td>mica</td>
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<tr>
<td>C58</td>
<td>0.25 µF</td>
<td>paper</td>
</tr>
<tr>
<td>C59</td>
<td>500 µF</td>
<td>12V electrolytic</td>
</tr>
</tbody>
</table>

* The value (0.003µF) given for C49 in Fig. 1 (August issue) gives a de-emphasis time constant of about 15sec (not 30sec as stated) for treble boost. For 50sec de-emphasis (flat electrical response) C49 should be 0.01µF. References to 1,200pF for C40 in both the caption to Fig. 1 and p. 369 should be deleted.
**R.F. and Oscillator**

**Former:** Neosid 3500, Bakelite, 7 mm outside diameter (o.d.).

**Core:** Neosid 901, 6 x 12 mm.

**R.F.:**

**T1**
6 turns 20 s.w.g. tinned-copper (t.c.) wire spaced to occupy 0.4 in.
Coupling coil; 2 turns 36 s.w.g. interwound with last turn at earthy end.

**Oscillator:**

**T2**
8 turns 20 s.w.g. t.c. spaced to occupy 0.6 in.
Coupling coil; 2 turns bifilar 36 s.w.g. connected as 4 turns with centre tap and interwound with last turn at earthy end. Base tapping one turn from emitter end of winding.

**Bias Choke:**

**L1**
110 turns 40 s.w.g. close wound on \( \frac{1}{8} \) in. o.d. Paxolin tube or rod, with 20 s.w.g. t.c. end wires in a separate part.

**Mixer Choke**

**L2** (optional)
40 turns 38 s.w.g. centretapped (c.t.) on Neosid CH2 dust core.

**L.F. Amplifier**

**Former:** Neosid 5000 B/6E (7.6 mm o.d.).

**Top:** Neosid 5001/6E.

**Can:** Neosid DT1/4.

**Core:** Neosid 900, 6 x 1 x 12 mm.

**Input:**

**T3**
Primary: 5 turns bifilar 22 s.w.g. close wound, connected as 10 turns (1, 3) with c.t. (2).
Insulation; 2 turns cellulose tape.
Secondary; 7 turns (4, 5) 22 s.w.g. close wound centrally over primary.

**Second i.f.:**

**L3**
Primary at top, 12 turns 22 s.w.g. (1, 3) tapped (2) at 3 turns from (1).
Coil spaced to occupy \( \frac{1}{8} \) in.
Capacitor, C19, across coil, 330 pF silvered mica.
Spacing between coils \( \frac{1}{8} \) in.

**Secondary:**

12 turns 22 s.w.g. (4, 6) tapped (5) at 3 turns from (4).
Coil spaced to occupy \( \frac{1}{8} \) in.
C21 across coil, 330 pF silvered mica.

**Third i.f.:**

**L5**
24 turns 28 s.w.g. (1, 3) close wound tapped (2) at 6 turns from (1).
C26 across coil, 68 pF silvered mica.

**Fourth i.f.:**

**L6, L7**
As second i.f. L3, L4 respectively, (capacitor numbers C31, C34). 

**Limiter:**

**T4**
Primary at top starting (1) \( \frac{1}{8} \) in below top plate, 32 turns 38 s.w.g. (1, 3) tapped (2) at 8 turns from (1).
Secondary; 72 turns 38 s.w.g. (4, 6)
Wound as single layer solenoid with 24 turns of primary (2, 3) interwound with first 24 turns of secondary starting at (4).

**Third-harmonic filter:**

**L8**
25 turns 38 s.w.g. close wound (5, 6) finishing (5) \( \frac{1}{8} \) in from base of same former as limiter T4. C41 across coil, 3.3 pF.

**Discriminator:**

**L9**
Primary at top, starting at (3) wound on one layer of cellulose tape, sticky side out, to allow adjustment, 15 turns 30 s.w.g. spaced 1 : 1 (1, 3, 6) C43 across coil, 120 pF silvered mica.
Spacing between coils about \( \frac{1}{8} \) in.

**L10**
Secondary 20 turns 30 s.w.g. close wound (4, 6).
Two capacitors, C44, C45 (3, 4) and (3, 6) 120 pF silvered mica.

**A.F. Driver Transformer**

**Core:**

**T5**
\( \frac{1}{8} \) in stack of 0.015 in. Type 158 Mumetal* laminations. Fully interleaved, but joint in centre limb.

**Primary:**

1200 turns 38 s.w.g. in two sections of 600 turns each side of secondary winding (7, 9).

**Secondary:**

2 windings, 300 turns 34 s.w.g. wound bifilar (1 and 4, 2 and 5).

Satisfactory results can be obtained with a Gilson Type WO929/6 transformer, but there may be a 1 to 2 dB loss in feedback and power output.

**Transistors and Diodes**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>V1, 2</td>
<td>GEX66</td>
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<tr>
<td>V3</td>
<td>2N247</td>
</tr>
<tr>
<td>V4, 5, 6, 7</td>
<td>OC170</td>
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<tr>
<td>V8</td>
<td>OA86</td>
</tr>
<tr>
<td>V9, 10</td>
<td>OA81</td>
</tr>
<tr>
<td>V11</td>
<td>OC75</td>
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<tr>
<td>V12</td>
<td>OC71</td>
</tr>
<tr>
<td>V13</td>
<td>V10/30A</td>
</tr>
<tr>
<td>V14</td>
<td>Z2A110</td>
</tr>
<tr>
<td>V15, 16</td>
<td>GET115</td>
</tr>
</tbody>
</table>

**Batteries**

Two Ever-Ready Type AD39 or equivalent (7.5V each, series connected).

*To be concluded.* (Part 1, dealing with design considerations and giving the theoretical circuit diagram, was published in the August issue of Wireless World).

**Aluminium in Telecommunications**

TWENTY of the thirty pages in the latest edition of the Aluminium Courier (No. 49), published quarterly by the Aluminium Development Association, are devoted to a review of the "ever-widening range of applications" of aluminium in telecommunications engineering. The review covers cables, waveguides, aerials and towers, radar scanners, components and the aluminizing of c.r. tubes. The Aluminium Courier is obtainable from the A.D.A., 33, Grosvenor Street, London, W.1, price 2s 6d.

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*Telcon Metals Ltd., Manor Royal, Crawley, Sussex.*

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**Wireless World, September 1960**
Medical Electronics at Olympia

THIRD INTERNATIONAL CONFERENCE AND ASSOCIATED EXHIBITION

One of the main objects of organizing conferences, exhibitions and other media of communication in medical electronics has been to bring together medical men and electronics engineers into a partnership from which both sides could benefit by an exchange of ideas. So far this cosy situation has not materialized. In spite of three conferences, two exhibitions and the formation of an international body, the medical profession has failed to co-operate and the communication is still all one way.

Whether this is because of conservatism, fear of being "blinded by science," or just professional snobbery on the part of the doctors, the tactics of the electronics people have clearly not been very successful. The Third International Conference and associated exhibition, held at Olympia in July, was, therefore, like the two previous events, largely a means of preaching to the converted. It served a useful purpose in bringing together the limited number of specialists in medical electronics—whether engineers or doctors—but did not reach the larger audience that was hoped for.

A noticeable technical trend in the medical electronics apparatus on view was, as might be expected, the wide use of transistors. In hospitals it is particularly important that instruments like electrocardiographs and stimulators should be as small and light as possible, for they have to be moved from department to department very quickly, and in operating theatres in particular there is a limit on the space available for them. A transistorized electrocardiograph which was particularly noticeable for its small size, clean lines and elegant appearance was shown by the Tokyo Sibaura Electric Company of Japan, where medical electronics is a highly-organized sphere of activity.

Apart from reducing the size of existing types of apparatus, transistors have made possible new instruments which could not have been developed before.

One example was the implantable pacemaker for the heart shown by Sierex Ltd. This device, originally developed by Elmgrist of Sweden, is a tiny transistor stimulator, encased in plastic which is implanted inside the body with its output electrode, on the end of a flexible lead, sewn on to the heart. The transistor circuit supplies pulses of 2msec duration and 2V amplitude at the normal heart rate of about 70 per minute. It is energized by a sealed nickel-cadmium battery which is charged at intervals by an electromagnetic induction system using a coil carrying 10kc/s a.c., outside the body and a small coil and rectifier inside the pacemaker.

Another small transistor device for internal operation, is, of course, the "radio pill" or telemetry transmitter which has now been widely reported. Production models of these tiny transmitters were on view. They are used mostly for measuring pressures in the gastro-intestinal tract (in the range 0-31b/sq. in.) but later models are being developed to measure temperature and pH values. An experimental "pill" for measuring pH, shown by the Medical Research Council, is designed so that the whole case acts as a voltaic cell when immersed in the fluid inside the alimentary canal. The varying voltage derived from this is applied to a back-biased silicon junction diode so that its capacitance is varied, and the alterations in capacitance are then used to modulate the frequency of the transistor oscillator.

In a paper by Farrar, Zworykin and Berkley a new type of radio pill was described in which the size was reduced and the limitation on operating life (due to the battery) was eliminated by using a system of energization from outside the body. As with the implantable pacemaker, electromagnetic induction is used but there is no battery to be charged in the "pill." Short bursts of 400kc/s energy are sent into the "pill" at 3,000 per second. These cause a tuned circuit to ring, and it does so in the intervals between bursts, not at 400kc/s, but...
at its own resonant frequency, which is determined by a capacitance transducer measuring pressure in the alimentary canal. The energizing coil is also used for picking up these responses, and in the f.m. receiver used for detection an electronic gating system separates them from the energizing bursts.

Another tiny device for measuring pressures internally was really a probe—a micromanometer, shown by Telco of France, mounted on a catheter for passing along a blood vessel into the heart. Measuring only 2-7mm in diameter and 7mm long, the micromanometer has a transducer consisting of a magnetic core fixed between two thin diaphragms. This moves axially with pressure changes and produces corresponding inductance changes in a coil. These changes are measured by a frequency modulation system. The pressure range of the device is ±300mm of mercury and as the frequency response extends to 5kc/s, the manometer can also be used as an intracardiac phonocardiograph for making a record of the sounds associated with heart action.

The use of an intracardiac phonocardiograph for locating precisely the source of murmurs and other defects of the heart was described in a paper by Wallace, Lewis, Dietz and Brown. In this case, however, the instrument was based on a barium titanate transducer and had a response up to 10kc/s.

Another paper concerned with cardiac instrumentation by L. J. Ryan described a miniature, self-contained cardiotachometer for recording the heartbeats of patients while they move about. Looking rather like a hearing-aid, it contains a four-stage transistor amplifier for amplifying the electrical potentials from the heart and the counting is done by a wristwatch movement through electromagnetic actuation of the escapement mechanism. Incidentally this device was developed on a voluntary spare-time basis by a group of American engineers called S.A.V.E. (Service Activities of Volunteer Engineers).

Turning to the circulation system itself, Winston Electronics showed an equipment for continuously recording a patient's blood pressure over long periods of time. In this follower system, the arterial pulsation from a finger or toe is picked up by a piezoelectrical crystal. The pulsation signal is used to open an air-valve which inflates a cuff from a small pump. This cuff starts to occlude the artery and when the occlusion is complete the air valve closes. A leak then allows the cuff to deflate until arterial pulsations reappear and once again the pump starts to inflate the cuff. The cuff pressure needed to occlude the finger artery is only a few millimetres of mercury above the arterial pressure. Indication of the measured pressure is given on a dial and on a pen recorder.

For measuring the rate of flow of blood in the circulatory system it is normally necessary to puncture the blood vessels in some way. In the electromagnetic flowmeter, for example, the blood moving through a magnetic field generates a small voltage across a section of the artery, and this has to be picked up by inserting electrodes. A technique which requires no such connections to the patient was described in a paper by J. R. Singer. It is based on nuclear magnetic resonance and makes the measurements through the agency of radio frequency and steady magnetic fields. The application of the r.f. field in a short burst, locally through a coil, causes the magnetic movements of the nuclei of the blood atoms to change their orientation rapidly back and forth with respect to the steady magnetic field. This produces a kind of "tracer" condition in the bloodstream which persists for about 0-4 second. At a known distance along the blood vessel from the point of application of the r.f. field the arrival of the "tracer" is detected, and from the measured time between these two events the blood flow can be determined. The detection is based on the fact that the nuclei in the "tracer" condition do not absorb as much r.f. energy as they do in their normal condition, and this is shown up by an auxiliary r.f. oscillator and a receiver. Time interval measurement is done on the time base of a c.r.o.

In the field of ultrasonics, great interest was shown in C. N. Smyth's ultrasonic camera for internal examination. This device, which was described fully in our August 1958 issue* converts a pattern of 4Mc/s ultrasonic energy (produced by the absorption pattern of the object under examination) into a television-type picture by means of a piezoelectric quartz disc acting as the target in a television pick-up tube. Another ultrasonic examination system shown by the Western Infirmary, Glasgow, used echo-sounding principles and slow-mechanical scanning to build up a picture from responses displayed on a cathode-ray tube.

Ultrasonic reflections were also used in a simple apparatus, described in a paper by two Japanese

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authors, S. Satomura and Z. Kaneko, for examining the condition of the blood vessels and the patterns of flow in them. It consisted of an ultrasonic transducer energized for transmitting by a 5Mc/s oscillator and with a receiver and recorder for detecting and displaying the echoes. In the blood vessel, turbulences or fluctuations in the flow produce a kind of noise in the reflected ultrasonic signal due to complex interactions of waves on the Doppler principle. Since the turbulences are proportional to the rate of blood flow, the intensity of the noise in the reflected ultrasonic signal gives an indication of this rate of flow. So do the frequencies in the noise, which get higher with increasing rates of flow.

Summing up the conference which was organized by the I.E.E. in association with the International Federation for Medical Electronics, it could certainly be put down as a success... I drew about 150 contributions and about 800 delegates from all parts of the world. The exhibition, too, was very international in character, as a good 50 per cent of the exhibitors came from overseas. Although the commercial section of the exhibition was very well laid out, it was a pity that the stands devoted to research and hospitals were crammed into an inadequate area with narrow alleyways, hidden behind the escalators, like the slum quarters of a town. However, the scene here was greatly enlivened by the general air of informality, and the notice which said “Both of these demonstrations are pretty crude, but we only thought of the circuit last week” revived the pioneering spirit and cocked a healthy and corrective snook at the rather bland atmosphere of salesmanship that hung over the rest of the exhibition.

**BOOKS RECEIVED**


**Testing of Screened Enclosures,** by J. Miedzinski, B.Sc., A.M.I.E.E. Methods of measuring insertion loss and its dependence on the details of experimental arrangements as well as on frequency and the construction of the enclosure. Pp. 27; Figs. 19. Price 24s.

**The British Electrical and Allied Industries Research Association, Thorncroft Manor, Dorking Road, Leatherhead, Surrey.**


**OCTOBER ISSUE**

In addition to a varied selection of technical articles and the usual coverage of news from all quarters, our next issue, on sale on September 26th, will include the following special features.

**Radio Show Review.**—An assessment of trends in the design of sound and television receivers, as portrayed at the Earls Court Show.

**S.B.A.C.**—Developments in the field of aeronautical radio and electronics exemplified by manufacturers' displays at the static exhibition at the Farnborough Air Show (September 5th-11th).
Converting to Stereo

JOINING TWO MONO AMPLIFIERS

SUPERFICIALLY there would seem to be little more in setting up a stereo amplifier system than is implied in the sub-title above. But there can be snags and it may be worth while to consider the minor troubles which can arise, their cause and cure.

The usual general methods of layout should, of course, still be followed, with the addition that considerable care must be taken to avoid coupling between the two amplifiers. This care is necessary since, for a given degree of coupling, the crosstalk produced in the stereo case is much more serious than the level change produced in the corresponding mono case—3dB crosstalk is much more serious than 3dB level change. Such coupling can arise via stray capacities or common earth or h.t. wiring. As in the corresponding mono case with level changes, common earth or h.t. wiring is likely to be a much less serious source of crosstalk than stray capacities. To reduce stray-capacity crosstalk it may well be worth separating the two amplifiers by an earthed metal screen. The effects of any stray capacities can, of course, be reduced by decreasing the circuit impedances connected to these capacities.

Additional Layout Problems

Earth wiring can also, of course, form hum loops. Working out an arrangement of earth connections which avoids hum loops is likely to be more difficult in stereo since one is often committed in advance to a number of earth points which are common to both amplifiers. Examples of such earth points are the common terminal of the stereo pick-up when this is a three- rather than a four-terminal device, on the balance control when this consists of a single potentiometer with its slider earthed and one arm in each amplifier, and in a common power supply.

The desirability of mechanically ganging certain of the controls, for example, the volume, bass and steep-cut controls, also imposes some restrictions on possible layouts for the two amplifiers. It may be advantageous not to gang the treble controls so that one can still make some allowance for any difference between the two loudspeakers or their acoustic surroundings—such differences are likely to be most pronounced at high frequencies.

It will naturally often be convenient to use a single common power supply. The current ratings required for the rectifier and smoothing choke are then, of course, the sum of those for the two amplifiers, and for this reason a larger rectifier than is required for each separate amplifier will often be needed. Where the voltages required by the two amplifiers are different, a single power supply would obviously have to deliver the greater of these voltages, suitable arrangements being made to drop this voltage for the low-voltage amplifier. As we have already seen, crosstalk due to signal currents coupling in common h.t. wiring will be more serious in stereo than the corresponding level changes in mono. Thus it may occasionally be necessary to increase the value of any smoothing capacitor common to both amplifiers.

Signal currents in the h.t. wiring can, of course, be very much reduced by using class-A push-pull output stages. To avoid common wiring and hum loops in earlier stages it will probably be convenient to use separate rather than common capacitors to smooth the h.t. for such stages.

Modifications to the circuits of the two amplifiers are only likely to be necessary to provide a balance control. It is desirable that, when the balance control is adjusted, the sum of the two amplifier power outputs should remain constant so that the volume level does not have to be simultaneously adjusted. If the total power output were to be allowed to vary too much, one might just as well use independently adjustable (i.e. unganged) volume controls and dispense with a balance control. The required constant total power output can at least approximately be obtained by making the balance control in the form of a variable resistive divider gain control in each amplifier, the two gain controls being connected so that the gain of one amplifier is increased while that of the other is decreased as the balance control is adjusted. This general type of balance control is, in fact, almost universally used in practice. It is also desirable that the balance control should not produce more than about 6dB total gain variation in each channel, any greater difference between the two stereo channel sensitivities being taken up by preset adjustments. The maximum gain variations can, of course, be restricted by connecting a fixed resistor in series with the variable balance resistor in each circuit; a fixed resistance equal to the maximum variable resistor value gives a maximum variation of 6dB. Any loss in average gain due to the provision of a balance control must, of course, be allowed for.

Practical Balance Controls

Most of the balance controls in use fall into one of two general types: the two variable resistors are either two separate but ganged potentiometers or, alternatively, the two arms of a single potentiometer with its slider earthed. The latter type is perhaps not so suitable for the experimenter, since he is then committed to a common earth point, and hum loops may be more difficult to avoid. Stray-capacity coupling between the two ends of the single potentiometer is also perhaps more likely.

Where two separate but ganged potentiometers are used, the sum of the two amplifier outputs normally varies by only 0.5dB when fixed series resistors are used to restrict the maximum gain variation in each channel to 6dB: the variation in total output increases to 3dB if the fixed resistors are decreased to zero so that the maximum gain variation is increased to infinity. The first value of 0.5dB variation in the total output is certainly quite acceptable, being below what can easily be heard.

When the two amplifiers have equal gains, they are obviously balanced when the variable balance resistances and consequently also the gain losses due

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Wireless World, September 1960

www.americanradiohistory.com
to the provision of a balance control are the same in each channel. It is convenient to assume this condition of equal amplifier sensitivities when quoting the gain loss due to the provision of a balance control. Usually the two variable balance resistors are equal when each is half its maximum value. In this case, the loss in gain due to the provision of a balance control is a factor of 1:3:1 when in addition series fixed resistors are used to restrict the maximum gain variation in each channel to 6dB, this loss increasing to 2:1 if the fixed resistors are decreased to zero so that the maximum gain variation is increased to infinity. As pointed out by Mullard, if one potentiometer is given an antilogarithmic law and the other a logarithmic law and is also wired in reverse, then the two variable balance resistors are equal in value when each is 0.9 of its maximum value.

Apart from zero up to 0.2dB of 1.9dB tiometers then, the gain loss due to the provision of a balance control is reduced to a factor of 1.05:1 when series fixed resistors are used to restrict the maximum gain variation in each channel to 6dB, this loss increasing to 1.1:1 if the series fixed resistors are decreased to zero so that the maximum gain variation is increased to infinity. When such potentiometers are used the variation in the sum of the two amplifier outputs is somewhat different, being within 0.2dB of 1.9dB for any value of fixed series resistance from zero up to the maximum potentiometer value. Apart from this possibility there seems little to choose between linear and logarithmic potentiometers for the balance control.

Switches for reversing the phase of one channel or interchanging the two amplifiers relative to the loudspeakers are also sometimes provided for correcting errors in the connections between various units. However, since after any such correction the switches need never be further used, it would seem preferable to correct any connection errors directly, and thus avoid the capacity-coupling problems which are likely to arise on a switch connected to both amplifiers. Capacity coupling in such cases can be reduced by arranging for any stray capacities to occur in pairs whose junctions are connected via a relatively larger capacity to earth. Coupling either way is then attenuated by the capacitive dividers so formed.

S.B.A.C. EXHIBITORS

ABOUT a third of the exhibitors in the static exhibition at the Farnborough Air Show (September 5-11) are in, or closely associated with, the radio and electronics industry. The following list of manufacturers and research establishments has been selected from the list of nearly 300 exhibitors. A review of the developments in aeronautical radio and electronic equipment as seen at the exhibition, which is organized by the Society of British Aircraft Constructors at the Royal Aircraft Establishment, will be included in our next issue.

A.E.I. Airamed
Albright & Wilson
Amalgamated Wireless (Aust.)
Ampli-vox
Bakelite
Bell Precision Engineering
Belling & Lee
B.I. Callender's Cables
Boulton Paul Aircraft
Bristol Aircraft
British Communications Corp.
Brown, S. G.
Bryans Aeroquipment
Burgess Products
Burndect
Canadian Marconi Co.
Cementation (Mulfelite)
Chelton (Electrostats)
Chloride
Ciba (A.R.L.)
Cole, E. K.
Costor, A. C.
Costor Radar & Electronics
Curran, John
Deca Navigator
Deca Radar
d'Ave Hilland Propellers
Ebsco Electronics
Eliott Brothers
English Electric
Ferranti
Fibreglass
Formica
G.E.C.
General Precision Systems
Godfrey, Sir George
Goodmans
Graseby Instruments
Grundy & Partners
Hawker Siddlemy
Hellermann
Hendrey Relays
Honeywell Controls
Imhof
Integral

K.L.G. Sparking Plugs
Kelvin & Hughes
Lucas, Joseph
M.L. Aviation Co.
McMichael
Marconi instruments
Marconi's W/T
Marston Exellors
Microcell
Ministry of Aviation
Murphy
Napier, D. & Son
Newmark, Louis
Optical Measuring Tools
Plannair
Plessey
Pullin
Pye
Redilon
Rotax
Royceon Industries
S.T.C.
Sallford Electrical Insts.
Sanders, W. H. (Electronics)
Sangamo Weston
Savage, W. Bryan
Short Brothers & Harland
Simmonds Aerocessories
Smiths Aircraft Instruments
Solartron
Solu-schall
Southern Instruments
Soery
Tecalemit
Technograph Electronic Prods.
Thermionic Products
Thorn
Trix
Ultra Electronics
Vaccie
Venner
W.S. Electronics
Waymouth Gauges
Western Manufacturing
Westinghouse
Whiteley Electrical
Wireless Telephone Co.

SHORT-WAVE CONDITIONS

Prediction for September

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THE full-line curves indicate the highest frequencies likely to be usable at any time of the day or night for reliable communications over four long distance paths from this country during September.

Broken-line curves give the highest frequencies that will sustain a partial service throughout the same period.

WIRELESS WORLD, SEPTEMBER 1960
West German "I.T.A.?"

THE introduction of a second television network in West Germany has developed into a major political issue which may effect the introduction of a u.h.f. television service. There have been prolonged negotiations as to who should operate the second network, initially to consist of 29 u.h.f. transmitters due to be completed by the end of this year. At the end of July the German Chancellor announced the setting-up of a commercial television company—Deutschland Fernsehen—in which the Länder broadcasting organizations would be invited to join. For some time now, of course, there has been a limited number of commercial television programmes broadcast by the Länder organizations.

The Länder organizations have now asked the Government for permission to build a network of u.h.f. stations—some are already in operation experimentally. Our West German correspondent reports that no decision on the proposed u.h.f. networks is likely for some months, especially in view of next year's Government election.

Space Research

MOST of the sixteen grants, totalling £184,540, recently made by the D.S.I.R. to universities for space research, are for projects associated with radio and electronics. The grants, made on the recommendation of the British National Committee on Space Research set up by the Royal Society, are for salaries of staff, travel and subsistence and development or purchase of special equipment.

The biggest award goes to Dr. R. L. F. Boyd, of the physics department of University College, London, who during the next three years is to receive £35,450 for rocket research in the upper atmosphere and a further £8,880 for the development and use of photoelectric satellite tracking equipment.

Dr. R. C. Jennison, of the Nuffield Radio Astronomy Laboratories, Jodrell Bank, is to have £30,297 over the next three-and-a-half years for low-frequency radio astronomy from an earth satellite and for microwave meteorite investigations from an earth satellite. Professor A. C. B. Lovell is to have £2,500 this year for the tracking of satellites and space probes. To enable Professor J. Sayers, of Birmingham University, to undertake electron and ion propulsion studies in the upper atmosphere and interplanetary space he is to receive £26,000.

Professor W. J. G. Beynon, University College of Wales, is granted £16,530 for a three-year study on the measurement of electron density/height profile with rockets using the Doppler method and the pulse method.

Three workers at Cavendish Laboratory have received grants: Dr. F. G. Smith is awarded £11,230 for a two-year research programme on the measurement of cosmic radio noise by receivers mounted on rockets and satellites; Professor M. Ryle, £2,678 for recording and interpretation of Doppler and Faraday effects in the radiation from artificial satellites; and Dr. K. G. Budden, £1,694 for studying the theory of propagation of radiation from artificial satellites.

Other awards include £13,006 to Professor E. A. Stewardson, physics department, Leicester University; £15,005 to Professor D. R. Bates, applied mathematics department, Queen's University, Belfast, £8,775 to Dr. H. E. Elliot and £7,935 to Dr. S. H. Hall, both of Imperial College, London and £4,560 to Dr. J. T. Houghton, of Clarendon Laboratory, Oxford.

Jubilee Lectures.—A limited number of free tickets are available for the first of the series of lectures being organized by Ultra to mark their 25th anniversary. It is being given at the Royal Festival Hall, London, at 6.30 on September 14th, and Dr. Arthur Porter, of the University of Saskatchewan, will speak on the evolution of instrumentation. Applications for tickets should be sent to the Public Relations Officer, Ultra Electric, Western Avenue, London, W.3.

Anglo-Japanese Trade.—An increased quota of transistor sets is permitted to be imported from Japan during the 12 months ending 31st March next year under a new Anglo-Japanese trade agreement. The new figure is £200,000. The quota for sound radio and television sets (other than transistorized) is £100,000 and for radiograms and gramophones it is also £100,000.

Wind-Powered Relay Station.—Two wind generators with 30-ft diameter air screws are used to provide power for this microwave relay station on the Schöneberg in the Eifel mountains. The station forms part of the Frankfur- Cologne radio link installed by the German Post Office originally for television but now used for a 60-channel pulse-modulated multiplex telephone service. The two generators together provide an overall output of 40kWh/day. Photo. courtesy "NTZ," Brunswick.

Wireless World, September 1960
Radio Industry Council.—Lord Brabazon of Tara, who has been president of the R.I.C. since 1957, has agreed to serve for another year. In consequence of the sudden death of Air Marshal Sir Raymund Hart who had been full-time director of the R.I.C. since last year, R. Keif-Cohen, C.B., has been appointed acting director until an appointment is made. He was under-secretary, Ministry of Fuel and Power, from 1946 to 1955. The 1960/61 representatives of the three constituent bodies forming the council are:—B.R.E.M.A., G. Darnley-Smith (Bush); F. W. Perks (British Radio Corp.), E. E. Rosen (Ultra), and A. L. Sutherland (Philips, B.V.A., S. S. Eriks (Mullard), F. V. Green (S.T.C.), G. A. Marriott (G.E.C.), and J. W. Ridgeway (A.E.I. Woolwich); and R.E.C.M.F., P. D. Canning (Plessey), Hector V. Slade (Garrard), K. G. Smith (N.S.F.) and Dr. A. V. Sower (Telecon). E. C. Rosi has chairman and H. V. Slade vice-chairman.

Goldup Memorial.—An annual award, which will be known as the Goldup Prize, has been established by the I.E.E. for the best Higher National Certificate student who takes electronics or telecommunications subjects in his final examination. The prize will be endowed by Mullard Ltd., as a memorial to the late Mr. E. H. M. Goldup, a director of the company and a past president of the Institution, who took a keen and extremely active interest in education.

I.E.E. Council.—The following have been elected to fill the vacancies which will occur on the council of the I.E.E. on September 30th:—Sir Hamish D. MacLaren (president); T. C. Melling and B. Donkin (vice-presidents); G. E. Strong (hon. treasurer); R. T. Barron, F. H. S. Proven, Professor J. M. Meek, Dr. R. L. Smith-Rose, Dr. H. G. Taylor, J. C. Arkless and J. S. McCulloch ordinary members of the council.

Electronics and Communications Section, I.E.E.—The new chairman of the section is T. B. D. Terroni (A. T. & E.) and R. J. Halsey (G.P.O.) is a vice-chairman. The six vacancies among ordinary members of the committee have been filled by:—W. H. Alcock (Chairman Research Labs.), W. J. Perkins (National Institute for Medical Research), Dr. K. F. Sander (Cambridge University), Dr. J. A. Saxton (D.S.I.R.), T. R. Scott (Standard Telecommunications Laboratories) and F. J. D. Taylor (G.P.O.).

B.E.A.M.A. has set up a Semi-conductor Devices Section in order to foster standardization of semi-conductor devices based on an international basis. The initial membership of the section, which is stated as "will cooperate closely with the Electronic Valve and Semi-conductor Manufacturers' Association" (V.A.S.C.A.) comprises:—A.E.I. (Rugby), A.E.I. (Woolwich), E.C.T. (London), Ferranti, G.E.C., Hackbridge & Hewittic Electric, International Rectifier, Philips, S.T.C. and Westinghouse.

Pye Show.—The Pye group of companies are holding their own radio, television and electronics exhibition in the Royal Festival Hall, London, from August 22nd to 24th. The exhibition will cover not only the domestic sound radio and television side of the group's business but also industrial electronics, instruments, marine radio and also telephone equipment from "Temco" the newest member of the group. It will be open to the public from 11.00 to 9.00 on the first two days and from 3.00 to 9.00 on the last day.

Cabinet Styling.—B.R.E.M.A. is to hold its fourth "cabinet styling" exhibition in the Victoria Halls, Bloomsbury Square, London, W.C.1, on October 4th, 5th and 6th from 2.0 to 6.0. It is a trade show of embellishments, cabinet materials, fabrics, ornamental finishes, "in-the-room" aerals, etc., and admission is by trade card.

P. P. Eckettsley is giving a talk entitled "Radio from the beginning" at a meeting in the Iford Town Hall, Essex, at 3.0 on October 9th. The meeting has been arranged by the East London Group of the R.S.G.B.

Jodrell Bank.—Manchester University's radio astronomy laboratories at Jodrell Bank have been renamed the Nuffield Radio Astronomy Laboratories. The Nuffield Foundation originally donated £200,000 towards the cost of the radio telescope at Jodrell Bank and has recently given a further £25,000 and Lord Nuffield personally has contributed another £25,000 in order to clear the deficit on the project.

Sound propagation in the atmosphere is the theme of a symposium to be held in the new physics building of Imperial College, South Kensington, on September 8th. It is being organized by the Acoustics Group of the Physical Society, and is available from Drs. G. G. Partitt and R. W. B. Stephens, Imperial College, South Kensington, London, S.W.7.

Amateur Television Convention.—The fifth convention of the British Amateur Television Club is being held on September 10th in the Conway Hall, Red Lion Square, London, W.C.1. Further particulars and tickets (5s all day, 2s 6d after 2) are obtainable from D. W. E. Wheele, 56 Burlington Gardens, Chawell Heath, Romford, Essex.

Autumn Audio Fair Cancelled.—Audio Fairs Ltd. have announced that the Audio Fair planned for October at Southport, Lancs, has been cancelled.

Matters Educational

Logical Circuits.—A course of 12 lectures on the design of logical circuits, followed by an 11-week laboratory course, is being held on Friday afternoons from September 30th at the Borough Polytechnic, London, S.E.1. The fees are 25s and 20s respectively.

Pulse Techniques.—The Borough Polytechnic is also providing a 20-lecture course on pulse techniques on Monday evenings from October 3rd (fee £2 10s). Supplementary to this course is a 12-week laboratory course which runs concurrently with it on Monday afternoons or Thursday evenings (fee £1).

Servicing Electronics.—A course in preparation for the C. & G./R.T.E.B. new certificate in electronics servicing is offered by the Matthew Boulton Technical College, Suffolk Street, Birmingham, during the coming session. The college is also providing a new course for the C. & G. certificate in supplementary studies in telecommunications.

Norwood T.C.—Full-time technical courses listed in the 1960-61 prospectus from the Norwood Technical College, Knight's Hill, London, S.E.27, cover telecommunications engineering, machine operating and radar maintenance. There are also part-time day and evening courses in preparation for the C. & G. telecommunications engineering certificate, the C. & G./R.T.E.B. servicing certificate and a 2-year evening course on television technology.

Radio Amateur Exam.—We have been notified of the following classes of instruction (both radio theory and mors) being held during the coming session in preparation for the Radio Amateur Examination:—Battersea Men's Institute, Latchmere Road, Lavender Hill, London, S.W.11, Wednesdays. Holloway Evening Institute, Menton School, Hornsey Road, London, N.7; Mondays, repeated on Tuesdays and Wednesdays.

Iford Literary Institute, High School for Girls, Cranbrook Road, Iford; an eight-month course on Wednesdays, with mors on Mondays.

Wembley Evening Institute, Copland School, High Road, Wembley; Mondays.

Bognor Regis Technical Institute, Southway, Bognor Regis, Wednesdays and Fridays.

Bradford Technical College, Central Hall, Bradford, 5; Wednesdays.

Glasgow.—Allan Glens School, Montrose Street: Tuesdays and Thursdays.

Openhaw Technical College, Whitworth Street, Manchester 11, classes for first and second year students.
Personalities

Sir Willis Jackson, F.R.S., director of research and education of Associated Electrical Industries (Manchester) Ltd., is to return to academic life as professor of electrical engineering at Imperial College, University of London. Sir Willis resigned his chair at Imperial College some seven years ago to become director of research and education of Metropolitan-Vickers Electrical Co. now A.E.I. (Manchester). After graduating at Manchester University and lecturing in electrical engineering at Bradford Technical College, he joined Metro-Vick as a college apprentice in 1929. In 1938 he was appointed professor of electrotechnics at Manchester University and eight years later accepted the chair at Imperial College. Sir Willis, who was knighted in 1958, is this year’s president of the I.E.E. and is a member of a number of national bodies including the National Council for Technological Awards.

Sir Leslie Gamage, chairman and managing director of the General Electric Co. since 1957, is to retire at the end of this year. He is relinquishing his executive duties as managing director immediately but will continue as chairman until December 31st. He joined the company in 1919 and was appointed vice-chairman and joint managing director in 1943.

Two British women engineers, Miss Lesley S. Souter, B.Sc., A.R.T.C., F.Phys. Soc., A.M.I.E.E., and Miss Rosina Winslade, M.S.I.T., have been awarded by the Caroline Haslett Memorial Trust “travelling exhibitions” to enable them to study the training, employment and prospects of women engineers in the U.S.S.R. Miss Souter, who studied electrical engineering at the Royal Technical College, Glasgow, obtained her B.Sc. degree from Glasgow University in 1940. She was in the research laboratories of the G.E.C. and Mullard before joining the A.E.I. Research Laboratory at Harlow, Essex, where she now leads the magnetic materials section. Miss Souter is vice-president of the Women’s Engineering Society. Miss Winslade is senior sales engineer with Research and Control Instruments Ltd., where she is in charge of the industrial measuring and recording apparatus in the instrument group. She was for ten years with the Plessey Co., first as junior laboratory assistant and later working on the design and development of electronic test equipment. Miss Winslade was the first woman member of the Society of Instrument Technology.

P. E. F. A. West, M.A., A.M.I.E.E., has been appointed Regional Engineer, B.B.C. West Region, in succession to G. H. Daly, M.B.E., who joined the British Broadcasting Company in 1925 as a transmitter engineer at Savoy Hill, London. He has been regional engineer since 1955. Mr. West joined the Corporation in 1936. During the war he served in the Royal Navy, where he attained the rank of Lieutenant Commander. He returned to the B.B.C. Design and Installation Department in 1946 and two years later was transferred to the Overseas and Engineering Information Department. In 1951 he was appointed assistant to the Chief Engineer and since 1956 has been a member of the staff of the Senior Superintendent Engineer, External Broadcasting.

Air Vice-Marshall H. B. Wrigley, C.B.E., until recently Director of Guided Weapons Research and Development (Air) in the Ministry of Aviation, has been appointed senior technical staff officer at Fighter Command Headquarters. He was at one time Chief Signals Officer of the 2nd Tactical Air Force in Germany, and in 1954 was appointed Director of Signals in the Air Ministry.

F. A. Vick, O.B.E., Ph.D., becomes director of the Atomic Energy Research Establishment, Harwell, in succession to Sir Basil Schonland, C.B.E., F.R.S., on September 1st. Sir Basil, who was knighted in this year’s Birthday Honours List, is to continue as director of the Atomic Energy Research Group of which A.E.R.E., Harwell, is a part. In 1986 he became exhibitioner at Gonville and Caius College, Cambridge, and carried out research at the Cavendish Laboratory. He joined the staff at Capetown University in 1922 and in 1937 founded and took charge of the Bernard Price Institute for Geophysical Research at the University of Witwatersrand, Johannesburg. He was a brigadier in the South African Corps of Signals in the early days of the last war but from 1941 to 1944 was Superintendent of the Army Operational Research Group, Ministry of Supply. After the war he returned to South Africa but came back to the U.K. in 1954 as deputy director of Harwell. Dr. Vick, who is 49 and was educated at Birmingham University, was a lecturer in physics at University College, London, before he joined the Ministry of Supply in 1939 as assistant director of scientific research. In 1945 he returned to his academic work as lecturer in physics at Manchester University. From 1950 until his appointment last year as deputy director of Harwell, he was professor of physics at the University College of North Staffordshire. Dr. Vick was vice-president of the Institute of Physics from 1953 to 1956.

Dr. F. A. Vick.

Dr. R. L. Smith-Rose.

Dr. R. L. Smith-Rose, C.B.E., has been appointed by the Postmaster General as chairman of the Post Office Frequency Advisory Committee in succession to Sir Lawrence Bragg, O.B.E., F.R.S., who has resigned owing to his many other commitments. Dr. Smith-Rose retires in September from the directorship of the Radio Research Station of the D.S.I.R., which he has held since 1948. He has been a member of the Frequency Advisory Committee since it was set up under the chairmanship of Sir Lawrence Bragg in 1958. The other members of the committee are:—Granville Berry (city engineer and surveyor, Coventry); Sir Harold Bishop (B.B.C.); Capt. C. F. Booth (Post Office); J. R. Brinkley (Pye Telecommunications, nominated by the Electronic Engineering Association); J. Claricoats (R.S.G.B.); Major General E. S. Cole (War Office); N. H. Elgood (Home Office); Sir Robert Fraser (I.T.A.); Supt. F. Gee (Lancashire Constabulary); Sir Maurice Goldsmith (Ministry of Transport); H. van Hasselt (S.T.C., nominated by the

Wireless World, September 1960
Telecommunication Engineering and Manufacturing Association); G. F. Jefferies (Ministry of Aviation); R. J. Jones (Dunlop, nominated by B.R.E.M.A.); R. J. Kemp (Marconi's, nominated by E.E.A.); Air Commodore C. C. Morton (British Joint Communications Electronics Board); Capt. W. J. Parker (Admiralty); G. F. Peirson (Midlands Electricity Board); C. G. Phillips (Ministry of Aviation); D. J. A. Stevenson (Automobile Association, nominated by the Mobile Radio Users Association); H. E. F. Taylor (E.E.A.); Air Commodore F. E. Tyndall (Air Ministry); A. Wolsencroft (Post Office); Capt. F. J. Wylie (Radio Advisory Service of the Chamber of Shipping and Liverpool Steamship Owners' Association); and J. E. Golohan (Post Office), secretary.

H. G. Whiting, A.M.I.E.E., has been appointed Regional Engineer, B.B.C. Midland Region, in succession to W. A. Roberts, M.I.E.E., who becomes Administrative Officer in the Region. Mr. Roberts, who joined the Engineering Division of the B.B.C. in 1937, became assistant to the Chief Engineer in 1949. He was a member of the Broadcasting Commission appointed by the Gold Coast (now Ghana) Government in 1953 to advise on the development of broadcasting in that country, and later of the Commission which was appointed to study broadcasting development in Kenya. During 1954 and 1955 he was seconded to the Colonial Office as technical adviser on broadcasting development in the Colonies. Mr. Whiting joined the Corporation in 1932 as an engineer in the Transmitter Department. He transferred to the Television Service in 1936, and since 1952 has been Engineer-in-Charge, Television, Birmingham.

T. H. Cook, B.Sc.(Eng.), M.I.E.E., has been appointed chief applications engineer of the Morgan Crucible Co. He was previously technical sales manager of the company's carbon department. He will be attending the New Delhi meeting of the International Electrotechnical Commission in November.

G. D. Speake, M.A., has been appointed deputy chief of research of Marconi's research and development laboratories, Great Baddow, Essex. He joined the company in 1950 at the age of 31 and was engaged in radar systems research until 1954, when he was appointed chief of the vacuum physics division. Two years later he took charge of the microwave physics section. Educated at St. Catharine's College, Cambridge, where he graduated with first-class honours in physics, he served in the Technical Branch of the R.A.F. as a flight-lieutenant, and was for four years with Imperial Chemical Industries as instrument manager of the plastics division before joining Marconi's.

OBITUARY

Air Marshal Sir Raymund Hart, who died as a result of an accident on July 16th at the age of 61, had been director of the Radio Industry Council since his retirement from the R.A.F. in January, last year. His Service career began in the Royal Flying Corps in 1917. In 1936 he was attached to the Bawdsey experimental station as "Commandant of R.D.F. Training" and so began his long and close association with radar development. It was Sir Raymund who introduced the "filter room" principle into the radar reporting system. In 1942 he became Command Signals Officer of Fighter Command and was at one time Deputy Director of Radar in the Air Ministry from 1951 to 1955 Director General of Engineering.

Pye Ltd. and its subsidiaries increased their "total available profit" for the year ended 1959/60 by nearly 75% compared with the previous year. The figures are £1,464,274 and £842,762. The company's trading profit was £1,927,041 and £834,841 for 1958/59. The annual general meeting is being held on August 24th to coincide with the group's exhibition being held at the Royal Festival Hall, London.

Temco.—By the purchase of shares on the London Stock Exchange Pye have acquired a controlling interest in the Telephone Manufacturing Co. in face of a bid for the whole of the company's shares by a consortium of seven companies—A.E.I., A.T. & E. Ericsson, G.E.C., Marconi's, Plessey and S.T.C. It is Pye's intention to continue the business of Temco as a separate entity.

Thorn Electrical Industries group trading profit for the year ended last March was £3,916,990 compared with £2,953,536 the previous year. Deducing all charges, including taxation of £495,069, the net profit is £1,525,988 against £979,371 last year.

Firth Cleveland Group reports a turnover of £21.5M with a profit before taxation of £2,144,806 in 1959 compared with £18M and £1,455,000 the previous year. The group, which comprises about 30 companies in this country and some 20 abroad, includes Solartron, Simmonds Aerocessories, and four chains of retail stores totalling in all some 450 shops.

Brimar valve and cathode-ray tube division of Standard Telephones and Cables has been acquired by Thorn Electrical Industries Ltd. A new company is being formed under the name Brimar Electronics Ltd. The "special" valve division of S.T.C. is not included in the agreement signed by the two companies.

Anglo-Swedish Agreement.—Technical and commercial co-operation between E.M.I. Electronics Ltd. and the Swedish SAAB Aircraft Co. is provided for under a recently signed agreement. SAAB will sell E.M.I.'s equipment in the industrial, automation, broadcast, instrument and specially tube fields throughout Sweden, Norway and Denmark, through its sales organization, SAAB Electronics. E.M.I. will market SAAB products in the British Commonwealth and other countries.

Associated Electrical Industries Ltd. and Davy-United Ltd. have formed a jointly financed Steelworks Automation Unit to apply new automatic control techniques to the processing both of steel and of non-ferrous metals. The A.E.I./Davy-United Steelworks Automation Unit has its headquarters at Mill Road, Rugby.

Hughes International (U.K.) Ltd. set up in Glenrona, Fife, by the Hughes Aircraft Co. of the U.S.A. for the manufacture of a wide range of semiconductor components for the European market, plans to open its factory this month. David Simpson is general manager of the Scottish company.

News from Industry

Wireless World, September 1960
A trade exhibition is being held by Thompson, Diamond & Butcher at the Trocadero Restaurant, Piccadilly Circus, London, W.1, from August 23rd to September 1st. T.D.B. are both wholesalers and manufacturers; they make the range of "Top Rank" record players. Invitation tickets are obtainable by writing to the Sales Manager, 1/9 University Street, London, W.C.1.

McCarthy Radio and Electronics Ltd., of Studland Street, London, W.6 (Tel.: Riverside 1633) is the new name of what was previously Radio Mailing Ltd. The company, of which A. S. Williams is managing director, manufactures McCarthy radio-grams, record players and tape recorders, and Felgate inverters.

Elstone Electronics Ltd., of Hereford House, North Court, Vicar Lane, Leeds, 2 (Tel.: Leeds 35111), of which A. C. Farnell and A. Wolfenden are directors, have been appointed British distributors for Weller Elektro-Werkzeuge, of West Germany. The company manufactures soldering guns and heat-controlled soldering irons.

Stretch, the IBM computer capable of performing well over a million logical operations per second, has been ordered by the U.K. Atomic Energy Authority. The system, to be installed towards the end of 1961, will have random access disc storage units capable of transferring one word every 8 microseconds, 6 magnetic core storage units with retrieval time of 2.18 microseconds, and a vast magnetic tape backing store.

Films & Equipments Ltd., of 138 Wardour Street, London, W.1 (Tel.: Gerrard 7711), of which D. Forrester and G. M. Forrester are directors, have disposed of their recording division to Aviation and Electronic Equipment Ltd., of the same address. The company's connector division has been taken over by Cannon Electric (Great Britain) Ltd., also of the same address.

Decca has obtained from Thermionic Products the sole manufacturing rights of their micro-lift for pickups.

Solartron Electronic Group is to provide the instrumentation and control apparatus for the next major experiment for controlled thermo-nuclear research to be undertaken by the Atomic Energy Authority. The intermediate current stability experiment (I.C.S.E., pronounced "ice") will be undertaken at the new laboratory which the A.E.A. is establishing at Culham, near Oxford.

G.E.C. is to supply and Install for the Post Office a dual radio link between Carlisle and Kirk o’ Shotts for the relaying of television transmissions. There will be two intermediate repeater stations along the 90-mile route. The broadcast equipment, which operates around 6,000Mc/s can provide a television link or 960 speech circuits.

The printed circuits division of Mills & Rockleys (Production) Ltd. has been formed into a separate subsidiary company called Mills & Rockleys (Electronics) Ltd., of Swan Lane, Coventry (Tel.: Coventry 26222). The general manager is D. L. Phillips.

Teleng Ltd. are to design and supply the distribution equipment and cabling for the television relay system to be installed by Marconi's on the new luxury liners, Oriana and Canberra.

EXPORT NEWS

British manufacturers who are participating in the exhibition being held in Stockholm from September 10th to 17th in conjunction with the Fifth International Instruments and Measurements Conference include: Ether Langham Thompson, G.E.C., General Radio-logical, Hobson, Plessey, Solartron, 20th Century, Ultra, A.E.I., Cannon Electric, Colvern, Erie, Hunt and Texas Instruments. The last two companies are combining as the "English Component Group" through an agent.

Sub-miniature automatic direction-finders made by Bharat Electronics, of Bangalore, under a general manufacturing agreement made between the Government of India and Marconi's W/T Co., are to be fitted in AVRO-748 twin turbo prop aircraft being built in India. The radio compass is Type AD722.

Airfield control radar is being supplied by Cossor Radar & Electronics to the East African Directorate of Civil Aviation for installation at the recently opened Nairobi Airport.

Closed-circuit television equipment was recently installed by Marconi's on a locomotive of Rhodesian Railways so that the action of the wheels could be studied while in motion because abnormal wear had been noticed on sharp curves of the track.

An O.B. television unit has been supplied to the Hungarian broadcasting authority by E.M.I. Electronics. The unit, mounted on a 7-ton chassis, is equipped with four image orthicon cameras.

Colour TV.—The colour television unit commissioned by Smith Kline & French Laboratories from Marconi's two years ago, which has been placed by the owners at the free disposal of medical authorities in this country, is now on a three-month tour of Australia. It will visit hospitals in Adelaide, Melbourne, Brisbane and Sydney. Marconi's have provided the engineering team accompanying the vehicle.

Hong Kong.—The mast of the Colony's new v.h.f./f.m. broadcasting station, Four Marconi S-kW transmitters in two parallel pairs are used to radiate two programmes—English on 91Mc/s and Chinese on 94Mc/s.

Wireless World, September 1960
**LETTERS TO THE EDITOR**

The Editor does not necessarily endorse the opinions expressed by his correspondents

**Negative Resistance**

HAVING studied "Cathode Ray's" article "Ohm's Law and Negative Resistance" in the July issue I can now see how our differences of opinion as to whether or not a battery is equivalent to a negative resistance can be resolved.

But first, since it is hard to find a text-book which even hints that Ohm did not create Ohm's Law, "Cathode Ray's" main point in his 1953 article, that there are two distinct Ohm's Laws, should be brought to the attention of all text-book writers. Very briefly, the first Law is based on Ohm's work and might be called Ohm's Linearity Law $R=K$; the second is what has become to be called Ohm's Law, $R=B/I$, which defines the ohm and in which $R$ need not be constant, and is replaced by $Z$, the impedance, for a.c. working.

B.S. definition No. 1276 quoted by "Cathode Ray," expresses my point that for a device to be a resistance the voltage and current must be related. When shortened, the second paragraph of the definition reads, "The resistance is equal to the applied p.d. divided by the current which it produces when the body has no e.m.f. acting therein."

Hence a battery cannot be a resistance and Ohm's Law cannot be applied to it, which was the basis of my original objection. But Ohm's Law can be applied (without any modification) to a resistance having the same p.d. and current as the battery at any particular instant, and the battery can be said to be equivalent to the resistance in certain respects.

If the current through the battery is reversed, the battery absorbs energy and becomes equivalent to a positive resistance. If the battery is an accumulator on charge or even a dry cell (see, for instance, R. W. Hallows, "Reactivating the Dry Cell" W.W. August, 1953) some of the energy may be stored chemically, whereas in a resistor it is all dissipated. But inductances and capacitances, both positive and negative, can absorb or give out energy; the battery actually behaves much more like a large charged positive capacitance than a resistance if any changes are made to the circuit.

An engineer might ask, "Does it work?" "Cathode Ray" has shown that the battery and resistance in the circuit are equivalent to two resistances, one of which is equal to the negative of the other, and these are equivalent to a short-circuit. This simplifies the circuit but makes it impossible to find the current.

A similar thing happens when solving simultaneous equations if one substitutes twice in the same equation.

One proves that $0=0$, which does not help in finding $x$.

As regards "Kirchhoff's" Third Law, in a simple loop where all components pass the same current, the Law is reduced to Ohm's Law to Kirchhoff's Second Law, while if the mesh is part of a network and the current is different in different parts of the mesh, the Third Law does not hold.

Binley, nr. Coventry. D. L. CLAY.

**Analogue Computer Techniques**

THE simple analogue computer as described by G. B. Clayton (May and June issues) can be used to demonstrate many problems.

A familiar example is that of the simple projectile which moves with initial velocity $V$ ft/sec, included at an angle $\theta$ to the horizontal, with downward acceleration $g$ ft/sec$^2$ due to gravity.

\[ Y = Vt \sin \theta - \frac{1}{2} gt^2 \]
\[ X = Vt \cos \theta \]

By assigning fixed voltages to represent the constants $V$ and $g$, it is possible to generate voltages representing these displacements using a computer arrangement as in Fig. 2.

The outputs obtained can be fed into the $X$ and $Y$ plates of a cathode ray tube, and a trace will be produced representing the path of the projectile. It is quite easy to demonstrate the effect of varying either $V$, $g$, or $\theta$, the latter set by the potentiometers representing $\sin \theta$ and $\cos \theta$, both of which must be adjusted for any change of $\theta$.

The more complex case of the catenary can be illustrated in this way, this being the curve in which a uniform chain or "perfectly flexible" string hangs when freely suspended from two fixed points.

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*Wireless World, September 1960* 433
The equation for the curve is

\[ y = c \cosh \left( \frac{x}{c} \right) \]

The computer can be used to obtain such a function, by first assuming a signal for \(- \sinh \left( \frac{x}{c} \right)\) and integrating twice with respect to \(x\) (\(x\) here being represented by time).

The output of the second integrator is \(-c^2 \sinh \left( \frac{x}{c} \right)\) which can be modified to \(- \sinh \left( \frac{x}{c} \right)\) by use of a potentiometer set to \(1/c^2\). Thus by assuming \(- \sinh \left( \frac{x}{c} \right)\) we have obtained \(- \sinh \left( \frac{x}{c} \right)\), and hence if the output is fed back into the input, the circuit will produce functions as indicated in Fig. 3, the output of the first integrator \(c \cosh \left( \frac{x}{c} \right)\) being fed to the \(Y\) plate of an oscilloscope. The \(X\) Plate is fed with voltage \(Kx\), which increases linearly with \(x\). Such a voltage is readily obtained by integrating a constant voltage \(-K\) as indicated.

The effect of changing \(c\) can be seen by observing the different oscilloscope traces for various settings of the \(1/c^2\) potentiometer.

A further technique worthy of mention, is that of a method of solution of simultaneous equations, such as those arising from simple beam problems. For instance if we have a light uniform beam simply supported as in Fig. 4, and with weights of 2 lb and 28 lb as shown, it may be required to find the reactions at the supports \(X\) and \(Y\).

By resolving vertically and taking moments, the following equations for \(X\) and \(Y\) are obtained.

\[ X + 2Y = 30 \quad ; \quad Y = 30 - X \]
\[ 2X - 3Y = 10 \quad ; \quad X = \frac{10 + 3Y}{2} \]

Using these relationships and assuming a signal for \(-3Y\), summing amplifiers can be used to develop signals for \(X\) and thence \(-3Y\), and by feeding the output back to the input the above equations can be satisfied (see Fig. 5).

If the appropriate fixed voltages of \(-10\) and \(-30\) are applied as shown, using a scaling of 1 volt \(\equiv 1\) unit, then the values of \(X\) and \(Y\) can be read as the output voltages of amplifiers 1 and 2 respectively.

This technique cannot always be used, since certain types of equations will require a computer arrangement which may be unstable. In these cases more advanced methods of solution are used.

A demonstration of these uses of the analogue computer has been made by Louis Newmark Ltd., to the sixth form students of Orpington Grammar School, where the interest aroused is now building its own computer. New Addington, Surrey.

M. A. COLLINS, Louis Newmark Ltd.

**Line Standards**

YOUR leading article on number of lines is a refreshing change in that an authoritative opinion favours retention of 405 lines in this small island of ours, with its attendant co-channel problems.

The writer sees little to recommend a change except perhaps exchange of programmes with the Continent and the advent of colour. For the former it would be cheaper to arrange a separate camera chain from the studio on 625 lines when an exchange with Europe was necessary. 625 lines would not help a great deal with picture degradation when changing to French 819 lines.

Regarding colour, the writer recently saw the latest adaptation of the N.T.S.C. system on 405 lines at the laboratory of a leading manufacturers and the results would have satisfied even the most artistic viewer, the compatibility being excellent.

Lying near the Continent the writer often has the chance to view television in the average home on 625 and 819 lines. On 625 there is no significant improvement, but with 819, provided that the television is in reasonable alignment, and the aerial system covers the bandwidth required, the picture quality is a marked improvement; but the writer has noticed when the bandwidth is restricted for any reason, the result is a very unpleasant comparison of good vertical definition with poor horizontal detail.

At present in this country, towns served by i.f. wired systems do not enjoy in most cases more than 2 Mc/s bandwidth on the whole network, so any overall improvement would be lost to these viewers.

Dover.

B. A. A. SMYE-RUMSBY

**"Things Great and Small"**


Of passing interest is the fact that the Greeks did indeed have words for quantities above 1,000. Herodotus in his history, Book VII, Polymnia section 60, counts Xerxes’ Army in terms of myriads (literally, μυριας, his word for 10,000). Also, Archimedes devised a set of names for numbers greater than 10,000, using as a base the octal (108).

But of major significance in the article is the set of metric prefixes Dr. Peterson proposes. Here is a simple method of prefixes that takes us from \(10^{-20}\) to \(10^{10}\).
with logic not found in the likes of nano, giga,tera, and pico.

Basically, a Peterson prefix is, for positive powers of 10, a Greek prefix and an "iilo." The "iilo" comes from the prefix for $10^9$, kilo, a serves to identify the prefix immediately as being positive. For negative prefixes, Peterson combines standard Latin prefixes with "iili" (from milli, the prefix for $10^{-3}$). The following table shows how ingeniously simple this system is.

<table>
<thead>
<tr>
<th>Value</th>
<th>Prefix</th>
<th>Symbol</th>
<th>Value</th>
<th>Prefix</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^3$</td>
<td>kilo</td>
<td>k</td>
<td>$10^{-3}$</td>
<td>milli</td>
<td>m</td>
</tr>
<tr>
<td>$10^6$</td>
<td>dilo</td>
<td>d</td>
<td>$10^{-6}$</td>
<td>bili</td>
<td>b</td>
</tr>
<tr>
<td>$10^9$</td>
<td>trilo</td>
<td>TR</td>
<td>$10^{-9}$</td>
<td>trilli</td>
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<tr>
<td>$10^{12}$</td>
<td>tetrilo</td>
<td>TT</td>
<td>$10^{-12}$</td>
<td>quadrilli</td>
<td>qd</td>
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<tr>
<td>$10^{15}$</td>
<td>pentilo</td>
<td>PN</td>
<td>$10^{-15}$</td>
<td>quintilli</td>
<td>qn</td>
</tr>
<tr>
<td>$10^{18}$</td>
<td>hextilo</td>
<td>HX</td>
<td>$10^{-18}$</td>
<td>sextilli</td>
<td>sx</td>
</tr>
<tr>
<td>$10^{21}$</td>
<td>heptilo</td>
<td>HP</td>
<td>$10^{-21}$</td>
<td>septilli</td>
<td>sp</td>
</tr>
<tr>
<td>$10^{24}$</td>
<td>oktilo</td>
<td>OK</td>
<td>$10^{-24}$</td>
<td>octilli</td>
<td>oc</td>
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<tr>
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<td>$10^{-27}$</td>
<td>nonilli</td>
<td>nn</td>
</tr>
<tr>
<td>$10^{30}$</td>
<td>dekilo</td>
<td>DK</td>
<td>$10^{-30}$</td>
<td>decilli</td>
<td>dc</td>
</tr>
</tbody>
</table>

It is a pity that Peterson's article wasn't published 10 years ago, before such alogical absurdities as giga won their acceptance through default. But it is only a matter of time before man is again begged down for lack of additional prefixes, and then perhaps logic will have its day.

Meanwhile, several publications have reprinted the Peterson article, and I recommend it to those who crave logic in language.

Lexington, FREDERICK T. VAN VEEN Massachusetts, U.S.A.

**Self-balancing Push-pull Circuits**

MR. BIRT'S reply to the first part of my letter in the August issue is quite acceptable. In fact, by showing how the magnetic coupling in the output transformer ensures no error-signal at the junction of R-R. in my two-stage amplifier (Fig. 1, p. 397), Mr. Birt makes "a fair cop". Apparently, in this case, to take the error-signal from a resistor at the primary tap is the only way. Even so, this could be coupled to the first stage common bias resistor without the intervention of a "gannless" valve stage; the gain over two stages—especially if the first is a pair of pentodes or cascodes (not cross-coupled)—ensures very close balance.

The diagram herewith shows a "Croscode" with lower triodes having a gain of $\times 2$, the right upper triode $\times 20$, and the left upper triode $\times 25$. Tracing through (plain figures) an a.c. signal with an instantaneous input of $-2$ shows an unbalanced output of $-80$ and $+100$ at the anodes. Now adding a fraction of the error-signal in reversed phase of $-0.1$ at the cathodes (relatively positive feedback to the right side and negative to the left), the signal thus modified is traced through afresh (underlined figures). It is seen that the grid-cathode signal to both upper triodes is still 4, as before, and the output balance not improved. Thus, the "Croscode" does not lend itself to self-balancing by the methods under discussion. (Easy figures, rather than practical, are used for illustrating the principle.)

To save the Editor's precious space I leave the reader to re-draw the diagram without cross-coupling (i.e. with earthed upper grids), not forgetting that the gain of the lower triodes is now $\times 4$ as explained by Mr. Birt (p. 283, June issue). Tracing through the same signal, it will be found now that adding a $-0.1$ error-signal improves the balance to $-88$ and $+90$.

Walsall, Staffs.

STANLEY MAY

**EDUCATIONAL AIDS**

The photographs show top and bottom views of the Associated Electrical Industries Type R2330 amplifier, one of a new range of educational aids. Also in-

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Wireless World, September 1960

435
National Radio Show Guide

THE 27th British National Radio and Television Show at Earls Court opens to the public on August 24th with a preview for overseas visitors and invited guests the day before. Organized by Radio Industry Exhibitions on behalf of the British Radio Equipment Manufacturers’ Association it is essentially a domestic sound and television equipment show, although the Services, B.B.C. and I.T.A., provide interesting background.

We give in the following pages a preview of the technical exhibits compiled from information available at the time of going to press. The stands in the Audio Hall are covered in a separate section at the end. In the October issue we shall give an assessment of trends in the design of equipment as portrayed at the Show.

### ALPHABETICAL LIST OF EXHIBITORS

<table>
<thead>
<tr>
<th>Exhibitor</th>
<th>Stand</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.E.I.</td>
<td>21 (X27)</td>
</tr>
<tr>
<td>Admiralty</td>
<td>407</td>
</tr>
<tr>
<td>Aerialite</td>
<td>13</td>
</tr>
<tr>
<td>Air Ministry</td>
<td>406</td>
</tr>
<tr>
<td>Alan-Markovits</td>
<td>115</td>
</tr>
<tr>
<td>Alba</td>
<td>16</td>
</tr>
<tr>
<td>Amateur Tape Recording</td>
<td>412</td>
</tr>
<tr>
<td>Amition</td>
<td>54</td>
</tr>
<tr>
<td>Antifrence</td>
<td>17</td>
</tr>
<tr>
<td>Argosy Radiovision</td>
<td>61</td>
</tr>
<tr>
<td>Associated Television</td>
<td>74</td>
</tr>
<tr>
<td>B.B.C.</td>
<td>408, 409 &amp; 410</td>
</tr>
<tr>
<td>Barclays Bank</td>
<td>203</td>
</tr>
<tr>
<td>Belling &amp; Lee</td>
<td>63</td>
</tr>
<tr>
<td>Bernards (Publishers)</td>
<td>123</td>
</tr>
<tr>
<td>Bowmaker</td>
<td>216</td>
</tr>
<tr>
<td>Brimar Electronics</td>
<td>104</td>
</tr>
<tr>
<td>Bulgin</td>
<td>66</td>
</tr>
<tr>
<td>Bush</td>
<td>51 &amp; 60 (X14)</td>
</tr>
<tr>
<td>“Careers”</td>
<td>405</td>
</tr>
<tr>
<td>Casian</td>
<td>219</td>
</tr>
<tr>
<td>Charterhouse Credit Co.</td>
<td>8</td>
</tr>
<tr>
<td>Chorlton &amp; Co.</td>
<td>217</td>
</tr>
<tr>
<td>Collaro</td>
<td>38</td>
</tr>
<tr>
<td>Cossor Radio &amp; TV</td>
<td>57</td>
</tr>
<tr>
<td>Dansette</td>
<td>44</td>
</tr>
<tr>
<td>Decca Records</td>
<td>35 (X6 &amp; X7)</td>
</tr>
<tr>
<td>Defiant</td>
<td>7</td>
</tr>
<tr>
<td>Design Furniture</td>
<td>103</td>
</tr>
<tr>
<td>Domain Products</td>
<td>214</td>
</tr>
<tr>
<td>Dubllier</td>
<td>62</td>
</tr>
<tr>
<td>Dynatron</td>
<td>52</td>
</tr>
<tr>
<td>E.M.I. Records</td>
<td>65</td>
</tr>
<tr>
<td>E.M.I. Sales &amp; Service</td>
<td>24</td>
</tr>
<tr>
<td>Econasign</td>
<td>121</td>
</tr>
<tr>
<td>Ekco</td>
<td>58 (X8)</td>
</tr>
<tr>
<td>Electrical &amp; Radio Trading</td>
<td>111</td>
</tr>
<tr>
<td>Electronic Technology</td>
<td>264</td>
</tr>
<tr>
<td>Elizabethan</td>
<td>26</td>
</tr>
<tr>
<td>Emerson Electronics</td>
<td>50</td>
</tr>
<tr>
<td>Ever Ready</td>
<td>34 (X10)</td>
</tr>
<tr>
<td>Ferguson</td>
<td>39 (X5)</td>
</tr>
<tr>
<td>Ferranti Radio &amp; TV</td>
<td>20 (X30)</td>
</tr>
<tr>
<td>Fidelity Radio</td>
<td>48</td>
</tr>
<tr>
<td>Fountain Press</td>
<td>124</td>
</tr>
<tr>
<td>Fund for the Blind</td>
<td>414</td>
</tr>
<tr>
<td>G.E.C.</td>
<td>32 (X24)</td>
</tr>
<tr>
<td>G.P.O.</td>
<td>403</td>
</tr>
<tr>
<td>Gala Records</td>
<td>202</td>
</tr>
<tr>
<td>Garrard</td>
<td>56</td>
</tr>
<tr>
<td>Goodmans</td>
<td>220</td>
</tr>
<tr>
<td>Gramophone Co.</td>
<td>46 (X11)</td>
</tr>
<tr>
<td>Hacker Radio</td>
<td>113</td>
</tr>
<tr>
<td>Heathkit</td>
<td>112</td>
</tr>
<tr>
<td>“His Master’s Voice”</td>
<td>33 (X9)</td>
</tr>
<tr>
<td>Hobday, Christopher</td>
<td>221 (X25)</td>
</tr>
<tr>
<td>Home Maintenance</td>
<td>118</td>
</tr>
<tr>
<td>Hunts Capacitors</td>
<td>49</td>
</tr>
<tr>
<td>I.T.A.</td>
<td>74</td>
</tr>
</tbody>
</table>

With this plan and the alphabetical lists of exhibitors in both the main exhibition and the audio section visitors will readily be able to locate a particular stand. Demonstration rooms and offices are prefixed with "X" on the ground floor and "O" in the Audio Hall.

**Dates:**
August 24th to September 3rd

**Times:**
11 a.m. to 10 p.m.

Wireless World, September 1960
<table>
<thead>
<tr>
<th>Place: Earls Court London, S.W.5.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admission: 3s 6d (children 1s 6d)</td>
</tr>
</tbody>
</table>

Wireless World, September 1960

---

**AUDIO HALL (First Floor)**

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Booth Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.E.I. Sound Equipment</td>
<td>308</td>
</tr>
<tr>
<td>Acos</td>
<td>310 (O2)</td>
</tr>
<tr>
<td>Alba</td>
<td>306</td>
</tr>
<tr>
<td>Brenell</td>
<td>311</td>
</tr>
<tr>
<td>Decca</td>
<td>303</td>
</tr>
<tr>
<td>Dynatron</td>
<td>313</td>
</tr>
<tr>
<td>E.A.R.</td>
<td>319</td>
</tr>
<tr>
<td>Expert Gramophones</td>
<td>307</td>
</tr>
<tr>
<td>Ferguson</td>
<td>324</td>
</tr>
<tr>
<td>G.E.C.</td>
<td>322</td>
</tr>
<tr>
<td>Gainborough Tape Recorders</td>
<td>301</td>
</tr>
<tr>
<td>Goodmans</td>
<td>316</td>
</tr>
</tbody>
</table>

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**Audio Equipment**

- Gramophone Co. (323 (O1))
- Gramdeck (314)
- Lustraphone (309)
- Philips (320)
- REPS (305)
- Rola Celestion (312)
- Symphony Amplifiers (302)
- Tape Recording Hi-Fi Magazine (321)
- Truvox (317)
- Whiteley (304)

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**Place:**
Earls Court
London, S.W.5.

**Admission:**
3s 6d (children 1s 6d)
Prominent among the exhibits on this stand is the Type CME2104, short-neck, 21-in television tube. It has a tri-epitaxial electron-gun assembly and the overall length is only 13½in. It has a 12.6V heater and forms a companion for the CME1709, 110°, 17in model introduced last year.

Semiconductor devices include the new Mazda XA161 and XA162 high-speed switching transistors of "mesa" construction and a 100-Mc/s amplifier transistor, the XA131. Also included are three n.p.n. switching transistors and a comprehensive range of transistor packages for the entertainment industry.

There is a representative group of Siemens-Edlwald dry batteries and among other items a range of Solon electric soldering irons.

Associated Electrical Industries Ltd.,
155 Charing Cross Road, London,
W.C.2.

**AMIRALTY** (407)

"Navigation and charting the seas" is the theme of the Navy's display which is centred around a mock-up of a ship's bridge and plotting room. Amongst the equipment to be seen in this mock-up is the Two-range Decca Navigator, a radar display with chart comparison unit and a low-power transmitter-receiver. Airborne equipment including a u.h.f. direction finder is also on show together with a radar simulator for training purposes and a flight data system.

Amiralty, Whitehall, London,
S.W.1.

**AERIALITE** (13)

In addition to ranges of aerials for television and radio for both overseas and home markets, cables for wired television and radio distribution will be shown. Two new cables will be introduced—one will be a "trunk" cable of low attenuation in Band III and another, utilizing an unusual construction, for which very low radiation is claimed. Also shown will be distribution amplifiers and installation accessories such as plugs and sockets and aerial filters.

Aerialite Ltd., Castle Works,
Styalbridge, Cheshire.

**AIR MINISTRY** (406)

Many examples of electronic and radio aids used both operationally and in training by the Royal Air Force are shown on this stand. The unique remote-command landing system developed by the Blind Landing Experimental Unit of the Royal Air-

craft Establishment is illustrated, and among the training equipment shown is the trainer Type 102, which simulates the operation of airborne radar navigational and bombarding aids.

Air Ministry, Adastral House,
Theobalds Road, London,
W.C.1.

**ALAN-MARKOVITS** (115)

Embellishments in the form of metal escutcheons, decorative fittings, cut-outs of various kinds and die-stamped name plates in a wide range of designs are made by this firm.

Alan-Markovits Ltd.,
Emblem House, Sussex Road, Hove, Sussex.

**ALBA** (16)

The very wide range of models displayed includes transistor and mains receivers, stereo record reproducers and radio-grams, the Duchess tape recorder and several television sets. Special features of these last are the mounting of the components on plug-in sub-chassis for ease of servicing, and provision of gated a.g.c. for more accurately reproducing picture contrasts. An unusual feature of the new Model T766 is that the brightness and contrast controls are preset. This model also uses an extra-short necked 110° tube for minimizing the cabinet depth.

Alba (Radio and Television) Ltd.,
Tabernacle Street, London,
E.C.2.

**AMPLION** (54)

Shown by this company are a number of record reprocers, tape recorders and battery eliminators, as well as a stereo amplifier and transistor receiver. The "Marine" tape recorder is very unusual in that it can be operated from a.c. as well as a.c. mains.

Amplion Ltd., 175-179 Cricklewood Lane, London, N.W.2.

**ANTIFERENCE** (17)

The "Cresta"—a new "in-the-room" B.B.C.-I.T.A. television aerial, which uses a full-wave Band-III dipole matched for extra gain and control over the radiation pattern, will be featured on this stand, together with new loft aerials. The remainder of the display will comprise a complete range of television and radio aerials and accessories for both home and overseas channel allocations; mounting brackets, masts, etc.; and a new "Autex" car-radio aerial.

AntifERENCE Ltd., Television and Radio Aerial Division, Bicester Road, Aylesbury, Buckinghamshire.

**ARGOSY** (61)

The two new television receivers shown on this stand employ substantially the same circuitry, are housed in matching cabinets and differ only in the tuning systems employed. One, Model 17K12, has push-button selection of five stations, while the Model 17K14 has rotary-switch selection of all 13 channels. Both sets have 17in, 110° electro-static focus tubes.

Sound radio sets include a transistor portable and an AM/FM table model, while for sound reproduction there is a very wide range of transistor equipment including a single-speed (3½in/sec) tape recorder.

Argosy Radiovision Ltd., Eastern Avenue West, Romford, Essex.

**B.B.C.** (408, 409, 410)

Two of the three B.B.C. stands are devoted to entertainment—408 the "Gramstand" and 409 the "Telescope." Part of stand 410 is devoted to the activities of the Corporation's engineers in research and development. Here will be seen a remotely controlled TV camera designed and produced by B.B.C. engineers. The advances made in the application of transistor techniques in various types of equipment are also illustrated in this section.

Although not strictly a technical feature, the specially constructed news studio, from which bulletins will be actually broadcast in the Light Programme, is of particular interest. Members of the Engineering Information Department are manning an information centre located between stands 408 and 409.

British Broadcasting Corporation,

**BELLING-LEE** (63)

A range of set-top, or "in-the-room," aerials will form part of the display on this stand. Making its debut is a new well-equipped "Golden-V" and "Metropolitan" aerials is the "Vedette"—a low-priced set-top aerial.

Other aerials to be shown include attic types for Bands I, II and III, and the Necked III aerial which plug directly into the aerial socket of the receiver and a wide range of outdoor aerials, including types for Band V. Also featured will be complete equipments for individual units for communal-aerial and relay systems.

Belling and Lee Ltd., Great Cambridge Road, Enfield, Middlesex.
WHilst on Stand 60 there is a complete range of television, radio, record-playing and radio-gramophone equipment produced by this company which will be shown; whilst on Stand 60 working television receivers will be massed in front of rows of seats.

New products on show will include the 21-in T.100c television receiver using the Bush push-button tuner, the TR.90 medium- and long-wave transistor portable receiver and the "Top Ten" record player. Specifically designed for the "pop" market this player is a battery-operated transistor model for 45 r.p.m. records only and it also can be switched to receive the long-wave Light Programme.

**BRIMAR ELECTRONICS (104)**

A comprehensive range of valves and cathode-ray tubes for radio and television will be shown. Innovations are the 23-in 110" television tube with square corners to its screen and the E.L.L.80 which is a double output pentode for push-pull and stereo output-stage applications.

Also shown will be the "Trustworthy" range of valves and other industrial types.

Brimar Electronics Ltd., Footscray, Sidcup, Kent.

**BULGIN (46)**

Many new items have been added to the Bulgin range of components recently but only a few can be mentioned here. A side-entry screened jack-plug conforming to BS666 requirements is compact, slender and has numerous applications. It is available in chrome (P535) or gold-plate (P536) finish. New side-entry plug and socket combinations are also shown.

Many additions have been made to their ranges of miniature and micro switches all of which constitute an improvement of one kind or another or to give them greater versatility. "Rocker-contact" switches of entirely new design in double- and single-pole types are now available. Some have a central "off" position and the rating is 6A to 10A at 250V a.c. Pure silver contacts are fitted and there are 8 new models in all.

A. F. Bulgin and Co. Ltd., Bye-Pass Road, Barking, Essex.

**WIRELESS WORLD, SEPTEMBER 1960**

**CAREERS (405)**

The would-be trainee will get a glimpse of the job of a serviceman from this stand, which also shows the public the standard of servicing they should expect from a dealer. There is also a display of the latest types of test equipment available to the dealer.


**CASIAN (219)**

Shown on this stand is the Trav-ler transistorized tape recorder. This operates at a single tape speed of 3 in/sec and at this speed the wow and flutter is claimed to be less than 0.4% r.m.s., the signal-to-noise ratio 30dB, and the frequency response flat within 3dB from 150 to 5,000 c/s.


**COLLARO (38)**

New additions to the range of tape decks, pickups and automatic and manual record turntables include the TRP594 inexpensive transcription turntable and pickup arm, and the Studio C60 record changer. This latter incorporates a new speed-change mechanism which makes it impossible to change speed while the motor is running, thus avoiding one source of damage to the rubber driving wheels. The pickup arm is weight-rather than spring-counter-balanced so that the stylus pressure difference between the top and bottom records of a stack is kept below 1 gm. Also shown is the three-speed, three-motor "Studio" tape deck. This is normally fitted with two heads, but there is space for a third.

Collaro Ltd., Ripple Works, By-Pass Road, Barking, Essex.

**COSSOR RADIO AND TV (57)**

Two new television receivers are included this year, the CT1700U is a 17-in model with 110° tube and side-mounted, recessed controls. The loudspeaker while side mounted is canted forward for better sound distribution. Total depth is 15in. The other new model (CT2100U) is a
21-in version of the CT1700U and its circuitry and general features are substantially the same.

Among the new sound radio receivers is a 7-valve a.m./f.m. stereo radio-gram with two end-mounted 8-in loudspeakers. A 4-speed automatic record changer is used which is push-button operated and takes all sizes of records.

Cessor Radio and Television Ltd.,

**DANSETTE (44)**

A new addition to the wide range of record players and transistor receivers is the TRG45 transistor 45 r.p.m. radio-gram. This has a 500 mW push-pull output which feeds a 5-in loudspeaker. Also exhibited is a valve radio-gram, a portable stereo record reproducer, and two stereo consoles.


**DECCA (35)**

Features of the range of television sets on show are the use of two spaced loudspeakers, tripod-mounted rotatable cabinets for readily altering the viewing direction and, for ease of servicing, a specially hinged chassis. Several of these sets incorporate v.h.f./f.m. receivers. New models introduced this year include a combined television set and v.h.f./f.m. stereo radio-gram and also a transistor radio-gram. Also shown are several transistor receivers and stereo radio-grams.


**DEFIANT (7)**

Automatic brightness control is a feature of the Defiant 2A22 21-in television receiver on which push-buttons are provided for sound tone, on/off and picture sharpness control. 17-in models will also be shown.

For radio reception seven models of table receivers and radio gramophones are offered. A new receiver—Model A52—is described as a "cordless" receiver. In fact, this is a battery-powered transistor set, in a polished-wood table cabinet, giving a three-quarter-watt output to a large loudspeaker, thus simulating the performance of a mains-driven receiver. Also shown will be three record reproducers.

Co-operative Wholesale Society Ltd.,
1 Balloon Street, Manchester, 4.

**DESIGN FURNITURE (103)**

Tables and trolleys of various kinds, some fitted with easy-running casters and designed especially to accommodate and harmonize with modern television receivers, are shown on this stand, together with a range of record storage and equipment cabinets.

Design Furniture Ltd., Carnmab Road, Fulham, London, S.W.6.

**DOMAIN PRODUCTS (214)**

To the range of showroom display shelves and floor-stands, made principally of tubular steel finished in attractive colours, has this year been added the "SL" series in 2- and 3-tier types for displaying to advantage modern "slimline" television sets.


**DUBILIER (42)**

New developments to be shown on this stand include encapsulated paper tubular capacitors which meet the RCS131 joint services standard, sub-miniature electrolytic capacitors for transistor applications, high-stability resistors and tantalum electrolytic capacitors of both solid and foil construction.

A comprehensive range of capacitors, resistors and suppression devices for the television, radio and electronics industries will complete the display.


**DYNATRON (53)**

An unusual feature of the Autoview combined 21-in television and v.h.f./f.m. receiver is that station selection is by means of push-buttons which actuate a motor-driven turret tuner. A feature of several of the single-cabinet stereo and mono a.m./f.m. radio-grams is that bass reflex loudspeaker mounting is adopted. Several record reproducers are also on show. Transistorized units include a four-

(Continued on page 441)

Wireless World, September 1960
speed record reproducer, a radio-gram and several receivers. Newly introduced is this company’s first tape recorder—the Cordova, Dynatron Radio Ltd., Maidenhead, Berks.

E.M.I. RECORDS (55)
H.M.V., Columbia, Parlophone, Capitol, M.G.M. and Mercury records will be displayed. Comprehensive record enquiry facilities will also be available.


E.M.I. SALES & SERVICE (24)
On show is the complete range of Emitape magnetic recording tape for amateur and professional users, which includes 2-in wide videotape as well as ordinary-, long-, and double-play 4-in tape. Also displayed is the complete range of Marconi valves.

E.M.I. Sales & Service Ltd., Blyth Road, Hayes, Middx.

EKO (58)
Special features of several of the new television receivers on show are the use of two speakers mounted on either side of the cabinet, gated a.g.c. for more accurately reproducing picture contrasts, and the inclusion of a v.h.f./f.m. receiver.

Another new introduction is Ekko’s first tape recorder which is an inexpensive single-speed (3½in/sec) model. Record reproducers include a new portable stereo record player as well as the well-known Nine-Octave RP341 which features a tuned reflex loudspeaker cabinet, an 8-watt output and bass and treble controls.

Features of a new small transistor receiver, the PT352, are provision of a push-pull output and slow-motion tuning. The wide range of valve receivers on show includes a.m., a.m./f.m. and f.m.-only models, and the well-known Radiotime combined radio, alarm clock and time mains switch.


ELIZABETHAN (24)
Two four-track models are additions to the range of tape recorders. One of these, the FT1, is claimed to give a response up to 12,000 c/s at the single speed provided (3½in/sec). The other new model, the FT3, can be operated at 1½, 3½ or 7½in/sec. Independent mixing of two channels is also possible with the FT3. Also on show is the two-track, three-speed Major tape recorder which features a record replay head with a gap as short as 3 microns, a meter recording-level indicator and a six-watt push-pull output.

Elizabethan (Tape Recorders) Ltd., Bridge Close, Romford, Essex.

EMERSON (58)
The Models 911 and 555 transistor portable receivers have both car-aerial and personal-listening earphone sockets and cover medium and long wavebands, as does the personal portable Model 888. A “table” model (666) also tunes over medium and long waves.

Three gramophones will be shown, two being automatic record players, one with a “slumber switch” for turning off the mains supply after the last record has been played. The Model 502 is a stereo player with external loudspeakers. Also shown will be two medium- and long-wave radio-grams (mono) and a 21-in television receiver.

Emerson Electronics Ltd., Brent Crescent, North Circular Road, London N.W.10.

EVER READY (34)
The “Sky Baron” and the “Car Portable” are the two newest transistor sets shown on this stand. The latter is of special interest as it includes provision for operation as a portable from its own battery or as a car radio from the 12V car battery, switching from one to the other being instantaneous. It employs 6 transistors and change from medium to long waves is effected by push-button switches.

A full range of current models in transistor and valve types are also included, as well as the Berce receivers in which series the “Musketee” and “Auto Portable” are electrically similar to the “Sky Baron” and “Car Portable” respectively.

Ever Ready Co. (Great Britain) Ltd., Hercules Place, London, N.7.

FERGUSON (39)
A transistor v.h.f./f.m. receiver will be shown on this stand. The Model 626BT is a battery-powered receiver, using nine transistors and covering v.h.f./f.m. and medium and long waves. One-watt a.f. output is fed to an 8 x 5in elliptical l.s. and the styling is such that this set, although it has internal v.h.f. and a.m. aerials, is better regarded as a “cordless” table model than as a portable receiver. Also featured will be the Model 627 a.m./f.m. a.c./d.c. table receiver, which has a contemporary-styled case.

Several television models feature “Golden Glide” tuning—channel switching is achieved by means of a slide-bar control. Ferguson television receivers have the line and frame timebases stabilized against mains-supply variations and both horizontal and vertical retrace blanking is applied.

Radio-grams and record players will also be shown: demonstrations Stand 324 (Audio Hall).


FERRANTI (20)
Using the well-known B.S.R. deck, the new Ferranti Model RT1044 tape recorder has a 7 x 4in internal loudspeaker and extension i.s. sockets (output power 3W).

New 21- and 17-inch television receivers are designed so that access for servicing is easy and models with and without v.h.f. radio will be shown. The personal portable transistor receiver, Model F 1031, covers the medium-wave band and provides pre-tuned reception of the long-wave Light Programme. V.h.f./f.m. and a.m. receivers will complete the display.

To the Argyl series of tape recorders has now been added the Argyll Minor, a twin-track recorder running at 3½ ips. A "magic-eye" indicator provides visible check of recording amplitude. It is sturdily constructed and operates from a.c. mains.

Elegantly housed in the modern style is the RG26 radio-gram. It has ample space for record storage, the radio and gramophone compartments are side-by-side, the latter being exceptionally accessible, and the 6-volt radio unit provides for a.m. and v.h.f./f.m. broadcast reception. The gramophone is a 4-speed, auto-changer type. It is an a.c. mains model.


G.P.O. (403)
Radio interference and its suppression, the use of ferrite cores in telecommunication and the part played by the Post Office in linking sound and television studios to transmitters, are among the various aspects of the work of the G.P.O. illustrated on the stand. There is also a careers section where young people can obtain information on the variety of openings available to Post Office trainees.


GALA RECORDS (202)
Among the disc records shown on this stand is a new "Goldentone" series for children in 6in size (78 r.p.m.) costing 2s 9d each. Also introduced this year is a series of four language courses on 12in, 1p. records in which is included Russian.


GARRARD (54)
A new model in the range of crystal and moving-coil pickups and record turntables is the Laboratory Series Auto Turntable Type A which is a combined transcription and automatic record player. The turntable in this unit has an unusual construction consisting of a sandwich made up out of an inner steel shell to provide a magnetic screen over the motor, a foam polyurethane disc, and a heavy non-magnetic outer shell. Also shown are the well-known 301 transcription turntable, TPA12 adjustable pickup arm, and SPG3 stylus pressure gauge.

Garrard Engineering & Manufacturing Co. Ltd., Newcastle Street, Swindon, Wilts.

GOODMANS (220)
A new addition to the range of compact loudspeaker systems is the inexpensive AL100. Also newly-introduced is a corner horn enclosure suitable for home construction for which working drawings but not kits are available and which is designed to be used with the Triaxette three-element coaxial loudspeaker. Also shown are the new Axiom 110 and 112 10-in loudspeakers.

Goodman's Industries Ltd., Axiom Works, Wembley, Middx.

GRAMOPHONE COMPANY (46)
On show are three-speed tape recorders and mono portable automatic record reproducers. Also displayed is the new E.M.I. high-quality stereo pickup. Special features of the head of this are its very low effective tip mass (=1 mgm) and high lateral compliance (7 x 10^-4 cm/dyne). The arm is balanced both laterally and longitudinally, and the single pivot is viscous damped. The offset angle is chosen to minimize the distortion rather than—as is usual—the tracking angle. The arm incorporates a device for gently raising and lowering it so as to prevent damage to the record.

Gramophone Co. Ltd., Blyth Road, Hayes, Middx.

HACKER (113)
The main exhibit is the new Herald seven-transistor portable receiver. Interesting features of this are a specially-loaded large (8in x 5in) loudspeaker, a one-watt push-pull output, and three-position tone control. Speakers are provided for an external aerial for use in a car and for connecting a microphone for using the receiver as a Baby Alarming. Also shown will be a portable transistor record player and radio-gram.

Hacker Radio Ltd., Norreys Drive, Cox Green, Maidenhead, Berks.

HEATHKIT (112)
New kits on show include mono and stereo tape record/replay amplifiers as well as a transistor portable receiver. This latter covers the short and longwave as well as the usual medium and long wavebands, and has a 500mW push-pull output and relatively large (7in by 4in) speaker. The tape amplifiers can be matched to high- or low-impedance heads and feature a push-pull bias supply with a three-position level control for obtaining optimum results from any make of tape. New instrument kits include an r.f. generator covering from 100kc/s to 100Mc/s on fundamentals, as well as a valve grid-dip meter and its transistorized near equivalent.

Daystrom Ltd., Gloucester.

"HIS MASTER'S VOICE" (33)
The Model 1421 is a new a.m./f.m. transistor table receiver notable for employing an r.f. stage for both a.m. and f.m. broadcast reception. It has 9 transistors, 4 diodes and a 1-watt output stage feeding an 8 x 5in elliptical loudspeaker, v.h.f. dipole and ferrite-rod aerials are included in the set.

The tuner in the Model 1910 television receiver, new this year, includes coils for all 13 channels and...
with 4 on immediate call by means of piano-type key switches. A 17in, 110° tube, printed circuits and a 5-in front-facing loudspeaker are employed. A set of matching legs is available. There is also a 17in (110°) portable TV set with all 13 channels on call by means of an orthodox rotary switch located on one side of the very slim-looking cabinet.


CHRISTOPHER HOBDAY (221)
Wholesale distributors to the radio trade this firm is showing a representative range of receivers, sound reproduction equipment and associated apparatus supplied by them. Christopher Hobday Ltd., 98-102 Broadway, Leigh-on-Sea, Essex.

HOME MAINTENANCE (118)
Servicing of radio, television and other domestic appliances for the trade is the function of this organization. On Stand 118 will be found a trade enquiry bureau.

Home Maintenance Ltd., Blyth Road, Hayes, Middlesex.

HUNTS CAPACITORS (49)
This company manufactures capacitors for all radio, television and electronic purposes. On show will be a wide range of both miniature and normal-sized units made by a variety of techniques, recent introductions being "Duoelectric" metalized paper and plastics film units in metal or moulded casings and "Huntalitic" tantalum electrolytic capacitors of dry construction. Also shown will be many types of capacitors developed for use with printed wiring.


I.T.A. (74)
This joint display by two programme contractors (Associated TeleVision and Southern Television), Independent Television News and the I.T.A., includes an O.B. unit with three complete picture units being used for closed-circuit transmissions within the exhibition. It also serves as an information centre for independent television.

Independent Television Authority, 14 Princes Gate, London, S.W.1.

J-BEAM (5)
Well-known for their slot aerials for Band III, this company have devoted considerable research to reducing the unsightliness of television aerial arrays. Possibly the most striking examples of the outcome of this research are the combined Band I/III Double Beam 4/2, Omni-beam 4/2 and New J.One aerials; although in the New J.One the familiar slot construction has disappeared. Three more new aerials on show will be a telescopic car aerial for transistor portable receivers: this is temporarily attached to the car by p.v.c. suckers, the Indoor Omnibeam—a wideband (Channels 6 to 13) Band-III slot combined with a telescopic Band-I element to cover Channels 1 to 5, and the "Marine Omnibeam" for the reception of television on ships.

J-Beam Aerials Ltd., Westonia, Weston Favell, Northampton.

KERRY'S (10)
This exhibit comprises a representative display of the various proprietary makes of radio and TV receivers, radio equipment, test gear and accessories, which, as wholesale distributors, they supply to the radio trade.

Kerry's (Great Britain) Ltd., Warton Road, Stratford, London, E.15.

KOLSTER-BRANDES (22)
The Kolsterama, Consort and Sovereign television receivers to be shown use a new 23-in c.r.t. with right-angle corners so that the complete picture as "seen" by the camera is displayed without the corner cutting inevitable when the whole screen of a more conventional c.r.t. is used. Other apparatus to be shown will include 17-in television set, radio receivers for v.h.f./f.m. and a.m., radio gramophones, record players and a tape recorder.

Kolster-Brandes Ltd., Footscray, Sidcup, Kent.

LABGEAR (35)
Television and v.h.f./f.m. aerials, accessories, amplifiers; intercommunication equipment and test instruments will be shown on this stand.

ECC88 valves are used in the E5053 and E5054 amplifiers, both of which are dual-channel (Band I/III) types providing gains of 15-18dB and 35-38dB respectively.

The intercommunication equipment exhibited will include instruments using the mains wiring alone for interconnection.

Labgear Ltd., Willow Place, Cambridge.

LEE PRODUCTS (55)
The wide range of products shown includes public address equipment and the Dulci and Elpico ranges of high-fidelity mono and stereo amplifiers and pre-amplifiers. Also shown are five- and fifteen-watt guitar amplifiers for which additional units for producing a tremolo effect are available. Elpico column-shaped loudspeaker enclosures as well as cabinets for housing a record turntable, pickup, pre-amplifier and amplifier are also on show.

Components exhibited include a very wide range of car aerials as well as resistors and capacitors.


LE GREST (122)
This firm manufacture television tables and trolleys of various kinds. There is shown a range of tables with and without lower shelves for programme journals and there are models with special non-slip tops and easy-running casters.


LIFEGUARD (30)
On this stand C.R.T. Ltd., a newcomer to the new-tube industry, will be showing representative samples from the Lifeguard range of completely new cathode-ray tubes for television.

Cathode Ray Tubes Ltd., Factory Centre, Kings Norton, Birmingham 30.

LINGUAPHONE (109)
Language courses on gramophone records, many of them now on microgroove discs, are available from the Institute.


MARCONIPHONE (47)
The new 17in (110°) portable television receiver (Model VP168) shown this year is housed in an attractive case giving the impression of even greater "clinniness" than its modest front-to-back measurement of 12in. Coils for all 13 channels are included and special attention has been given to achieving maximum r.f. gain with minimum noise. Printed circuits are used except for the tuner and mains wiring.

Among the valve-type receivers is a
new a.c./d.c. long, medium and v.h.f. sound receiver (Model T89DA) with provision for feeding into a tape recorder, also a 4-speed auto-radio-gram (Model RG56) which caters for v.h.f./f.m. as well as medium and long wave broadcasting.

The latest transistor portable is the Model T85B employing 6 transistors and a 400mW push-pull output stage feeding into a 5in (round) loudspeaker.


MARKOVITS (120)

This stand is devoted to a representative display of metal nameplates, receiver and equipment emblems and various kinds of metal embellishments supplied by this firm to the radio industry.


McMichael (53)

The new television sets introduced this year are notable for at least two features of unusual interest. One is provision of remote control of brightness, volume, and on/off while the other is the inclusion in the set of a light-sensitive cell (cat's eye) which automatically adjusts the contrast to compensate for changes in the room lighting. The remote control, or on/off, unit can be located up to 15ft from the set.

The new sets include a 17-in (110") model in either a transportable (Model MP27) or "static" type cabinet (Model M75T) both similar electrically and providing for v.h.f. broadcast reception. A 21-in version is also available and it is made as a contemporary console.

To complete the range of new sets is a 17in portable, the Model MP20.

The sound radio sets include stereo auto-radio-grams and transistor portables.

Radio and Allied Industries Ltd., Langley Park, Slough, Bucks.

METROPOLITAN POLICE (492)

This is the first time for some years that the Metropolitan Police have provided a display at the Radio Show. Replicas of a radio operator's position at New Scotland Yard, a "999" operator's position and that of an Interpol operator—who by international agreement still uses a morse key—are being shown. Various mobile radio installations are also on show. An interesting feature of the 7-channel transmitter-receiver installed in the Traffic Accident Car is that it uses the r.f. output valve (a double tetrode) as a class B a.f. amplifier to feed the loudhailers.


MULLARD (40, X19)

The interior of Stand 40 is given over to the presentation of " Mullardrama " on a continuous showing principle. Mullardrama is part colour film (starring Jon Pertwee), part display (starring Mullard products for the radio and television industry) and stands out as the most different between the old and the new means for providing entertainment by electronic techniques.

The Home Constructor Centre this year is at Stand X12. Here circular diagrams and constructional details for Mullard designs will be available.


MULTICORE AND MULTIMUSIC (71)

This combined stand will display both the well-known Multicore solder products, such as the Savbit alloy for prolonging the life of soldering iron bits, as well as the new Reflec- 

tograph tape recorders, one of which is for two tracks and the other for four. Both of these new recorders use the same mechanical deck which provides tape speeds of 3/2 or 71/2in/sec and which has the unusual feature that a single potentiometer control provides variable-speed fast forward and rewind. Separate record and replay amplifiers are used.

Multicore Ltd., Maylands Avenue, Hemel Hempstead, Herts.

MURPHY (23)

The TR1, Murphy's first tape recorder, will be on show. Using the Garrard's cassette-loading deck, as whose controls the recorder switching is ganged for simple operation, the TR1 has a "magic-eye" record-level indicator which operates before the tape can be set in motion.

Among the new radio-grams will be the portable A512R. Instead of the more usual m.w. and l.w. radio an f.m. tuner is provided. A stereo-phonic turnover cartridge is already fitted—for stereo reproduction the companion amplifier/loudspeaker unit is plugged-in. Another new radio-gram features a return almost to the flat baffle for its loudspeaker mounting (A592R).

The television receivers shown will include 17- and 21-in models in both " standard " and " luxury " classes, both with and without v.h.f./f.m. radio. Those receivers with f.m. facilities retain the automatic frequency control feature introduced last year so that switch programme selection, without fine-tuner fiddling, is provided.

A new transistor portable receiver, the B483, has a plastics cabinet of " Forticol ", which possesses shock-resisting qualities.

Murphy Radio Ltd., Welwyn Garden City, Hertfordshire.

NEY (218)

The Nottingham Electronic Valve Company claim that their cathode-ray tube recording equipment is the first to be shown at a National Radio Show. The apparatus includes semi-automatic machines suitable for the dealer who wishes to condition up to 25 c.r.t.s per week and the plant can be expanded to deal with up to 1,000/week.

Nottingham Electronic Valve Co. Ltd., Kenrick Street, Netherfield, Nottingham.

PERDIO (41)

The wide range of transistor receivers on show includes the Continental. Special features of this are a loudspeaker as large as 8in by 5in, a one-watt push-pull output with bass boost to partially compensate for the small cabinet size, inclusion of the 70-200 metres traffic waveband, and a selectivity which automatically decreases as the station strength falls so as to minimize the signal-to-noise ratio. New transistor receivers which it is hoped to introduce include one for the v.h.f./f.m. band and another giving continuous coverage of a.m. from 11 to 570 metres as well as the long wave band.


PERTH (285)

The "Home and Away" radio-gram is a combination of transistor a.m. radio receiver and, in a radio-gram cabinet, a mains-powered turntable and amplifier to which the transistor receiver can be attached as a tuner unit. The transistor receiver can, of course, be removed and used separately as a portable.

Four versions of a wholly mains-powered radio-gram will be shown: a.m., a.m./stereo, a.m./f.m. and a.m./f.m./stereo. All Perth radio-grams have polished wood backs so that they are freed from the limitation of having to be stood against a wall.

Two record players (single-channel and stereo) a tape recorder (Clarissa Mk IV) and a small all transistor receiver will complete the display.


PETO SCOTT (27)

Seven types of television receiver will be shown on this stand including portable, table and table-with-f.m. models as well as the Fanfare tape recorder.

The two of the television receivers will be seen for the first time at the show—a 21-in model with twin loudspeakers and side controls and a 17-in set which is described as an "extra-slim " with keyboard tuning.

Peto Scott Electrical Instruments Ltd., ADDLESTON ROAD, WELWYN, Hertfordshire.

PHILCO (48)

Following the trend for picture-on-the-wall television, started last year with the " Telerama ", Philco have introduced this year the "Pictu-rama " 17-in. receiver using the so-called "rotary neck 110" r.t.—which can be hung on the wall. This set is not available in the UK.

NEW WIRELESS WORLD, SEPTEMBER 1960
1. Aluminizing machine from Nottingham Electronic Valve Company's "400" c.r.t. reconditioning plant.

2. Picturama 17-in TV receiver by Philco hangs on the wall or uses its mounting bracket as a table stand.


"just a pretty face"—inside information is given to the serviceman by completely colour-coded sub-assemblies, so that, Philco claim, most servicing can be carried out without reference to a service manual.

Other new designs to be shown will be radio-grams, record players, radio receivers and, in addition to the Picturama, television receivers.

Philco (Great Britain) Ltd., 30/32 Gray's Inn Road, London, W.C.1.

PHILIPS (10)

Recent introductions by this company include an a.m./f.m. receiver, a de luxe version of the Phillette transistorized receiver which has a detachable handle for converting it from a portable to a table radio, an automatic version of the Disc Jockey stereo record reproducer, and an a.m./f.m. stereo radio-gram in which the loud-speakers are mounted at the ends of the cabinet and angled outwards. Well-known features of this company's range of television receivers are the use of a hinged chassis for ease of servicing, and side mounting but forward angling of the loudspeaker.


PILOT (11)

The "Spacemaker" range of television sets introduced last year is continued with little change; this includes 17in. and 21in. models in table and portable form with and without v.h.f. radio channels.

Among the sound reproducing apparatus is a lightweight portable stereo record player with 4-speed auto record changer and embodying two detachable loudspeakers which form the lid of the player. There is also a transistor portable which can be operated from its self-contained aerial or a car aerial. It covers medium and long wavebands.

Pilot Radio and Television Ltd., Television House, Eastcote, Ruislip, Middlesex.

PITRIE (108)

This stand will hold a display of reconditioned television cathode-ray tubes and function as a trade enquiry office.


PLESSEY (73)

This stand is primarily an office where design engineers, representatives of manufacturing organizations and business associates from abroad can discuss immediate and future requirements with members of the Plessey organization. Available for their
inspection are examples of this firm’s current and newest products.

Plessey Co. Ltd., Vicarage Lane, Ilford, Essex.

R.G.D. (28)
Among the wide range of television and radio receivers, radio-grams, record players and a tape recorder to be shown will be five models introduced for the exhibition. Of particular interest will be the Model 612 television receiver with its press-button tuner and the 204 a.m./f.m. radio-gram which is styled in the modern long, low look.

For the connoisseur of recorded and broadcast sound the Model 418 radio-gram will be shown. This uses a Goldring variable-reluctance pick-up and is fitted with an integral 6.5W amplifier and five loudspeakers, the bass cabinet using an acoustic resistance unit. For stereo a second amplifier/loudspeaker combination is added, but the controls are grouped in the original console.

Radio Gramophone Development Co. Ltd., Eastern Avenue West, Romford, Essex.

R.S.G.B. (411)
The Radio Amateur Emergency Network is featured on the Society’s stand on which will be found a wide variety of amateur transmitting, receiving and test equipment. There is also a selection of the books and pamphlets issued by the Society, including the new editions of the "Amateur Radio Call Book" and "A Guide to Amateur Radio."


R.T.R.A. (261)
A reception centre is provided for members of the Association and an information bureau for the general public where visitors may obtain a list of R.T.R.A. members in their particular district.


RECORD HOUSING (116)
The motto of this company is “Hi-Fi Furniture is our Business” and this puts in a nutshell what will be seen on their stand. Among the cabinets for records, equipment and loudspeakers added to their range since last year’s show will be found examples of the long, low trend (Polonaise de Luxe) and the more traditional approach to cabinet design (Delius).

Record Housing: Brook Road, London, N.22.

REDICORD (123)
This firm is showing a range of stereo record players in portable form and also for mains operation at home. One model “The Nevin” is designed with the small-flat occupier in mind as it provides, in compact form, a stereo record player, a tape recorder fitted with a Garrard magazine tape deck and integral twin loudspeakers. There is a portable tape recorder and “The Calypso” transistor 4-speed lightweight record player.


REGENTONE (59)
The SRG15 seven-valve stereo radiogram to be shown is a one-box design in which the necessary separation between the loudspeakers is achieved by mounting them at the ends of the four-foot wide cabinet. Its companion new single-channel model, the ARG14, is wired for stereo conversion.

Among the television receivers which will include models with f.m.
radio, will be two new sets, one of which, the Model 178-18, is fitted with the "Fingermatic" press-button tuner for instant selection of the desired channel.

Other products to be exhibited will include a.m. and f.m. radio receivers, record players, and a tape recorder.

Regentone Radio and Television Ltd., Eastern Avenue West, Romford, Essex.

ROBERTS (70)
The R200 transistor portable is the latest addition to this firm's range of small portables. It is a two-band a.m. set, embodies a printed circuit with 6 transistors, two being a push-pull output pair, and a diode. The 5in loudspeaker is large for a portable and it has a magnet with the exceptionally high flux of 13,000 gauss.

Battery economy is one of its main features, the consumption being only 20mA from the 9-V battery. Provision is made for operating the set, which has a ferrite-rod aerial, from a car aerial if required.

Roberts' Radio Co. Ltd., Creek Road, East Molesey, Surrey.

ROLA CELESTION (113)
A very comprehensive range of loudspeakers is displayed. Those for set manufacturers include several elliptical types as well as circular ones with diameters ranging from 2½ to 15in. Those for public address purposes include re-entrant horns and column units. Among the loudspeakers for special purposes are some which are flame proof.

Rola Celestion Ltd., Thames Ditton, Surrey.

ROSE PROJECTS (119)
Television tables, record storage cabinets and showroom display stands are a speciality of this firm. Included among their TV tables is a novel design known as "Long-Tom" measuring 42in x 21in and having a revolving platform at one end for the TV set which can be locked in any desired viewing position.

Rose Projects Inc., Bourne End, Bucks.

S.T.C. (14)
Special valves for industrial applications, transistors, tunnel diodes, tantalum capacitors and many other components occupy much of the space on this stand.

There is a range of quartz crystals including some triple crystal units in a single glass envelope for crystal control of the mixer oscillator in v.h.f./f.m. broadcast sets, also the FST14 silicon rectifier for h.f. supply in television sets. Two are required in series on 200/240V a.c. mains for half-wave rectification. The rated maximum d.c. output is 500mA.


SLINGSBY (31)
Wheeled trucks and trolleys designed especially for handling television sets, radio-grams and the heavier kinds of audio apparatus in dealers' showrooms and warehouses, as well as loading and unloading equipment for vans, are shown on this stand.


SLOSS (102)
This company will be exhibiting television aerials, accessories, and coaxial cables. The "Regal" aerial arrays are coated with a plastics film in various decorative colours to provide protection against corrosion.

Band-III aerials have the "Ben Nevis" diplexer built-in and are designed to be added to an existing Band-I installation. Provided with a 0½ft coaxial cable, the installer removes the existing cable from the Band I aerial, connects it to the Band III aerial and connects the tail to the Band-I aerial.

Andrew Sloss, Belmont Works, Belmont Site, Lewis Street, Stranraer, Scotland.

SOBELL (64)
The new 21in television console, Model SC37, is fitted with a forward facing loudspeakers, a "magic eye" automatic control of contrast actuated by the degree of lighting in the room and an armchair unit on a 15ft plug-in lead giving remote control of on/off, brightness and volume. This set also provides v.h.f./f.m. reception.

There is a 17in model (110") in three styles, TPS781 and T279 respectively, also two portables, a 21in Model T293 and a 17in, Model TPS710. Both are fitted with chassis which swing outward on a hinge for servicing when the back is removed.

Their new AM/FM stereo radio-model SG670 has a 4-speed autochanger and built-in twin loudspeakers. Ample space is allowed for record storage and for programme periodicals.

Radio and Allied Industries Ltd., Langley Park, Slough, Bucks.

SOUTHGATE TUBULAR PRODUCTS (216)
Manufacturers of tubular-metal stands and industrial furniture, this firm is showing a selection of its products especially suitable for window and showroom display of radio sets and accessories. Also included is a small display electric turntable claimed to run continuously for one month on two U2 batteries.


STELLA (6)
Four radio models and a record player comprise the show introductions.

Other sets on display will include radio, radiogramophone and television receiving equipment and a record player which is adaptable for stereo.

The ST562A is the new record player. Portable, it has a stereo amplifier and twin loudspeakers, one of which can be detached for full stereophonic effect. A Philips record changer is used.


F.C.C. (47)
New developments in capacitors, printed wiring and ceramics will be featured on this stand. For instance, both dry and wet types of tantalum electrolytic capacitors will be shown, together with extensions to the range of miniature dry electrolytic capacitors for transistor-philosophy output, such as hearing aids. New interference-suppression equipment will include an additional forward-scatter filter for use in the aerial lead of television receivers.

The other exhibits will be the well-established ranges of components for radio, television and electronics industries.


TAPE RECORDERS (3)
A wide range of tape recorders and accessories will be on show. This includes four-track versions of the Sound Studio and Prince recorders as well as a new dictating machine which can be completely remotely controlled. Another new four-track recorder is the Sound Master which features a 14-watt stereo linear push-pull output, level indication by means of a meter, separate record and replay amplifiers, and facilities for mixing, monitoring and multiple superimposition. Tape accessories include splicers and the Sonocolor range of ordinary and Synchro-Cine tapes.

Tape Recorders (Electronics) Ltd., 784-788 High Road, Tottenham, London, N.17.

TELENG (107)
Well known in the television- and radio-relay field, this company will be exhibiting their range of equipment, cables and accessories for wire- and broadcast distribution, together with test equipment for networks.

One item, the Type U4000 amplifier, for communal or "extended" aerial service is unusual in that it uses transistors, even in the Band III section. This, of course, has the advantage of reducing size, maintenance and power consumption, which is 1.5W from the mains, for a Band-I, -II and -III amplifier of about 40dB gain. Thus, where line powering is used, many amplifiers can be operated from one central power point.
service and dual types for secondary- and fringe-area aerials include combined Band range of television and v.h.f./f.m.

Additions to this company’s wide range of television and v.h.f./f.m. aerials include combined Band-I and Band-III sections, which are connected together with a diplexer built-in at the factory. The new “Lofree” attic arrays have telescopic all-channel Band-I aerials and are suitable for both vertical, both horizontal or orthogonal polarizations of the transmitted signals.

TELERECTION (28)

Additions to this company’s wide range of television and v.h.f./f.m. aerials include combined Band-I/III types for secondary- and fringe-area service and dual-band loft aerials. Splayed-H Band-I construction is used in the Primax-5 and 8 Band I/III aerials and the Maxima D5 and D6 extreme-fringe arrays use delta matching for both Band-I and Band-III sections, which are connected together with a diplexer built-in at the factory. The new “Lofree” attic arrays have telescopic all-channel Band-I aerials and are suitable for both vertical, both horizontal or orthogonal polarizations of the transmitted signals.

TELERECATION Ltd., Antenna Works, Lynch Lane, Weymouth, Dorset.

TELESURANCE (9)

Details of the insurance-maintenance scheme operated by the organization, through dealers who are members of R.T.R.A., are available on this stand.


TERRITORIAL ARMY (413)

Equipment typical of that used for training purposes by the 65th Signal Regiment T.A. (formerly No. 1 Special Communications) and the affiliated 328 W.R.A.C. Signal Squadron (for women) is displayed on this stand. Among the trades for which training is provided are radio mechanical and W/T operators. 65th Signal Regiment, T.A., 79/85 Worship Street, London, E.C.2.

TRIX (37)

This exhibit consists of record reproducing, tape recorders, public-address and sound-reproducing equipment. The Model B100 amplifier is rated at 12W output and operates on 12V, consuming 1.5A d.c. It has eight transistors and the pre-amplifier section has separate inputs and controls for microphone and music, the latter being suitable for tape, gramophone or radio. Provision is made for mixing the input signals; bass and treble controls are included.

Trix Electrical Co., Ltd., 1-5 Maple Place, London, W.1.

ULTRA (15)

The new “Bermuda” range of television receivers occupies a prominent place on this stand. Tuning resembles the dialling system of the G.P.O. telephone. To operate it the required television-channel, or r.f./station, selector button is depressed and the whole dial then rotates automatically to the desired position. The auto tuner can also be operated manually. The range includes 17in and 21in tube models in table or console types. The cabinets are designed to accentuate the slimmness of the set arising from the use of the new short-neck, 110° tubes.

The range of sound radio receivers includes an a.m./f.m. transistor portable, Model TR81.

Ultra Radio and Television Ltd., Stonefield Way, South Ruislip, Middlesex.

VALRADIO (114)

D.C.-to-a.c. and d.c.-to-d.c. converters are a speciality of this firm and examples with outputs between one watt and nearly half a kilowatt will be shown. The units for operation from supplies in the range 6 to 50V use transistors; but for convers-

WIRELESS WORLD, SEPTEMBER 1960
WIRING OF D.C. MAINS TO A.C., VALVE UNITS ARE AVAILABLE.

The separation of apparatus using half-wave rectifiers (such as television receivers) d.c.-to-d.c. units are recommended because the unbalanced waveform on a.c. might upset operation of the converter.

Also shown will be the "Mirrscope" projection television receiver—this produces large-screen pictures up to four feet wide.

Valradio Ltd., Borelows Lane, Feltham, Middlesex.

WALTER (72)

Designed with an eye on the export market the new 'Battery-Mains' transistor tape recorder while having portable applications is in all respects a "full-size" machine. It provides for twin-track recording, runs at 3½in/sec, is fitted with 2½in tape spools and is claimed to deliver an uninterrupted output of 2W. The recorder is completely self-contained, embodying a mains supply unit, batteries (for 9V operation) and a 7in x 4in elliptical loudspeaker. Suits also most of the current models. Walter Instruments Ltd., Garth Road, Morden, Surrey.

WHITELEY (49)

Shown here is a selection of the wide range of audio equipment made by this firm. For stereo reproduction the WBBS amplifier, which comprises a pre-amplifier and power amplifier giving 8W per channel, has been modified for use with both crystal or low-output magnetic pickups, tape and radio. Its pre-amplifier can be used with one of several main amplifiers. Also included is a new 200mW transistor amplifier using printed circuit technique.

Loudspeakers range in size and type from 1½in and 2½in models, some with plastic chassis and for use in personal portables, to 12in models with 16,000-gauss magnets and new cone assemblies responding to a very wide range of frequencies.

Whiteley Electrical Radio Co., Ltd., Victoria Street, Manchester, Notts.

WIRELESS FOR THE BEDRIDDEN (67)

The stand occupied by this society, which provides free radio facilities for needy bedridden, housebound and aged invalids, has been given by the exhibition organizers for the distribution of literature and the collection of donations. The society, which relies entirely on voluntary support, has supplied over 7,000 installations—either sets or relay services—which are maintained free.


WOSLEY (43)

A wide range of television and v.h.f./f.m. radio a erials for indoor (attic and room) and outdoor use will be shown together with a working demonstration of the Wosley "Vision Network System" carrier-frequency television and v.h.f./f.m. communal-aerial and relay equipment. A range of aerials called "Collector-Combine" will be introduced: these aerials feature individual tuning and phasing by means of phasing bars on both Bands I and III. V.N.S. apparatus can be used for small block-of-flat systems with as few as half a dozen subscribers up to the provision of relay services for a whole town and the working demonstration will carry four television and four sound channels.

Wosley Electronics Ltd., Cray Avenue, St. Mary Cray, Orpington, Kent.

A.D.U.O. HALL

A.E.I. SOUND EQUIPMENT (308)

Both industrial and domestic high-fidelity loudspeakers, amplifiers and control units will be shown. An unusual feature of the domestic mono control unit is that the low-pass filter cut-off frequency is continuously variable. The loudspeakers include 12- and 18-in direct radiators as well as dual-concentric units in which the centrally-mounted tweeters are horn loaded. Also shown is the Coffee Table Console cabinet suitable for mounting a record turntable, pre-amplifier, amplifier and radio tuner.


ACOS (310)

Being demonstrated is the Hi-Light pickup with its stereo head. This retains the usual flexible cantilever arrangement of the mono head and has a needle tip mass of the order of a milligram. The head produces a very low side mass (0.02 gm) and is very insensitive to external displacements and vibrations.

Microphones on show include the stereo Mic44 in which two pairs of crystal inserts are used to produce a double figure-of-eight response up to about 8kc/s with the individual element responses extending still higher (up to about 12kc/s).

Cosmocord Ltd., the Eleanor Cross Road, Waltham Cross, Herts.

ALBA (304)

Being demonstrated are two a.m./f.m. stereo radio-grams, a portable stereo record reproducer with the second amplifier and loudspeaker mounted in a separate matching cabinet, and the Duchess tape recorder. An unusual feature of the latter model is the use of two neon to indicate the recording level.


BRENELL (311)

A wide range of complete tape recorders as well as separate tape decks and amplifiers will be on show. This includes the new stereo version of the Three Star recorder which has separate modulation indicators for each channel and the very unusual facility of allowing one track to be recorded while the other is being replayed so that synchronized recordings can be made. A very versatile deck is the Mark 5 since it has four operating speeds and room for four magnetic heads. Also shown is an inexpensive high-impedance three-channel mixer.


DECCA (303)

Demonstrations will be given of the new stereo Decola record reproducer. Special facilities for providing this include a multi-directional high-frequency loud-speaker system for providing a large area of good stereo effect, incorporation of the very low (≈ 1mmg) effective needle-tip mass "flicks" pickup, and provision of a micro-lift for gently raising and lowering this pickup.


DYNATRON (311)

Stereo will be demonstrated with the aid of the well-known Berkeley 2×10 watt a.m./f.m. radio-gram as well as the new MazaUzka record reproducer, in each case together with its associated separate second-channel loudspeakers. On show are valve and transistorized four-speed record reproducers as well as the Cordova—this company's first tape recorder. This is a three-speed device.

Dynatron Radio Ltd., Maidenshead, Berks.

E.A.R. (319)

Among the three new additions to the MusicMaker range of record reproducers is a stereo model in which the second loudspeaker is housed in a detachable lid. Mono and stereo versions of the 1965 and Triple-Four ranges of record reproducers are also on show. Transistorized units exhibited include a four-speed record player and radio-gram as well as a receiver. A tape recorder using the B.S.R. Monardeck is exhibited: it is also hoped to show new models incorporating the Garrard and Colaro tape decks.

Electric Audio Reproducers Ltd., The Square, Isleworth, Middlesex.

EXPERT (307)

On show are the Stereofon II and 111 stereo v.h.f./f.m. radio-grams. Both of these use the same 2×8-watt amplifier, pre-amplifier and f.m. tuner, but whereas the Stereofon II uses an autochanger and inexpensive pickup arm, the Stereofon III uses

WIRELESS WORLD, SEPTEMBER 1960 449

www.americanradiohistory.com
a transcription turntable and the Expert pick-up arm. An unusual feature of the pre-amplifier used in these models is that the tone controls take the form of switched bass boosts and treble cuts. Also exhibited are a column-shaped loudspeaker enclosure and the Master horn-loaded loudspeaker system, Expert Gramophones Ltd., 78 Bal-ham High Road, London, S.W.12.

FERGUSON (324)
Demonstrations of a new high-quality radiogramophone, the 655KG, will be given in this room. For details of other Ferguson products, see Main Hall listing.


G.E.C. (321)
An interesting feature of some of the stereo demonstrations is the use of a third central loudspeaker fed with part of both the left and right signals so as to define the central image more accurately. Demonstrations will be given of the small Bookcase loudspeaker and also the Slender Periphonic acoustic “push-pull” two loudspeaker system for reducing low-frequency second harmonic distortion. On show are standard and hi-flux tweeter Presence Units as well as the well-known metal cone speaker and suitable cross-over filters.


GAINSBOROUGH (301)
Three three-speed tape recorders will be shown on this stand. Special features of the Mark IV are the use of separate record and playback heads and amplifiers, a push-pull erase and bias oscillator, and a meter as the record level indicator.

Gainsborough Tape Recorder Ltd., 189 Northcote Road, London, S.W.11.

GOODMAN (316)
Being demonstrated are the new AL100 and the well-known AL120 compact loudspeaker systems, a new corner horn enclosure suitable for home construction which incorporates the Tristette three-element coaxial loudspeaker, and the new Axiom 110 and 112 10in loudspeakers in suitable cabinets.

Goodmans Industries Ltd., Axion Works, Wembley, Middx.

GRAMDECK (314)
The Gramdeck utilises the rotation of a gramophone turntable to drive a tape deck, a turntable speed of 75 rpm, producing a tape speed of 7½ in/sec. Also provided with the deck is a transistor record/playback amplifier and bias supply. Thus recordings can be made from a microphone or from the output transformer secondary of a radio-gram or record reproducer and replayed via the pickup input. Easance is possible by means of a permanent magnet. This device thus essentially converts a radio-gram or record reproducer into a tape recorder.


GRAMOPHONE COMPANY (323)
Being demonstrated are a range of loudspeaker systems and cabinets suitable for housing a tape deck, record turntable and associated pre-amplifiers and amplifiers. Equipment used includes the new E.M.I. high-quality stereo pickup which features a very low effective needle-tip mass (≈ 1 mgm) and a viscous damped single-pivot arm with a raising and lowering mechanism. Also demonstrated are the Models 557 2 × 10-watt stereo amplifier and the 556 stereo combined pre-amplifier and very comprehensive tone control unit, an unusual feature of which is the provision of a c.r.t. channel-level monitor.

Gramophone Co., Ltd., Blyth Road, Hayes, Middlesex.

LUSTRAPHONE (309)
A new addition to the wide range of microphones of all types is a relatively inexpensive stereo ribbon microphone, the VR/65NS. This is similar to the VR56 except that the phase switch and mechanism for relatively rotating the two ribbon elements have been omitted. Also available is a miniature noise-canceling microphone.

The range of transistorized units includes pre-amplifiers and power-amplifiers as well as a four-channel microphone mixer.

Lustraphone Ltd., St. George’s Works, Regent’s Park Road, London, N.W.1.

PHILIPS (320)
Recent introductions by this company in the field of sound reproduction include an a.m./f.m. stereo radio-graph in which the loudspeakers are placed at the corners of the cabinet and angled outwards. Also newly introduced is an automatic version of the Disc Jockey Stereo record reproducer in which one of the loudspeakers can be detached from the main cabinet for improving the stereo effect. The output of this record reproducer is 1½ watts per channel.


REPS (305)
Newly introduced is the R10 three-speed tape recorder, special features of which are that the frequency response at the lowest speed of 1½ in/sec. is claimed to be only 3dB down at 7½ c/sec and that a meter is used to indicate the recorded signal level. Both two- and four-track versions of this recorder are available. Also being shown are improved versions of the R20, R30 and R40 recorders, a special feature of which is that each has a push-pull bias and erase oscillator.

REPS (Tape Recorder Ltd.), 118 Park Road North, London, W.3.

ROLA CELESTION (312)
An interesting unit for high-fidelity sound reproduction is the Colaudio 1550. This consists of a 15in bass unit in the centre of which are mounted two tweeters forming a short column. The high-frequency polar response of this loudspeaker can thus be altered by rotating it so as to rotate this column. Other loudspeakers on show include elliptical units as well as circular models with diameters ranging from 2½ to 15in.

Rola Celeston Ltd., Ferry Works, Thames Ditton, Surrey.

SYMPHONY (302)
Equipment on show includes two tape recorders, a bass reflex loudspeaker cabinet available in kit form or ready built, f.m. and a.m.f.m. tuners, and mono and stereo combined amplifiers, pre-amplifiers and tone control units. An unusual feature of these last is that the middle as well as the bass and treble frequencies can be boosted. Also exhibited is the Sterophone, which is claimed to provide music that resembles that obtained with stereophonic equipment when connected between a single-channel output transistor secondary and two spaced loudspeaker systems.

Symphony Amplifiers Ltd., 16 Kings College Road, London, N.W.3.

TRUVOX (317)
The main exhibits will be the R6 and R7 tape recorders, an unusual feature of which is that each is provided with an R.I.A.A. compensated pickup input. Other special features of the R7 recorder are that it will record or replay with the tape travelling in either direction, and that it has a ten-watt push-pull output. Both of these models can operate at tape speeds of 7½ or 3½ in/sec. Also on this stand is a 1½ watt Jack miniature tuners mounted on a jack plug for recording from the local B.B.C. stations.

Truvox Ltd., Neasden Lane, Lon-don, N.W.10.

WHITELEY (304)
In addition to the range of domestic-type loudspeakers that it can accommodate here is a selection of various industrial type loudspeakers in a wide variety of cabinets including “line source” types for both indoor and outdoor use.

The latest technique in audio component potting in epoxy and polyester resins is exemplified by a selective range of transformers, filters and inductors encased in this form. The range of “breakdown cabinets” which includes bass reflex types, is continued this year.

Whiteley Electrical Radio Co. Ltd., Victoria Street, Mansfield, Notts.

WIRELESS WORLD, SEPTEMBER 1960
The Genius of

A. D. BLUMLEIN

By M. G. SCROGGIE, B.Sc., M.I.E.E.

GENIUS was defined by Carlyle as, first of all, transcendent capacity for taking trouble. It was analysed by Edison as 1% inspiration and 99% perspiration. These both corrected popular ideas on the subject by emphasizing the part played by hard work. But that 1% is just as essential. If there have been people whose brilliant originality died with them, there were many more whose slogging failed to make up for their lack of imagination.

The thinking of most of us is shaped by concepts we have received from others. When the genius comes along, with thoughts that break out into new concepts, his fellows often find him hard to understand. They may even oppose him, because he doesn’t conform to their ways of thought. Matters are made worse when, like Heaviside, he is unable or unwilling to make his ideas clear to the less intelligent.

If, as I am convinced, the genius of A. D. Blumlein is not yet widely enough appreciated, that is certainly not the reason. His exposition was exceptionally lucid. The trouble is that so very little of it was published. His contribution to technical literature amounts to little more than two I.E.E. papers, the first shared with Prof. Mallett and the second with several colleagues. (Both of these papers, incidentally, were awarded I.E.E. Premiums.) He was too busy to write. So technical literature is the poorer and his name is seldom seen by his successors.

Then the last few years of his work were shrouded in wartime secrecy and his career was cut short at the early age of 38 in the service of his country. Even that fact was not published until more than three years later, and then only briefly.

Besides this, he avoided rather than encouraged publicity to such an extent that photographs of him are almost non-existent, unless one includes a back-seat view of him addressing the I.E.E. in 1938.

Some originators are commemorated in the name of a device, law or discovery—for example, the Hartley circuit, Ohm’s law, and the Hall effect. Unfortunately none of Blumlein’s frequently mentioned inventions bears his name. Although it appears here and there in the literature, probably very few even of the workers in the same field, and especially the younger ones, have any idea of how far ahead he was in so many important developments.

How many present-day stereophony fans, for example, realize that the system of recording brought on to the market during the last year or two was invented by Blumlein in 1931?

I have therefore attempted a review of the more important of his inventions, as a modest tribute to his memory. Not having had the privilege of knowing Blumlein personally, and lacking close acquaintance with some of the branches of work in which he excelled, it is a regrettably poor one, but I hope better than nothing. Lest my emphasis on technical achievements give the impression of a one-sided individual, it should be mentioned that, notwithstanding them all, Blumlein was thoroughly human and found time for such relaxations as flying, practical astronomy, enjoyment of music and theatre. I am indebted to a number of his friends and colleagues for encouragement and information readily supplied, notably S. J. Preston and H. A. M. Clark of E.M.I., J. B. Kaye of Paimont, formerly of International Standard Electric, and M. van Hasselt of Standard Telephones.

Alan Dower Blumlein was educated at Highgate School and the City and Guilds College, London. It was in January 1925, soon after he had graduated, that he and Prof. E. Mallett read their I.E.E. paper, “A New Method of High-Frequency Resistance Measurement”—a problem which was receiving much attention at the time. Their method was ingenious and potentially very accurate, but proved too complicated to achieve popularity.

At about this time Blumlein began his professional career by joining the International Western Electric Corporation. His work there was mainly on problems of interference in telephone lines, and he soon provided evidence of his exceptional ability and originality in circuit engineering. At least eight patents resulted from this line communication work, the first of which (No. 291,511, in conjunction with J. P. Johns) came early in 1927 and described a method for reducing mutual interference between channels (“cross-talk”) in long-distance telephone cable systems. Nowadays long-distance telephony is usually by modulated carrier, with the conversations shifted into separate frequency bands; but then they were at the original speech frequency. To equalize signal velocity over the band, the cables were inductively “loaded” by three-coil units, and these were to blame for much of the cross-talk. Having studied the problem and identified each particular source of cross-talk with great accuracy, Blumlein rearranged the windings to concentrate the unbalances at the points of connection, and then dealt with each of them independently. This method greatly reduced the trouble, and was adopted for all three-coil units from then on. It is, in fact, still used.

In order to carry out this development it was necessary to measure very small differences in impedance. Existing impedance bridges were unsatisfactory in two respects: the ratio arms were insufficiently pre-
cise, and they were too much affected by stray shunt capacitances. So in 1928 Blumlein made a major departure in a.c. bridge technique by using ratio arms consisting of two inductors with practically 100% coupling, as in Fig. 1. This looks at first glance like a conventional a.c. bridge network, so much so that it is those who are familiar with bridges in general who may have most difficulty in realizing that at balance its points B and C as well as A are effectively at earth potential, so there is no p.d. across either ratio arm, and therefore admittances effectively at much lower effect. Blumlein obtained a very close approach to this ideal by using bifilar winding, making the two coils occupy substantially the same position on their iron core. This construction at the same time automatically achieved a 1:1 ratio with much higher precision and constancy than conventional resistance arms.

The patent, No. 323,037, is a short one—only two pages, with no Provisional Specification—yet it clearly and simply explains the principle, the construction both for 1:1 and other ratios, the applications of screening, the advantages accruing, and how it can be used to measure direct capacitance between two conductors regardless of capacitances from them to earth. For good measure, it shows how the same device can be used to obtain a precise centre tap for a phantom circuit in telephony. A later specification (334,652) shows an application of the same principle to the simplifying of telephone circuits.

Unpublished Treatise

As with so many of Blumlein’s inventions, his concentration on the work in hand left no time for wider publicity and exploitation, so although possibly the most important step in bridge technique since 1865, when Maxwell applied Wheatstone’s circuit to a.c., it went almost unnoticed. Even when, years later (1941), Blumlein wrote an extensive fundamental treatise on the principles implicit in this apparently simple device, it was not published. The substance of it only came prominently to light in 1949, in Part 1 of an I.E.E. paper by H. A. M. Clark and P. B. Vanderly. It is a fine piece of exposition, which the authors acknowledged as being almost verbatim Blumlein. The remainder of this paper was concerned with the application of these principles in a wide-range impedance bridge produced for the Services. An accompanying paper described quite a different application—a low-reading aircraft altimeter, involving the measuring of capacitance changes of the order of one-millionth of a picofarad (10^-18 F) in the presence of much larger capacitances to earth. All these developments were patented by Blumlein.

In the discussion of these papers, the first speaker wanted to know why such an attractive invention had been in existence for over 20 years without making more of a mark on bridge design. The explanation was lack of publicity. Since then, inductively coupled ratio arms have come into much use, notably for radio frequencies up to v.h.f. One thinks especially of the B.B.C., C. G. Mayo, and Wayne Kerr in this connection.

Another interesting Blumlein bridge patent is 338,588, which covers a mutual-inductance bridge in which the usual difficulties in varying M are overcome by means of a resistive potential divider directly calibrated in inductance (Fig. 2). This was embodied in a valuable and widely used instrument for measurements on balanced-pair carrier cables.

Other inventions of this period concerned submarine cables.

In 1929 Blumlein moved to the research department of the Columbia Graphophone Company. Electrical recording apparatus was then at an early stage of development, having displaced acoustic recording only a few years before. It consisted of a capacitive or carbon microphone, an amplifier based on public address practice, and a moving-iron cutter—satisfactory for the transition period, but far from perfect. A team was working on an improved system, and though lacking in experience of sound recording Blumlein soon grasped the principles of electromechanical transducers and made a major contribution to the effort, notably with a moving-coil microphone, an equalized amplifier and a moving-coil cutter. He showed how to match impedances by reducing the length of the cutter arm, and to eliminate the effects of mechanical resonances by electrical circuits with parameters the inverse of those of the mechanical circuits." For this treatment to be effective, the system had to be designed for a very high electromechanical coupling factor. The first records were made with this equipment in 1930 and set a new standard of fidelity.

At the same time, with P. W. Willans, he showed how to place the needle in relation to the armature of a gramophone pickup so as to raise its resonant frequency to a maximum.

Next year the Columbia and H.M.V. companies merged to form Electric & Musical Industries Ltd.—E.M.I.—and the new recording gear was adopted as standard by the combine. Blumlein continued to work on it, and by improving the sensitivity of the cutter reduced the size of the amplifier sufficiently for portable use. He also extended the possible frequency range to 10 kc/s, but surface noise due to the record materials then available prevented full advantage being taken of this.

Two-channel Stereophony

At the same time Blumlein was thinking a lot about stereophony. Experiments in two-channel sound transmission had been made as long ago as 1881, using headphones. By the time we are considering, however, there was clearly no commercial

Fig. 2. Mutual-inductance bridge with fixed coils wound toroidally on an iron core. The balance of mutual inductance is shifted to either side of the bridge by a potential divider calibrated directly in inductance of the unknown L.

Wireless World, September 1960
future for headphone listening. Loudspeakers had displaced them in the home, and the "talkies" had established themselves in the cinema. The problems of monophonic reproduction were quite enough for most people. But not for Blumlein. The multiple-speaker method is the obvious approach to practical stereophony and in the years following was adopted in America for experimental demonstrations and the public showing there of Disney's Fantasia. It was found that the ideally vast number of channels required for it could be reduced to three, with acceptable results. But even before this Blumlein had evidently decided that three was one too many, and he tackled the problem of achieving satisfactory spatial reproduction with only two loudspeakers. Characteristically, he began by thoroughly working out for himself the principles involved. Now, 28 years later, with stereophony a household word, there are still people claiming to be technical who suppose that the two loudspeakers are analogous to the two earphones in the earlier experiments. But Blumlein saw clearly that both speakers communicate with both ears, thereby setting a very difficult—one might almost declare impossible—problem. His solution, based on the theory that directional hearing at low frequencies depends on time difference and at high frequencies on intensity difference, was much more subtle than it looks at first sight, and depended on the sum and difference of the outputs from the two microphones. By this means, results equivalent to cardiods pointing in opposite directions were obtained using omni-directional microphones: a remarkable achievement.

Being the first to make a serious attempt at stereophony with loudspeakers, Blumlein had the field to himself, and his patent (No. 394,325) runs to 22 pages and has 70 claims! His system was intended primarily for improving motion picture sound, but other applications, such as domestic records, were included. In almost every respect this patent was more than 20 years ahead of its time.

At that date, and for years to come, shellac-loaded disks and needle needles were in use, but Blumlein advised a material of the nature of cellulose acetate, and a sapphire point as is now standard. The system as a whole was commercialized 25 years later,* at first with tape recording, but Blumlein's original 45° disk track has now been adopted throughout the world for stereophonic records, at least one make of which is produced with a cutter of a type shown in his patent.

Rather ironically, the first practical application was one not envisaged when the patent was drawn up, its techniques were adapted by Blumlein for better sound location of aircraft during the 1939-45 war, and some thousands of this type of equipment were produced.

Television

Even before his stereophony patent appeared in print, Blumlein's enthusiasm had been directed into another channel. Soon after the formation of E.M.I., the new company began a full-scale programme of television development. H.M.V. had already demonstrated moderately high-definition pictures (150 lines) using a mechanical system, and the first question was whether to continue along this line or venture into the unknown towards an electronic system. Although it is obvious now that the right answer was the one actually given, the number of unsolved problems that were thereby accepted must have looked pretty appalling. For one thing, the cathode-ray tubes of the period were gas-focused types that went out of focus if the beam current was varied. There was no electronic camera. Even the more familiar items such as amplifiers, transmitters and aerials had to be developed afresh to deal with signals of unprecedented bandwidth. In this connection, another bold decision, made by the E.M.I. Director of Research, I. Schoenberg, was to go far beyond the Television Advisory Committee's requirement of 240 lines—beyond anything that receivers could have been expected to handle fully for some time to come—by adopting a 405-line standard. Again, the rightness of the choice has been proved by events, for after more than quarter of a century of rapid change this same standard continues to give satisfaction and has been accepted in 10 million British homes.

There was therefore plenty of work for the development team, and no time for mistakes. The story is told by S. J. Preston in a Television Society paper, "The Birth of a High Definition Television System."† Blumlein's contribution displayed his characteristics—grasp of essential principles, foresight, versatility, originality, soundness of engineering and insistence on "designability." He would reckon a few extra components well spent if they enabled him to design a circuit on paper with confidence that any number of sets made up from the design would work as intended. It is significant that the E.M.I. equipment of the Alexandra Palace Station, almost every part of which owed something to Blumlein, made straight up from drawings to begin the world's first public high-definition service in 1936, was still in use in 1950.

One of his first developments was a highly original scanning system. Contemporary practice charged a capacitor slowly through a resistance and discharged it quickly through a thyratron, the capacitor voltage being applied to the deflection plates of a c.r. tube. Blumlein's patent 400,976 of April 1932 specifies a simple hard-valve circuit (Fig. 3) to produce a linear

![Fig. 3. Early television sawtooth current generator circuit, in which during the working stroke current flows through deflecting coils L and valve V1. The flyback is generated by a half-cycle of oscillation at the frequency of L and C, and is terminated by V2. L1, C1 curbs any tendency to oscillate at half working frequency.](image-url)
sawtooth current for magnetic deflection. The valve V1 is initially conducting, and current grows linearly through the coil L, until a sync pulse cuts off V1. The circuit LC then performs a half-cycle of oscillation at a comparatively high frequency, forming the flyback. Further oscillation is prevented by conductance of V2, which limits the rate at which current through L (now negative) can decrease. L, C1 was included to suppress a waveform component at half scanning frequency.

The origin of negative feedback is invariably attributed to H. S. Black in B.S.T.J., January 1934. This is strange, for a number of earlier references can be found. For instance, Patent No. 425,553 of Sept. 1933, by Blumlein and F. A. M. Clark, specifies it by name for reducing the output impedance of pentodes, as in Fig. 4, and gives the now familiar formula for output impedance:

$$R_a = \frac{1}{1 + \mu R}$$

where $\mu$ is the fraction fed back, now commonly denoted by $\beta$ or B.

Considerable confusion has been caused by later writers, led by Black, who used $\mu$ in identical formulae to mean amplifier voltage gain, instead of correctly as above to mean valve amplification factor. Negative feedback was mentioned even earlier in a patent of American origin for linearizing sawtooth current waveforms in frame scanning. Blumlein substantially improved on this with a circuit (Patent No. 479113 of 1936) which is the one commonly used to this day—Fig. 5.

A form of negative feedback that especially appealed to him was the cathode follower. He did not actually originate this configuration, but was the first to appreciate its great value, particularly in television. His specification 448,421 of 1934 sets forth with characteristic clarity how by virtue of its very low input capacitance it can be used to advantage in connecting a high-frequency high-impedance source such as a photocell to an amplifier. Furthermore, it anticipated by 15 years the discovery that it can be used as in Fig. 6 to eliminate almost entirely the shunt capacitance of the source and connecting lead. Note, too, the screened coupling; long after this, people were still saying that pentodes were unsuitable for cathode followers!

Television, with its wide signal frequency band down to zero, introduced difficult amplifier problems. It was impracticable to use d.c. couplings throughout the transmitting and receiving chain; but the trick of d.c. reinsertion or restoration, making use of the constant level of synchronizing signals, had been devised. It looks quite a simple technique, but Blumlein and his colleagues had to do considerable work to make it practical, and some of the most involved specifications relate to this development. In particular, “clamping” at an intermediate black level was due to them. The whole thing was tied up with the television waveform, which necessitated a great many irrevocable decisions. Blumlein was mainly responsible for establishing the waveform that has (with very minor adjustments) been used in Britain ever since, and was declared by L. H. Bedford to be one of the outstanding technical triumphs of television. Blumlein explained the reasons for each decision in his 1938 I.E.E. paper.*

The bearing of this waveform on an effective system of vision a.g.c. in receivers was foreseen by Blumlein, who invented several circuits for it; but a good many years passed before vision a.g.c. came into general use.

The extension of the bandwidth to zero caused troubles with power supplies, and Blumlein devised modifications to filter circuits to give them a constant resistive impedance at all frequencies. To cope with the high frequencies in amplifiers he originated the familiar series (Fig. 7) and shunt “building out” circuits. Among his many other television circuit devices were: “black spotting” to make interference less conspicuous; a method of sync pulse separation; “spot wobble”; an anti-“ghost” device; and (with E. C. L. White) the now familiar “efficiency diode.”

As if this were not enough for one engineer, he was collaborating with J. D. McGee in devising the


Wireless World, September 1960
very important C.P.S. Emitron, and with E. C. Cork in the r.f. cables that were used to convey the television signals between Alexandra Palace and Broadcasting House and elsewhere, and with H. E. Holman in the manufacture of very fine insulated wire. The only camera tube available for the opening of the B.B.C. television service in 1936 was the ordinary Emitron, in which relatively large spurious signals were created by secondary emission. Blumlein took a full share in providing "tilt" and "bend" signals to transmit the information while he was still working on the problem of a tube that would make this unnecessary. The McGee-Blumlein patent, No. 446,661, dated as early as 1934, describes an essential feature of the cameras introduced since the war and those now in general use throughout the world. This is the cathode potential stabilization, by which secondary emission is prevented. A major improvement in the received picture was the result.

Several important inventions not particularly connected with television were contemporary with these. There was the "long-tailed pair," intended to rid push-pull signals of unwanted push-push components. Another, of great interest to Wireless World readers, was the so-called ultra-linear amplifier circuit, in which the screen grids of the push-pull output stage are tapped on to the output transformer. Here, again, it was a good many years before general practice caught up with Blumlein. Admittedly, he does not appear to have appreciated how effective this arrangement can be for reducing distortion; he regarded it mainly as a convenient alternative to the control-grid feedback shown in Fig. 4, for reducing the undesirably high impedance of pentodes while retaining their efficiency. One notes, by the way, how many of Blumlein's devices were concerned with impedance matching.

His freedom from convention can be illustrated by his contribution to the discussion of a paper entitled "Instruments Incorporating Thermionic Valves." It is worth quoting:

"All the devices referred to in the paper have one point of similarity—the signals are applied at the grid and come out at the anode. It might be worth while to note that there might be advantage in departing from this convention. One possible application of valve voltmeters is to the measurement of very high voltages. For this purpose one constructs a valve where the grid is earthed and used as a shield between anode and cathode. A very high voltage is put on a very small anode remotely situated from the grid, and in the cathode lead is put the inevitable feedback resistance, which is given a high value.* In those circumstances the valve cathode rises to such a potential that there is practically no anode current. The valve acts as a potentiometer, the cathode voltage being about 1/(p+1) of the anode voltage. At first sight the arrangement would seem to have no advantage over a resistance-type voltmeter, but the usual very high-voltage voltmeter resistances are cumbersome, and this arrangement will follow variations of the anode voltage quickly, so that measurements of very high voltage can be made in the comparative safety of a shielded cathode."

This contribution was ignored by the authors in their reply!

Slot aerials are now commonplace, having come into use during the war for short-wave radar. But in 1938, when Blumlein applied for the slot-aerial patent, which in due course was numbered 515,684, it must have seemed quite revolutionary.

Another Blumlein characteristic—dislike of dependence on uncertain parameters—is exemplified by his patent No. 563,464 of 1940, which describes a simple method of stabilizing the amplitude of oscillators without relying on grid current. The mode of operation is not nearly so simple as the relevant part of the circuit, shown in Fig. 9. Valves with extra diodes being still current practice, this idea might well be about due to be discovered!

By this time Blumlein, as senior engineer in the E.M.I. research laboratories, was at work on war projects. The adaptation of his stereo ideas to the aircraft sound locator has already been mentioned. The direction of the sound source relative to the axis of the locator was indicated by a trace on a c.r. tube. His early invention of the inductively-coupled ratio-arm bridge also found novel application in an altimeter depending on the change of capacitance, induced by the ground, between two electrodes fixed to the underside of the aircraft. This type obviously was most advantageous at low altitudes, where others fail. It was fitted to Welling-

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Wireless World, September 1960

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One of the problems of radar is the generation of pulses of short duration, often only fractions of a microsecond, at precisely controlled instants. Such pulses are used in many low-power circuits, and also for modulating powers of hundreds of kilowatts in transmitters. In this field Blumlein made much use of the novel device of a short delay line. If a timing square wave such as Fig. 10(a) is applied to one end of such a line, and the far end is short-circuited, the step is reflected in opposite polarity. It reaches the input a short time later (b) and the resultant of the two is a pulse waveform (c). This principle was applied in many different ways for many purposes. In one particularly ingenious arrangement Blumlein used two lines end-to-end which were charged in parallel from the middle and discharged in series by a spark gap at one end, developing a high-power pulse for modulating airborne radar transmitters (Fig. 11). Delay lines are now well established as circuit elements.

One class of these airborne radars was AI, used to intercept enemy aircraft at night. The early types required an operator, which was very inconvenient in a high-performance fighter. In conjunction with E. L. C. White, Blumlein developed for production the locking strobe for AI Mark VI, which automatically performed the necessary operations of searching for an echo, locking on to it when found, and identifying it.

In these sophisticated types of radar there was need for a much more linear time base than those already available, and also for precise and adjustable time delays. To achieve these, Blumlein devised the basic circuit shown in Fig. 12, commonly known as the Miller integrator. His patent, No. 580,527, explains its principles and goes on to give a sample of each of the two applications just mentioned. These initiated a whole series of circuits, using diodes as auxiliaries, including the celebrated "phantastron" and "sanatron." He also extended the principle to the integration of more than one voltage at a time, as used later in analogue computers.

During the war such patents were not published, and it turned out that the basic circuit was covered by a patent applied for by A. C. Cossor Ltd. and J. W. Whiteley a few months earlier. Actually Blumlein's invention was the earlier, but owing to the elaborate secrecy procedure some time elapsed before the application could be filed.

Two days after the application for Blumlein's patent was lodged, on 7th June 1942, he and two of his E.M.I. colleagues, C. O. Browne and F. Blythen, took off from Deford in a Halifax bomber to make tests on another airborne project—H.S. On the return there was engine trouble and the pilot attempted to land in a field, but on doing so the aircraft caught fire. There were no survivors.

For sheer quantity, Blumlein's inventiveness is impressive. No fewer than 132 patents were granted to him, with or without collaborators; that is to say, an average of one every 46 days during his entire working life of 17 years! Nor is the total made up mainly of minor details or improvements, struggling for a little elbow-room of novelty among rivals.

A surprising number were so original as to carve out large new tracts and have very many claims admitted. Some were so original that years and even decades passed before their full value was appreciated. There may be some even now waiting for application.

Their most notable characteristic is that each is a practical solution arrived at by a careful study and clear understanding of the principles involved, rather than by chance or merely following the direction of current practice. How Blumlein would have enjoyed exploiting the possibilities of transistors! Is it unfair to those who have brought about such rapid developments in this field to suggest that he may have made a contribution through his influence? There can be no doubt that he set a fine example.
Quarter-wave Transformers

SOME NEW APPLICATIONS

By "CATHODE RAY"

My problem right at the start is to know whether it is necessary to explain what quarter-wave transformers are. After an interval for intense thought I have come to the not very helpful conclusion that for some readers it won’t be and for others it will be. If my treatise on that subject had been published within the past few months I would have asked your permission to take it as read. But since it actually dates back 10 years, to the Aug. 1950 issue, I would be a little unreasonable to expect a favourable reply from your readers. So I’m going to cater for both classes by referring those whose hopes were aroused by the main title to the appendix, while inviting those who were more interested in the sub-title to carry straight on.

For the reasons explained in the appendix, a piece of transmission line quarter of a wavelength long can be and often is used as a transformer to match a source of r.f. power to a load which has the wrong impedance for direct connection. Suppose for example the source was a 200-Ω line from a transmitter and the load was an aerial with an impedance of 70 Ω. If they were joined straight together there would be a mismatch at the junction, as a result of which a substantial part of the power arriving wouldn’t go into the aerial but would be reflected back along the line, setting up standing waves and consequent excessive voltages and currents at certain points. The solution is to join the line to the aerial through a quarter-wave line transformer designed to have a characteristic impedance of \( \sqrt{70 \times 200} = 118 \Omega \), as in Fig. 1. If the system was balanced to earth, one would make the transformer of parallel wires (or cylinders, for low impedances); if one side was earthed, a coaxial line.

That is old stuff. The April issue of our learned contemporary, *Electronic Technology*, had a contribution from a B.B.C. research engineer, Dr. G. J. Phillips, explaining quite a lot of other ways in which quarter-wave lines come in useful. They are all based ingenuously on the same principle—the way in which current and voltage change places, as it were, at opposite ends of the line. As you may have noticed, the principle of duality appeals to me, and here is an interesting example. For the benefit of those who are staring blankly, I will mention that duality is the term used to refer to the fact that for the relationships which hold for any circuit there are analogous relationships for the “dual” of that circuit, derived from it by changing series into parallel, current into voltage, impedance into admittance, inductance into capacitance, etc., and vice versa.

We have just used the formula \( Z_1 = Z_0/j\pi Z_0 \) in which \( Z_1 \) is the load impedance, \( Z_0 \) the quarter wave line impedance, and \( Z_1 \) the input resistance of that line with the load at the end of it. \( 1/Z_1 \) is the same thing as \( Y_1 \), the admittance of the load; so we have an impedance transformed into an admittance, \( Z_0 \) being the connecting ratio. If \( Z_1 \) happened to be an inductive load, \( j\omega L_1 \), it would be transformed to \( 1/(j\omega L_0) \), which (because \( j^2 = -1 \)) is \(-j/(\omega L_0)\), the \(-j\) showing that the load has been transformed into a capacitance. The appendix shows that \( V_1 = Z_0 I_1 \), etc., the ratio between voltages and currents being \( Z_0 \). And so on for other relationships.

Now consider a little problem. You have three or four items in a circuit, all of which have one terminal earthed, and you want to connect them all in series. Can you do it? Without, of course, shorting any of them! You are allowed to assume that the system works at only one frequency, in the v.h.f. region.

If I had begun with this it might have caught quite a few people out, but since the clue has been provided almost as obviously as in a give-away quiz, everyone should get the prize. The answer is to connect them in parallel through quarter-wave lines, as in Fig. 2, and these lines will transform the parallel connection to a series one.

Unless your intelligence is of a brilliance that would be wasted reading this, or your readiness to take my word for things is touching but unwise you will want a little more evidence before accepting that A, B and C are really all effectively in series. Looking at the circuit, and supposing that B and C have widely different impedances, one could be excused for not instantly seeing that a current generated in A must pass equally through B and C.

You will however grant that in a series circuit all items carry the same current, whereas in a parallel circuit all items receive the same voltage. And in a

Wireless World, September 1960 457
series circuit the total voltage round it comes to zero (otherwise the same point would be at two different potentials at the same time), whereas in a parallel circuit the total current flowing away from the common junction is zero (otherwise some current would have to come from nowhere).

Now it cannot be denied that all the inner ends of the line in Fig. 2 are at the same voltage, seeing that they are all firmly connected in parallel. And in the appendix we have proved—I hope to everyone's satisfaction—that the currents entering the other ends are all proportional to that voltage, and are therefore equal provided that $Z_0$ is the same for all the lines. So the same current must pass through A, B and C, and they are as good as in series. Moreover, the currents leaving the centre junction add up to zero, so the voltages across the outer ends of the lines add up to zero; again, just as they should do if they were all in series.

Of course, this state of affairs holds good only for the frequency that makes the lines quarter of a wavelength long—or a quarter plus any number of whole wavelengths. In practice one would avoid the latter alternative, because it would introduce unnecessary losses and undermine our assumption that these are negligible.

In Fig. 3 we have Dr. Phillips' suggested simplified representation of Fig. 2, together with the equivalent circuit. Fig. 4(a) and (b) are exactly the same diagrams laid out slightly differently so as to make it clearer that A can be regarded as being in parallel with the combination B and C in series. Connections made directly at B and C instead of through inverting quarter-wave lines of course have their normal effect, so if another "star" is connected in parallel with them as at (c) they are also in parallel in the equivalent, (d). So it is possible to apply the same earthing technique to a series-parallel circuit.

Actually it can be done more simply. The quarter-wave lines attached to impedances A and B, looked at from the junction ends, are equivalent to impedances $Z_0^2/A$ and $Z_0^2/B$ respectively, as at (e), where $Z_0$ is as usual the impedance of the line. So now we have the lines arranged in a closed ring instead of in star formation. Because Fig. 4(e) now has exactly the same formation when turned on its side, for all we know it might have been derived from an arrangement in which B and C were the impedances on stalks, in which case (f) would be its equivalent—and therefore the equivalent of (d).

Another point is that if Fig. 4(d) were a desired equivalent, in which A was say a capacitance, and operation was required over a band of frequencies, an actual circuit of form (e) would need an inductance $Z_0^2/A$, or alternatively A and a line as in (c).

If the quarter-wave line is doubled in length to make a half-wave line, the two quarter-wave impedance transformations cancel out. Doubting Thomases can satisfy themselves by going through the motions, thus: if Z is the impedance at one end of the half-wave line, then half-way along the line it will (owing to quarter-wave transformer action) look like $Z_0^2/Z$. This in turn, viewed through the remaining half of the line, looks like $Z_0^2/(Z_0^2/Z) = Z$. This is because the phase difference between a wave entering the line at one end, and the reflection of that wave arriving back, is one cycle; which is to say, in phase. And the phase difference between the
two ends, being half a cycle, is in effect a reversal of polarity. So a half-wave line is commonly used as a reversing or 1:1 ratio transformer.

A useful circuit explained by Dr. Phillips is obtained from the preceding one by inserting a half-wave line in series with one of the four sides of the ring as in Fig. 5(a). (In practice a rather leaner form of transformer can be used, but the principle is the same.) Remember that in Fig. 4(d) — the equivalent of Fig. 4(e) — A and D are fed in phase by any voltage generated in B. The only change made in Fig. 5(a) is the introduction of a phase reversal in one of these arms, so in the equivalent circuit any B voltage feeds D in opposite phase to A. This is indicated by the 1:1 transformer in Fig. 5(b). The merit of this scheme is that if the impedances A and D are made equal the currents through them due to voltages in B will be equal and opposite, so they will cancel out in C. And voltages generated in C will send equal currents through A and D and the two halves of the transformer in such a way as to cancel therein and allow no appreciable voltage to be developed across B. So B and C communicate with A and D without affecting one another. Similarly, if B and C are equal, any voltages originating in A or D will affect them but not one another. This is the v.h.f. analogue of the ‘hybrid coil’ used in telephony (and the ‘rat-race’ used in waveguide circuitry).

The foregoing is only the beginning of what (to use an apt phrase) can be done along these lines. Anyone interested can obtain much more from Dr. Phillips’ paper. But before closing down I had perhaps better do something for those who may have spotted an apparent contradiction. I have emphasized that these quarter-wave (and half-wave) lines work as described only at the frequencies corresponding to their lengths. On the other hand, except for standard-frequency transmissions all practical radio systems require a band of frequencies. At the sort of frequencies that make quarter-wave lines reasonable in length for circuit purposes, one expects to have television, f.m. broadcasting, and such things that take up quite a wide frequency band. However, it is usually only a small percentage of the nominal or carrier frequency, causing practically the same percentage departure from exact quarter wavelength, which should be tolerable in most applications. The effect of a quarter-wave line not being exactly quarter of a wavelength long for some part of the signal is equivalent to introducing a reactance at the end of the line, and also to altering its characteristic impedance slightly. Here again, Dr. Phillips goes into the matter more deeply. He also shows how the whole idea can be applied to waveguides.

To end, here is a little problem arising from Fig. 4. Circuit (e) is entirely symmetrical in form; there is nothing to distinguish one pair of impedances from the other. (Zo^2/A and Zo^2/D could of course be denoted by single letters, such as E and F.) It has two equivalents (d) and (f), in each of which one pair of impedances is distinguished from the other by being connected in series across them. One would expect — I would, anyway — that an entirely symmetrical equivalent existed. So far I haven’t found a general equivalent; for the special case of B + C = Zo^2/A + Zo^2/D, there is a symmetrical equivalent consisting of all four connected in series. Can anyone produce an all-lumped circuit equivalent to (e) in which the impedances can have any values?

**APPENDIX**

There is a limit to how far back towards the beginning of the story we can go just now, and anyone who doesn’t know (and isn’t prepared to take my word for it) that an endless transmission line is equivalent to a resistive impedance Zo called the characteristic impedance and determined by the cross-sectional geometry and materials of the line, will have to look it up in a book.

Fig. 6 shows a short length of line — parallel-wire or coaxial — with a generator to supply an alternating e.m.f. E at one end, and a load impedance Zl at the other. When the generator is first connected, a current I starts to flow. By Ohm’s law* I is equal to V/Zo V being the voltage at the generator terminals. Because time is needed for the wave of current to travel along the line, Zl can have no effect at this stage. But when eventually (after a small fraction of a microsecond) the current reaches the far end, what then? If Zo is equal to Zl Ohm’s law continues to be satisfied and Zl absorbs all the power that comes.

But suppose Zo is greater than Zl. Then, since the ratio of V to I arriving is right for Zo it can’t be right for Zl. V is not enough to pass I through it. The falling off in current makes V rise, and because it is now greater than the line voltage it acts as a generator, driving the surplus current back along the line. In other words, part of the wave is reflected. The combined effect of voltage rise and partial return of current makes Ohm’s law fit Zl. Of course, no other laws must be broken in the process. The amount of power absorbed by the load, plus that which sent back to the generator, must exactly equal what arrives. And the ratio of the surplus voltage and current, which we shall call v and -i (minus, because

* Meaning what is commonly but wrongly understood by this term: the relationship "v = fI," or " V = IZ." Actually Ohm’s law was " v/1 is a constant."

**WIRELESS WORLD, SEPTEMBER 1960**

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**Fig. 5.** A half-wave line is a 1:1 phase-inverting transformer, so by inserting it in one arm of Fig. 4(e) one gets the equivalent shown here at (b). This has some interesting properties.

**Fig. 6.** A length of transmission line of characteristic impedance Zo fed at one end by a v.h.f. generator of source impedance Zo and terminated at the other by a load impedance Zl.
cause it is a deduction from $I_1$, must of course equal $Z_o$.

Next, suppose that the length of the line is such that the time taken to travel once along it is equal to quarter of a cycle at the generator frequency. Then at any moment, if the pattern of current and voltage along it were visible, we would see quarter of one wave. We say it is a quarter-wave line.

That being so, there is half a cycle phase difference between the starting of a wave from the generator and the receiving back of the weaker reflected wave from the load. So if, as in our example, the reflected voltage at the load adds to the forward voltage, and the reflected current subtracts from the forward current, these phase relationships will be reversed at the generator. The total voltage at the generator terminals ($V-v$) is less, and the total current ($I+i$) is greater, than they were when the line fed a matched load.

Their ratio ($V-v$)/($I+i$) is therefore a smaller number than $Z_0$, and the quarter-wave line with its greater-than-$Z_0$ load presents a smaller-than-$Z_0$ impedance at the generator terminals. To take things to extremes, if the load end of the line were open-circuited, no power could be absorbed there; all the power would be reflected, the voltage at the generator terminals would be cancelled and the current doubled, so the input impedance of the line would be zero. This is the inverse of the infinite impedance of the load.

The same kind of argument for $Z_L$ less than $Z_0$ leads to the conclusion that at the generator end of the line it looks like a correspondingly higher impedance than $Z_0$. In the limit, the quarter-wave line transforms a short-circuit (zero $Z_L$) into an apparent infinite impedance or open-circuit (Fig. 7). In fact, it is sometimes used as an insulator at the one particular frequency that makes it quarter of a wavelength long; at other frequencies its impedance is quite low, and at zero frequency negligible.

All we need now is to be more explicit. To comply with Ohm's law:

$$V = \frac{EZ_0}{Z_0 + Z_a} \quad \cdots \quad (1)$$

$$\frac{V}{I} = Z_0 \quad \cdots \quad (2)$$

$$\frac{v}{i} = Z_0 \quad \cdots \quad (3)$$

$$\frac{V + v}{I + i} = Z_L \quad \cdots \quad (4)$$

The resistance and other losses of the line itself are neglected. Let $Z_1$ denote the input impedance of the quarter-wave line terminated by $Z_L$.

Then

$$Z_1 = \frac{V - v}{I + i} \quad \cdots \quad (5)$$

Using (2) and (3) to substitute $IZ_a$ for $V$ and $iZ_0$ for $v$ in (4),

$$I + i = \frac{Z_L}{Z_0} (I - i) \quad \cdots \quad (6)$$

Similarly $V - v = \frac{Z_L}{Z_0} (V + v)$.

So

$$Z_L = \frac{Z_L (V + v)}{V - v} \quad \cdots \quad (7)$$

or $Z_0 = \sqrt{Z_L Z_a}$.

So if you want to make any impedance $Z_L$ look like a different impedance $Z_0$, interpose a quarter-wave line ("transformer") having a characteristic impedance equal to $\sqrt{Z_L Z_a}$.

And if the input current and voltage, $I + i$ and $V - v$, are called $I_1$ and $V_1$ and the output current and voltage, $I - i$ and $V + v$, are called $I_L$ and $V_L$.

By "Ohm's law" $V_1 = Z_L I_1$

Using (6)

$$\frac{Z_L}{Z_0} = \frac{I_L}{I_1} \quad \cdots \quad (8)$$

Using (7)

$$V_L = \frac{Z_0}{Z_L} I_L \quad \cdots \quad (9)$$

That is to say, for a given type of quarter-wave line, the voltage at either end is proportional to the current at the other end.

### I.E.E. PREMIUMS

The premier award of the Electronics and Communications Section of the I.E.E.—the Duddell Premium (£20) —for papers read or accepted for publication during 1959, is to be given to Dr. G. B. B. Chaplin (Plessey), A. R. Owens (University College of N. Wales) and A. J. Cole (Plessey) for their papers "A method of designing avalanche transistor trigger circuits" and "A sensitive transistor oscillograph with d.c. to 300 Mc/s response."

The Ambrose Fleming Premium (£15) goes to Dr. A. E. Karpowiak and V. H. Knight, of Standard Telecommunication Laboratories, for "An experimental investigation of waveguides for long-distance transmission."

Premiums of £10 each are being awarded to A. H. W. Beck (for his paper "High-current-density thermionic emitters: a survey"), L. Lewin ("The efficiency of a ferrite as a microwave mixer," "A ferrite boundary-value problem in a rectangular waveguide" and "Phase measurements through tapered junctions"), and G. Craven and V. H. Knight ("The design and testing of integrally constructed waveguide assemblies"), all of Standard Telecommunication Laboratories, Professor A. L. Cullen ("Theory of the travelling-wave parametric amplifier") of Sheffield University, K. Beaufoy ("Transistor switching-circuit") of British Telecommunications Research, and to H. A. C. Hogg ("Periodic electro-static beam focusing") of G.E.C. Research Laboratories.

The premier award of the Measurement and Control Section (the Silvanus Thompson premium—£20), goes to Dr. L. Essel, E. G. Hope, J. V. L. Parry and J. McA. Steele for two papers on the N.P.L. caesium standard.
Transistor Inverters and Converters

2.—Basic Principles of the Push-pull Square-wave Oscillator System

By M. D. BERLOCK,* Grad. I.E.E., and H. JEFFERSON,* M.A.

IN the first article we described the single-ended transistor oscillator which operated on what might be described as a pump basis. The energy is fed into a storage device, which is actually an inductor, on the charging stroke and then transferred to the load on a second, discharge, stroke. The limitations of a system of this kind are fairly easily seen. At best each part of the circuit is working for half the time so that the losses involved in cramping the energy through are doubled, while any deviation from the 50-50 ratio reveals that what you lose on the swings you do not get back on the roundabouts.

The use of a push-pull oscillator circuit operating in class-B is an obvious step forward in converting direct current to alternating. We can see, indeed, the whole family of class-B and class-C oscillators of traditional design but modified to use transistors available for this purpose. Much more interesting, however, is a family of push-pull square-wave oscillators which have come into use only with the advent of transistors. These oscillators are now quite widely used and provide efficiencies which range from perhaps 80% upwards depending on the conflict of the requirements presented to the designer: 95% is not uncommon but demands a bigger, more expensive unit than 90%. The choice is there to be made.

It is an interesting problem in semantics whether these circuits should be described as oscillators at all. The essence of an oscillatory system, one might say, is that it should have two energy storage methods with the energy being passed from one to the other and back again. In the pendulum the energy is now potential, now kinetic: in the LC oscillator the energy is now \( \frac{1}{2} CV^2 \), now \( \frac{1}{2} LI^2 \), in the tank circuit. The active element provides a make-up energy which is small compared with the energy stored in the system. An oscillator of this kind will also, of course, have a stored energy content large compared with the energy delivered to the load. Not surprisingly, this means that at low frequencies the tank circuit is both bulky and noisy.

The square-wave circuits with which we are concerned have, in their ideal form, no stored energy at all. The transistors act as switches, the transformer, for most of the time, purely as a transformer. Each half-cycle is an operation independent of the past. Let us examine the basic form of the circuit, which is shown in Fig. 1. It has, as you can see, the appearance of an oscillator circuit, although the tank circuit capacitance is missing and, as we shall see, the concept of inductance should not be applied to the collector winding of \( T \). The core of \( T \) is, indeed, one of the so-called square-loop materials which have ideally infinite permeability below saturation and a very sharp knee at which the permeability falls to a very small value. How does this circuit operate?

When we first switch on let us assume that \( Q_1 \) is in a higher gain condition than \( Q_2 \). Current flowing into \( Q_1 \) produces, through the conventional transformer action of \( T \), a forward bias into the base of \( Q_1 \) and a cut-off bias into the base of \( Q_2 \). In consequence \( Q_1 \) becomes a virtual short-circuit: a voltage drop of less than one volt at a current of ten amperes is normal. Across one half of the collector winding of \( T \), we have almost the whole of the supply voltage and this, appropriately transformed, appears across the load.

The basic circuit during this phase of the operation can be simplified right down to that shown in Fig. 2, with the transistor put in even though it is a short-circuit, and the load resistance transformed back as a resistance \( R \) across the half collector winding. We could now write

\[
\frac{dI_m}{dt} = \frac{V}{L}
\]

But the trouble is that in a circuit of this kind the only way to define \( L \) is by the equation

\[
L = \frac{V}{dI_m/dt}
\]

We can avoid this difficulty by considering the

*The Phoenix Telephone and Electric Works Ltd

Wireless World, September 1960
From where flux, $I_b$, $V_b$, $V$, $I$, $J$, $B$, $H$, $C$, $L$, $R$, $J_H$ are connected by the equation $B = \mu H$, though $\mu$ is very large and probably not very constant.

In consequence we have

$$I_m = \frac{kVt}{\mu C}$$

which is proportional to time and, because of the size of $\mu$, rather small. There comes a limit to this state of affairs, however, when $B$ reaches some value $B_c$. Any further increase in $B$ then requires a very large increase in $H$, or if you prefer it, $\mu$ falls to a very small value. In consequence $I_m$ attempts to rise rapidly to meet this demand.

The total available current is, however, limited by the transistor to a value $\beta_b$ so that $I_m$ can rise only if $I_b$ falls. We have, however, $V = RI_b$ so the voltage across the winding collapses. The onset of this condition reduces the base drive to $Q1$ and the positive feedback loop drives $Q1$ off. The stored energy $BH$ is small, but it is sufficient to lift $Q2$ into conduction and away we go, in the opposite direction.

The current and voltage waveforms for this circuit are shown in Fig. 3. It will be seen that the transistors are subjected to twice the supply voltage when cut-off and that the current is almost constant during the on period. In practice it is found that the voltage spikes shown, which are due to leakage reactances, may be substantial. The whole transient switch-over period is a rather dangerous one, with the very high current spike just at the end of the conduction period giving high dissipation in the transistor and also presenting a momentary heavy loading on the supply line. This current spike makes the transient behaviour very dependent on supply impedance.

The first stage in setting up a practical circuit of this kind is shown in Fig. 4. This circuit differs from the simplified circuit of Fig. 2 in the addition of the base current limiting resistors $R_b$. To begin the design we must, of course, choose our transistors. We assume that the supply voltage and power output are fixed: the current drawn from the supply will be something more than (power)/(voltage) and during its on period all this current flows through one transistor. Thus for a 30-W inverter operating from a 12-V supply the collector current rating must be over 2.5A. Because the efficiency will not be

We can make life easier by writing $t_a = 0$ so that $B = kVt$

flux, $B$, in the core, which satisfies the equation

$$\frac{dB}{dt} = \frac{V}{nA} \times 10^8$$

where $n$ is the number of turns and $A$ the core area.

From this we see that we have

$$B = k V (t + t_a)$$

($k$ and $t_a$ are constants)

This flux is associated with a magnetomotive force $H$ which can be written simply as

$$H = C I_m$$

($C$ is another constant)

Fig. 6. More economical method of biasing the transistors.
N₁ = N₂ = 88 turns of 18 s.w.g.
N₃ = N₄ = 12 turns of 22 s.w.g.
N₅ = N₁ x Vₒᵤₜ/28
Core = 1.37 cm² toroidal ribbon wound with Bₘₐₓ = 14.8 k gauss.
f = 400 c/s.
η = 93% on full load.

N₁ = N₂ = 33 turns of 16 s.w.g.
N₃ = N₄ = 8 turns of 26 s.w.g.
N₅ = 5.3 Vₒᵤₜ
Core = 1 in wide centre limb and 1.5 in stack height of 0.004 in Si steel.
f = 75 c/s.
η = 60% on full load.

N₁ = N₂ = 50 turns of 14 s.w.g.
N₃ = N₄ = 12 turns of 20 s.w.g.
N₅ = 5 Vₒᵤₜ
Core = 1 1/2 in wide centre limb and 1 1/2 in stack height of 0.004 in Si steel.
f = 50 c/s.
η = 67% on full load.

N₁ = N₂ = 50 turns of 0.4 mm dia.
N₃ = N₄ = 15 turns of 0.15 mm dia. (38 s.w.g.).
N₅ = 2,280 turns of 0.1 mm dia. (42 s.w.g.).
Core = EE30 core of Siemens Ferrit No. 1100N22
with 0.2 mm air gap
f = 4 k/s approx.
η = 80%.

Fig. 7. Typical designs for inverters: (a) is suggested by Texas Instruments in their Bulletin No. DL-S 909, March 1958, (b) and (c) by Newmarket Transistors in their Application Notes Nos. 18 and 22 respectively, and (d) by Brush Crystal on p. 21 of their Intermetall "Silizium-Germanium Halbleiter Bauelemente" (1959).
100% the current might be assumed initially as 3A. The voltage on the cut-off transistor will be twice the supply voltage, which for a charged battery means some 28-30 V.

These rather rough and ready sums are intended just to guide us in preparing a short list of possible transistors. For our example the average current is about 2.5A and the peak current will probably be about 4-5A during the spike. Prices and deliveries will now play some part in cutting down the list.

When a transistor has been selected we have the essential data for continuing the design: lack of this data is a reason why one manufacturer's products never appear in the short list. To drive the transistor fully on the data will indicate that we need some base current $I_b$, which may be given in characteristic curves, or may be taken from the minimum value of $\beta$ as simply

$$I_b = I_e / \beta$$

To get this current to flow into the base we need a base-emitter voltage $V_{be}$ so that the ratio of the transformer must be

$$N_2 = V_{be} + I_e R_e$$

$$N_1 = V_{be} - V_{ce}$$

where $V_{be}$ is the supply voltage and $V_{ce}$ the transistor knee voltage. In what follows we shall write $V_{ce}$ in place of the more exact form $V_{ce} - V_{ce}$. If $R_e$ is such that $V_{be} N_2 / R_e N_1$ is less than the maximum permitted value of $I_b$ then the transistor cannot be overdriven.

The next problem is to decide the value of $N_1$ the collector winding. This is given by

$$N_1 = V_{ce} \times 10^8 / 4AfB_n$$

The manufacturers of square-loop core materials, such as HCR, Mu-metal and some ferrites, give details of the saturating flux density $B_n$. The choice of area $A$ and frequency $f$ is left to the designer. He will begin by choosing a frequency based on a previous design. It will not be high, because the transient loss will become too great: it will not be too low, or $N_1$ becomes too large. A convenient value for the 10-100 W class of converter is 400-800 c/s. With the value of $f$ determined a core size must be guessed, to give a value of $A$ and thus of $N_1$. We now make the first test, to see whether we can actually wind two windings of $N_1$ into half the window area of the core chosen (the other half is reserved for the load winding). Resistance, copper-loss and core-loss calculations follow with the usual painful reappraisal and the choice of a new core size. As this side of the design work is leading towards a satisfactory compromise between cost and efficiency, a new assessment of frequency may be made.

As the process of transformer design approaches completion it becomes necessary to examine the losses in the transistor itself. When passing its full current there will be a drop of about 0.5 to 0.8 V across the collector-emitter path and for a current of 3A this means a loss in the pair of 1.5-2.4 W. Transient distortion is more difficult to estimate even when the waveform can be displayed on an oscilloscope, and in general is small enough to be omitted from a broad study unless the frequency is abnormally high. The term we have just considered, say 2 W out of 30, suggests the order of magnitude we must allow for the transformer loss. The base circuit loss is added and we have a good idea of what the inverter will do. For our arbitrary example with a 3A limit and an output of 30 W we cannot afford more than 6 W total loss. This means an efficiency of 83%, which is quite reasonable.

It is now necessary to elaborate the circuit slightly. The elementary circuit has the transistor bases returned directly to the emitters and the transistors may therefore be regarded as biased pretty close to cut-off. The loop gain will often, though not always, be too low to start the system oscillating and this is especially true when the load is permanently connected.

One starting mechanism used consists merely of a resistor in one base line, the base winding of the transformer being split to enable it to be put on the battery side of the winding, with a capacitor taken back to the negative centre-point of the collector winding. When the battery is suddenly applied this base is flicked sharply negative into a high-gain region and the circuit starts off. The disadvantage is that if the supply does not come on quickly enough the base does not get sufficient kick. When a large capacitor is connected across the supply terminals and the battery leads have significant kick there may be starting trouble. Increased resistance means better starting but also, since base current flows through the resistor, lower efficiency.

Stephenson has shown in *Electronic Engineering*, Vol. 31, No. 380, October 1959, that to get this kind of oscillator to start it is necessary to provide a minimum base current of

$$25 n/((\beta R_2 - n R_0) m A)$$

where $n$ is the (collector winding)/(base winding) turns ratio, $R_0$ the collector load, and $R_0$ the total resistance in the base path. For very simple applications it is sufficient to adopt the standard method of biasing the transistors to this working point. The result is the circuit shown in Fig. 5. Although this circuit is economical in components it is wasteful in power as the base current, which may be substantial, must flow through the bias resistors.

The standard bias circuit is that shown in Fig. 6.
The resistor provides the starting base current given by the expression above. It is, of course, quite calculable. The much larger base current taken once the system starts oscillating will flow through the diode. Once the diode is conducting the voltage drop across it does not vary very much with current and in a typical case of a 100-W inverter the diode current of 1 A results in a voltage drop of about 0.7, V. A power loss of only 0.7 W. Allowance must be made for this additional voltage drop in determining the ratio N2/N1.

Starting circuits involve the designer in a compromise which must be studied rather carefully. As we have seen, the starting condition is that a specified minimum current should flow in the transistors: this current must not be large enough to overheat the transistors if the load on the inverter is excessive and the circuit fails to oscillate.

The basic Uchrin-Royer inverter which has been described in this article is probably at the moment the most commonly used form of circuit. Most transistor manufacturers publish designs for using their transistors in this way and give details of the transformers. Some, at least, of the inverters available commercially are based on their information.

Typical designs are those illustrated in Fig. 7.

For higher supply voltages it is possible to work with two transistors in series in the circuit shown in Fig. 8. This circuit was described in Mullard Technical Communications, Vol. 4, No. 36, December 1958. All the transformer windings are on a common core of HCR laminations.

There are a number of disadvantages to the simple transistor inverter which we have described here. In the next article we shall discuss these and show how they are overcome in another slightly more complex circuit. We also hope to describe a new variant of this circuit which is slightly more economical and which has been found to have a number of operating advantages.

Corrections: In part I of this article (August issue) on p. 400, col. 2, line 21, C1 should read C1c; on p. 401, col. 1, line 11 should read I1 = βIb; on p. 402, col. 1, line 10, "to" should be deleted; line 19 of the same column should read

$$I_{pk} = \frac{4W}{E\left(\frac{1}{i_1} + \frac{1}{i_2}\right)};$$

line 27 of the same column should read I1 = I_{pk}/\beta

$= E \left(\frac{N_2}{N_1}\right)/R_0$; on p. 402, col. 2, line 19 should read $t_1 = L_1I_{pk}/E$.

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### HOW PRECISE IS YOUR ATTENUATOR?

**EFFECT OF RESISTANCE TOLERANCES ON ATTENUATOR ERRORS**

*By H. STERN, B.Sc.*

The simple potential divider, consisting of two resistors in series (Fig. 1), is frequently used in electronic equipment to adjust the level of an incoming signal; for instance, it is used as the input attenuator in many cathode-ray oscilloscopes. In many cases the divider consists of high-stability close-tolerance resistors, the accuracy of the step-down being dependent on the accuracy of the resistors.

From comparison of circuit component values with the specifications of some instruments and from conversations with several engineers, it is obvious that it is frequently assumed that, if resistors of equal percentage tolerance are used in the divider, the maximum percentage error in the step-down ratio will be equal to that tolerance. It will be shown below that this is only true in a very limited number of cases.

If we let the desired voltage ratio $V_{out}/V_{in}$ equal $n$ we have, assuming precise resistor values:

$$n = \frac{R_2}{R_1 + R_2} \quad \quad \quad \quad \quad (1)$$

Taking partial differentials we get:

$$\frac{\partial n}{\partial R_2} = \frac{R_3}{(R_1 + R_2)^2} \quad \text{and} \quad \frac{\partial n}{\partial R_1} = -\frac{R_2}{(R_1 + R_2)^2}$$

Now $\delta n = \frac{\partial n}{\partial R_2} \delta R_2 + \frac{\partial n}{\partial R_1} \delta R_1$

$\therefore \delta n = \frac{R_1 \delta R_2 - R_2 \delta R_1}{(R_1 + R_2)^2}$

and by appropriate substitutions for $R_1$ and $R_2$ from equation (1) we get

$$\frac{\delta n}{n} = (1 - n) \left(\frac{\delta R_2}{R_2} - \frac{\delta R_1}{R_1}\right) \quad \quad \quad \quad (2)$$

From (2) it is obvious that the maximum percentage error in the ratio $n$ will be proportional to the sum of the percentage errors in the two resistors.

---

**Fig. 1. Simple resistive potential divider.**

**Fig. 2. T-type attenuator.**
In a practical example, for a 100 : 1 ratio with ± 1% resistors the error in the attenuator ratio may be as great as 1.98%.

The above considerations may easily be extended to cover more complex attenuator circuits. For instance, a T type of attenuator (Fig. 2) may (assuming purely resistive loading) be redrawn in the form of two cascaded potential dividers (Fig. 3).

The first of these dividers has the combination of \( R_1 \) shunted by \( R_3 \) in series with \( Z \) as its lower arm.

In a similar way a \( \pi \)-type attenuator (Fig. 4) can be redrawn as a potential divider (Fig. 5).

The maximum possible error can then be calculated from the above theory if one takes into consideration the following factors:

For a parallel combination of resistors (Fig. 6):

\[
\frac{8 \Delta R}{R} = \frac{1}{R_9 + R_{10}} \left( R_9 \frac{\Delta R_{10}}{R_{10}} + R_{10} \frac{\Delta R_9}{R_9} \right)
\]

If \( R_9 \neq R_{10} \) this simplifies to

\[
\frac{8 \Delta R}{R} = \frac{\Delta R_9}{R_9} = \frac{\Delta R_{10}}{R_{10}}
\]

For resistors in series (Fig. 7):

\[
\frac{8 \Delta R}{R} = \frac{8 \Delta R_{11} + 8 \Delta R_{12}}{R} = \frac{8 \Delta R_{11}}{R_{11}} = \frac{8 \Delta R_{12}}{R_{12}}
\]

Again, if \( R_{11} = R_{12} \) this simplifies to

\[
\frac{8 \Delta R}{R} = \frac{8 \Delta R_{11}}{R_{11}} = \frac{8 \Delta R_{12}}{R_{12}}
\]

**Commercial Literature**

Electronic Cable Gauge, for continuous measurement of diameter in cable works, based on a scanning light beam and phototelectric pick-up, with a system for measuring the time interval of the cable shadow passing across the pick-up. Said to be more accurate than light intensity methods. Leaflet from The Addison Electric Company, Ltd., 10-12 Bosworth Road, London, W.10.

Catalogue of Components made by A. F. Bulgin and Co. Ltd., Bye Pass Road, Barking, Essex. 2s 6d by post, or free to trade.


Television and V.H.F. Distribution systems made by Belling and Lee Ltd. are constructed on a modular basis to ensure serviceability and adaptability. The equipment is suitable for any size of installation and any television receiver or v.h.f. radio can be connected. Booklet from Belling and Lee Ltd., Great Cambridge Road, Enfield, Middlesex.

Sensitive D.C. Relay, Type K01, made by B. & R. Relays, is an alternative to the well-known P.O. 3,000 pattern, but is not affected by 25g acceleration. Vibration-resisting qualities are enhanced by replacement of the usual knife-edge armature support by a stainless steel shaft. Details of this and many other relays are given in a new catalogue from B. & R. Relays Ltd., Temple Fields, Harlow, Essex.

"Resins and Glues for Industry" is the title of a new edition of the catalogue of Lester, Lovell & Co. Ltd., North Baddesley, Southampton.

Five-valve 250-W a.f. amplifier or 150-W 30Mc/s transmitter are two possible applications of the S.T.C. Type 828 house-power amplifier valve. Application report giving details from Standard Telephones and Cables Ltd., Special Valve Sales Department, Footscray, Sidcup, Kent.


Wireless World, September 1960
Automatic Stereo Phase Corrector developed by the American Columbia Broadcasting System laboratories was described at the recent New York I.R.E. Convention. In this corrector, portions of both the left and right stereo signals are amplified and then added and subtracted, the sum and difference signals so formed being then rectified. The resulting d.c. signals are applied to a mechanical flip-flop. If the relative phases of the left and right stereo signals are correct, the sum d.c. signal will be greater than the difference. If this is not so, the mechanical flip-flop automatically reverses the phase of one stereo signal to correct their relative phases.

Pinlite sub-miniature incandescent electric light shown in the photograph is claimed by its manufacturer, the American Kay Electric Company, to be at least 30% smaller than the next smallest mass-produced bulb. Its actual dimensions are 0.062in long by 0.015in in diameter and it operates from a supply of 1.5V at 15mA. Possible uses for this bulb are in computer readouts or as a meter pointer position indicator. Because it operates at low voltages and currents it is also suitable as a transistor circuit on/off indicator.

Cleaning Flux from printed-wiring boards is necessary to avoid subsequent breakdown due to short circuiting or corrosion. In Electronic Industries for November 1959 (p. 110) results of a radioactive-tracer test are given. Flux containing a radio active substance was brushed on to the boards and allowed to dry. The boards then solder-dipped at 520°F for 5 seconds. Cleaning methods compared were mechanical agitation in a 100% chlorinated solvent and a water-based detergent solution, and sonic agitation in the same two liquids. The results were, in percentage flux removed: 93%, 91.3%, 89.1% and 97.8% respectively. In the last case, the 2.2% remaining flux was found to be trapped in the solder and board or dispersed so as not to be a hazard in the future life of the board.

Galium Arsenide Transistor has been developed by R.C.A. according to the May 13 issue of Electronic. One advantage of using GaAs as the semiconductor in a transistor is that it can be operated at a higher temperature even than Silicon—250°C compared with 175°C. The new R.C.A. transistor is a diffused-junction drift-field type with an alpha cut-off frequency of approximately 100Mc/s.

Pulse Sharpener, described by J. F. Golding and L. G. White in the September 1959 issue of Electronic and Radio Engineer (now Electronic Technology), uses a pentode switched on by the differentiated pulse leading edge to rapidly discharge the stray capacitance across which the pulse is developed and thus to provide a very fast pulse leading edge.

"Cocktail Party" Effect—i.e. one's ability to concentrate at a cocktail party on a single voice amid the surrounding babble and other party noises—has been reproduced electronically by E. E. David and J. F. Kaiser at the Bell Telephone Laboratories. This effect is due to our being able to separate sound sources according to their different directions, and in a two-earred listener can produce an apparent improvement in the signal-to-noise ratio of from 5 to 15dB. Since this improvement is greater than that theoretically possible by means of linear processes, non-linear processes were used in attempting to reproduce this effect electronically. In one experiment the outputs from two spaced microphones were compared by cross correlation to produce a gating signal. This signal was arranged to increase the combined output of the two microphones when they each produced simultaneous identical signal outputs. (It was also, of course, arranged that such simultaneous signals were produced by the voice to be concentrated on.) Interfering signals then only had their intensities increased if they occurred at the same time as the desired signal. In this way in the combined microwave output the signal-to-noise ratio was improved by 9dB with a single interfering talker and by 5dB with two interfering talkers.

Artificial Reverberation obtained from mechanical spring delay lines (see photograph) developed by the Hammond Organ Company is being incorporated in new American Philco and Zenith stereo record reproducers. Two lines giving delays of 29 and 37msec are used. According to Electronic News for the 30th May, the delay is obtained from torsional motion of the springs; conversion between this torsional motion and the electrical input and output signals being carried out by means of ferrite rotors. By deliberately mismatching the delay lines, repeated reflections are produced and the delayed signal decays logarithmically as in natural reverberation. In the Philco units the sum of the left and right channels is reverberated and fed back into the left and right channels. In the Zenith units the stereo signals are summed and differenced, and the sum channel is reverberated and fed into the difference channel.

WIRELESS WORLD, SEPTEMBER 1960
Elements of Electronic Circuits

17.—BLOCKING-OSCILLATOR TRANSFORMER-COUPLED TIMEBASE


Although this type of relaxation oscillator is used primarily as a square-wave generator, a sawtooth waveform can be obtained from it. Fig. 1 shows a simple form of free-running blocking oscillator and Fig. 2 illustrates the waveforms.

Superficially the circuit resembles the familiar tuned-grid oscillator without its tuning capacitance, but its action is rather more complex. A single triode amplifier is used and the necessary positive feedback is obtained from the antiphase output of the tightly-coupled anode-to-grid transformer (usually having a Mumetal or ferrite core). When the valve starts to conduct, \( V_a \) falls and \( V_g \) is driven positive by the transformer action. A cumulative build-up of \( I_a \) and \( I_c \) to high values occurs, which causes \( V_a \) to drop sharply. The grid capacitor \( C \) is consequently charged by the large grid current and the tight transformer coupling ensures that the grid voltage is driven sufficiently far positive to permit this large current to flow.

The charge on \( C \) is now of such a value that it carries the grid well beyond the cut-off bias of the valve, thus stopping the flow of \( I_a \) and hence the production of the alternating grid voltage. The valve remains non-conducting while \( V_g \) rises exponentially towards earth potential with a time constant \( CR \) seconds. As soon as cut-off bias is reached, \( I_a \) flows again and the cycle repeats.

For correct operation a high negative bias voltage must be developed across \( C \) as there is a possibility of the positive-going excursion of the remaining, damped grid-voltage oscillation raising the grid above cut off again. To avoid this, damping (usually a parallel resistor) is sometimes added across the transformer. Choice of value of capacitor \( C \) is also influenced by the chance of ringing—if \( C \) is made large it may not be charged sufficiently by grid current to ensure that the valve is held cut off after the half-cycle of oscillation. Thus for a slow p.r.f. a relatively small value is chosen for \( C \) with a correspondingly high value of \( R \).

The timebase sawtooth waveform can be taken from \( C \) and, to make the rise in voltage more linear, grid-leak resistor \( R \) is sometimes connected to h.t. + instead of to earth. Positive-going pulses can be developed across the cathode resistor and applied to the c.r.t. cathode as blanking pulses, so blacking out the spot during the flyback period (i.e. the oscillatory period when \( I_a \) is flowing).

**TECHNICAL WRITING**

It is announced by the Technical Publications Association that nineteen colleges have registered as providing courses in technical authorship for the 1960/61 session. Details of the technical authorship syllabus and of the colleges providing courses are obtainable from the City and Guilds of London Institute, 76, Portland Place, London, W.1.
CONFERENCES AND EXHIBITIONS

Latest information on events both in the U.K. and abroad during the next four months is given below. Further details are obtainable from the addresses in parentheses.

LONDON
Aug. 24-30 National Radio and Television Show
Sept. 3 (Radio Industry Exhibitions Ltd., 59 Russell Square, London, W.C.1.)
Sept. 1 Rocket and Satellite Instrumentation
(Society of Instrument Technology, 20 Queen Anne Street, London, W.I.)
Nov. 21-25 Industrial Photographic and TV Exhibition
(Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, W.C.2.)
Nov. 22-24 Electronic Telephone Exchanges (Conference)
(I.E.E., Savoy Place, W.C.2.)
Nov. 23-26 Radio Hobbies Exhibition
(R. A. Thorogood, 35 Gilbert Green, Edgware, Middx.)
Jan. 16-20 Physical Society Exhibition
(Physical Society, 1 Lowther Gardens, S.W.7.)

BOURNEMOUTH
Oct. 18-19 Air Traffic Control Convention
(Town Hall
Gulf of Air Traffic Control Officers, 118 Mount Street, London, W.1.)

CAMBRIDGE
Sept. 15-17 R.S.G.B. National Convention
(St. John's College, Cambridge.)

CARDIFF
Aug. 31- Sept. 7 British Association Annual Meeting
(British Association, 18 Adam Street, London, W.C.2.)

CHETTENHAM
Sept. 22-24 Theory and Practice of Ultrasonic Inspection
(Queens Hotel
Conference
(I. M. Barnes, Materials Laboratory, de Havilland Propellers Ltd., Hatfield, Herts.)

FARNBOROUGH
Sept. 5-11 Farnborough Air Show
(Society of British Aircraft Constructors, 29 King Street, London, S.W.1.)

MANCHESTER
Sept. 21- Oct. 1 International Factory Exhibition Exhibition
(Belle Vue
Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, W.C.2.)

OVERSEAS
Aug. 29- Sept. 4 Physics of Semiconductors Conference
Prague
(I. R. E., 1 East 79 Street, New York.)
Aug. 30- Sept. 5 First-European International Radio Show
Amsterdam
(Firato Radio, Emilianaan 20, Amsterdam, Z.)
Sept. 14-15 Military-Industrial Electronic Test Equipment Symposium
Chicago
(Conference
(Armour Research Foundation, 10 West 35 St., Chicago.)
Sept. 19-21 Space Electronics and Telemetry
Washington
(Conference
(I. R. E., 1 East 79 Street, New York.)
Sept. 19-21 International Symposium on Data Transmission
Delft
(B. Barlow, I.R.E., Postbus 174, The Hague.)
Sept. 21-22 Industrial Electronics Symposium
Cleveland
(I. R. E., 1 East 79 Street, New York.)
Oct. 3-5 Communications Symposium
Utica
I. R. E., 1 East 79 Street, New York.)
Oct. 4-6 Radio Interference Reduction (Conference)
Chicago
(Armour Research Foundation, 10 West 35 St., Chicago.)
Oct. 10-12 National Electronics Conference
Chicago
(I. R. E., 1 East 79 Street, New York.)
Oct. 19-26 Interkama—Congress and Exhibition for Instrumentation and Automation
Dusseldorf
(Conference
(Nordwestdeutsche Ausstellungen, Ehrenhof 4, Dusseldorf.)
Oct. 24-26 Aeronautical and Navigational Electronics (Conference)
Baltimore
(I. R. E., 1 East 79 Street, New York.)
Nov. 14-16 Mid-American Electronics Convention
Kansas City
(L. R. Crissman, T. W. A., 10, Richards Rd., Kansas City.)
Nov. 14-17 Magnetism and Magnetic Materials (Conference)
New York
(L. R. Bickford, I.B.M. Research Center, Yorktown Heights, N.Y.)
Nov. 15-17 Electronics Research and Engineering Meeting
Boston
(I. R. E., 73 Tremont Street, Boston, Mass.)
Dec. 13-15 Eastern Joint Computer Conference
New York
(P.O. Box 2580, Grand Central Station, New York, 17.)
Jan. 9-11 Reliability and Quality Control Symposium
Philadelphia
(R. Brewer, G.E.C. Research Labs., Wembley, Middx.)

Wireless World, September 1960

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FROM facts and figures issued by the National Council for Technological Awards one gathers that the Dip. Tech. has not only made a most promising start but has come to stay. The qualification, equal in standing to an honours degree at a university, has already been awarded to 163 students, including one woman. There are now 95 recognized courses at 23 technical colleges and nearly 4,000 students, including 84 women, have been enrolled. The demand for men and women with science qualifications is ever increasing and the universities are already so packed that there can't be room for all who would like to become students. And there's more to it than that. As its name implies, a university should deal with all branches of human knowledge. It must not specialize or it ceases to be a university, nor must it allow any faculty to become so big that it overshadow the rest. Hence it would never do to allot vacancies to all those who wish to obtain scientific qualifications. To do so would mean upsetting the balance. The Dip. Tech. provides a very satisfactory answer to the problem of coping with a far greater number of would-be science and technology students than the universities can cater for.

**TV/DX in Bermuda**
FROM Pembroke in Bermuda a reader writes to tell me of his experiences of long-distance TV reception. He is service manager of a firm and it occurred to him that it would be very useful if he could obtain a good picture in the showrooms at times when the local station, on Channel 10, wasn't working. He put up a 5-element aerial covering the American Channels 2-13 on a 20-foot mast on the roof of the 45-foot high building. The result was just astonishing. Havana, in Cuba, though 1,000 miles away, comes in steadily and regularly with very little background snowiness. Other distant stations giving pictures with real entertainment value are Daytona Beach in Florida on Channel 2 and Washington, D.C., on Channel 3. A glance at an atlas will show you that these are quite remarkable feats. His concluding sentence is of particular interest: "The British receiver which my firm stocks always gives a better contrasted and more snow-free picture than the most expensive American sets of any make, even those claimed to be in the luxury class."

**Telesmellevision?**
IN the U.S.A. several cine theatres are now equipped with apparatus which relays the proper smells at the right moments. In jungle scenes, for instance, there might come whiffs of lion, tiger or elephant, or a garden scene can be accompanied by the scent of roses. The idea seems to have caught on, for a good few other theatres are ordering the apparatus. The gear has not yet reached a form suitable for domestic use but it could be developed to meet the requirements of a theatre showing big-screen television. Television has shown that it can do most if not all of the things so far achieved by the cinema. So why not? How does it work? A revolving platform carries bottles charged with the required scents, and capable of dispensing the scent in aerosol form. A foil strip pasted on the film switches on a device which brings the required bottle into position and then causes a plunger to press the knob. The scent is diffused via the air conditioning system and is said to be mopped up electrostatically when it ceases to be required. For telesmellevision the transmission of special trains of pulses would be needed, of course.

**Pulse Pacemaker**
WHEN Galvani made the leg of a dead frog twitch by connecting the muscles to an electric cell it is extremely unlikely that he had any idea that he had made a discovery which long after his death would lead doctors to developing methods of dealing with conditions in the human body which had hitherto been regarded as incurable. Yet this has happened, for doctors in Britain, Sweden and the U.S.A. are now using electric pulses to regulate heart beats. You couldn't very well run wires leading to the heart from a battery, but you can use the transformer principle, with the secondary, buried in the body and the primary outside it. As I wrote some time ago in these notes, the induction principle was used by a French doctor in an attempt to make a totally deaf person hear. What is being done in the case of irregular hearts is to implant a small secondary coil into the body and to connect it to the main nervous system of the heart. Outside the body is a time-base connected to the primary. By means of this, sync pulses are applied to the heart, which responds to them and begins to beat regularly. It is reported that when the device has been

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<td>33 6</td>
</tr>
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<td>MICROWAVE DATA TABLES</td>
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**WIRELESS WORLD, SEPTEMBER 1960**

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www.americanradiohistory.com
in use for some time the heart may become so trained that it continues to beat as it should when the pulses are switched off for a while.

**Bigger and Bigger Screens**

IN most countries which have television services there's a marked movement towards larger c.r. tubes for receivers. In France 19-, 21- and 23-in tubes have been popular for a year or two now. That's understandable, for even with such large screens an 819-line image is not liney, even if sets are used in quite small rooms. One rather wonders, though, whether the 19- and 23-in screens which are expected to be the standard size in the U.S.A. this year will be successful with 525-line images. Still the radio industry over there is predicting that the bigger (and let's hope better) sets will sell like hot cakes. So far I haven't seen a 625-line picture on a 19-in screen, but it's pretty well bound to be liny at clossish quarters. There is, I fancy, bedrock truth in the suggestion made in a recent *Wireless World* editorial that many viewers don't mind lini-ness. At any rate no British receiver using spot-wobble or spot-astigmatism has succeeded in catching on. Whenever I've seen spot-wobble sets in use in people's homes the wobble switch has always been in the off position.

**Still Going Up**

WITH 55,193 new combined TV/ sound licences taken out in June, the total at the end of the month was 10,702,131. The summer months aren't normally responsible for big increases, though this year the cold, wet weather may be making people think more of indoor rather than of outdoor diversities. Anyhow, as the combined total of television and sound-only licences had reached 15,104,329 at the end of June there can't be an enormous number of homes now where there isn't a set of one kind or another, or sets of both kinds. Still, we're a good way yet from reaching saturation, in TV at any rate. With nearly four and a half million homes with nothing but sound only receivers there's still a bigbigh slice of our population to be roped into the television fold. New stations, both B.B.C. and I.T.A., are going up and satellites and boosters will be coming into action in more and more of the difficult areas. Every such station is bound to keep things moving and in some places where good pictures have seldom been obtainable the increased number of viewers should be considerable.

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"Line upon Line"

As these notes are intended for the September issue, it means that it is just thirty years since I started writing in these columns by prophesying that the then largely discredited superhet showed unmistakable signs of staging a comeback (September 17th, 1930). It was then considered that good quality and the superheterodyne principle would never run together in harness. But that attitude has long since been forgotten.

Nowadays, judging by the Editor's remarks in the July issue, the question is whether a good-quality picture—or at any rate a reasonably non-linear one—can be obtained with 405-line television.

I certainly received a salutary shock when I first read in the July issue the Editor's stringent strictures on the popular idea that everything in the garden would be lovely if we changed our TV system from 405 to 625 lines. Hitherto I have not given any very serious thought to the matter but in my ignorance have just followed the herd-minded belief that the only remedy for lines was to have more of them.

The Editor brightly tells us there are ways of getting rid of lines other than by increasing their number, and one method which he picks out for mention is "spot wobble." At the risk of being impeached for lese-majesty I feel I must disagree, as spot-wobble to my mind is rather like the dodge of the old-time photographer who used to use what we called a soft-focus lens to blur the blemishes and iron out the hard lines on the faces of some of his fair sitters who were no longer as young as they wished to appear in the photograph. Like Oliver Cromwell I prefer my picture "warts and all."

To my mind the real cause of the totally unnecessary lininess one sees on some TV screens is simply that the set is not interlacing correctly.

After all, if the odd-numbered lines do not fall squarely between the even-numbered ones, they tend to merge with them and so produce a coarse thick-lines and wide-spaces effect. I'm afraid many viewers don't know that incorrect interlacing can occur and so they wrongly blame the 405-line system.

1910 and All That

As I sat listening to the "Scrapbook for 1910" some time ago, I could not help thinking what a wonderful year it must have been to have lived through. Life seemed to be one long round of music, dancing and theatre-going, with no clouds of war and no nuclear nightmares; and only the rollicking fun of the militant suffragettes to cause anxiety to the Government.

As I sighed and remarked on this to Mrs. Free Grid, she, with the uncompromising reason of her sex, tartly reminded me that I had lived through the year 1910. So indeed I had, but I suppose my memory is not what it was, otherwise I should have recognized the joyful scene.

My one criticism of the programme, however, is of a technical nature. Naturally we were regaled with the oft-told story of Dr. Crippen. We were given a touch of realism by being permitted to hear the actual message from Captain Kendall of the Montrose to Scotland Yard, being fowled out by the ship's radio operator.

As I rather fancy myself as a morse reader, I naturally seized pencil and paper to take down the message. But I must confess I couldn't make neither head nor tail of it. It seemed just a jumble of gibberish. Surely the radio operator of the Montrose, if he is still alive, could obtain substantial damages for libel, slander, defamation of professional ability and half a dozen other things?

Yet the Post Office radio operator at Land's End must have understood the message as its receipt at Scotland Yard sent Inspector Dew scurrying across the Atlantic in the Laurentic to overtake the Montrose. Could it be that the jumble of sound was sent by somebody who knew nothing of morse? Surely the B.B.C. could have borrowed a radio operator from somewhere or even invited the services of a competent amateur. As it was, the producer's attempt at realism turned to ashes in my mouth, or should I say the sounding of brass and the tinkling of cymbals in my ears.

There is another small point of criticism, which is also a technical one but chronometrical rather than radio. It is simply that the producer did not seem familiar with the correct method of measuring the passing years. 1910 was not the first year of a new decade as was stated. One thing more. If I, as I believe, have to hear a scrapbook for 1911, I hope Wireless World's birthday in that year will not be forgotten.

Out of Synchrony

We are often told that science is measurement, and this view was certainly confirmed in my mind when I heard of a molecular clock which does not lose or gain one second in a century. Actually I read about this in I.E.A News, a publication issued at the time of the I.E.A. exhibition by its organizers to tell us all about the wonders to be seen there.

But turning to another page of the same publication, my faith in science measurement was rudely shattered when I found that the Editor (or one of his slaves) makes it very plain that 1960 is regarded as the first year of a new decade. This sort of muddled thinking is what one might expect in lay circles, but is hardly in keeping with the split-second and split-micron accuracy that pervades the other pages of the I.E.A. publication.

In theory the present era began on January 1st in the year a.d. 1. Not until ten years had passed could our ancestors have legitimately hailed the beginning of the second decade on 1st January, a.d. 11, and it was not until six complete decades had passed that they could on 1st January, a.d. 61 hail the birth of the seventh decade. Similarly, we of the present century must wait until it has completed six decades before we start our own seventh one on 1st January, 1961.

It is true the "sixties" and the seventh decade are nearly but not quite in synchrony; just 10% out.

But in scientific matters "nearly" or "10%" is not good enough; it would be useless, for instance, for an ordinary electric clock to be nearly but not quite in step with the supply mains.

Of course, I may be quite wrong in my view. It could be it is myself who is out of step, or, in other words, not quite in synchrony. If so, I hope somebody will take on the role of sergeant-major and devastate me with a blast of invective as so frequently happened in the days of the first world war when my faltering footsteps were so often nearly but not quite in synchrony with those of the rest of the platoon.

Wireless World, September 1960

Mrs. Free Grid also has views on lines.

he called a soft-focus lens to blur the blemishes and iron out the hard lines on the faces of some of his fair sitters who were no longer as young as they wished to appear in the photograph. Like Oliver Cromwell I prefer my picture "warts and all."

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Tubes are being developed which provide electronic writing and reading facilities for use in information processing systems. Of particular interest is a single-gun tube capable of storing a high resolution television picture for purposes of standards conversion, or processing for band-width compression. In the radar field it has applications in systems employing true-motion display or moving target indication.

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adjustment of $\pm 7\%$

with an accuracy of better than $\pm 0.02\%$.

Any assembly in the Mullard Vinkor range can be easily adjusted to an accuracy of better than $\pm 0.02\%$ by using a trimming screwdriver, whilst stability is ensured by the self-locking action of the adjuster core. The range of adjustment is approximately $\pm 7\%$ about the nominal mid-position of the adjuster core. Over and above these advantages, for each size of core there is a choice of three permeabilities which are controlled to close limits so that it is possible to calculate and wind an inductance to $\pm 3\%$ of the value required before adjustment.

These are just some of the reasons why leading equipment designers acclaim Vinkor as the world's most efficient pot core. If you have not received your copy of Vinkor data, write at once to the address below.

Mullard Ltd. Component Division, Mullard House, Torrington Place, W.C.1.
This Ediswan Radio DF Compass Tube ends parallax errors for the simple reason that the scale is printed on the inside face in actual contact with the phosphor screen. The scale pigment used is completely inert and unaffected by the electron beam. It is a dense black and does not fade after prolonged use.

Contrast is further improved by the aluminised screen which greatly intensifies the brilliance of the trace.

Anti-Dazzle Face All CRTs in this range have a concave face, treated on the outside with a robust process which eliminates distracting specular reflections and gives the impression of a soft matt ground glass finish.

Scale Applications The tube is available with an octantally corrected scale (31C1) or a uniformly graduated scale (31C2). Other versions can be supplied printed with selected portions of the Smith's Impedance Diagram.

Invitation We should welcome discussions with designers and manufacturers who have specific requirements involving special scales.

BRIEF SPECIFICATION

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater voltage (volts)</td>
<td>$V_h = 4.0-6.3$</td>
</tr>
<tr>
<td>Heater current (amps)</td>
<td>$I_h = 0.72-0.6$</td>
</tr>
<tr>
<td>Anode voltage, rating (kV)</td>
<td>$V_a (\text{max}) = 10.0$</td>
</tr>
<tr>
<td>Anode voltage, typical operation (kV)</td>
<td>$V_a = 9.5$</td>
</tr>
</tbody>
</table>
nearly as much as the scope itself.
the simultaneous observation of two signals on the
Hitherto an electronic switch of this nature, permitting
beam instrument.
in addition it has exceedingly short re-trace and rise
times and electronically stabilised
power supply. Included is a 40-page Instructional Manual.

Seeing is believing

So come along to our Stand and study these instruments
at close range. They will bear the keenest scrutiny and will
convince you of their outstanding quality.

5in. OSCILLOSCOPE KIT
Model O-12U
Laboratory quality at utility oscilloscope price and ease of assembly make this kit of outstanding value. Vertical frequency response 3 c/s to 5 Mc/s, ±1.5 dB. -5 dB, sensitivity 10 mV per cm. at 1 kc. Horizontal frequency 1 c/s to over 400 kHz: ±1.0 dB, up to 150 kc. The Heath patented sweep circuit functions from 10 c/s to 500 kc. in five ranges giving five times the usual sweep of other scopes.

In addition it has exceedingly short re-trace and rise
times and electronically stabilised
power supply. Included is a 40-page Instructional Manual.

STEREO CONTROL
UNIT KIT
Model B-HU
Incorporates all worthwhile features for high fidelity stereo and mono. Push-button selection, accurately matched ganged controls to ±1 dB. Negative feedback, rumba and variable low-pass filters. Printed circuit boards. Accepts inputs from most tape heads and any stereo or mono pick-up.

BALUN COIL
UNIT KIT
Model MGP-I

POWER SUPPLY UNIT
KIT Model MGP-I

Compact, general purpose unit suitable for FM Tuners, Tape Recording Amplifiers and general laboratory use. 120, 240, 200/250V, 100/120V, 150/160V, 250/250V, 40-60 c/s. Output: 6.3 V 2.5A A.C.; 200, 250, 270V; 120 mA, max D.C.

MULTIMETER KIT
Model MM-1U
Provides wide voltage, current, resistance and dB ranges to cover hundreds of applications. Sensitivity 20,000 ohms/volt for D.C. and 5,000 ohms/volt A.C. Ranges: 0-1 V to 1,500 V, A.C. and D.C.; 150 mV to 150 A.C.; 0.1V to 20 mAo. 4½ in. 50 µA meter.

DECAY CAPACITOR
KIT Model DC-1U
Capacity values 10µuf to 0.11µuf in 10µuf steps. Precision silver-mica capacitors and minimum loss ceramic wafer switches ensure high accuracy.

2½in. SERVICE 'SCOPE
KIT Model OS-1
Light, compact, portable, for service engineers. Printed circuit board for easy construction. Wt. 10 lb. Size 8in. x 8in. x 14½ in. long.

STAND 112
See these kits at

the RADIO SHOW 112

“CHEPSTOW” EQUIPMENT CABINET KIT
Specially designed for those whose floor space is at a premium. Will house Record Player, FM Tuner, Stereo Amplifiers and additional power amplifiers where needed. An upper deck is available for the self-powered stereo amplifiers to ensure maximum heat dissipation. Venetian and left in white for finishing to personal taste. Overall dimensions are 35’’ x 18’’ x 33’’ high.

HI-FI STEREO AMPLIFIER KIT
Model S-88
Gives 16 w. output (8 per channel with 0.1 per cent. distortion at 6 w. per channel). It has ganged controls, STEREO/MONOAURAL, gram, radio and tape recorder inputs and push-button selection as well as many other first class features well above its price range. In two-tone grey metal cabinet with a golden surround and fittings. Also ultra-linear push-pull output. Basic sensitivity 10 mV. (±5 mV. available 20/- extra).

DUAL-WAVE TRANSISTOR RADIO
KIT Model UJR-1
This sensitive headphone set is a fine introduction to electronics for any youngsters. Operated by a small torch battery.

TRANSISTOR PORTABLE KIT
Model UXR-1
Presented in elegant real hide case with tasteful gold relief. Can be assembled in 4 to 6 hours, and you have a set in the top flight of transistor portables. Presized I.F. transformers, printed circuit and a 7in. x 4in. high-flux speaker.

AUDIO WATTMETER KIT
Model AW-IU. Up to 25W continuous, 50W intermittent.

VARIABLE FREQUENCY OSCILLATOR KIT
Model VF-1U
For all Amateaur Bands, 160-10 metres. Ideal for Heathkit DX-4OU and similar transmitters.

Stereo Control
UNIT KIT
Model USC-I
Specially designed for those whose floor space is at a premium. Will house Record Player, FM Tuner, Stereo Amplifiers and additional power amplifiers where needed. An upper deck is available for the self-powered stereo amplifiers to ensure maximum heat dissipation. Venetian and left in white for finishing to personal taste. Overall dimensions are 35’’ x 18’’ x 33’’ high.

STEREO CONTROL
UNIT KIT
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6 WATT STEREO AMPLIFIER KIT Model S-33
A versatile high-quality self-contained STEREO/MONOAURAL Amplifier with adequate output for a living room—or with which to convert a favourite (monaural) radiogram into a stereo-radiogram. 3 watts per channel; 0.3% distortion at 2.5 w/chnl.; 20 dB N.F.B., inputs for Radio (or Tape) and Gram., Stereo—or Monaural. Ganged controls. Sensitivity 100 mV. £11.8.0

VALVE VOLTOMETER KIT Model V-7A
The world's most popular valve voltmeter, with printed circuit and 1 per cent, precision resistors to ensure consistent laboratory performance. It has 7 voltage ranges measuring respectively d.c. volts to 1,500 and a.c. to 1,500 r.m.s. and 4,000 peak to peak. Resistance measurements from 0.1 ohm to 1,000 M ohms with internal battery. D.C. input impedance is 11 Megohms and dC measurement has a centre-zero scale. Complete with test prods, leads and standardising battery... £13.0.0

R.F. PROBE KIT Model 309-CU
This complete probe kit will extend the frequency range of the V-7A Valve Voltmeter to 100 Mc/s. and will enable useful voltmeter indication to be obtained up to 300 Mc/s. £15.6

**H.A.M** TRANSMITTER KIT Model DX-40U
Covers all amateur bands from 80 to 10 metres. Power input 75 watts C.W. 60 watts peak controlled carrier phone. Output 40 watts to aerial. Provision for V.F.O. Filters minimise F.M. interference... £29.10.0

AMATEUR TRANSMITTER KIT Model DX-100U
The world's most popular "Ham" TX Kit
- Completely self-contained, compact "Ham" Transmitter.
- Built-in, high stable VFO and all Power Supplies.
- TVI: Careful design has reduced TVI to a minimum by use of effectively screened frequency-generating stages and pi tuned circuits at the input and output of the PA stage, and by 11 chokes and pi network filters to all outlets from the cabinet. No fewer than 35 disc-ceramic by-pass capacitors help to achieve the exceptional stability and high-performance for which this Transmitter is noted.
- The KT88 high-level anode and screen modulator stage gives over 100 watts of audio from less than 1.5 mV. input.
- Adjustable drive and clamp control ensure that valves are only driven sufficiently to maintain the required output.
- Keying on CW is via the VFO and buffer amplifier cathodes; the other RF valves are biased beyond cut-off. When zero-beating the TX with incoming signals, the exciter stages only may be run without the final amplifier being switched on.
- Provision has been made for remote control operation.
- VFO slow-motion drive is very smooth and back-lash free. VFO or Crystal control.
- Covers all Amateur bands up to 30 Mc/s. phone or CW............. £78.10.0

HI-FI F.M. TUNER

MATCHED HI-FI STEREO KIT
4-speed Transcription Record Player
- Model RP-1U.................. £12 10 0
- 6 w. Hi-Fi Amplifier, Model S-33.................. £11 8 0
- Twin Stereo Speaker Systems Model SSU-1... £20 11 0
- Total cost if purchased separately................ £64 9 0
- Yours for £42/10/- if all ordered together or £81/8/- deposit and 9 monthly payments of £4/3/-: Pedestal speaker legs £2/14/- optional extra.

COTSWOLD SPEAKER SYSTEM KIT
This acoustically designed enclosure measures 26 x 23 x 15in., and houses a special 12in. bass speaker with 2in. deep elliptical middle speaker together with a pressure unit to cover the full frequency range of 30-20,000 c/s. Its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete with speakers, crossovers, level control; Tygarn grille cloth, etc. Left 'in the white' for finish to personal taste, all parts are pre-cut and drilled for ease of assembly. £19.15.6

DAYSTROM LTD.
DEPT. W.W.9, GLOUCESTER, ENGLAND
A MEMBER OF THE DAYSTROM GROUP MANUFACTURERS OF
HI-FI SINGLE CHANNEL AMPLIFIER KIT Model MA-12
A compact high fidelity power amplifier (including auxiliary power supply), 12 watts output. Wide frequency range and low distortion. A variable sensitivity control is fitted enabling it to be used with an existing amplifier in a stereophonic system. Other applications include sound reinforcing systems, transmitter modulators, for use with tape recorders, also as a general purpose laboratory amplifier. £9.19.6

TAPE DECKS now available as " packaged deals " with other equipment.

AUDIO SIGNAL GENERATOR KIT
Model AG-9U
10 c/s to 100 kc/s, switch selected. Distortion less than 0.1%. 10 v. sine wave output metered in volts and d'b's. £19.3.0

AUDIO VALVE MILLIVOLT METER KIT
Model AV-3U
Very sensitive. High stability. 1 mV to 300 V. A.C. 10 c/s to 400 kc/s. £13.18.6

We are also showing at the 'DO-IT-YOURSELF' EXHIBITION Stand 97 OLYMPIA SEPT. 8th-23rd

STEREO HEAD BOOSTER KIT
USP-I
Hi-Fi Stereo Pre-Amplifier for low-output Hi-Fi P.U.s. Input 2 mV to 20 mV. Output adjustable from 20 mV to 2 V. 40-20,000 c/s. Also suitable as low-noise R.C.-Coupled high-gain monaural amplifier. £5.19.6

FREE ON REQUEST
A copy of our NEW (British) Heathkit Catalogue. Prices include free delivery in U.K.

To receive full details tick the kits which interest you.

<table>
<thead>
<tr>
<th>Kit Nr</th>
<th>Description</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-88</td>
<td>Hi-Fi Stereo Amplifier</td>
<td></td>
</tr>
<tr>
<td>S-33</td>
<td>6-Watts Stereo Amplifier</td>
<td></td>
</tr>
<tr>
<td>UXR-1</td>
<td>Transistor Portable</td>
<td></td>
</tr>
<tr>
<td>DX-40U</td>
<td>&quot;Ham&quot; Transmitter</td>
<td></td>
</tr>
<tr>
<td>O-12U</td>
<td>Sin. Oscilloscope</td>
<td></td>
</tr>
<tr>
<td>V-7A</td>
<td>Valve Voltmeter</td>
<td></td>
</tr>
<tr>
<td>SSU-I</td>
<td>Hi-Fi Speaker System</td>
<td></td>
</tr>
<tr>
<td>AG-9U</td>
<td>Audio Signal Generator</td>
<td></td>
</tr>
<tr>
<td>C-3U</td>
<td>Resistance-Capacitance Bridge</td>
<td></td>
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<tr>
<td>VIF-1U</td>
<td>Variable Frequency Oscillator</td>
<td></td>
</tr>
<tr>
<td>USP-I</td>
<td>Stereo-Head Booster</td>
<td></td>
</tr>
<tr>
<td>USC-1</td>
<td>Stereo Control Unit</td>
<td></td>
</tr>
<tr>
<td>OS-I</td>
<td>2jin. Service Oscilloscope</td>
<td></td>
</tr>
<tr>
<td>B-IU</td>
<td>Balun Coil Unit</td>
<td></td>
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<tr>
<td>DC-1U</td>
<td>Decade Capacitor</td>
<td></td>
</tr>
<tr>
<td>MGP-1</td>
<td>Power Supply Unit</td>
<td></td>
</tr>
<tr>
<td>UJR-1</td>
<td>Dual-Wave Transistor Radio</td>
<td></td>
</tr>
<tr>
<td>S-3U</td>
<td>Electronic Switch</td>
<td></td>
</tr>
<tr>
<td>309-CU</td>
<td>R.F. Probe</td>
<td></td>
</tr>
<tr>
<td>DX-100U</td>
<td>Amature Transmission</td>
<td></td>
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<tr>
<td>RP-1U</td>
<td>Transcription Record Player</td>
<td></td>
</tr>
<tr>
<td>MA-12</td>
<td>Hi-Fi Single Channel Amplifier</td>
<td></td>
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<tr>
<td>HM-1U</td>
<td>Multimeter Kit</td>
<td></td>
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<tr>
<td>AW-1U</td>
<td>Audio Wattmeter</td>
<td></td>
</tr>
<tr>
<td>AV-3U</td>
<td>Audio Valve Millivoltmeter</td>
<td></td>
</tr>
</tbody>
</table>

CAPACITANCE METER KIT
Model CM-1U
This Direct-Reading Capacitance Meter is a very low priced, time-saving instrument which is so useful that it should be part of the general equipment of every electronic laboratory and production line. Easily built in a few hours. 0-100 uF, 0-1,000 uF, 0-0.01 uF, 0-0.1 uF. The meter has 4jin. scale and can be used by an unskilled operator after a few minutes' instruction.

£14.10.0

Deferred Terms • available on all orders above £10.

GLoucester Stereo Cabinet Kit
Specially developed to meet the varying needs of different homes. It will house Tape Deck and/or Record Player, F.M. Tuner and Stereo Amplifier. In addition, for the convenience of those to whom space is an overriding consideration, it is possible to house speakers systems at each end. For this purpose a loudspeaker kit, comprising two 4in. plus 8in. speaker systems, each end. Neutral hardwoods have carefully been selected so that the finished product can be stained and polished to individual choice. There is storage space for records, etc., also for power amplifiers. Dimensions: length 46½", height 30", depth 21".

Hi-Fi Single Channel Amplifier for both T/D and R/P £18.6
Hi-Fi Single Channel Amplifier £17.6
Hi-Fi Single Channel Amplifier £16.6
Hi-Fi Single Channel Amplifier £15.6
Hi-Fi Single Channel Amplifier £14.6

FREE ON REQUEST
A copy of our NEW (British) Heathkit Catalogue. Prices include free delivery in U.K.

NAME ........................................(Block Capitals) ADDRESS ........................................W.W.9
NEW HYSTERESIS SYNCHRONOUS MAIN MOTOR

When equipment enjoys a very high reputation among enthusiasts and professional users (as Brenell’s does) the manufacturers are rightly expected to provide developments in keeping with that status. Sometimes the advance must even outdate existing standards.

Here is a development of that kind.

As of now, every Brenell tape deck and complete recorder will incorporate a new type of extremely high quality main motor.

An HYSTERESIS SYNCHRONOUS MOTOR with a balanced outer rotor and a heavy, statically and dynamically balanced flywheel. This brings 'wow and flutter' down to below .1% at 7½ i.p.s. and adds to the already superlative qualities of Brenell equipment.

At the recent British Exhibition in New York, this feature aroused special interest. We demonstrated also, a piano recording at 1⅞ i.p.s. We do not suggest that this should be indicative of standard practice, but its quality showed the remarkable extent of our products' capabilities.

Similar demonstrations will be given at the Radio Show.

Visit the BRENNELL DEMONSTRATION ROOM NO. 311, in the Audio Section, and see and hear for yourself just how good tape recording and reproduction can be.

3 STAR 58 GNS. | Mk. 5: 64 GNS. | 3 STAR R/P STEREO: 89 GNS.

Sole manufacturers
BRENNELL ENGINEERING CO. LTD.

1A Doughty Street, London, W.C.1. Chancery 5809 and HOLBORN 7538
**MODEL PST/8**

This small enclosure is ideal where space is limited. It is constructed from extended polystyrene panels giving reduction of panel resonance and is designed to house a single 8in. unit.

The PST/8 is suitable for mono or stereo use and may be stood on a table or on the floor.

**Recommended Units:**
- Super 8/FS/AL: £6 19 11 (inc. P.T.)
- 8in. Bronze/FS/AL: £4 6 7 (inc. P.T.)

All available 12/15 ohms or 2/3 ohms.

**8/145**

A high-quality 8in. unit specially developed for use in column enclosures. The 8/145 is fitted with foam surround, aluminium voice coil and centre dome for optimum treble response.

- **Impedance**: 2/3 ohms or 12/15 ohms
- **Bass Resonance**: 55/65 c/s.
- **Flux Density**: 14,500 gauss
- **Total Flux**: 60,000 maxwells
- **Max Input**: 4 watts rms (8 watts peak), rated up to 10 watts rms in suitable enclosure.
- **Price**: £6 19 11 (inc. P.T.)

Illustrated leaflets and constructional details of suitable enclosures free on request.

MARCONI
microwave communication systems

WORLD LEADERS IN ALL TRAVELLING WAVE TUBE MICROWAVE SYSTEMS
HIGH PERFORMANCE
Marconi microwave systems, with capacities from 60 to 960 channels and capable of carrying high quality television, are designed to meet exacting international standards of performance with margins in hand.

EXTREME SIMPLICITY
Travelling wave tube techniques ensure extremely simple circuitry and make full use of high gain and great band width available. A unidirectional repeater consists of only three travelling wave tube amplifiers and one frequency change oscillator with their power supplies.

GREAT RELIABILITY
The use of travelling wave tubes in the repeaters has allowed considerable reduction in the number of valves and components used. Thus the likelihood of unexpected failure has been considerably reduced.

EASY MAINTENANCE
The design of the units ensures easy access to all parts of the equipment and the extensive use of printed circuitry allows speedy and accurate replacement of precision circuits by technician staff, without realignment of the equipment.

EXTREME SAFETY
All high voltages are fully interlocked.

The Post and Telegraph Authorities in more than 80 countries rely on

MARCONI
COMMUNICATIONS SYSTEMS

MARCONI’S WIRELESS TELEGRAPH COMPANY LIMITED · CHELMSFORD · ESSEX · ENGLAND
MA TRANSISTOR Converters and Inverters

for fluorescent lighting and general applications. The range of operating voltages, powers and frequencies is under steady development.

Inverters for fluorescent lighting from 12 volt d.c. supplies cover the range from a single 6” tube to six 24” tubes or equivalent.

Inverters for 12v. d.c. to 50 c/s or 400 c/s a.c. up to 100 W.

Constant frequency and locked frequency inverters for camera and tape recorder operation.

Inverter-rectifier systems for d.c. to a.c. conversion.

TRANSPARENT Controller

Magnetic amplifier intermediate stage, saturable reactor power stage. A temperature controller for use with a platinum resistance thermometer to provide power control up to 60 KW 3-phase. No mechanical switches.

Constant current characteristic for platinum furnaces.
electronic engineers

for supervisory appointments

- High technical interest
- Opportunity to travel abroad
- Individual responsibility
- Good promotion prospects
- Excellent salary levels

Ferranti Computer Division are about to make supervisory appointments in connection with Computing Installations, planned or already operating, in the U.K., France, Norway, Sweden, Italy, Germany, Switzerland, South Africa and South America.

If you have no academic qualifications, good Service experience will be favourably considered, as successful candidates will be given six months' training.

This is an opportunity to join the most progressive computer team in Britain. Please write, giving details of your qualifications and experience, to T. J. LUNT, Staff Manager, Ferranti Limited, Hollinwood, Lancs. And quote reference CDM.
T.V. Pattern Generator

type GM 2671

PHILIPS electronic measuring

Sold and serviced by Philips Organizations all over the world

Overseas enquiries please, to the manufacturers,
N.V. Philips, EMA-Department, Eindhoven, the Netherlands.

Sole Distributors in the U.K.: Research & Control Instruments Ltd.,
207 King's Cross Road, London W.C. 1
VHF Television Generator

Type GM 2681

**Generators**

**GM 2671**
- Valuable tool for T.V. setmakers, development laboratories, T.V. stations, relay-transmitters etc.
- Fully complies with the C.C.I.R. 625 lines, F.C.C. 525 lines and French 819 lines specifications.
- Composite video pattern enables fast checking of picture geometry, linearity, ringing, overshoot, frequency characteristics, gamma etc.
- High accuracy and stability of waveforms by using binary dividers and delaylines.
- Checking of heater voltages and mains locking by means of a meter-instrument.
- Can also be supplied for 19” rack mounting.
- Suitable for all normal mains voltages (110 - 245 V).

**TECHNICAL DATA**

**T.V. Systems**
- CCIR 625 lines, 50 c/s
- F.C.C. 525 lines, 60 c/s
- French 819 lines, 50 c/s

**Master oscillator**
- Synchronisation by a crystal oscillator, mains comparison or external source.

**Wave forms**
The pulse timing, duration and rise times fully comply with the system specifications. The picture/sync ratio is adjustable around the standardized value.

**Output**

<table>
<thead>
<tr>
<th>Video</th>
<th>Voltage</th>
<th>composite, 1 V_{pp}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polarity</td>
<td>negative or positive (reversible)</td>
<td></td>
</tr>
<tr>
<td>Impedance</td>
<td>75Ω</td>
<td></td>
</tr>
</tbody>
</table>

**Auxiliary signals**

| Voltage | 3 V_{pp} |
| Impedance | 75Ω |

**External picture modulation**

| Voltage | 1 V_{pp} |
| Impedance | 75Ω |
| Polarity | positive |

**GM 2681**
- Suitable for the television bands I and III
- Can be used in connection with the Pattern Generator, type GM 2671 or separately
- Supplies picture and sound carriers separately or simultaneously, modulated or unmodulated
- Output voltages, modulation depth and sweep can be adjusted to standard specifications with the aid of the built-in voltmeter
- Suitable for all normal mains voltages (110-245 V)
- Available for incorporation in the GM 2671 rack, in separate casing or mounting in 19” rack (as below).

**TECHNICAL DATA**

**TV System**
- Video modulation: negative
- Sound modulation: FM

**Executions**
- CCIR 625 lines, 50 c/s
- F.C.C. 525 lines, 60 c/s or
- OIR 625 lines, 50 c/s system and special executions for Australia, Austria, Italy and New Zealand.

**Output**

- Picture and sound carriers
  - Frequency: up to 12 channels in band I and III,
  - Voltage, picture carrier: 100 mV max.
  - Sound carrier: 30 mV max.
  - Attenuation: max. 50 dB, in steps of 4 and 20 dB
  - Accuracy: 0.5 dB

- Auxiliary oscillator
  - Frequency: equal to the picture-sound distance
  - Voltage: 1 V_{rms}
  - Impedance: 75Ω

**Modulation**

- Video External
  - Voltage: 1 V_{pp}
  - Impedance: 75Ω
  - Polarity: positive

- Internal sound
  - Voltage: 1000 c/s
  - External sound
    - Voltage: 30 - 16,000 c/s
    - Impedance: 600Ω

**instruments**: quality tools for industry and research
A simple and logical system of control

The Quad 22 Control Unit incorporates every practical refinement for the full appreciation and enjoyment of the discriminating listener.

For instance...

THE BASS & TREBLE CONTROLS

It is probably true that most bass and treble control systems—because of misuse—degrade quality more often than they improve it. Bass and treble controls should properly be designed for musical balance adjustment only, completely divorced from all filtering requirements and from all applications which can better be achieved by fixed networks. Even so, bass and treble controls should be used sparingly with a proper reference to "cancel" to ensure optimum adjustment. With a very good loudspeaker it should seldom be possible to improve the balance professionally achieved at the transmitting studio.

Send a postcard to Dept. WW for illustrated leaflet.

ACOUSTICAL MANUFACTURING CO. LTD. Huntingdon, Hunts. Telephone: Huntingdon 361

QUAD for the closest approach to the original sound
The ENGLISH ELECTRIC Type C.1112 has a maximum anode dissipation of 250W and is suitable for use as a power amplifier in transmitters up to 400W, or in R.F. heating equipment (up to 1 kW per valve). Type C.1108 is a smaller version designed for similar uses at lower power levels (anode dissipation 125W).

<table>
<thead>
<tr>
<th>E.E.V. type</th>
<th>C.V. number</th>
<th>American equivalent</th>
<th>British equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.1108</td>
<td>2130</td>
<td>4-125A</td>
<td>QY3-125</td>
</tr>
<tr>
<td>C.1112</td>
<td>2131</td>
<td>4-250A</td>
<td>QY4-250</td>
</tr>
</tbody>
</table>

Full data relating to these valves will be sent on request.

'ENGLISH ELECTRIC'

ENGLISH ELECTRIC VALVE CO. LTD.

Chelmsford, England.
Telephone: Chelmsford 3491
As examples of maximum capacitance, voltage and size within the range, the following may be of interest. The full range includes more than one hundred. Others can be provided on request.

<table>
<thead>
<tr>
<th>Maximum Capacitance (MFD)</th>
<th>Working Voltage</th>
<th>Size (Diameter)</th>
<th>Size (Length)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>6</td>
<td>3/4&quot;</td>
<td>5/8&quot;</td>
</tr>
<tr>
<td>40</td>
<td>6</td>
<td>3/16&quot;</td>
<td>9/16&quot;</td>
</tr>
<tr>
<td>12</td>
<td>3</td>
<td>1/8&quot;</td>
<td>9/16&quot;</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>1/4&quot;</td>
<td>13/32&quot;</td>
</tr>
</tbody>
</table>

WELDED WIRE TERMINATIONS—Patent applied for
CONTROLLED POWER

New G.E.C. Silicon Controlled Rectifier now available

The SCR96 silicon controlled rectifier is a three-junction semiconductor device developed and manufactured by G.E.C. for use in power control and power switching applications requiring blocking voltages up to 200V and load currents up to 10A. Series and parallel circuits may be used for higher power applications.

<table>
<thead>
<tr>
<th>Type</th>
<th>Maximum Continuous P.I.V. (V)</th>
<th>Maximum Transient P.I.V. (5ms)* (V)</th>
<th>Maximum average current† (A)</th>
<th>Peak one-cycle surge current (A)</th>
<th>Maximum average gate power (W)</th>
<th>Average gate current to fire (mA)</th>
<th>Typical turn-on time‡ (µs)</th>
<th>Typical turn-off time‡ (µs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCR961</td>
<td>25</td>
<td>35</td>
<td>10</td>
<td>120</td>
<td>0.5</td>
<td>20</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>SCR962</td>
<td>50</td>
<td>75</td>
<td>10</td>
<td>120</td>
<td>0.5</td>
<td>20</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>SCR963</td>
<td>100</td>
<td>150</td>
<td>10</td>
<td>120</td>
<td>0.5</td>
<td>20</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>SCR964</td>
<td>150</td>
<td>225</td>
<td>10</td>
<td>120</td>
<td>0.5</td>
<td>20</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>SCR965</td>
<td>200</td>
<td>300</td>
<td>10</td>
<td>120</td>
<td>0.5</td>
<td>20</td>
<td>2</td>
<td>15</td>
</tr>
</tbody>
</table>

* For zero or negative gate voltages    † Depends on cooling system and conduction angle. ‡ Value depends on circuit.
Advance TC1

1Mc/s TRANSISTORISED COUNTER

INTERKAMA

STAND No. B2025/6/D

... in this case up to 1 Mc/s. And the inside of the Advance time and frequency measuring counter type TC1 is rather exceptional. Over 145 transistors and 21 printed circuit boards have been combined in an advanced design to provide the full facilities and high performance expected of a first grade laboratory instrument.

Nett Price in U.K. £350

Leaflet Y101 will be forwarded on request.

SIX FIGURE DISPLAY accurate to ±1 count
FREQUENCY MEASUREMENT from 10 to 1,000,000 c/s
TIME MEASUREMENT from 1 -sec. to 2,777 hours
PERIOD MEASUREMENT 1 or 10 periods of input waveform down to 10 c/s
RANDOM COUNTING totalling over any period
OUTPUT TIMING PULSES from 10⁻¹ to 10⁰ p.p.s.
INTERNAL STANDARD oven controlled 1 Mc/s crystal
STABILITY ±1 part in 10⁴ at 25°C to internal crystal standard
SELF-CHECK FACILITIES
FREQUENCY MEASURING PERIOD 0-1, 1-0 or 10 seconds
REPETITION OF COUNT manual or automatic
POWER CONSUMPTION 3 W (battery), 14 VA (mains)
DIMENSIONS length 12in., height 9in., depth 6in., weight 12 lb.

AND NOW—Virtually to d.c. with V.L.F. Converter type C.A.1.
S

Tyled in beauty to delight your eyes and ears.

Providing the most critical listener with concert-hall mono or stereophonic reproduction of radio and record in the comfort of his own home, in cabinets of undating charm and beauty... a range of moderately priced radio receivers and radiograms that will satisfy the taste of the most fastidious, in keeping with modern furnishing trends.

Available from leading Departmental Stores and Radio Dealers
Sale Concessionnaires for United Kingdom

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Telephone: Park 1341 (10 lines)
Where great things are done

with Microwaves

RADAR: Fire Control · Navigation of Aircraft and Small Ships · Automatic Landing · Missile Guidance · Transponders

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INSTRUMENTS: Comprehensive Waveguide measuring circuits covering 6 to 75/GCS

RESEARCH: Outstanding Research and Development of the latest techniques.
Get it TAPED
to perfection

- naturally

<table>
<thead>
<tr>
<th>Sizes</th>
<th>Standard</th>
<th>Long Play</th>
<th>Double Play</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feet</td>
<td>Feet</td>
<td>Feet</td>
<td>Feet</td>
</tr>
<tr>
<td>Price</td>
<td>Price</td>
<td>Price</td>
<td>Price</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3'</td>
<td>150</td>
<td>225</td>
<td>3'</td>
</tr>
<tr>
<td>4'</td>
<td>300</td>
<td>450</td>
<td>4'</td>
</tr>
<tr>
<td>5'</td>
<td>600</td>
<td>850</td>
<td>5'</td>
</tr>
<tr>
<td>6'</td>
<td>850</td>
<td>1200</td>
<td>6'</td>
</tr>
<tr>
<td>7'</td>
<td>1200</td>
<td>1800</td>
<td>7'</td>
</tr>
<tr>
<td>8'</td>
<td>1750</td>
<td>2400</td>
<td>8'</td>
</tr>
</tbody>
</table>

A MEMBER OF THE TERRI GROUP OF COMPANIES

MSS Mastertape
MSS RECORDING COMPANY LIMITED, COLN BROOK, BUCKS, TEL. COLN BROOK 2431
The OC123 is a ferrite core driver transistor similar to the OC23, but scaled down into a small metal can for those applications where space saving is of cardinal importance—such as in closely packed printed circuit boards—and where the dissipation rating need not be so high as with the OC23.

The total dissipation rating of the comparatively small OC123 is, in fact, 200 mW at an ambient temperature of 45°C. The peak current is 1 amp, and the voltage rating and current gain are also high. Even at a collector current of 1 amp, α is 50 minimum.

The OC123 is particularly suitable for gating current pulses generated by its larger companion type OC23 for driving ferrite cores. In such an application, a 350mA 2 microsecond pulse with a leading edge rise time of 0.4 microsecond can be passed by the transistor when it is fully bottomed.

Abridged details are given below—for full data please write to Mullard House.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$V_{cb}$ max. ($I_c = 0$)</td>
<td>-50 V</td>
</tr>
<tr>
<td>$V_{ce}$ max. ($V_{be} &gt; +0.5V$)</td>
<td>-50 V</td>
</tr>
<tr>
<td>$V_{ce}$ max. ($I_c = 0.5A$)</td>
<td>-25 V</td>
</tr>
<tr>
<td>$I_c$ (pk) max.</td>
<td>1.0 A</td>
</tr>
<tr>
<td>$I_c$ (av) max. (averaging time 20 ms)</td>
<td>0.5 A</td>
</tr>
<tr>
<td>$P_{tot}$ at 45°C ambient</td>
<td>200 mW</td>
</tr>
<tr>
<td>$T_j$ max.</td>
<td>90°C</td>
</tr>
<tr>
<td>Junction temp. rise above ambient in free air</td>
<td>0.22°C/W</td>
</tr>
<tr>
<td>Junction temp. rise above case</td>
<td>0.06°C/W</td>
</tr>
<tr>
<td>$V_c$ (knee) ($I_c = 400$ mA)</td>
<td>-350mV</td>
</tr>
<tr>
<td>$f_1$ ($V_c = -2V$, $I_c = 100$ mA, $T_j = 25°C$)</td>
<td>1.5Mc/s</td>
</tr>
</tbody>
</table>

MULLARD LIMITED - Semiconductor Division - Mullard House - Torrington Place - London W.C.1 - Telephone LANgham 6633
THE MAGAZINE TAPE DECK.

Designed by Garrard to bring quality tape recording and playing within the range of everyone. Controls reduced to an absolute minimum plus magazine loading— anyone can operate this deck. No threading, anchoring or spilling of tape. All the pleasures of tape recording without the headaches.

LABORATORY SERIES
AUTO TURNTABLE TYPE A.

The perfect product of combined design and engineering achievement. A brand new model to meet the demand for a Transcription Record Player with provision for automatic use if desired. Perfect playing from both stereo and monophonic records. This is a unit for the enthusiast.

MEET US ALL AT THE
RADIO SHOW
STAND 56

THE GARRARD ENGINEERING AND
MANUFACTURING, CO., LIMITED

Factory and Registered Office:
NEWCASTLE STREET,
SWINDON, WILTS.

Tel: SWINDON 5381. TELEX 44-271
Measure dc currents 0.3 ma to 1 ampere with
No Breaking of Leads
No DC Connection
No Circuit Loading
HEWLETT PACKARD
428A Clip-on
Milliammeter

Think of the measuring convenience, time saved and accuracy gained when you don’t have to break into a circuit, solder on a connection or worry about probe loading.

With the new -hp- 428A Milliammeter and its new probe, you literally "clamp around" and read! You get maximum accuracy because there is no effective circuit loading from the 428A’s dc probe. The instrument easily measures dc currents in the presence of ac. And insulation is more than adequate to ensure safe measurements at all normal voltage levels.

SPECIFICATIONS

Current Range: Less than 0.3 ma to 1 amp, 6 ranges. Full scale readings from 3 ma to 1 amp; 3 ma, 10 ma, 30 ma, 100 ma, 300 ma, 1 amp.

Accuracy: ±3% ±0.1 ma despite line voltage variations of ±10%, probe closure, ageing or Earth’s magnetic field.

Probe Inductance: Less than 0.5 µh maximum.

Probe Induced Voltage: Less than 15 mv peak.

Effects of ac in circuit: Ac with peak value less than full scale affects accuracy less than 2% at frequencies different from the carrier (40 KC) and its harmonics.

Power: 115/230v ± 10%, 70 watts.

Size: Cabinet mount, 7½in. wide, 11½in. high, 14½in. deep. Weight 19 pounds. Rack mount 19in. wide, 7in. high, 12½in. deep. Weight 24 pounds.

Probe Tip Size: Approximately ½in. x ⅛in. Wire aperture diameter ⅛in.

Price: delivered U.K. and exclusive of duty where payable.

£195 (cabinet mount)
£197 (rack mount)

Continuous progress in design may affect the above specification which is therefore subject to change without notice.

LIVINGSTON LABORATORIES LTD.
RETCAR STREET · LONDON · N.19 · Telephone: ARChway 6251
The Transmitter TDMS 5BV — Provides telegraph test signals with or without distortion.

The Receiver TDMS 6BV — Enables a telegraph circuit to be monitored without interruption. The signal can be displayed against a circular or spiral time-base, each characteristic instant of modulation being shown as a bright dot on the screen.

The Telegraph Signal Display Unit TDU — A specialized oscilloscope, having a linear time-base of good short term stability and long term accuracy, for examination of the d.c. telegraph wave form against a continuous start/stop time-base. Valuable features of the instrument are an X shift calibrated in terms of code element transitions and an X expansion control.

Speed Ranges. The standard models cover the speed ranges 40-60, 60-80, 80-100, 160-180, and 180-200 bauds. Other ranges within the limits 20-200 bauds can be provided to special order.

AUTOMATIC TELEPHONE AND ELECTRIC CO. LIMITED
STROWGER HOUSE, ARUNDEL STREET, LONDON, W.C.2

One of the unique facilities of the TDMS 6BV is examination of the stop element in cases where its mutilation is suspected. When the TDMS is operated in the spiral time base condition, the spiral is started at the beginning of each start element and the trace makes a number of revolutions, depending on the Unit Code switch setting, before returning to "rest". For example, if the switch is set for 7, the trace completes 6 revolutions, and while this shows any distortion at the beginning of the stop element, the duration of this element is not shown.

If the switch is set for 14, in examining a 7.5 unit code signal, two complete characters appear on the trace, one at zero and the other at 50%, or displaced by a percentage indicating the amount of stop element distortion. For a 7 unit code signal the characters appear under each other at zero, separated by the stop element length; for a 7.42 unit code signal the second character appears at 42%, each alternate stop element length is thus shown for examination and any defect in the telegraph or transmission path, affecting the stop element, made apparent. The example above shows a 50 baud 7.5 unit signal, for the letter S, displayed against a 14 count. Here the stop element length is correct (1 rev., 20 μ = 30 ms) but the TDMS shows a split stop element, possibly due to a faulty transmitter.
By far the largest number of hospital and industrial installations of the pocket receiver type in this country, and overseas, are Multitone. Our selective induction system "Personal Call" is saving time, money and worry in well over 100 different types of industrial concerns from airports to zymurgists. (We are looking for a Quill Manufacturer to complete the alphabet.) The New MULTI-CHANNEL equipment provides over 400 individual channels using the new flat receiver (as illustrated).

**MULTITONE**

**personal call**

system of staff location

(the 'peep-peep' in the pocket), the only staff location system worth installing

Write or 'phone for further particulars. We can be found in 10 seconds.

MULTITONE ELECTRIC COMPANY LTD., 12/20 Underwood St., LONDON, N.1. (CLErkenwell 8022)

Additional Facilities

**ELECTRONIC TRUNCHEON**

The Electronic Truncheon is no bigger than standard equipment carried by guards and serves the same purpose, but inside there is a transmitter which, when the button is pressed, sends out a signal. This is picked up by the loop of wire around the area to be protected. The pulse is used to operate a small receiver, which automatically switches on any form of electrical alarm. It can be operated from any point in the area.

**INTERNAL TRANSPORT COMMUNICATION**

The Multitone "Personal Call" loudspeaker-receiver has been designed to solve the problem of conveying verbal instructions to transport vehicles used for handling loads inside a given area. Messages can be conveyed to all or selected vehicles from the central transmitter.

**MULTITONE INDUCTION SYSTEMS CAN SOLVE YOUR STAFF LOCATION PROBLEMS:**

★ Equally suitable for large and small areas or concerns

★ Low rental terms

★ Virtually no internal wiring
seven-range meter, including V, mV, µA, made for Elliott's at short notice

The Anders Instrument Centre commands the largest stocks of meters in the country, unique calibrating facilities, and detailed knowledge of metering problems. Most standard meters are supplied immediately. Non-standard meters of all kinds, shapes and sizes, for special voltage and current ranges, are accurately calibrated, tested and normally ready within 10-14 days. Makes include Avo, Crompton Parkinson, EAC, Elliott, Pullin, Taylor, Turner, Weir, Weston. Types include moving coil, moving iron, thermocouples, electrostatic, dynamometers, from 1 1/2" to large switchboard instruments, and complete range of accessories. Please write or 'phone for details of the Anders meter service.

ANDERS ELECTRONICS LIMITED
103 Hampstead Road, London NW1. Tel: EUSTon 1639
Contractors to GPO and Government Departments. Ministry of Aviation approved.

METERS, ELECTRONIC AND TEST EQUIPMENT TO INDIVIDUAL SPECIFICATIONS
If your problem is the design of Thermostatic or pressure sensitive systems, small shaft couplings, pressure seals or vacuum seals, then the versatile metal bellows will provide the solution. HYDROFLEX are, of course, to be preferred. Please write to the Bellows Division for your copy of the catalogue, quoting reference “WW”.

DRAYTON REGULATOR & INSTRUMENT CO. LTD.
West Drayton, Middlesex.

West Drayton 4012
TRANSFORMERS

<table>
<thead>
<tr>
<th>Voltage Range</th>
<th>Output Amps</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 V</td>
<td>80 A</td>
<td>£10.50</td>
</tr>
<tr>
<td>4 V</td>
<td>70 A</td>
<td>£10.50</td>
</tr>
<tr>
<td>110-120 V</td>
<td>4 A</td>
<td>£9.00</td>
</tr>
<tr>
<td>12 V</td>
<td>40 A</td>
<td>£9.00</td>
</tr>
<tr>
<td>17 V</td>
<td>30 A</td>
<td>£9.00</td>
</tr>
<tr>
<td>24 V</td>
<td>25 A</td>
<td>£10.00</td>
</tr>
<tr>
<td>30 V</td>
<td>15 A</td>
<td>£10.00</td>
</tr>
<tr>
<td>55 V</td>
<td>10 A</td>
<td>£11.00</td>
</tr>
<tr>
<td>110-120 V</td>
<td>10 A</td>
<td>£15.00</td>
</tr>
<tr>
<td>40 V</td>
<td>23 A</td>
<td>£15.00</td>
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<tr>
<td>5 V</td>
<td>300 A</td>
<td>£20.00</td>
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<tr>
<td>6-12 V</td>
<td>50 A</td>
<td>£10.00</td>
</tr>
<tr>
<td>12 V</td>
<td>60 A</td>
<td>£10.00</td>
</tr>
<tr>
<td>17 V</td>
<td>60 A</td>
<td>£16.00</td>
</tr>
<tr>
<td>50 V</td>
<td>60 A</td>
<td>£25.00</td>
</tr>
<tr>
<td>10-15-25 V</td>
<td>100 A</td>
<td>£26.00</td>
</tr>
<tr>
<td>10-20-30 V</td>
<td>100 A</td>
<td>£33.00</td>
</tr>
<tr>
<td>110 V centre tapped</td>
<td>25 A</td>
<td>£28.00</td>
</tr>
</tbody>
</table>

All for 240 V Input. Other Supply Voltages as Required.

CONTINUOUS RATING. Short Rating Transformers also available

<table>
<thead>
<tr>
<th>Voltage Range</th>
<th>Output Amps</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 V</td>
<td>5,000 A</td>
<td>£11.00</td>
</tr>
<tr>
<td>2.5 V</td>
<td>5,000 A</td>
<td>£120.00</td>
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<tr>
<td>4 V</td>
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<td>2 V</td>
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<td>3.5 V</td>
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<td>4 V</td>
<td>1,000 A</td>
<td>£29.00</td>
</tr>
<tr>
<td>110 V centre tapped</td>
<td>1,000 A</td>
<td>£90.00</td>
</tr>
</tbody>
</table>

VOLTMOBILE VOLTAGE SELECTOR AUTO-TRANSFORMERS

Range: From 1.6% to 100% of Supply Volts in 64 steps of 1.6%.

VOLTMOBILES can be used by themselves or in the primary of another transformer to give very fine changes of output. Overvoltage available as extra.

ONE LOAD SWITCHING.

D-CMOBILE RECTIFIER SETS

For 240 V AC. The larger outputs are available for 3-phase supply.

Full load DC Volts and Amps are stated. Prices are without Meters and Regulators.

<table>
<thead>
<tr>
<th>Voltage Range</th>
<th>Output Amps</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 V</td>
<td>15 A</td>
<td>£14.00</td>
</tr>
<tr>
<td>6 V</td>
<td>10 A</td>
<td>£15.00</td>
</tr>
<tr>
<td>12 V</td>
<td>30 A</td>
<td>£25.00</td>
</tr>
<tr>
<td>12 V</td>
<td>60 A</td>
<td>£35.00</td>
</tr>
<tr>
<td>12 V</td>
<td>105 A</td>
<td>£55.00</td>
</tr>
<tr>
<td>12 V</td>
<td>210 A</td>
<td>£71.00</td>
</tr>
<tr>
<td>12 V</td>
<td>1,000 A</td>
<td>£150.00</td>
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<td>60 A</td>
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<tr>
<td>24 V</td>
<td>750 A</td>
<td>£262.00</td>
</tr>
<tr>
<td>36 V</td>
<td>10 A</td>
<td>£26.00</td>
</tr>
</tbody>
</table>

Built in to order—Ammeters—Voltmeters—Rheostats—Stabilising Circuits—Chokes—Varicas.

SPECIFIC ENQUIRIES are invited for Transformers and Rectifiers. We specialize in HEAVY CURRENT EQUIPMENT.

HARMSWORTH, TOWNLEY & CO.
2 JORDAN STREET, MANCHESTER 15. CENTRAL 5069
NEW FROM COLLARO!

The "Studio" C 60 Record Changer

- New fool-proof four-speed mechanism
- Motor dynamically balanced
- Stereo or monaural cartridge
- Muting switch standard on all stereo machines

The "Studio" Tape Transcriptor

An outstanding achievement in design and performance.

- Three speeds—1⅛, 3⅞ & 7⅛ I.P.S.
- Three motors
- Very low "Wow"—less than 15% at 7⅛ I.P.S.
- Fast rewind—1200 feet in 65 seconds
- Space for monitor or stereo playback head

The RP 594 4-speed STEREO and MONAURAL Record Playing unit

Heavy 12in. Turned non-ferrous turntable... latest counterbalanced pick-up arm... 4 speeds... simple controls... choice of pick-up cartridges.

MODEL RP 594

—To same specification but with 10in. steel turntable.

ON VIEW AT THE

Radio Show
STAND 38

RIPPLE WORKS, BY-PASS RD., BARKING, ESSEX
Telephone: RIPpleway 5533. Telex: 28748
Telegram: KORLLARO-TELEX-BARKING.

Where quality is the first consideration the world's leading manufacturers fit Collaro equipment.

Makers of Record Changers, Gramophone Units, Pick-Ups, Electric Motors etc.

—Synonymous with Quality
vital

**STICK tactics**

The waist of a new Caslite tuning slug deserves your attention. It has a waistband of chemically stable plastic which enables it to anchor itself unshakeably to the thread. Vibration and temperature change won't move it. However, the slug can be turned easily . . . for retrimming. Clever thing; it grips but never sticks.

---

Plessey  Caslite self-locking cores

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HALTRON RADIO TUBES,
we are happy to announce that we are now operating from our new and enlarged premises. This enables us to offer a much wider range of receiving, transmitting and special purpose tubes, backed by prompt deliveries. Come to our unique organisation and get all your valve requirements from one reliable source.

We invite your specific enquiries for valves tested to CV, JAN, and MIL specifications.

Our Organisation is A.R.B. Approved.

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HALL ELECTRIC LTD
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for general insulation

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NEW
10-Mc/s
ELECTRONIC COUNTER

OPTIONAL ACCESSORIES

- VIDEO AMPLIFIER TYPE TM 5950
- FREQUENCY CONVERTER TYPE TM 5951
  (10 Mc/s TO 100 Mc/s)
- FREQUENCY CONVERTER TYPE TM 5952
  (100 Mc/s TO 220 Mc/s)
- TIME INTERVAL UNIT TYPE TM 5953
- OSCILLATOR — 1 PART IN 10^7 PER WEEK

BRIEF SPECIFICATION

High-speed counter/timer with built-in precision frequency standard. Stability: ±2 parts in 10^7 short term. Readout by neon indicators on 8-decade digital display. Counts up to 10^7 per sec; measures frequency from 10 c/s to 10 Mc/s, period of waveforms up to 100 kc/s. Selection of plug-in accessories extends frequency range to 300 Mc/s, allows time measurement down to 1 μsec, increases sensitivity to 10 mV. Display time: manual, or continuously variable from 0.1 to 10 sec. with automatic and repetitive resetting.

For full details, write for leaflet G178.

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North:
23/25 Station Square, Harrogate. Telephone: 67455
Export Department:
Marconi Instruments Ltd., St. Albans, Herts. Telephone: St. Albans 56161

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Ease and speed of installation, cable economy, maximum screening qualities and performance specifications have all been acquired through long experience in building-up cable networks. Teleng cable fittings provide full screening against induction and ghosting in both indoor and outdoor versions of Junction, Tee, Splitter and Load units.

THE FULL RANGE INCLUDES...
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Tel.: EUston 1477 (3 lines) Grams.: Untonexh, London
THEY LOOK SO GOOD  The moment you see the styling of a Truvox Tape Recorder, you know it is the machine for you. Foolproof and simple in operation with professional facilities, a Truvox Recorder will be the centre of your home enjoyment of speech and music. See them at your dealers.

THEY SOUND SO GOOD  You’ll enjoy ‘listening’ more than ever before. All the technical know-how of a decade of specialisation, to give perfect sound enjoyment, is embodied in the Truvox R6 and R7... the original sound truly recorded and truly re-played through large loudspeakers. Hear them at your dealers.

THEY ARE SO GOOD  That you’ll never be satisfied with any other Recorder... once you’ve seen and heard them, you’ll decide for yourself...

THEY MUST BE TRUVOX

R.7
7in. spools. 10 watts output. Records/Replays both directions. Twin speakers. Response 30-17,000 c/s.
Retail Price 75 gns.

R.6
7in. spools. 4 watts output. 2 speeds. 8in. x 6in. speaker. Response 30-15,000 c/s.
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POCKET MULTIMETER 460

Covers all normal measurements in radio and TV. Sensitivity 10,000Ω/V. 28 ranges: from 3 V. to 750 V., from 150μA to 1.5 A., A.C. and D.C. Accuracy: 1.5% on D.C., 2.5% on A.C. Resistance measurements from 10Ω to 2 MΩ. Many accessories to extend ranges.

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High quality multi-range meter. High sensitivity: 20,000Ω/V. on D.C., 6,330Ω/V. on A.C. Low volts drop on current ranges: 0.2 to 0.5V. on D.C., 0.7 to 1.5V. on A.C. Screened magnetic circuit. Frequency response to 20,000 c/s. Complete overload protection, relay remains tripped as long as overload is applied even if reset button is pressed. 0.3 to 1,600V. D.C., 1.58 to 1,600V. A.C., 50μA to 5 A D.C., 160μA to 5 A A.C., 1Ω to 50MΩ, 1,000pF to 100μF. Many accessories available to extend ranges.

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Our chassis are made with new 16 s.w.g. heavy-duty bright aluminium. Front panels in 19 s.w.g. steel with attractive hammered gold finish and clearly marked with neat control positions; all finishes and construction are made to enable constructors to match one unit with another.

MULLARD CHASSIS

"5-10 " Amplifier Chassis, base, screen and screws

"5-10 " Slim Line Chassis, without control positions, complete with base and screws

Complete Metalwork for the 5-10 T.C.C. printed circuit

Four-Channel Input-Mixing Pre-Amplifier Chassis, printed front panel and screws

Type "A" Pre-Amplifier Chassis and front panel (unprinted)

Type "B" Pre-Amplifier Chassis and front panel (unprinted)

2 Valve Pre-Amplifier Chassis complete with printed, hammered gold finished front panel and screws

3 Valve Pre-Amplifier Chassis, complete with printed, hammered gold finished front panel and screws

3 Valve, 3 Watt Hi-Fi Amplifier Chassis

20 Watt Amplifier Chassis, base, transformer covers, transformer adaptation plate and screws

20 Watt Pre-Amplifier Chassis

Mullard Tape Recorder, type "A" amplifier chassis

Mullard Tape Recorder, type "B" amplifier chassis

Mullard Tape Recorder, type "C" and new type "C" amplifier chassis

Mullard Tape Recorder, power pack chassis

7 Watt Stereophonic Amplifier Chassis, printed front panel and screws

3 Valve Stereophonic Amplifier Chassis and printed front panel

Stereophonic Pre-Amplifier Chassis, printed front panel and screws

Mullard 7 Watt D.C./A.C. Amplifier Chassis with Paxolin and bracket

Note: Transformer holes are not drilled in the above chassis excepting for the 20-watt amplifier.

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Type "C" Tape Pre-Amp. with EM81 escutcheon cut-out, 11½ x 4½in.

"5-10 " Amplifier, 13½ x 5½in.

Type "A" Pre-Amplifier, 4½ x 2½in.

Type "B" Pre-Amplifier, 10½ x 2½in.

WF1388 push-pull bias and erase Tape Deck Oscillator Coil for the Mullard type "C" Tape Pre-Amplifier

Trebble lift Inductor for the Mullard type "C" Tape Pre-Amplifier

GENERAL CATALOGUE covering full range of components, send 1/4 in stamps or P.O. PLEASE SEND S.A.E. WITH ALL OTHER ENQUIRIES.

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(Dept. W.W.), 357/9 Old Road
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Westminster Bank uses Pye Television

The Pye Industrial TV Division, a member of the Pye Instrument Group, has supplied all the television equipment to the Westminster Bank for the first inter-branch TV network. The new system which makes centralised bookkeeping possible has been brought about by the closest co-operation with the GPO who have supplied Post Office lines to carry the signals. The illustration shows a customer checking his banking account.

A TRULY REMARKABLE
BRITISH INVENTION!

Gramdeck
GRAMOPHONE TAPE RECORDER

Ready to record, complete with 600 feet of twin-track tape.

Instantly turns your gramophone into a first class Tape Recorder. You simply slip it on to your turn-table and you are ready to record direct from radio or microphone... the voices of your family... radio programmes... your favourite music—and you can instantly play it back through your own gramophone or radio WITH LIFELIKE FIDELITY. Gramdeck now brings full tape-recording and playing facilities to every gramophone owner, at little extra cost.

MADE BY THE FIRM THAT MAKES RADAR RUNS FOR VISCOUNTS AND BRITANNIAS

A stable signal of very low harmonic content within the frequency range 10 c/s to 120 kc/s, plus direct reading; these are two outstanding advantages of the Wayne Kerr Audio Signal Generator Type S121. This is a high grade laboratory instrument designed for use with circuits under test, development or service conditions. The output frequency is clearly and accurately shown and the amplitude remains constant to within 0.2dB at any setting, with a particularly low level of distortion. The unique dial display is designed for simple, rapid operation, permitting either the selection of major intervals by means of switches or the continuous fine control of frequency on an open horizontal scale.

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The Wayne Kerr Audio Signal Generator is fully described in Information Service Leaflet DS121, copies of which are available on request.

WAYNE KERR Audio Signal Generator S121
THE WAYNE KERR LABORATORIES LTD., Sales and Service, 44 Coombe Road, New Malden, Surrey. Telephone: MALden 2202
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for d.c. CONVERTERS

Transformers suitable for use in the circuits described in the recently published G.E.C. Application Reports on d.c. converters are now included in our standard range.

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
<th>RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 V</td>
<td>100 V</td>
<td>1, 1.5, 2,</td>
</tr>
<tr>
<td>6 V</td>
<td>200 V</td>
<td>3 or 4 WATT</td>
</tr>
<tr>
<td>6 V</td>
<td>400 V</td>
<td></td>
</tr>
<tr>
<td>6 V</td>
<td>800 V</td>
<td></td>
</tr>
<tr>
<td>12-18 V</td>
<td>250 V</td>
<td>50 WATT</td>
</tr>
</tbody>
</table>

TYPICAL SPECIFICATIONS

FORTIPHONE TRANSFORMER DIVISION (DEPT. 5) 92 MIDDLESEX ST. LONDON E.I.

GOOD COMPANIONS!

MINIATURE TRANSISTORIZED

SIGNAL GENERATOR TYPE 40

- Up to 20 Mc/s on fundamentals.
- R.F. and Audio Output, Attenuated.
- Accuracy better than 2%.
- Miniature size only 4½ in. x 3½ in.

PRICE NET £5.15.0. Battery 2/6 extra
Post (C.O.D. or C.W.O.), 2/6.

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- Resistance 5 Ω to 20 MΩ.
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- Calibrated Power Factor Check.
- Miniature Size—Light Weight.

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- Band III Folded Dipoles (As illustrated).
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Connoisseur

FOR STEREO
OR MONOAURAL

Stereo Pickup Mark III. Designed to accept both monaural and stereo heads. Adjustable for height of various turntables. Pick-up head specification identical with the Type C61. Arm only £3 plus 19/11 P.T.

Stereo Pickup Type C61. The pick-up head employs miniature ceramic micro, frequency range 20-16,000 c.p.s. output 20 mV. Diamond stylus. Will accept Mark II monaural heads.

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EXTRA HIGH SENSITIVITY

INSTRUMENT TUBE 5CLP31

THE FIVE-INCH instrument tube 5CLP31 has a deflection sensitivity of 1.85V/cm with a useful y scan of 6 cm. A special system of shielding the post deflection field from the deflection plates in this tube allows p.d.a. ratios as high as 15 to 1 to be used without pattern distortion. The extraordinary deflection sensitivity achieved with such high p.d.a. ratios profoundly affects oscillograph design. Bandwidths can be increased, amplifiers simplified and power supply requirements reduced. Write to the address below for full details of 'ETEL' Instrument Tube type 5CLP31.

* P.d.a. ratios of 15:1 possible without pattern distortion.
* Sensitivity 1.85V/cm with useful y scan of 6 cm.
* Sensitivity substantially independent of final p.d.a. voltages from 10 to 15 kV,
* High sensibility — only 200 mV for a deflection of one spot-width.
* Versatility — by simply altering one electrode potential the 5CLP31 may be converted from a very sensitive tube to a higher writing speed tube—pulses may be first examined and then a single shot photograph taken.

Abridged data
This is tentative. Final data is being prepared.

5-INCH FLAT FACED PRECISION OSCILLOGRAPH TUBE SCLP31.

<table>
<thead>
<tr>
<th>Capacitances</th>
<th>2.0 pF</th>
<th>2.0 pF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cx'—x'</td>
<td>Cy'—y'</td>
<td></td>
</tr>
<tr>
<td>Cy—all (x' earthed)</td>
<td>5.5 pF</td>
<td>4.3 pF</td>
</tr>
<tr>
<td>Cx—all (x' earthed)</td>
<td>5.5 pF</td>
<td>4.0 pF</td>
</tr>
</tbody>
</table>

Compare conditions shown in typical operation below

1 and 2 to see how deflection sensitivity is maintained over range of Va4 and Va3.
1 and 2 with 3 for a slightly lower sensitivity condition giving higher brightness.
2 and 4 for the reduction required in Va4 potential to achieve higher writing speeds.

<table>
<thead>
<tr>
<th>Va5</th>
<th>Va4</th>
<th>Va3</th>
<th>Va1</th>
</tr>
</thead>
<tbody>
<tr>
<td>10kV</td>
<td>15kV</td>
<td>15kV</td>
<td>15kV</td>
</tr>
<tr>
<td>10kV</td>
<td>15kV</td>
<td>15kV</td>
<td>3kV</td>
</tr>
<tr>
<td>1kV</td>
<td>1kV</td>
<td>1.5kV</td>
<td>1kV</td>
</tr>
<tr>
<td>1kV</td>
<td>1kV</td>
<td>1.5kV</td>
<td>1kV</td>
</tr>
</tbody>
</table>

-28 to -60V -28 to -60V -42 to -90V -42 to -60V

Deflection sensitivity...

<table>
<thead>
<tr>
<th>Line width</th>
<th>Useful screen area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.85V/cm</td>
<td>6cm</td>
</tr>
<tr>
<td>7.5V/cm</td>
<td>6cm</td>
</tr>
<tr>
<td>7.5V/cm</td>
<td>10cm</td>
</tr>
<tr>
<td>11.2V/cm</td>
<td>10cm</td>
</tr>
</tbody>
</table>

(The green medium persistence phosphor used by E.T.L. has now been designated P31. It is exactly the same as the E.T.L. phosphor previously called P1.)
AUTOMATIC COIL WINDING MACHINE

THESE MACHINES INCORPORATE THE FOLLOWING FEATURES:

- Infinitely variable wire gauge adjustment with easily read scale calibrated in .001”.
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We will be pleased to send you an illustrated leaflet giving a full technical specification on request.

KLECTRIC LTD
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The Stereo 12 Mk. 2 is a new and improved version of the famous Stereo-Twelve. A hi-fi system on one chassis, it includes AM and FM tuners, a stereo control unit and two hi-fi amplifiers, and the price is only 42 guineas. Compare the features and specification of each section with tuners and amplifiers sold separately and then compare the cost.

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The Stereo 12 Mk. 2

AM TUNER
Ferrite rod aerial and unique 2nd IF stage provide good continental reception. Miniature tuning indicator.

FM TUNER
High fidelity tuner covering the full VHF band (87-108 m/c). Automatic frequency control ensures complete stability.

STEREO CONTROL UNIT

TWO HI-FI AMPLIFIERS
Each amplifier provides 8 watts push-pull output, 16 watts total. Frequency response 20-30,000 c.p.s. ± 2dB.

and the new

STEREO 55 32 GNS
A tuner-amplifier chassis giving 10 watts output, 5 watts each amplifier, covering full VHF and Medium bands. Similar in facilities and appearance to the Stereo 12 Mk. 2.

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ADDRESS ________________________

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THE DOUBLE SEALING
EMPIRE RUBBER GROMMET

indefinitely accommodating in use:
considerably reduces range of sizes
because the same grommet can be used with
several plate thicknesses or cable sizes

PAT. APP. No. 5255/59

This newly developed self-conforming grommet,
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sealing problems.

Any one size will not only accommodate itself to a
variety of mounting plate thicknesses, but (designed
for cable or control rod) will take these in a variety
of sizes and be weather-, water- and dust-proof at a
variety of angles to the cable or rod.

Because of its capacity to conform to many varying
requirements, it enables a workshop stock range
of grommets to be reduced to perhaps one tenth of
that at present maintained.

THE NEW BLIND GROMMET
FREE
Note how when sprung into position the grommet
provides a perfect double seal by its own permanent
pressures. The angled groove also creates a tight
pressure hold on the metal plate.

THE NEW DESIGNED GROMMET
FREE

Fitted

In the cable grommet variety the same double pressure
seal is created, allied to tight seal on various diameters of
cable. This new grommet gives sound sealing at all
vital points.

A useful feature of this cable grommet is that by reason of the designed taper
of the cable entry and the flexibility of the web, a considerable angle of cable
entry and a variety of cable size are possible. This avoids necessity for
special grommets with angled bores.

In the conventional grommet, only one
thickness of plate and only one size of
cable can be accommodated. No effective
seal is afforded by

ENQUIRE
for catalogue section
and detailed particulars.

Now being produced in a range of sizes
THESE GROMMETS WILL SOLVE
YOUR SEALING PROBLEMS

EMPIRE RUBBER COMPANY • DUNSTABLE • BEDFORDSHIRE • ENGLAND

R.B.101
**HETERODYNE FREQUENCY METERS**

**BRITISH MANUFACTURED**

Designed and built to rigid services specifications.

**TYPE T75.**
- Frequency Range: 85 to 1,000 megacycles.

**TYPE T74.**
- Frequency Range: 20 to 250 megacycles.
- Frequency calibration accuracy: ±0.02% at 25°C (or ±0.1% between -20°C to +70°C).
- Crystal-controlled, portable heterodyne-type Frequency Meters used for field testing and measurement of pulsed, modulated, or C.W.R.F. transmitters, receivers and signal-generators.
- Mains Operated Power Unit available as optional extra and designed to fit into the battery compartment.
- Reconditioned and calibration-checked B.C.221 Frequency Meters, range 125 Kc/s to 20 Mc/s, still available.

Provisional specifications on a new wide-range, very high accuracy Frequency Meter and also an instrument covering the range 100 Kc/s to 1,000 Mc/s (higher under favourable conditions) available on request.

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**WEYRAD P.50 TRANSISTOR COILS AND I.F. TRANSFORMERS**

**FOR 2-WAVE PORTABLE WITH PRINTED CIRCUIT AND ROD AERIAL**

- **P50/IAC M.W. OSCILLATOR COILS.** For 176pF TUNING CONDENSER
  - **PRICE** 5/4d.

- **P50/2CC 1st and 2nd I.F. TRANSFORMER.** 470 Kc/s OPER. “Q” = 150
  - **PRICE** 5/7d.

- **P50/3CC 3rd I.F. TRANSFORMER.** 470 Kc/s OPER. “Q” = 170
  - **PRICE** 6/0d.

- **RA2W L.W. and M.W. ROD AERIAL 6in. long.** flying-lead connections. For 280pF TUNING CONDENSER
  - **PRICE** 12/6d.

- **LFTD2 DRIVER TRANSFORMER.** Split.Secondary Type, semi-shrouded. With 6 connecting tags
  - **PRICE** 9/6d.

**PCA1 PRINTED CIRCUIT PANEL.** 2½ x 8½in. ready drilled with component positions and references printed on rear
- **PRICE** 9/6d.

**BOOKLET OF DETAILED ASSEMBLY INSTRUCTIONS AND CIRCUIT DIAGRAMS FOR 6-TRANSISTOR LONG AND MEDIUM WAVE SUPERHET**
- **PRICE** 2/0d.

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In instrumentation

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Watch that WOW!

with the Gaumont-Kalee

FLUTTER METER

Accurate measurement of sound equipment speed deviations

The Flutter Meter measures those components which are commonly described as "Wow" and "Flutter" resulting from speed variations in sound recorders and reproducers. This instrument is equally suitable for use with machines employing perforated film, tape, wire or disc records.

Type 1740 is of entirely new design. More compact, lighter in weight and costing considerably less than earlier Gaumont-Kalee Flutter Meters, but with the same high performance and facilities.

Net weight: 29 lb. 13.15 kilos.

Write for full details to:

RANK PRECISION INDUSTRIES LTD
G.B-KALEE DIVISION (STUDIO), WOODGER RD., LONDON, W.12, ENGLAND

Watch that WOW! with the Gaumont-Kalee FLUTTER METER

Gaumont-Kalee Fluttermeter Type 1740

Brief Technical Data

Operating carrier frequency 3,000 c.p.s.±5%
Minimum Input signal 50 mV R.M.S.
Input Impedance I Megohm.
Input amplifier bandwidth -3db at 2,500 and 3,500 c.p.s.
Minimum input signal 50 mV R.M.S.
Input Impedance I Megohm.
Input amplifier bandwidth -3db at 2,500 and 3,500 c.p.s.
Effective limiter range -10dB.
"Wow" and "Flutter" 0 to 1% R.M.S.
"Wow" and "Flutter" 0 to 1% and 0 to 0.2% R.M.S.
Crossover frequency 20 c.p.s.
"Flutter" meter response -3db at crossover.
"Wow" meter response -3db at 200 c.p.s.
C.R.O. output frequency response level down to zero frequency-3db at 200 c.p.s.
3,000 c.p.s. oscillator output level
5V R.M.S. into 0.5 Megohms.
Power consumption 35 watts.
Mains 100/150v. and 200/250v.

The possibility of a component change—due to shortage of supplies, increased costs or failure to meet specific conditions—is a problem facing every designer of electronic equipment. However, one basic component can be 'tailor-made' from the start, for LAB will supply the precise type of Resistor required, ex stock and at the right price. Write for full technical data, prototype samples and price schedules to—

THE RADIO RESISTOR CO. LTD.,
9-11 PALMERSTON ROAD,
WEALDSTONE, HARROW, MIDDX.
Telephone: HARrow 6347

<table>
<thead>
<tr>
<th>CARBON</th>
<th>WATTS</th>
<th>OHMIC RANGE</th>
<th>TOLERANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Solid</td>
<td>1 &amp; 2</td>
<td>10-10M</td>
<td>±5% &amp; 10%</td>
</tr>
<tr>
<td>2. Cracked</td>
<td>1/30-20</td>
<td>1-50M</td>
<td>±5% &amp; 10%</td>
</tr>
<tr>
<td>3. High Stability</td>
<td>1/10-3</td>
<td>5K-2M</td>
<td>0.5% &amp; 1% &amp; 2% &amp; 5%</td>
</tr>
<tr>
<td>4. Variable</td>
<td>1-3</td>
<td>50M-101</td>
<td>±5% &amp; 10%</td>
</tr>
<tr>
<td>5. V. High Resistance</td>
<td>1/10-1</td>
<td>10-1K</td>
<td>1% &amp; 2%</td>
</tr>
<tr>
<td>6. V.H.F. (Rods &amp; Discs)</td>
<td>1/8-1</td>
<td>10-42M</td>
<td>±5% &amp; 10%</td>
</tr>
</tbody>
</table>

WIREWOUND

<table>
<thead>
<tr>
<th>RHENOSTAT</th>
<th>VOLUME</th>
<th>TEMPERATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Rheostats</td>
<td>1-18K</td>
<td>±5% &amp; 10%</td>
</tr>
<tr>
<td>5. Vitreous</td>
<td>1-15K</td>
<td>±5% &amp; 10%</td>
</tr>
<tr>
<td>6. Cemented</td>
<td>1-33K</td>
<td>±5% &amp; 10%</td>
</tr>
</tbody>
</table>

*The ubiquitous blue (1%) grey (2%) "HISTABS"

Do you KNOW
THAT Rheostats (4) can be made up in twos and threes on a common spindle.
THAT the whole of the vast range shown under (3) can be delivered ex stock in all Preferred values.
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For the guidance of the trade and public we publish below a list of the most popular ELAC replacement loudspeakers.

We have made this selection from our wide range of speakers as they cover practically all the requirements of the replacement trade.

The new prices are now operative.

<table>
<thead>
<tr>
<th>Type</th>
<th>Ref</th>
<th>Flux</th>
<th>Retail Price</th>
<th>Purchase Tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>5in.</td>
<td>5G</td>
<td>6500 g</td>
<td>20/6</td>
<td>6/7</td>
</tr>
<tr>
<td>6½in.</td>
<td>6G</td>
<td>6500 g</td>
<td>21/6</td>
<td>6/11</td>
</tr>
<tr>
<td>7 x 4in.</td>
<td>47G</td>
<td>6500 g</td>
<td>20/6</td>
<td>6/7</td>
</tr>
<tr>
<td>7 x 3in.</td>
<td>37G</td>
<td>6500 g</td>
<td>20/6</td>
<td>6/7</td>
</tr>
<tr>
<td>8 x 3in.</td>
<td>38G</td>
<td>6500 g</td>
<td>20/6</td>
<td>6/7</td>
</tr>
<tr>
<td>8 x 5in.</td>
<td>58C</td>
<td>8500 g</td>
<td>24/6</td>
<td>7/10</td>
</tr>
<tr>
<td>8in.</td>
<td>8C</td>
<td>7000 g</td>
<td>25/6</td>
<td>8/2</td>
</tr>
</tbody>
</table>

All loudspeakers have Standard 3 Ohm impedance. Higher impedances can be supplied at an extra cost of 3/- plus 1/- Purchase Tax.

Please write for leaflets and further details.

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2 A. 250 v. A.C.

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250 v. A.C.
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occupies a length of only 9
inches.

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LOK 2 models available
DPDT or 4 pole DT
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  Continuous control down to 250 µV
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T.280: Sensitive Snap Action Switch
Popular switch for tape recorders
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7. Rectifier 300 v. 300 mA. 13/6.

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5 x 5 x 8in. Sloping Front.......................... 14 11
6 x 6 x 12in. Sloping Front.......................... 4 1 9
4 x 4 x 24in. Rectangular.......................... 6 8
6 x 3 6in. Rectangular............................... 8 10
8 x 6 x 3in. Rectangular............................. 11 0
10 x 6 x 24in. Rectangular........................ 13 3
10 x 7 x 11m. Alum. Panel.......................... 4 1 4
14 x 7 x 11m. with Alum. Panel.................... 11 5
14 x 7 x 11m. with Alum. Panel.................... 11 9
16 x 9 x 11m. with Alum. Panel................... 2 5 8
16 x 9 x 11m. with Alum. Panel................... 2 9 6
16 x 9 x 11m. with Alum. Panel................... 2 6 8
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This range has been developed primarily for providing a power supply to transistorised circuits, but can also be used for many other applications where a low voltage output is required.

SECONDARY (a): Windings of 1 to 24V. are tapped in approximately 1 volt steps and those of 2 to 48V. in approximately 2 volt steps. The D.C. current ratings shown are those obtainable from a bridge rectifier with either choke or condenser filter.

SECONDARY (b): An H.T. winding is provided on certain models for stabilised circuits and this is tapped at each 50V. from 0-250 volts.

All Standard transformers have their primaries wound 10-0-200-220-240V. 50 c.p.s. supply. An electrostatic shield is fitted between primary and secondary windings on all models.

<table>
<thead>
<tr>
<th>CATALOGUE No.</th>
<th>SECONDARY (A)</th>
<th>SECONDARY (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VOLTAGE</td>
<td>RATING (AMPS)</td>
</tr>
<tr>
<td></td>
<td>R.M.S.</td>
<td>R.M.S. OR D.C. CHoke</td>
</tr>
<tr>
<td>P-2945</td>
<td>1 to 24V.</td>
<td>1-6A.</td>
</tr>
<tr>
<td>P-2946</td>
<td>2 to 48V.</td>
<td>1-6A.</td>
</tr>
<tr>
<td>P-2947</td>
<td>1 to 24V.</td>
<td>2-2A.</td>
</tr>
<tr>
<td>P-2948</td>
<td>1 to 24V.</td>
<td>1-6A.</td>
</tr>
<tr>
<td>P-2949</td>
<td>2 to 48V.</td>
<td>1-6A.</td>
</tr>
<tr>
<td>P-2950</td>
<td>1 to 24V.</td>
<td>2-2A.</td>
</tr>
<tr>
<td>P-2951</td>
<td>1 to 24V.</td>
<td>3-2A.</td>
</tr>
<tr>
<td>P-2952</td>
<td>1 to 24V.</td>
<td>5-0A.</td>
</tr>
<tr>
<td>P-2953</td>
<td>2 to 48V.</td>
<td>5-0A.</td>
</tr>
</tbody>
</table>

A table showing method of connection is supplied with each transformer.

STANDARD SMOOTHING CHOKES

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>P-2954</td>
<td>1-6A</td>
<td>40mH</td>
<td>0-60</td>
<td>9000:49</td>
<td>2-3</td>
</tr>
<tr>
<td>P-2955</td>
<td>1-6A</td>
<td>60mH</td>
<td>0-90</td>
<td>9000:57</td>
<td>9-10</td>
</tr>
<tr>
<td>P-2956</td>
<td>3-2A</td>
<td>15mH</td>
<td>0-31</td>
<td>9000:49</td>
<td>2-3</td>
</tr>
<tr>
<td>P-2957</td>
<td>3-2A</td>
<td>35mH</td>
<td>0-39</td>
<td>9000:65</td>
<td>9-10</td>
</tr>
<tr>
<td>P-2958</td>
<td>5-0A</td>
<td>9mH</td>
<td>0-15</td>
<td>9000:57</td>
<td>9-10</td>
</tr>
<tr>
<td>P-2959</td>
<td>5-0A</td>
<td>25mH</td>
<td>0-16</td>
<td>9000:73</td>
<td>9-10</td>
</tr>
</tbody>
</table>

The Atlantic Series can accommodate transformer designs rated up to 650VA at 50 c.p.s. We shall be pleased to quote for your specific requirements.

PARMEKO LTD • PERCY ROAD • LEICESTER • ENGLAND
CAPACITORS
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- Insulation Resistance: Better than 20,000 MΩ at 20°C.
- Special Properties: Safe HF contact Low induction. Screened by extended outer foil.

Tolerances:

<table>
<thead>
<tr>
<th>RANGE</th>
<th>STANDARD</th>
<th>SPECIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 pF to 0.068 mfd</td>
<td>±10%</td>
<td>±5%</td>
</tr>
<tr>
<td>0.1 mfd to 1 mfd</td>
<td>±20%</td>
<td>±10%</td>
</tr>
</tbody>
</table>

CLOSER TOLERANCES can be supplied for some values against special orders.

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Working Rating: 750 V.—D.C. (Sea Level)

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Silver.

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Covers: Standard or 90° entry with
Cable Clamps—Steel Cad.
plated.

Joint Service Quality Approved Cert. No. 138
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Precision miniature soldering iron

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FINGERTIP CONTROL
with sharp, controlled heat for transistor and other small assemblies. Location of element under soldering tip produces 30 watt capacity for only 15 watts consumption. Available for 230/230v 220, 200, 110 and low voltages 6, 12, 24, 28, 50v. List prices range from 25/• to 29/• (all prices subject).

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SMALL GEARED MOTORS. In addition to our well-known range we can now offer smaller open type R.P.M. units, 200/250 v. A.C. Small speed either 6 or 12 r.p.m. (torque approx. 6 lbz/in.). Sizes: 5in. long by 2in. by 1in. with 1in. shaft pro. Suitable for display work and many industrial purposes. Either speed, only £1/6 (despatch 9/-).

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TELEX:
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quick, accurate soldering. Touch the
trigger—heat and spotlight come on
instantly. NEW copper bit for maxi-
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long life.

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<thead>
<tr>
<th>Size of main amplifier</th>
<th>Pre-amp.</th>
<th>For 50/60 c.p.s. A.C. mains 200-230-250 v. or to order for export.</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 in. x 7 in. x 5 in.</td>
<td>10 lb. Pre-amp.</td>
<td>3 lb. For 50/60 c.p.s. A.C. mains 200-230-250 v. or to order for export.</td>
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</tbody>
</table>

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<thead>
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<th>Mullard Amplifier Switches</th>
</tr>
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<tbody>
<tr>
<td>S1 (14061/81)</td>
<td>Tape Amplifier Type A</td>
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<tr>
<td></td>
<td>SS/567/A, B &amp; C 32/6 per set</td>
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<tr>
<td>S2 (14062/81)</td>
<td>Tape Amplifier Type B</td>
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<td>SS/567/A, 16/6 each</td>
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<tr>
<td>S4 (SS/566/1)</td>
<td>Tape Amplifier Type C</td>
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<td>SS/567/A, 16/6 each</td>
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<tr>
<td>S5 (SS/566/2)</td>
<td>SS/567/D, 8/4 each</td>
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<td></td>
<td>Two-valve Pre-amplifier</td>
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<td>SS/597, 10/12/s each</td>
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<tr>
<td></td>
<td>Three-valve Pre-amplifier</td>
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<tr>
<td></td>
<td>SS/593/A, B &amp; C 27½ per set</td>
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<tr>
<td></td>
<td>Stereophonic Pre-amplifier</td>
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<tr>
<td></td>
<td>SS/594/A, B &amp; C 34/8 per set</td>
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<th>P.I.V.</th>
<th>COMMERCIAL EQUIVALENTS</th>
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<tbody>
<tr>
<td>CV 7030</td>
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<td>8G7</td>
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<td>4G8</td>
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<td>CV 7027</td>
<td>200v</td>
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</tr>
<tr>
<td>CV 7026</td>
<td>100v</td>
<td>1G8</td>
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<th>Rating (at 20°C)</th>
<th>TYPE</th>
<th>Resistance Range ohms</th>
<th>Tolerance</th>
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<tr>
<td>Watts</td>
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These new connectors are illustrated full size, in comparison with a B.N.C. type plug, one of another international range of plugs and sockets made by "Belling-Lee".

"BELLING-LEE” NOTES
No. 20 of a series
Fusing, part 4.

By now it should be apparent that there is much more to this subject than mounting a piece of wire in a glass tube with a metal cap on each end. We have covered the importance of correct rating, and various thermal effects, touched on the range of pre-arching times encountered, and the matter of surges; now there is the rupturing capacity of a fuselink to consider, i.e. its ability to deal with the events that take place during the Arcing Stage.

When a short-circuit fault occurs in a low impedance circuit, in the absence of a suitable fuse or circuit-breaker, the current that flows can run into thousands of amps; it will be limited only by the overall circuit resistance including that of the power source. The heat developed constitutes a severe fire risk, and one of the purposes of fitting a fuse is to restrict the duration of this Prospective Current to a safe limit. It is of course possible that the fuselink will act so promptly that the current never attains the prospective value, in which event the fuse is said to "cut-off," but in either case the fuselink has to handle a considerable amount of energy, and the design must be such that it can do so without itself constituting a hazard.

For example, if a fuselink measuring 1/16 in. long by 1/16 in. diameter, is called upon to deal with the prospective current envisaged under category of duty 440 v. A.C.4 (30,000 amp.), it will have to withstand a sudden surge of power within its narrow confines equivalent to approximately 20,000 horse-power; the energy released would vaporize the element and burst a glass cartridge with the violence of a small bomb. For this reason, fuselinks for this and similar categories of duty are made with ceramic tubes, of far greater strength than glass, and the space surrounding the element is filled with finely divided silica to act as a shock-absorber, and also to interrupt and quench the arc which is formed along the path of vaporized metal.

Such fuselinks are often described as "High Rupturing Capacity" types, but this is a relative term of no precise physical significance. However, the prospective current that could flow in a circuit is obviously an important factor to be taken into account when deciding what type of fuselink is required for its protection.

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From every point of view the Redifon R 145 upholds its world-wide reputation as the finest communications receiver that has ever been produced. Re-setting accuracy better than 1 kc. and many other important features are included in the outstanding specification of this superb receiver. We shall be glad to supply you with full details on request.
Aspects of design

This is the twenty-sixth of a series of special features dealing with advanced problems in television and radio circuit design to be published by The Ediswan Mazda Applications Laboratory. We will be pleased to deal with any questions arising from this or other articles, the twenty-seventh of which will appear in the October 1960 issue.

The changes in techniques which have taken place in television line output stages and the increasing introduction of 110° C.R. tubes has been concerned mainly with attempts to keep the power requirements within reasonable limits and to present a linear scan despite the increase in deflection angle.

POWER REQUIREMENTS

The circuit of a typical line output stage for a television receiver using a 110° cathode ray tube is shown below. The general form of the circuit is similar to that used with tubes of 90° deflection angle except in the method of control of picture width. In 90° receivers it was common practice to control picture width by a combination of two variable inductors in series with the deflector coil and one shunting a small portion of the transformer primary winding. The variable-position cores of these inductors were mechanically coupled so that as deflection power was being applied the deflection coil extra inductance was added in series with the deflector coil to keep the load on the transformer substantially constant. This method, although performing its function admirably, increased the power requirements of the stage by up to as much as 40%. With the higher deflection power requirements of 110° tubes this extra power consumption by the width control is undesirable and other methods have been adopted.

Most receivers control linearity by means of two closed loops of copper foil inserted between the line deflector coils and the tube neck so as to intercept some of the line deflection flux. This control is moved longitudinally along the neck to a position of optimum linearity. Movement of this control affects both the linearity and width of the line deflection and it is found that small corrections within reasonable limits and to present a linear scan despite the increase in deflection angle. The linear correction referred to above compensates for the non-linear current through the deflector coil and wide screen.
EDISWAN MAZDA U381

The U381 is a half wave rectifier, giving a maximum output current of 110 mA, for use in radio receivers and audio amplifiers with series connected heaters.

Heater Current (amps) $I_h = 0.1$
Heater Voltage (volts) $V_h = 38$

PRELIMINARY RATINGS AND DATA

Design Centre Ratings
Maximum Anode Voltage (volts) $V_a(max) = 250$
Maximum Peak Inverse Voltage (volts) $PIV(max) = 700$
Maximum Heater to Cathode Voltage (d.c. + a.c. peak, cathode positive) (volts) $V_{h-k}(max) = 550^*$
Maximum Mean Anode Current (mA) $I_{a(mea)} = 110$
Maximum Peak Anode Current (mA) $I_{a(max)} = 600$
Maximum Reservoir Condenser ($\mu$F) $C_{pk} = 100^†$
Minimum Surge Limiting Resistance (Absolute Value) (ohms) $R_{lim} = 90^‡$

*Measured with respect to the higher potential heater pin.
†Maximum tolerance + 80%.
‡When using a reservoir condenser of 100 $\mu$F + 80% with anode voltage 250 V rms.

TYPICAL OPERATION

Input Anode Voltage (volts rms) $V_a(rms) = 110$
Output Load Current (mA) $I_k = 110$
Reservoir Condenser ($\mu$F) $C_{pk} = 100$
Surge Limiting Resistance (ohms) $R_{lim} = 90$
Rectified Output Voltage (volts) $V_{out} = 112$

Mounting Position: Unrestricted.
Base: B9A (Noval).

Maximum Dimensions (mm)
Overall Length 67.5
Seated Height 60.3
Diameter 22.2

Characteristic curves of Ediswan Mazda Valve Type U381

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COMPLETE SOUND AND TELEVISION SYSTEMS

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This high fidelity 10/15 watt Ultra Linear Amplifier has a built-in mixer and Baxendale tone controls. The standard model has 4 inputs, two for balanced 30 ohm microphones, one for pick-up C.C.I.R. compensated and one for tape or radio input. Alternative or additional inputs are available to special order. A feed direct out from the mixer is standard and output impedances of 4-8-16 ohms or 100 volt line are to choice. All inputs and outputs are at the rear and it has been designed for cool continuous operation either on 19 x 7in. rack panel form or in standard ventilated steel case.

Size 18 x 7½ x 9³⁄₄in. deep.

Price of standard model £49.

Also 3-way mixers and Peak Programme Meters.

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Full details and prices of the above on request

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TT 21

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<thead>
<tr>
<th>Mode</th>
<th>f 30 Mc/s</th>
<th>Va max</th>
<th>Ia</th>
<th>Pout</th>
<th>Pdr</th>
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<td>176 mA</td>
<td>174 W</td>
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<td>1000 V</td>
<td>150 mA</td>
<td>125 W</td>
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<td>AB1</td>
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<td>116 mA</td>
<td>80 W</td>
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MINIATURE THERMOSTATICALLY CONTROLLED OVEN

GENERAL DESCRIPTION

This oven was designed specifically for accurate temperature control of Style “J” Quartz Crystal Units but is ideally suited for other components such as transistors, diodes, thermistors, etc., which are sensitive to ambient temperature variations. Heat control is achieved by a bi-metallic thermal switch.

Capacity of the inner shell \( \frac{3}{8} \times \frac{3}{8} \times \frac{3}{8} \) (2.0 x 0.9 x 2.3 cms). Overall dimensions \( 1\frac{1}{4} \times \frac{3}{8} \times 2\frac{1}{2} \) long (3.2 x 2.0 x 6.6 cms). Weight 1 oz. (43 grms).

OPERATING DATA

6v or 12v supply. Power consumption 4.0 watts. Temperature settings between 50°C and 85°C. Standard tolerance on setting is ±2°C but ±1°C can be supplied. Temperature differential over the operating temperature range is within ±2°C of the setting-up temperature. The heating-up time is less than 5 minutes from +20°C to +85°C.
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M.A.15 POWER AMPLIFIER

SPECIFICATION
OUTPUT POWER: 15 watts nominal. 12 watts <0.1% distortion.
OUTPUT IMPEDANCE: 4 Ω, 8 Ω, 16 Ω selected by switch.
SENSITIVITY:
HUM & NOISE OUTPUT:
FEEDBACK:
STABILITY MARGIN:
VALVE COMPLEMENT: I-EF86, 1-ECC83, 1-EZ81, 2-EL34.
POWER OUTLET (preamplifier)
Consumption: M.A.
Size (chassis): 8½ x 6½ x 7 in. (overall height).
PRICE: 23 gns.

OUTPUT IMPEDANCE:
4 Ω, 8 Ω, 16 Ω selected by switch.
SENSITIVITY:
HUM & NOISE OUTPUT: 250 millivolts input for 15 watts power output.
FEEDBACK:
STABILITY MARGIN:
VALVE COMPLEMENT: I-EF86, 1-ECC83, 1-EZ81, 2-EL34.
POWER OUTLET (preamplifier)
Consumption: M.A.
Size (chassis): 8½ x 6½ x 7 in. (overall height).
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A STEREOPHONIC CONTROL UNIT OF ENTIRELY NEW CONCEPTION IN ELECTRO-MECHANICAL DESIGN AND STYLING. PROBABLY THE SMALLEST PREAMPLIFIER CONTROL UNIT IN THE WORLD YET EmployING 6 STAGES PER CHANNEL, INCLUDING A LOW NOISE TRIODE CONNECTED PENTODE INPUT STAGE AND A CATHODE FOLLOWER OUTPUT. IT HAS NEGLIGIBLE HUM AND NOISE AT FULL POWER OUTPUT GAIN SETTING. THE SUPERIOR PERFORMANCE OF RADFORD POWER AMPLIFIERS CAN BE REALISED FROM HIGH QUALITY LOW LEVEL INPUT SOURCES WITH THIS UNIT.
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ATE Radiotelephones are used by industrial, mining, agricultural, civil and military enterprises—and by research and survey teams—in 60 countries.

Extended frequency coverage over VHF and UHF bands.
New compact cabinet-type construction with slide-in chassis for easy access and maintenance.
Plug-in test meter facilities.
High or low power versions to suit propagation conditions.
Will work into any type of telephone exchange with improved 'outband' tone signalling facilities.
Modern design conforming to British Post Office, Canadian Department of Transport and Crown Agents' specifications.

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The specialist knowledge of ATE is at your disposal—take advantage of it!
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VHF DF is finding a growing application at busy terminal areas, such as London and Orly, for use in conjunction with radar as a simple and effective means of aircraft identification in crowded airspace. It is also proving to be an invaluable aid for airways monitoring.

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* Simple aerial system—5 frequencies—push button control—QDM or QTE—remote control up to 8 miles from aerial site.

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T. E. Ivall

A non-mathematical introduction to the principles and applications of computers employing valves, transistors and other electronic devices. It is designed to appeal to technicians, engineers and students with some knowledge of electronic or electrical engineering. The treatment has been made as general as possible in order to give a broad background picture of the whole field of computing, from which the reader can pass on to the more advanced and specialised studies.

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Model 'E' is a new addition to the famous range of Eta Coil Winding Machines. It will wind coils 6in. x 6in. also may be arranged to wind Flat Resistance Strips up to 6in. long.

A large diameter Lead-screw gives the feed great accuracy and runs in Ball-Races. The reverse is manual and only One Gear needs changing for the alteration to feed.

A Heavy Duty Revolution Counter with Five Figures and Reset.

The machine is heavily built and will wind much larger wires if required. Price on application.

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20TH TO 25TH FEBRUARY, 1961

UNIVERSAL TOOL CO. LTD.
29a WELFORD ROAD, LEICESTER.
FOUR-TRACK HEADS

Record—Playback—Erase Heads for recording 4 Tracks on ½" Tape

NOW AVAILABLE AT A PRICE TO SUIT ALL TAPE RECORDERS

WHY HAVE FOUR TRACKS?

The new 4-Track Standard has been brought out so as to take the maximum advantage of developments over the past few years in the manufacture of Tapes—of Heads—and in Tape Recorder Design. Most Technical Experts now agree it is unlikely that any further advances in the future could be of sufficient magnitude to suggest the use of more than 4 Tracks on ½in. Tape for Standard Tape Recorders.

One factor alone has held up the adoption of this Standard and that has been the high cost of manufacturing the Heads. We have now removed this obstacle.

THESE ARE THE ADVANTAGES OF FOUR TRACKS

* Tape Recorders fitted with 4-Track Heads will give DOUBLE THE PLAYING TIME on a reel of Tape (compared with the Two-Track System); so for the small additional cost of a Four-Track Head you HALVE the entire cost of Tape.

* Four-Track Heads comply with the NEW STANDARD FOR STEREOPHONIC RECORDING. Pre-recorded stereophonic Tapes will be on sale in the near future.

* Your present Two-Track recordings (monaural or stereo) can still be played on Four-Track Heads.

* The new 4-Track Standard calls for a gap of ONE TEN-THOUSANDTH OF AN INCH. MARRIOTT Heads comply with this standard, they have a guaranteed frequency response which allows for as good results at 3½ IPS as was previously obtainable at 7½ IPS.

* So with a 7½in. reel of Double Play Tape you can now store 8½ HOURS of first-class recording.

* Existing Tape Recorders can easily be modified to Four Track.

RECORD/PLAYBACK HEADS

| Track width | 0.043 in. |
| Impedance | 400mH at 1 Kc/s. |
| Bias Current | 0.45-0.8mA. |
| Record Current | 10-30mA. |
| Output Recorded Crosstalk | Better than—70 dB. |
| Playback Crosstalk | Not measurable |

ERASE HEADS

| Track width | 0.056 in. |
| Gap | Double Gap each of 0.004 in. |
| Impedance | 20061 at 50 Kc/s. |
| Volts | 10 V at 50 Kc/s. |
| Current | 50-60 mA. |

TECHNICAL SPECIFICATIONS

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XS2

Dry Reed Relay Insert

A gold plated relay contact hermetically sealed in inert gas for absolute reliability, high speed and low contact bounce.

- Maximum current ... 250 mA
- Maximum resistive load ... 15 W
- Maximum closed resistance ... 50 mΩ
- Minimum open resistance ... $5 \times 10^{11}$ Ω

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PARKERS SHEET METAL FOLDING MACHINE HEAVY VICE MODELS

With Bevelled Former Bars

<table>
<thead>
<tr>
<th>Model</th>
<th>Capacity</th>
<th>Price</th>
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<tbody>
<tr>
<td>No. 1</td>
<td>Capacity 18 gauge mild steel x 36in. wide</td>
<td>£7 10 0</td>
</tr>
<tr>
<td>No. 2</td>
<td>Capacity 18 gauge mild steel x 24in. wide</td>
<td>£6 5 0</td>
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</table>

End folding attachments for Radio Chassis, Tray and Box Making, for 36in. model, 3½ per ft. Other models 2½. The two smaller models will form flanges. As supplied to Government Departments, Universities, Hospitals. One year's guarantee. Money refunded if not satisfied. Send for details.

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OSCILLOSCOPE No. 01 by Cossor. A First Grade L.F. Oscilloscope incorporating the Hard Valve Time Base with speeds of 1-50 milliseconds, but easily converted for very fast shadings to produce 3 c.p.s. to 30 k.c.p.s. Has High Class Amplifier with Fine and Coarse Gain controls, Brightness and Focus controls, V. and H. shifts. A.C. mains pack for 115-230 v. nominal, fully fuse protected. Employs 241n., Tube ACR 10. Front panel 11in. x 7in., for rack mounting, depth 11in., or can be used in Standard Rack Molding having grey front panel size 19in. x 10in. x 6in. A superb Crystal Calibrator No. 10. Open until 81in. x 6in. x 81in. which increase their usefulness. Voltage stabilisation circuit and Frequency Meter, but have many additional features with AR88 Receiver or any set with 1 ohms output. Fitted lock and key, and shoulder strap. Ideal for Test Labratories. Comes in magnificent condition, the finest we have yet had. ONLY 30/- (carriage 10/6). BRAND NEW IN MAKER'S CARTON & UNUSED. ONLY £2/19/6 (Postage, etc., 3/6).

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Crystal controlled heterodyne frequency meter covering 100 kc/s to 20 kc/s, in switched bands and virtually the British IRC.49 Power requirements 110 volts A.C., 240 volts, 50 microamps D.C. at 10 volts and 1 milliamp A.C. at 160 volts. 200 microamps D.C. at 10 volts. Specifications and full set of spares. BRAND NEW IN ORIGINAL TRANSPORT CASES. ONLY £21/9/6 (carriage 15/-).

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UNIVERSAL AVOMETER 34 RANGE MODEL D
DC-Air Ministry, but thoroughly re-conditioned and re-calibrated. Supplied with internal batteries and instructions. Covers ranges as follows:

<table>
<thead>
<tr>
<th>Range</th>
<th>Minimum</th>
<th>Maximum</th>
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<tbody>
<tr>
<td>U.C.</td>
<td>-4.5 V</td>
<td>4.5 V</td>
</tr>
<tr>
<td>D.C.</td>
<td>1 uA</td>
<td>1 mA</td>
</tr>
<tr>
<td>A.C.</td>
<td>1 uV</td>
<td>1 mV</td>
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</tbody>
</table>

V.R.F. RECEIIVER TYP. E.1982. A superb 15-valve superhet receiver covering 50-150 Mc/s. N.C./V.H.F., being fully tuneable over that range, with provision for Crystal Control. Bass & stages in B.V. 6.1, 6B6, 6C4, etc. Fitted with 2in. square meter for Oscillator and Audio Headphone, 1in. x 10in. x 18in. Used in very good order, thoroughly air tested before dispatch. Power supply required. 110/220 volts at 90 ma, and 6.3 volts at 4 amps. Complete with variometers and circuit diagram. ONLY 75/- (Carriage 10/-).

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Complete working unit containing 4in. spool of
fixing screws being required.

fixing into a portable case or cabinet, only four
for immediate operation, designed for easy
chassis incorporating Loudspeaker and com-

A complete

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TAPE AMPLIFIERS and PREAMPLIFIERS presented from MULLARD DESIGNS

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NELL WEARETE or NOETER Tape Decks, has
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KIT OF PARTS

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complete Kit of Parts

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The "HF/CR3" link to add tape recording facilities to High Fidelity installations. Incorporates the
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(b) Assembled

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£11.15.0.

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The "HF/CR3" link to add tape recording facilities to High Fidelity installations. Incorporates the
new TRUVOX MK. VI TAPE DECK, incorporates the popular 3-speed COLLARO TRANSCRIPTOR DECK for
Deck Switch Banks.

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The Preamplifier, Model HF/G2P is available separately for:
(a) Complete kit of parts
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(Excluding Power Unit £3/15/- and £1/10/- respectively.)

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Stereo Mark III with Crystal Pick-up and a

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The NEW NATIONAL UA 3.0 model is at the moment £10.5.0.

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We are proud to be able to offer this new type Car Radio employing up-to-the-minute circuitry, special 12 volt valves and transistorised output. The highest degree of sensitivity is assured by the incorporation of Permeability Tuning and a tuned R.F. Stage. Covers Medium and Long Waves. NO VIBRATOR PACK IS REQUIRED. This is a really compact receiver that will fit any car. Comprehensive assembly instructions are provided with all necessary components, including valves and transistor as a Special New Low Inclusive Price of Only **£11/10/- plus 3/6 P. & P. Instruction booklets with itemised price list, full description dimensions, etc., available separately at 3/6 post free.**

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A wonderful little set that you can take anywhere, ideal for campers, picnics, etc. Detachable set -up rod supplied. Complete with itemised price list, full description dimensions, etc., are free of charge with all parts but can be purchased separately as shown above.

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A new two-wave band (L and M) superhet using the latest miniature valves: E878, EF85 and E8780, plus contact cooled receiver. Incorporates Ferrite Rod Aerial and is of unit construction. Exceptional sensitivity and selectivity. Outstanding performance and quality of components throughout. Easiest constructed in one evening. Brown or ivory Bakelite or wooden Walnut finish cabinets. A.C. mains 200/250 v. All necessary components at special inclusive price of £7/16/- plus 3/6 P. & P. Instruction Booklet with itemised price list available separately at 5/- post free. Also available in De Luxe Cabines (as "Economy Four" at 5/- extras).
MORE CABLE BARGAINS

CABY UNIVERSAL TEST METERS

These pocket-size multi-range (

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Model A10 (2,000 ohms per vol) £4/17/6

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Precision quality half-shrouded drop-

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WIRING WIRE. 5 coils 10 yds plus 2/- P. & P.

RAILWAY CABLES Special. 2 varieties:

1. 10x22/2. 39 ft. 50c. each. Fully detailed and illustrated leaflet available on request.

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Full range at usual competitive prices. Interesting H.P. facilities.

B.S.R. T912. 4-speed semi-auto-

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Superior quality crystal insert and sapphire stylle.

An ideal unit for a small portable gramophone.

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The fastest, most economical and

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Wide Band (10 c/s. to 100 Kc/s.). Less than 1% distortion (20 c/s.-20 Kc/s.). High grade 200 pA f.s.d. meter with large scale for precision measurement. An invaluable instrument for hi-f audio and many ultra-sonic and I.F. applications requiring a very effective smoothing circuit. Eight different switch selected voltage ranges covering from 0-0.003 f.s.d. to 0-10V. f.s.d.

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The V-7A measures A.C. volts (0-1.5, 5, 15, 50, 150, 500, 1,500) R.M.S. and A.C. volts (0-4, 14, 40, 140, 400, 1,400 and 4,000) pk.-to-pk. D.C. volts (0-1.5, 5, 15, 50, 150, 500, 1,500). Ohms (with 10 ohms center) X1, X10, X100, X1,000, X10,000, X100K, and X1 megohm.

£19 complete with 32-page Handbook.

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New Low Priced Service

OSCILLOSCOPE

This is an ideal light and compact portable 'scope for the serviceman, the overall dimensions being 5in. x 8in. x 14in. long at a weight of 10 lb.

Specifications
Time Base 10 c/s. to 100 Kc/s. and 50 c/s. sine wave sweep. X amp. Sensitivity 1 V/cm. at 1 Kc/s. Calibration 1 v., 10 v. and 50 v. peak to peak available on front panel.

Valve Complement: 2-EC90, 2-EF90, 1-ECC82, 1-EZ80, C.R. Tube 1-3AF1 or equivalent (2 in. dia.).

Power Requirements, 200-250 volts, 40-60 c/s. A.C. 40 watts (fused).

£26. 7s. 6d. plus carriage.

MODEL O.S.1 (in Kit Form)
£18. 19s. 6d.
The world famous E.M.I. Angel Transcription P.U.

**SPECIFICATION**

**Physical**
- Length: 155 inches (40.32 cm)
- Height: 25 inches (6.41 cm)
- Width: 28 inches (6.03 cm)
- Centre of base to stylus tip: 12 inches (30.72 cm)

**Stylus**
- A diamond stylus is fitted to the 33 1/3 or 45 r.p.m. bead supplied.

**Head Impedance**
- 1 ohm (measured at 1,000 c.p.s.)

**Response**
- For a constant recorded velocity the frequency response is sensibly level within the following limits:
  - With microgroove stylus: 20-16,500 c.p.s.
  - With standard stylus: 20-20,000 c.p.s.

**Distortion**
- Measured at 400 c.p.s., the total harmonic distortion is less than 5% for a recording level of +20 db referred to 1 cm/sec r.m.s. transverse velocity.

**Sensitivity**
- 50 my at secondary of transformer provided from a recording level of +10 db referred to 1 cm/sec r.m.s. velocity.

**Weight at Stylos Point**
- Variable from 3-10 grammes as required.

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**500 MICROAMMETER**

A 4½" Panel mounting 500
Microammeter marked in ohms and ideal for building into a multi-range meter.

**PRICE £2.10.0**


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**PLESSEY TWEETER**

This well-known Plessey 3 ohm Tweeter at our amazing price of **12/6 TAX PAID**

Plus P. & P. 1/6.

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**SUPER SCOOP**

A few only pick-up heads for the above Angel P.U. **DIAMOND STYLUS**

Cost £8/15/-. Brand new. 78 or 33 1/3 at £2.0.0

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½ H.P. 220-250 A.C. motor, ideal for lathe, coil winder, drill, saw motor, etc. Don't miss it. Dimensions: 6½ x 3½. **29/6 P. & P. 2/3.**
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FOUR KIT
All parts and theoretical wiring diagram.
OUR PRICE
£4.12.6
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8 WATT Push Pull
MONAURAL AMPLIFIER
By well-known manufacturer—employing four Mullard valves: ECC.83, 2 EL.84 and EZ.80. Bass, treble and volume on remote panel. Elegant knobs.
OUR PRICE—Plus P. & P. 4/6,
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All Types Available.

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TUNER HEAD
(as illustrated) uses ECC.85, less valve
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Regret no Circuit

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COME AND SEE US.

WIRE. Twin padded, grey, with maroon tracer Mains Lead—usually 10d. per yard.—Our Price 15/- per 100 yd. coil. P. & P. 3/-.

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MONAURAL AMPLIFIER
Also a few Stereo left.

A few only left of this cabinet. Product of a well-known manufacturer. Don’t miss this wonderful offer.
Length 40in.
Width 17½in.
Height 19½in.
OUR PRICE
£9.15.0
Plus P. & P. 1/6.

6" x 4"
3 ohm Plessey Speaker
12/- Plus P. & P. 1/6.

We have a number of odd radiogram cabinets too numerous to catalogue. Send us your requirements.


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LATEST miniature EXPOlT ONLY

WALKIE TALKIE

“88” sets—just released by Ministry of Supply. Produced to exacting specifications by leading manufacturers. E. K. Cole & Co. This Transmitter/Receiver weighs only 1½ lb. (approx.) and measures 3½ in. x 2½ in. x 9½ in. It is a frequency channel set, heavy type crystal controlled, 40-42 Mc/s., and operates from a Standard Dry Battery—HT/LT. 94/1, 3 v. (i.e. Roben Mallory Type 1). 14 of the current series of B7G valves are employed: 1-3AG, 6-IL4, 4-IT4, 1-15S, 2-1A3. Each set is fully tested and in good condition.

Special quotations for quantities up to 3000 sets. “22” SETS ALSO—300 available only. New condition £10 each.

Only £10 each.

1,000,000 YARDS!!

SCREENED WIRE FLEX

FOR ONLY 3d. per yard.

For Immediate Delivery—priced far below cost.


ON MAKER’S REELS: 200 ft. REELS (cost quantity). 55/-. P. & P. 5/-. WITH CRYSTALS.

COMPLETE

research

TEN REELS

220 yd. REELS (min. quantity). 55/-. P. & P. 5/-. Applications: Microphone leads, pick-up heads, etc.


SPECIFICATION:

For Immediate Delivery—priced far below cost.

SCREENED WIRE FLEX

dividually tested, C9; 1½ £ each, P. & P.

with voltage control slider resistance switch.

WINDERS: 1 to 6 in.

FOR ONLY 3d. per yd.

HEAVY DUTY

20 AMP. L.T. SUPPLY UNIT

Normal cost over £100

Essential equipment for Electronic Engineering research laboratories, schools. Ideal for battery charging, etc. Guaranteed for 20 years.

Output: D.C. Variable up to 20 amp. and 24 v. or telephone charge 125/80/700 ampere hours. Input: A.C. 150/360 volts 65/65 cycles.

Size: 16 x 8 x 20in. H.W.

In attractive Grey Cabinet.

G.E.C. L.T. SUPPLY UNIT

OUTPUT: 94 volts 10 amps D.C.

New in original case

£13.10.0

Carr. 9/6.

ROVARY CONVERTORS

Input: 12 v. D.C.

Output: 230 v. A.C.

CARR. 150 watts 50 cycles

Housed in w.o. o. d en case and fitted with voltage control slider resistance switch, plugs and A.C. mains voltage output check meter. Supplied in perfect condition, individually tested. £9/16/6 each. P. & P. 10/-.
Portable/Mobile

V.H.F RADIO TELEPHONE

TYPE W.S B44 MK2.

A modern 14-valve superhet receiver and AM transmitter using current series of B7g valves. Valve line-up: 2-CV136/7D9, 1-CV137/EAC91, 7-CV138/EF91, 4-CV416/6F17. Robust cast aluminium case includes 5in. loudspeaker. Internal vibrator pack (synchronous type) provides operation from 12-volt accumulators or vehicle or boat 12-volt supply, in fixed or mobile use. Available, less crystals and accessories, but with connecting plugs, ex-stock. Accessories and crystals for specified frequencies in the range 60-95 Mc/s can be supplied to order at extra cost.

Each unit is fully tested and in good condition. Price (including packing FOB London), £20 each.

Special quotation for quantities up to 500 sets.

50 MICRO AMP MOVING COIL METERS

Brand New & Boxed—Large Stocks available

Made on Government Contract by Famous British Maker

3/in. Square—800 ohms resistance. 4 Scales operated by lever "Set-zero"—"0-3"—"0-30"—"0-300." Easily coupled to rotary range switch by cord or lever. Ideally suitable for transistor tester, output meter, volt-milliammeter. Adjustable to work as centre-zero 25-0-25 /µA.

A RANGE OF METER BOXES

Useful for all kinds of testgear, a quality job in welded steel, finished in grey hammer stoved enamel. Standard panel size 4½" x 7½", available in depths 2", 3", 4" and 6".

UNDRIILLED: 2' 12/6: 3' 13/-: 4' 13/6: 6' 15/-; With panel punched to take one 50µA meter, add 1/6, or to take two meters 2/6.

TEST GEAR COMPONENTS (LONDON) LTD

15 ARCANY ROAD, SOUTH OCKENDON, ESSEX TEL: SOUTH OCKENDON 2610

SPECIAL PRICES FOR 100 LOTS
AUTUMN BARGAINS FROM DUKE & CO.

LIST PRICE 29 gns.
NOW ONLY 18 gns.

COMPLETE TAPE RECORDER UNREPEATABLE VALUE


TAPE RECORDER AMPLIFIER CABINET.


SUPER CHASSIS 79/6 3/11

Cash Price. Per Week.

Made by a famous manufacturer. In polka dot cloth with clipped lid and carrying handle. 6in. x 14in. x 8in. deep. Carr. and ins. 4/6. Will take B.S.R. Monarch 4-speed Autochanger, 7in. elliptical speaker and our Mk. D.2 Portable Amplifier.

RECORD PLAYER CABINET MODEL R.P.2. CASH PRICE: 59/6


B.S.R. Monarch, 4-speed Autochanger, 60/19/6.
Collaro Conquest, 4-speed Autochanger, 60/19/6.
Collaro Conquest, Stereo Autochanger, 9 gns. Ronette Hi-Fi Crystal cartridge, 17/9.

RECORD PLAYER CABINET R.P.9 only 19/6


SOLO SOLDERING TOOL 12/6

110 v. 6 v. or 12 v. (special adaptor for 200/250 v. 10/- extra). Automatic solder feed including a 20ft. reel of Erosin 00/40 solder and spare parts.

It is a tool for electronic soldering or car wiring. Revolutionary in design. Instantly ready for use and cannot burn. In light metal case with full instructions for use Post 3/6.

AUTUMN SALE! BARGAIN! 17" T.V.'S COMPLETE 19 gns.

Cash, or terms over 3 weeks. (NO interest charged). Initial payment 8/10/7 and 10 weekly payments of 9/11. Carr. & ins. 30/-.

AUTUMN SALE! BARGAIN! 17" T.V.'S COMPLETE 19 gns.

Cash, or terms over 3 weeks. (NO interest charged). Initial payment 8/10/7 and 10 weekly payments of 9/11. Carr. & ins. 30/-.

ITV/BBC. Beautifully styled polished cabinets. These are table models with the option of contemporary legs fitted (2 gns. extra). 17in. rectangular tube guaranteed for 12 months. Valves and chassis guaranteed for 3 months. (Chassis salvaged but reconditioned). Where possible personal collection is advised.

SEND for FREE CATALOGUE ★ Full details of easy terms ★

DE LUXE TAPE RECORDER CABINET ONLY 29/9

Beautifully made Tape Recording Cabinet. Size 13in. x 101in. x 7in. Covered in twotone coloured rexine cloth. Stylish design. Carrying handle with detachable lid and lock and key. Easily adapted to Record Player Cabinet. Exceptional value at this very low price. P. & P. 4/6.

DE LUXE TAPE RECORDER CABINET ONLY 29/9

Beautifully made Tape Recording Cabinet. Size 13in. x 101in. x 7in. Covered in twotone coloured rexine cloth. Stylish design. Carrying handle with detachable lid and lock and key. Easily adapted to Record Player Cabinet. Exceptional value at this very low price. P. & P. 4/6.

★ AMPLIFIERS ★ ALL PORTABLE 12 MONTHS' GUARANTEE

MK. D.1 59/6


MK. D.2 89/6


MK. D.3 39/6


TAPE RECORDERS AMPLIFIER 571/9/6

DUKE & CO (LONDON) LTD

COMPLETE RECORD PLAYER
Model R.P.1.

The finest value yet in four speed portable players. Excellent volume and tone controls. Impeccably finished in smart two tone colour scheme. Width 14½in. Depth 14½in. Height 6in. Weight 13½ lbs. Insurance and carriage 9/6, or Initial payment 20/- (incl. carr.) and 19 weekly payments of 10/6.

COMPLETE RECORD PLAYER
Model R.P.20.

ONLY 14 Gns.

An elegant record player in Grey polka dot. Contains four speed auto changer and a modern amplifer. Sturdy carrying handle and fittings. Width 16in. Depth 14½in. Height 8½in. Insurance and carriage 12/6, or Initial payment 1½ (incl. carr.) and 19 weekly payments of 14/6.


TWIN GANG CONDENSERS 1/9. Salvage guaranteed. Standard size 2 gang 0003 (300 pf) also standard size 3 and 5 gang. 0005 (500 pf). All tested and guaranteed. Postage 1/3.


PRESENTATION CASES. Covered in hard wearing washable letherette of various colours and beautifully made. Hinged top for easy access to records and numbered index for easy reference. Plated clip fasteners. Carry all those expensive records safely to parties and record sessions.


CHASSIS FOR SPARES ONLY 9/6.

56 resistances incl. 7 variable controls. 54 condensers, incl. electrolytics, coils, 7 I.F. and R.F. transformers. Main, output, line and frame. Metal rectifier 300v. at 250 m.a. Fuse panel, scanning coils, focus magnet, plugs, sockets, switch, chassis screws, tage strips etc. I.F. strip can be separated. Power pack can be used without dismantling. These chassis have been used, but were working when stored. 6-page circuit showing positions of each component available with order. Carriage 7/6.


DON’T FORGET TO SEND FOR YOUR FREE CATALOGUE.

IDEAL FOR SPARES

621/3 ROMFORD ROAD, MANOR PARK, LONDON, E.12. ILFord 6001/3

COMPLETE PORTABLE PLAYER
Model P.L.5.

ONLY 8 Gns.

A petite portable player. Robust case with smart two tone colour scheme. Sturdy carrying handle and fittings. Contains four speed single player unit and 8in. x 5in. elliptical speaker. Width 12in. Depth 10½in. Height 6½in. Plays 7½in., 10in. and 12in. records. Insurance and carriage 4/6, or Initial payment 19/- (incl. carr.) and 19 weekly payments of 8/4.

COMPLETE CONTEMPORARY RECORD PLAYER Model R.P.80. 18 Gns.

This contemporary record player is beautifully suited for the modern home, in two tone grey with attractive cream plastic speaker front. Push button lid with lock. Fittings for screw in legs. Contains U.A.I. auto changer, 6½in. x 4½in. elliptical speaker, 2 control 4 watt amplifier. Size 12½in. x 13½in. x 5½in. Carriage and Insurance 12/6, or Initial payments 36/- (incl. carr.) and 19 weekly payments of 18/6.

STEREO RECORD PLAYER
CABINET WITH EXTENSION SPEAKER CABINET. AT THE AMAZING OFFER OF 99/6

Portable 1900 Show Model in two tone colour scheme. Extension speaker cabinet secured in lid. Size 18½in. x 14in. x 8½in. high. This stereophonic player COMPLETE, retails at 35/- Gns. in the shops today. Insurance and carriage 5/6 or Initial payment 1½ (incl. carr.) and 19 weekly payments of 4/11.

I.T.A. 23/6. For all I.T.A. channels. For outdoor or loft. 3 elements. Postage 2/6.


ELECTRIC CONVECTOR HEATERS 99/6

By famous manufacturer. Costs only 1½d. an hour or 3d. on high heat. 1 kilowatt or 2 switched (1-2 units). Unit and fitting 9½. Postage 2/-.


HEATER TRANSFORMERS, 1/9. 2-1 ratio auto transformer.

HEATER TRANSFORMERS, 2/6. 2-1 ratio auto transformer. 2v. at 1.6 amp. primary. 4 volt secondary. Post and packing 1/9.

EY5I 7KV ISOLATION TRANSFORMERS, 5/6. 1–1 ratio. Suitable for 0.5 tube as isolation transformer. Post and packing 1/6.


PHOTOGRAPHIC SLIDE CASES 15/6.

Covered in tan rexine. Made to take 90 of those expensive coloured transparencies in separ- ated partitions. This is the answer to that aggravating search for that particular slide.

TRANSFORMERS.

MAINS TRANSFORMERS, 6/6. Primary 200-250 volt. Secondary 300-0-300 80 m.a. 6.3 at 3 amp. 6v. 2 2 amp. Postage and packing 2/9.

HEATER TRANSFORMERS, 7/6. 12 volt at 1 amp. 0.250-200 volt primary. Postage 1/9.

HEATER TRANSFORMERS, 3/9. 2–1 ratio auto transformer. 2v. at 1.6 amp. primary. 4 volt secondary. Post and packing 1/9.

EY5I 7KV ISOLATION TRANSFORMERS, 5/6. 1–1 ratio. Suitable for 0.5 tube as isolation transformer. Post and packing 1/6.


VALVES

SALVAGED GUARANTEED

1D8 6H4 9D2 78 A48 EB34 KT241 OP21 VR35 2D21 6F13 6SG7 1BSK7 EAF42 HL14D5

3D6 6SA7 1ID8 210VPT ARP96 EF36 LP229 SP41 VT61A 6GA6 6F14 7CA 1BSK7 EBC41 HL42D5

AD1, 2SS7 12BE6 1200A CV32 EF37 ML4 SP91 VT510 6CA 6F15 7S7 1655 EF42 KT53C

BAC7 9B6 15C7 2550 CV188 EF50 NG2 U4 VF48 6F1 6K7 10F1 DF96 EF42 KT53L

6B7 7B7 15Y4 2161 DI GTC P5020 T711 V92 6F12 6L20 12SN7 DHN1 E952 KTW61

AND MANY OTHERS

5011/74 SP16
FOR VALVES, TUBES AND COMPONENTS—BY RETURN POST SERVICE

| EL41 | 91- | MSP417 | 7/6 | SP417 | 10/6 | UVB5 | 7- | 4F1 | 3- | 67G |
| EL42 | 10/6 | MHP41 | 6- | TP25 | 10- | VPJ3C | 3- | 6R6G | 9/6 | 67G |
| VP6 | 9/16 | MX40 | 16/10 | U16 | 9/16 | VP6 | 9- | 564C | 11/6 | 66G |
| VP7 | 9/14 | N110 | 14/11 | U14 | 12/6 | VP7 | 9/12 | 355G | 8- | 66G |
| EL84 | 9- | N78 | 19/11 | U16 | 12/6 | VP7 | 9/12 | 355G | 8- | 66G |
| VP8 | 9/12 | 477 | 14/16 | U71 | 12/6 | VP8 | 9/12 | 355G | 8- | 66G |
| AM34 | 9/16 | N339 | 33/23 | U35 | 12/6 | VP8 | 9/12 | 355G | 8- | 66G |
| VMP18 | 9/16 | OZ4 | 26/16 | U26 | 12/6 | VMP18 | 9/16 | OZ4 | 26/16 | U26 |
| VMP29 | 9/16 | P44 | 26/16 | U26 | 12/6 | VMP29 | 9/16 | OZ4 | 26/16 | U26 |
| EL961 | 9/12 | REC410 | 11/6 | U14 | 12/6 | EL963 | 9/12 | REC410 | 11/6 | U14 |
| EL963 | 9/12 | REC410 | 11/6 | U14 | 12/6 | EL964 | 9/12 | REC410 | 11/6 | U14 |
| EL967 | 9/12 | REC410 | 11/6 | U14 | 12/6 | EL963 | 9/12 | REC410 | 11/6 | U14 |
| AM34 | 9/16 | N339 | 33/23 | U35 | 12/6 | VP8 | 9/12 | 355G | 8- | 66G |

A SELECTION FROM OUR STOCKS.

- Semi Air Spaced Co-axial Cable, 64 yd.
- 2-gang Condensers, AM/FM type, 3/4 in. each.
- 140 High Resistance Headphones, 4,000 ohms, 1/36 pr.
- 2 MF Dr Paper Block Condensers, for X 191/2, 56 each.
- 1,200ft Reels of Recording Tape, 21/2-1 each.
- Golden 8 x Sin. Loudspeaker Units, 25/6 each.

ACOS GP 54 Pick-up Arm with cartridge, 27/6 each.

Well 100-watt Soldering Gun, 75/.

Line Cord 3-way, 3 amp. or 2 amp., 19/4 yd. each.

JB "00" 2-gang Condensers, for transistor kits, 9/6 each.

RCA C 85 2jm. Loud Speaker, 24/8 each.

Telescopic Car Radio Aerials, with mast, 11/1 each.

Solon 625 Instrument Iron, 25 watts, 24/- each.

Wave Change Switches, 2PMV or 1PMV, 3/- each.

ACOS MICROPHONES

AcosMic 391 crystal stick microphone for use as a hand held or floor stand units, for high quality recording and broadcasting and public address work. List price £3/-10/-. Our Price 3/-6/.

Table Stand 7/6.

Floorstand and Apollo, 12/6.

Acos Mic 40, as supplied with most modern tape recorders with folding rest and 8ft. lead. Listed £115/-.

Our Price 19/6.

10" ELAC Loudspeakers 25/-.

TELEVISION TUBES

REGUNDED, 12 MONTHS GUARANTEE

MW371/47, £5/10; CRM152B, 66; MW36/24, £5/10; CRM141 £5/10; CRM133, £5/10; MWV436/9, 66; CRM71, 64. Carriage and insurance 10/- extra. Allowance on old tube if returned.

A SINGLE RECORD PLAYER

Collaro Junior 4-speed turntable and pickup complete with crystal cartridge and sapphire stylus. Special offer at only 75/- plus 2/6 p. & p. 4-speed turntable and motor at 47/6, plus 2/6 p. & p. Pick up only at 1/4, 4/-, 7/-, 10/-.

E.M. Single Player, 4 speeds with automatic stop. Fitted with STEREO pickup, over cartridge, 66/-10/-.

ALL GALLORO STUDIO TAPE TRANSPORTER

3 motors, 3-speed, 1, 3, 5/2 i.p.s., takes 7in. spool. Push button controls. PRICE £13/-10/-. Tape extra. Carriage and insurance 5/-.

LATEST B.S.R.

"MONARDECK"

SINGLE SPEED

3 i.p.s., takes 52in. spools. Simple controls. £9/-19/6. Tape extra. Carriage and insurance 5/-.

AUTOMATIC RECORD CHANGER UNITS

B.S.R. "MONARCH" UAS, 4 speed unit with B.S.R. FULLI cartridge, £6/19/6.

B.S.R. "SUN-RACH" UAS. As above but fitted with B.S.R. FULLI STEREO cartridge, £7/19/6. B.S.R. "MONARCH" UAU. 4 speed unit in green and cream.

B.S.R. "MONARCH" UAU. 5 speed unit in two tone grey, £8/6/6.

COLLARO "CONQUEST." 4-speed fully mixing changer, complete with studio "0" cartridge, £7/19/6.

GARRARD RC120 4D MK. 2. 4 speed unit with manual control to enable records to be played singly, fitted, £9/6/6.

GARRARD RC121 4D. 4-speed unit with plug in pick-up head, £9/6/6.

CATALOGUE

OUR 1961 CATALOGUE IS NOW AVAILABLE. PLEASE SEND 1/- IN STAMPS FOR YOUR COPY. TRADE CATALOGUE ALSO AVAILABLE. PLEASE ATTACH YOUR BUSINESS LETTERHEADING.
**CONTINENTAL—6**—just right for a day’s outing

**COMBINED PORTABLE/CAR RADIO**

Medium and Long Wave Full Tuning

- **New Type Printed Circuit**
- **4 Transistor Design**
- **1600W Push-Pull Output**
- **Internal Ferrite Aerial**
- **Slow Motion Tuning**
- **Fully Illustrated Instructions**
- **Printed Circuit marked out**
- **Car Radio aerial socket and A.V.C.**
- **ALL COMPONENTS GUARANTEED**
- **Size 9x7 x 3\(\frac{1}{4}\)in. Weight 1 lb.**

Special Price of Complete Leaft and Prices

**NEW PRODUCTS**

**931A (27M1) PHOTO MODULATOR.**

On/Off MODULATOR. 100 KO. and 1 Mc/s. Output up to 20 MO.

CRYSTAL CONTROLLED OSCILLATORS:

<table>
<thead>
<tr>
<th>Model</th>
<th>Frequency</th>
<th>Price</th>
</tr>
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<tbody>
<tr>
<td>71A</td>
<td>30 Mc/s</td>
<td>15/-</td>
</tr>
<tr>
<td>XAI02</td>
<td>9 Mc/s</td>
<td>35/-</td>
</tr>
<tr>
<td>XAI04</td>
<td>6 Mc/s</td>
<td>35/-</td>
</tr>
<tr>
<td>XAI05</td>
<td>4 Mc/s</td>
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<td>XAI06</td>
<td>3 Mc/s</td>
<td>35/-</td>
</tr>
<tr>
<td>XAI07</td>
<td>2 Mc/s</td>
<td>35/-</td>
</tr>
<tr>
<td>XAI08</td>
<td>1 Mc/s</td>
<td>35/-</td>
</tr>
</tbody>
</table>

**TOTAL COST of All Components:**

- **£11.10.0 P.P. 3/6**
  - including Cabinet, Battery, Transistors, Car Radio, A.V.C. and all necessary items.

A highly sensitive and selective portable fully tunable on medium and long waves. Performs equally well as a car radio. Low running costs, good looks and ease of construction combine to produce a radio equal to commercial receivers.

**ALL COMPONENTS AVAILABLE SEPARATELY**

**WHEREVER you are**

**“First Class in every way”**

**CONTINENTAL AND LOCAL STATIONS AT YOUR FINGERTIPS**

**NEW PRODUCTS**

- **OpenGL MONDAY to SAT. 9-6. THURS. 1-6.**
  - **FREE LISTS**
  - **All components sold separately.**
  - **NO AERIAL—NO EARTH**

**MAJOR—3**

(3-Transistor Pocket Radio)

- **4-stage Reflex Circuits.**
- **No Aerial or earth required.**
- **Min. Volume Control.**
- **3 Ediswan Transistors.**
- **Medium Wave Tuning.**
- **Size 4 x 3 x 1\(\frac{1}{4}\)in.**
- **Weight only 4 oz.**

**TOTAL 69/6 POST 1/6**

**FREE BOOKLET:** All components sold separately.

**NO AERIAL—NO EARTH**

**RECEPTION GUARANTEED ANYWHERE**

**MARCONI No. 19 SET CRISTAL CALIBRATION RECEIVERS**

**CRYSTAL CONTROLLED OSCILLATORS:**

- **10 Kilos. 100 Kilos. and 1 Mc/s. Output up to 20 Mc/s.**
- **On/OFF MODULATOR.**

**QUARTZ CRYSTALS FROM 5/\(\frac{1}{2}\) EACH**

From 6 Kilos-47 Mc/s (FT243, FT241, 1DX1 and 87G).

All types for all purposes. Send for free list.

**WALKIE-TALKIE TYPE 18 TRANSMITTER/RECEIVER**

Complete with 5 valves. In new condition. These Sets are sold without Guarantee, but are serviceable (7 to 9 Mc/s), 2/6. P.P. 2/6. Headphones 7/6 pair, Jackon Box 2/6.

**931A (27M1) PHOTO MULTIPLIER**

BRAND NEW, ORIGINAL CARTONS

**HENRY’S (Radio) LTD.**

Opposite Edgware Road Tube Station. PADDINGTON, LONDON, W.2.

CLOSED MONDAY to SAT. 9-6. THURS. 1-6.

**FREE LISTS BY RETURN VALVES, TUBES, TX/RX STANDARD AND MINIATURE COMPONENTS**

**TRANSISTORS**

Free complete list and data on request. FULLY GUARANTEED

**EDISWAN**

- **XAI131 250 Mc/s. Ideal for F.M.**
- **XCI121 400 Wt Push-Pull**
- **XCI131 350 Mc/s in Push-Pull.**
- **XAI104 6 Mc/s osc/mixer, R.F.**
- **XAI103 4 Mc/s R.F., I.F., amp.**
- **XBI102 Audio Output Driver.**
- **XBI103 250 Mc/s Output.**
- **XAI105 5 Mc/s R.F., I.F., amp.**
- **XCI131 Matched paras., 500 Mc/s.**

**SEMICONDUCTORS**

- **S6708 30 Mc/s Short Wave**
- **S6305 25 Mc/s Radio Control**
- **S6231 30 Mc/s Radio Control**
- **S6231 35 Mc/s, H.F. osc/mixer.**

Above are direct equivalents of SB341:

**SB100G; SB101G; etc.**

**MULLARD**

- **OC72 Power Driver.**
- **OC45 6 Mc/s, R.F., I.F.**
- **OC71 Audio Driver.**
- **OC72 400 mW Push-Pull.**
- **OC70 70 Mc/s Short Wave.**
- **OC139 N.F.N. 4 Mc/s.**
- **OC140 N.F.N. 6 Mc/s.**

**SURPLUS**

- **Red Spot Audio Driver.**
- **White Spot R.F., I.F., amp.**
- **Phono-Transistor (General).**

**NEWMARKET**

- **V15/10P Up to 10 watt pairs**
- **V15/10P Up to 10 watt pairs**
- **12/6; P.P. 1/6.**

**STATIONS AT YOUR DISPOSAL**

**“STEREO 3 D”**

New high-gain circuit with full tone, balance and volume controls. Can be used with all types of records, as well as stereo.

- 2 watts peak per channel.
- E99C83, 2-CFL2 valves.
- Mains 110/250V A.C.

Complete with speaker sockets, calibrated dials, etc.

**BUILT AND TESTED 35/16. P.P. 2/6.**

**“Practical Transistors Circuits”**

- 14 Circuits for the Home Constructor, including date, prices and information. 1st Edition, 2/6, post free.
EVERETT EDGCOMBE SYNCCLOCKS.
Grade 1 industrial process timer with 3 inch dial covering 1 to 10 minutes in one tenth divisions. Driven by a 15 volt 50 c/s synchronous clock. A metal rectifier provides D.C. to pull in a relay that engages the drive until the time set on the dial elapses. As it reaches zero heavy duty contacts snap shut to close the external circuit (at the same time other contacts break to arrest the clock). Switching off the power trips the relay and the spring loaded dial returns to the time set ready for the next cycle. Whole totally enclosed in a heavy cast wall mounting case, stove enamelled black, size 6½ x 7 x 4 inches. Brand new in original packings 55/- post paid.

VENNER TIME SWITCHES.
Type T.S.2, first grade precision time switches as supplied to G.P.O. Comprises absolutely silent self starting 250 volt 50 c/s synchronous clock mechanism totally enclosed in heavy gauge brass case. Central drive takes detachable dial that revolves to operate sensitive on and off trips for external mains operated circuit. Self contained clock is easily detachable from rear mounting panel (self starting down to 80 v. and keeps running down to 15 v.). Brand new, in original packings, and with one dial 50/- post paid.

TORCH IGNITER PUMP.
£2 carriage paid. Plessey FP3 Mk. 4, totally enclosed, flame proof, compound wound motor driving a self-lubricating, positive displacement, sliding blade Kerosene pump through a 4 to 1 reduction gearbox. Running on 24 volts D.C. (designed for 16-20 v.) the motor develops 1/6th h.p. at 13,000 r.p.m., pumping about a gallon a minute at 30 p.s.i. (adjustable by pressure relief valve) Performance marginally less on 12 volts. Inlet and outlet unions 1½ in. B.S.P. Brand new.

200 AMPERE D.C. GENERATORS.
£6 carr. paid. Normally driven from tractor power take-off or the like to give a 29 v. output sufficient to weld ½ in. plate. American 403 cycles inverter. £2 carr. paid.

AMERICAN COWL GILL MOTORS.
Smaller and neater than British counterpart. Split-field, reversible. 12-24 volts. £6 carr. paid.

AMERICAN 403 CYCLES INVERTER.
£33/6 post paid. Very neat unit indeed, only 21 dia. by 4½ in. long on 1½ in. high pedestal base containing suppressor. B.W. bearings. 24 volt D.C. input for 26 volt single phase output. Instrument quality — as used with Bendix Magnesyn compass system.

MAINS OPERATED PHONE BELLS.
New, weather protected, sealed twin 500 ohm solenoids driving striker between twin 6 in. dia. plated gongs. £33/6 post paid.

VARIABLE SPEED HYDRAULIC GEARBOX.
This specially made oil-filled casing houses a hydraulic torque conversion unit originally precision made by Westinghouse from high quality materials for the U.S. Government at an acquisition cost exceeding £150 each. Highly suitable for lathes, head drive, workshop variable speed power take-off, etc. Basically the unit is a back-to-back mounted, oil submerged, variable displacement hydraulic pump (input shaft) feeding a reversible hydraulic motor (output shaft) so that variation of the pump displacement by manual control gives very fine selection of output speed from zero up to 6½ below input speed while a changeover valve in the supply lines to the motor provides instantaneous reverse at any speed. Recommended input speed 500-1,000 r.p.m., maximum power 14 h.p. Both shafts ½ in. dia. with Woodruff key. Tested and fully guaranteed, supplied complete with technical data and performance curves for the remarkable price of £16 only, carriage paid.

PORTABLE PETROL-ELECTRIC GENERATING SETS
Preliminary announcement — write for full details. Self contained 80 watt unit delivering 12 to 18 volts. Size only 15 x 8 inches, weight 46 lb.

As new £9 carriage £10/-

SPECIAL VALVE BARGAIN.
Set of 5 brand new 25 SN7's £1 post free.


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Type G10/241 Nomotron ("read out") tubes—latest type cold cathode, gas-filled, single pulse, uni-directional decade counter which displays count in actual numeral on tube face. Operating range 0-20 Kc/s; cathode output 40 volts, 3.7 mA. Applications include: tachometers, counting and batching, frequency and time measurement, direct operation of electro-magnetic relays, sequential monitoring of up to 10 different waveforms, etc. Brand new with base and instructions. 32/6 post paid.

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SMALL QUANTITY BRAND NEW CLASS D WAVE METERS
Complete with reference xtal. £5 carriage paid.

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£6 carr. paid. Five heavy duty 1/v. cells gives 6 v. for 75 amp.-hours. Fully charged in 15½ x 12 x 6 in. wooden crate.

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£16/- post paid. New, full wave, 12 volt, 4 amp. 4½ in. dia. Type B.56.

144
THE EASY SIX

Transistor Battery Portable
MAY BE BUILT FOR
£9.15.0 plus 3/- p. p.

STAR FEATURES:
- Six 1st grade Mullard Transistors
- Internal Ferrite Rod Aerial
- Provision for Car Radio Aerial
- 9 in. Loudspeaker
- Printed circuit, with component positions indicated
- Preassembled Dial Assembly
- 500 milliamp Power
- Full pull output
- Full medium and long waveband coverage
- Attractive two-tone Brown/Cream Vynide covered Cabinet, dimensions 81/4 x 61/2 x 3in.
- Full point-to-point instructions supplied
- Weights 7 lb with battery.

AVANTIC SP21 Stereo Pre-amp Control Unit. Brief specifications:
- 6 inputs for each channel, bass, treble, volume control, off/on stereo/3D/reverse stereo switch, stereo phase switch, low pass filter.
- Power requirements 6.3 v. at 1.2 A., A.C., 350 v. at 5 mA. D.C.
- Dimensions 141 x 9 x 4in.
- Original price £280-10-0. F. & P. 1/6. OUR PRICE 18 Gns.

All this equipment is Brand New and in manufacturers' original sealed cartons. Full descriptive literature available.

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By Well Known Manufacturer
SEND FOR FULL TECHNICAL DETAILS

THE PETITE PORTABLE
MAY BE BUILT FOR
£7.7.0 p. & p.

COMPACT GRAM. AMPLIFIER
PRICE £2.19.6

ASSEMBLE IT YOURSELF AND SAVE £ £ £

THE "CLARION"
Transistorized miniature battery-operated TAPE RECORDER
- Completely transistorised circuit.
- Constant governed speed of 30 L.P.S.
- Recordings interchangeable with other recorders.
- Remarkable reproduction on both speech and music.
- Price complete with Microphone and case—

THE "MID-FI" A NEW DESIGN 41 WATT AMPLIFIER KIT
MAY BE BUILT FOR
95/- plus 3/- p. & p.

THE VICEROY QUALITY CRYSTAL MICROPHONE. A good-quality crystal Microphone for the discerning enthusiast, finished in polished steel with Mullard Switch and detachable lead. Price 3 gns. F. & P. 1/6
**R.S.C. HI-FI TAPE RECORDER KIT**

Build a high quality recorder in the £10 class only for £25.

**R.S.C. BATTERY TO MAINS CONVERSION UNITS**

- **Selenium Rectifiers**
  - We can quote special prices for quantities of 12 to 1000 or more.
  - Special types made to order.

- **Rectifier Kits**
  - Special types made to order.

- **Seizure Units**
  - Can be used with all types of mains trans. 200-250 v. 50 c.p.s.; 12 v. 1 amp. selenium.

- **Audio Transformers**
  - Can be used with all types of mains trans. 200-250 v. 50 c.p.s.; 12 v. 1 amp. selenium.

**S.E.L.E.N.UM RECTIFIERS**

- **Power Pack Kits**
  - 6 v. or 12 v. 4 amps.

- **Battery Chargers**
  - 6 v. or 12 v. 4 amps.

- **Battery Charger Kits**
  - 6 v. or 12 v. 4 amps.

- **R.S.C. Hi-Fi Tape Recorder Kit**
  - Build a high quality recorder in the £10 class only for £25.

**RE-ENTRANT LOUD-SPEAKERS**

- **Low price is required, we highly recommend this unit with an amazing performance.**
  - B.W. "STENTORIAN" HIGH FIDELITY P.M.
  - Suitable for use with any record playing emit and most cabinets.

**BUILD A PORTABLE BATTERY OPERATED RECORD PLAYBACK UNIT**

- **Extension Speakers**
  - 6" in brown or cream bakelite or veneered walnut.

**THE SKY FOUR T.R.F. RECEIVER**

- **Full 7in. Diameter Reels of Tape**
  - **Fast rewind, Tape measuring and Calibrating Device.**

**B.S.R. MONARDECKS**

- As fitted to most tape recorders in the £20/21 class. With a suitable amplifier and speaker really excellent recordings can be made at 3 mph. **9 Gns.**

**S.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER KIT**

- **Selenium Rectifiers**
  - For 200-250 v. A.C. mains using 2 v. accumulator.

**JUNCTION TRANSFORMERS, B.P. Type**

- **Selenium Rectifiers**
  - 6 v. or 12 v. 4 amps.

**RECORDING HEADS**

- **Point to Point wiring diagrams**

**BATTERY CHARGERS**

- **6 v. or 12 v. 4 amps.**

**ASSEMBLED CHARGER**

- **6 v. or 12 v. 4 amps.**

**Battery Charger Kits for 200-230-250 v. 50 c/s. A.C. Mains**

- **Linear 1.5 miniature 4/5 w. Quality Amplifier**
  - Suitable for use with any record playing emit and most cabinets.

**Battery Chargers and Kits for 200-230-250 v. 50 c/s. A.C. Mains**

- **R.S.C. Hi-Fi Tape Recorder Kit**
  - Build a high quality recorder in the £10 class only for £25.

**SUPERHET RADIO FEEDER UNIT**

- **Design of a 3 speed, 200-250 v. A.C. mains 12 and 18.65 miliamps.**

**R.A. 12 STEREO AMPLIFIER KIT**

- **Hi-FI 10 WATT AMPLIFIERS**
  - **Brand New BUT SLIGHTLY SOILED CONDITION**

**SEIZURE UNITS**

- **Hi-FI 10 WATT AMPLIFIERS**
  - **Brand New BUT SLIGHTLY SOILED CONDITION**

**VALVES**

- **Full range at competitive prices**

- **Superhet Radio Feeder Unit**
  - Design of a high quality Radio Tuner Unit (suitable for use with any of our Amplifiers). A Triode Zeppa Frequency is used. Periods I.F. and double Brite Second Detectors, giving a V.O.C. and V.I.D. only, to V.O.C. distortion is avoided. The W. Ch. S.C. incorporates Gramophone Headphone. Output transformer is fitted. Will load most Amplifiers requiring 500 mV input depending on load position. Only 50/9, 6-12 v. 2-8 a. 6-3. 1 v. 1 amp. required from amplifier. Size of unit approx. 6-6 x 5in. Bin. Size of unit approx. 6-6 x 5in. Send S.A.E. for Illustrated leaflet.

**BUILD A PORTABLE BATTERY OPERATED RECORD PLAYBACK UNIT**

- **Extension Speakers**
  - Humane walnut veneered cabinets. All standard 2/3 chms. 6/3; 29/9; Bin. 39/9.

**RE-ENTRANT LOUD-SPEAKERS**

- **Low price is required, we highly recommend this unit with an amazing performance.**

- **R.S.C. Hi-Fi Tape Recorder Kit**
  - Build a high quality recorder in the £10 class only for £25.

**R.S.C. BATTERY TO MAINS CONVERSION UNITS**

- **Selenium Rectifiers**
  - We can quote special prices for quantities of 12 to 1000 or more.

- **Rectifier Kits**
  - Special types made to order.

- **Seizure Units**
  - Can be used with all types of mains trans. 200-250 v. 50 c.p.s.; 12 v. 1 amp. selenium.

**S.E.L.E.N.UM RECTIFIERS**

- **Power Pack Kits**
  - 6 v. or 12 v. 4 amps.

- **Battery Chargers**
  - 6 v. or 12 v. 4 amps.

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**ASSEMBLED CHARGER**

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**Battery Charger Kits for 200-230-250 v. 50 c/s. A.C. Mains**

- **Linear 1.5 miniature 4/5 w. Quality Amplifier**
  - Suitable for use with any record playing emit and most cabinets.

**Battery Chargers and Kits for 200-230-250 v. 50 c/s. A.C. Mains**

- **R.S.C. Hi-Fi Tape Recorder Kit**
  - Build a high quality recorder in the £10 class only for £25.

**SUPERHET RADIO FEEDER UNIT**

- **Design of a high quality Radio Tuner Unit (suitable for use with any of our Amplifiers). A Triode Zeppa Frequency is used. Periods I.F. and double Brite Second Detectors, giving a V.O.C. and V.I.D. only, to V.O.C. distortion is avoided. The W. Ch. S.C. incorporates Gramophone Headphone. Output transformer is fitted. Will load most Amplifiers requiring 500 mV input depending on load position. Only 50/9, 6-12 v. 2-8 a. 6-3. 1 v. 1 amp. required from amplifier. Size of unit approx. 6-6 x 5in. Bin. Size of unit approx. 6-6 x 5in. Send S.A.E. for Illustrated leaflet.

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**Battery Charger Kits for 200-230-250 v. 50 c/s. A.C. Mains**

- **Linear 1.5 miniature 4/5 w. Quality Amplifier**
  - Suitable for use with any record playing emit and most cabinets.
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A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 milliamps at full output. Full wave symmetrical output to suit all types of loudspeakers. Separate T.H. and Treble controls are provided. These give full long playing record equalisation.

Hum-level is negligible being 48 D.B. at 7/12 in.

Tone level is negligible being 71 D.B. at 7/12 in.


WE CAN QUOTE FOR SPECIAL OR STANDARD TYPES IN ANY QUANTITY. OUR

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RADIO FEEDER UNIT. Price in kit form with easy-to-follow wiring diagrams.

CERTIFIED PERFORMANCE

SURES THE SUITABILITY OF ANY

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Price only 25/17/6

Output for 2-3 ohm speaker.

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COLLARO AUTO-CHANGERS. Standard replacement for Garrard units. Includes crystal pick-up head, 23/- 19/6. Acoé Stereo/Monaural 49/- 9/6.

LOADSPEAKER IN WOODED WALNUT FINISHED CABINET.

Gallows Top Entry 10 Watts to match 6V6 26/6 to 3 ohms.


PLESSEY DUAL CONCENTRIC 12in. P.M. SPEAKERS

(15 ohms), consisting of a high quality 12in. speaker with twin support, giving a small elliptical speaker ready wired with chokes and condensers to suit as tweeter. This high fidelity line is highly recommended for use with our A11 or any similar amplifier. Retail is 10/- a pair. Price only 5/- 7/6/6. Or Deposit 10/6 and total payments of 10/- 6/6.
WAYNE KERR SIGNAL GENERATORS, TYPE 5/53

9 to 30 megacycles. Output 1 micro-volt to 10 millivolt. Five position switched attenuator. Variables multiplier 1 to 16, inflated 9-60 db. D.W. square wave and sine wave outputs. Complete with all valves, and leads. SUITABLE FOR ALIGNING T.V. and V.H.F. RADIO.

350-0-350 v. 100 mA., 6.3 v. 2 a., 5 v. 2 a. 7 a. 5 v. 3 a.

All 200-250 v. 50 c.p.s. input.

OLYMPUS

EX GOVT. MAINS TRANSFORMERS

All 200-250 v. 50 c.p.s. output. Pr. 0-110-220-250 v. 272-0-272 r. 100 mA., 6.3 v. 7 a. 5 v. 3 a. 250 v. 200 mA. 6.3 v. 2 a. 125/250 v. 100 mA., 6.3 v. 2 a. 5 v. 3 a. 350-0-350 v. 100 mA., 6.3 v. 2 a. 5 v. 3 a. 0-500-500 v. 12 amps. A.C. conservative Govt. rating (marked with D.C. rating after rectification) Carr. 15/-.

0-10-20-25 v. 54 a. (Govt. rating) Carr. 15.90


0-10-20-25 v. 120 a. (Govt. rating) Carr. 15/-

100-110-120-220-250 v. 50 c.p.s. input.

V.H.F./F.M. A.M. 4 WAVEBAND RADIO RECEIVERS


COSSOR BATTERY PORTABLE RECORD PLAYER

Operates with two 4.5 v. Dry batteries which last for months under normal conditions. Plays 45 r.p.m. records at ample output level. Ideal for picnics, etc. Attractive two tone finial covered cabinet. Limited number. Brand new, guaranteed, at only 9 Carr. 35/6 half list price.

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Carpenters Type Pointed 9 x 8.00 turns at 1,685 ohms. 19/6. Miniature Moving Coil Differential Type. Single pole 2-way, or centre stable. Two coils each 350 ohms. Minimum operating current 140 micro-amps, maximum 400 micro-amps, maximum 8 milli amps. Two-way coilset current 100 ma. at 50 v. A.C. or D.C. Size approx. 1 x 3 x Eln. 19/6. Miniature type G.R.O 470 x 32 H.B. M. 10.05, 7/11.

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Complete including bell 230 volt for office, shop, house, factory or outdoor communication. Operate with small dry battery lasting many months. Supplied complete in wooden carrying case. Only 59/6 Carr. 8/-.
V.H.F. COMMUNICATION RECEIVER 1392
15 VALVE SUPERHET
Frequency Range 95–150 Mc/s. (2 to 3 metres)
Gives reception of Police, Aircraft and Amateur transmissions.
Valve line up: 1st and 2nd R.F. Amp. VR.136 (EF.54), 1st Local Oscil-
lator; VR.82 (EP.61), 2 oscillator Multipliers; VR.136 (EF.54); 3 I.F. Amp.; VR.53 (EF.39); A.G.C. 6Q7; Output 65; Muting VR.92 (EA.50);
Noise Limiter VR.92 (EA.50); B.F.O. 6L7; Mixer VR.136 (EF.54); De Mod. 6Q7. Slow motion tuning, normally crystal controlled or tunable over 95–150 Mc/s. Power supply required: 240–250 volts at
80 mA., 6.3 volts at 4 amps. Size 19 in. x 10 in. x 10 in. Standard Rack mounting.

COMMUNICATION RECEIVER R.206
width switch; 0.7, 2.5 or 8 kc/s. A.V.C. switch, B.F.O. control. 900 c/s. filter switch. Transient interference limiter. Aerial, earth, muting, phones and line inputs. Designed for use with
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offered at only £22/10/-, carr. 50/-.

D.M.3 DYNAMOTOR. America's finest little dynamotor offering 12 v. In with 220 v. out at 80 mA. With suppression and smoothing mounting base. Size 4½ x 21 x 21 in. Original packing. ONLY 35/-.

TWO TRANSISTOR POCKET RADIO
with Miniature Speaker
HERE IT IS . . . The very best 2-transistor kit you have ever seen . . . at a price so low that it will amaze you!

Anyone can build it! This powerful pocket radio gives reception over the entire broadcast band. Complete
with all parts including two transistors, exclusive ferrite rod, miniature speaker, tuning condenser, plastic case, wiring
diagram and step-by-step instructions. Size 4½ x 1½ x 3½.

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A truly magnificent first-grade I.F. oscillo-
scope incorporating a hard valve time base, speeds 1–5–40 milliseconds, easily extended for a few shillings to 3 c.p.s. to 30 kc/s. speeds. Has high-class amplifier with fine and coarse
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20 in stock so first come first served. Genu-
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OUR PRICE £12.10.0 Carr. 15/-

ALL BAND RECEIVER R.107
AMATEUR—SHIPPING—BROADCAST
This magnificent 9-valve 3-wave band receiver gives world-wide reception over 1.2–17 Mc/s.
(2–300 metres). The sensitivity is 1 microvolt on C.W., and 2–6 microvolts on R.T. Panel
controls include Bandswitch ("Wide" or "Narrow"), choice of AVC and BFO, Audio
Filter, R.F. Gain, Aerial Trimmer. Has built-in
Output stage with internal speakers. Head-
phones sockets. Incorporates internal A.C. mains
power unit (110–250 v. ± A.C.) and 12 volts D.C.
Vibrator pack. Size 24 x 13 x 17 in. These sets
are extensively tested prior to despatch.

Supplied complete and ready for immediate use.

£13.10.0 Carr. 20/- (England and Wales), rest of U.K. extra.

WIRELESS SET No. 19 MK. II
SET ONLY 65/- Carr. 10/-
This most famous Army Trans/Receiver covers 2–8
Mc/s. (150–37 metres) in two bands and 230–246 Mc/s.
V.H.F. Has an in-circuit amplifier. Designed for 12
and 24 volt operation. Uses a 6 valve superhet receiver.

I.F. being 465 kc/s, and a 6 valve transmitter designed for voice and C.W. operation. Incorpor-
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Complete station (as illus.), comprising: 19 set, Supply Unit, Control box, Head-
phones, Microphone, Morse Key, Variometer, Short Wave and V.H.F. Aerials and
bases and full set of leads. All for only £9. Carr. 15/-.

VARIABLE TRANSFORMERS
Input voltage 230 v. continuously variable output from 0–260 v. These variable transformers are of advanced mechanical design offer-
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pout voltage. Direct-reading dial with large white numerals for ac-
curate output voltage selection. Supplied-complete.

MODEL B.10. Current rating 10 amps., £18/10/-.
MODEL B.20. Current rating 20 amps., £32/10/-.

WOT! You don't own a Relda catalogue? It's terrific and fully illus. Only 1/3.
PERIPHONIC
the no-distortion push-pull loudspeaker
STYLED FOR THE SIXTIES
in the new slender cabinet

BCS 1874
Maximum response
Minimum floor space
New slender cabinet
Two-tone walnut finish
Treble adjustable
Stereo or monaural
2 metal cone speakers in push pull
for 12 or 25 watt amplifiers
Full details and prices from Sound Equipment Section

HIGH QUALITY SOUND EQUIPMENT
Metal Cone Loudspeakers - Presence Units - Stereophonic Systems Periphonics Loudspeaker Systems Pre-amplifiers - Amplifiers

G.E.C. RADIO GROUP, THE GENERAL ELECTRIC CO. LTD.
MAGNET HOUSE, KINGSWAY, LONDON, WC2

PERIPHONIC the no-distortion push-pull loudspeaker
STYLED FOR THE SIXTIES in the new slender cabinet

BCS 1874
Maximum response
Minimum floor space
New slender cabinet
Two-tone walnut finish
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RESISTANCE WIRES
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Most Gauges Available
NICKEL-CHROME MANGANIN
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ENAMELLED, TINNED, LITZ, COTTON AND SILK COVERED
SMALL ORDERS PROMPTLY DESPATCHED
B.A. SCREWS, NUTS, WASHERS,
Rivets, EBONITE and BAKELITE PANELS
TUFNOL ROD, PAXOLIN TYPE COIL FORMERS AND TUBES, ALL DIAMETERS
SEND STAMP FOR LIST.

PERIPHONIC the no-distortion push-pull loudspeaker
STYLED FOR THE SIXTIES in the new slender cabinet

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Maximum response
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Rivets, EBONITE and BAKELITE PANELS
TUFNOL ROD, PAXOLIN TYPE COIL FORMERS AND TUBES, ALL DIAMETERS
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BRAND NEW. Boxed.

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85 mi./nes., 6.3 v. 5 amps., 6.3 v. 0.3 amps.

6-VOLT VIBRATOR PACKS.

BRAND NEW, 25/-.

NEW. Boxed. 45/-.

D.C. output

Funnel cooled.

very reasonable price.

750 V.

300 V.

15 V.

AR88D MAINS TRANSFORMERS.


Since the Avo "D,"

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These offer are in first-class condition,

completely overhauled and carefully tested

prior to despatch. Complete with battery,

test leads and Instructions. £7(10/-).

6-VOLT VIBRATOR PACKS. H.R.O.

type, 180 v. D.C., 65 m/amps. BRAND NEW.

25/-, post 3/6. Type PLZ, 250 v.

D.C. 100 m/amps, with OZ4 rectifier.

BRAND NEW, 25/-.

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ADMLARYAL HT TRANSFORMERS

Pri. 230 v. 50 c/s. Seca. 620-550-375-0.

375-350-300-250 v. (600 and 500 m/amps.,

/amps, 250 v. m/amps., plus

2 v., 3 v., 5 v., 3.6 v., 6.3 v. 3.6 v.)

Shrouded. Size 3 x 3 x 3 in.

high. Weight 18 lbs.

Post FREE.

PROPER MAINS TRANSFORMERS.


(255 m/amps., 6.4 v. 4.5 v., 2 v., 41 x 41 x 3.5 in.

high. Wt. 21 lb. Posted.

Tag ends. ARC BRAND NEW.

Boxed. 25/-, post 6/.

"C" CORE TRANSFORMERS

Pri. 230 v. 50 c/s. 510-0-510 at 275 m/.

375-375-350 at 85 m/amps, 6.3 v. 9 A.

6 v. 22 A. (twire), 6.3 v. 6 A. 1 x 1, (twire), 4.3 v.

at 1.5 A, 6 v. at 2.3 A, 5 v. at 3 A, 6.1 v.

x 6.7 in. high. Weight 25 lbs.

Moved from equipment but in

perfect condition, 52/-.

Carr. 5/6.

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Upon all day Saturday

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the scale is even larger.

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completely overhauled and carefully tested

prior to despatch. Complete with battery,

test leads and Instructions. £7(10/-).

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25/-, post 3/6. Type PLZ, 250 v.

D.C. 100 m/amps, with OZ4 rectifier.

BRAND NEW, 25/-.

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ADMLARYAL HT TRANSFORMERS

Pri. 230 v. 50 c/s. Seca. 620-550-375-0.

375-350-300-250 v. (600 and 500 m/amps.,

/amps, 250 v. m/amps., plus

2 v., 3 v., 5 v., 3.6 v., 6.3 v. 3.6 v.)

Shrouded. Size 3 x 3 x 3 in.

high. Weight 18 lbs.

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**WIRELESS WORLD**

0.250 F., 4 kV. wkg., 6/- each.

T.C.C. (10 mfd., 1500 v. wkg., 15/- each. 3/- post. 18 mkt. 1,209 v. wag. 11/- each.)

16 kV. wkg. at 71 deg. C., ceramic instil. times per second size 161 x 9 x 311 a., ceramic instil., 25/- each, 3/- oust. 0.05 mfd.

**SMOOTHING UNIT**

For the above power supply 3 phases and 0-1 m. akses (grade 1) metal case same as the p.e. 6/-, curr. 7/6 with circuit.

**RANGE CONVERTOR**

(50 800 volt A.C. input, 24 v. at 3 amps or 19 v. twice at 3 amps each winding. Continuous tarepowereating weaving, etc., in metal case that fits the 100m. mark size 19 x 7 x 71n. Brand new 23/-, curr. 7/6 with circuit.

**GEARED SHAFTS**

110 volts A.C., Unip H.P., variable speed box 0-166. Size of unit 141 x 91/2 x 81/8. Brand new 89/-, curr. 10/-.

**TRANSMISSIONS**

Transformers to operate this unit 35/- each.

**POWER UNITS**

100-500 volt A.C. output, 24 v. at 3 amps or 19 v. twice at 3 amps each winding. Continuous tarepower, etc., in metal case that fits the 100m. mark size 19 x 7 x 71n. Brand new 23/-, curr. 7/6 with circuit.

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**STEREO OUTFITS**

Consisting of two 3 valve (10F3, 10P14, U9J) 3-watt mains amplifiers each complete with 8in. loudspeaker in neat bakelite cases with independent controls, together with UA8 Stereo changer and screened leads. Unrepeatable £11.10! **AMPLIFIERS ONLY 49/- EACH.**

**UA8 STEREO CHANGERS**

B.S.R. Monarch Autochangers fitted with quality Stereo Cartridge. Truly amazing value at £6.19

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
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<tr>
<td>UA14</td>
<td>£9.11</td>
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<tr>
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<td>£12.12</td>
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<td>UA16</td>
<td>£14.14</td>
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**SPECIAL OFFERS**

**Sagatone Tape Recorders**

Few only reduced from £25.90, incorporating latest Calorcon Model tape transport, 3 valves, "superignite" speaker, mike, two lupos, excellent performance 29.90.

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**PM SPEAKERS Surplus 3 ohm**

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A service scope easily convertible for standard use, 200/200 V.A.C., all valves, B.S.R.20 tube, excellent case worth £15.15.

Our price £4.10

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<tr>
<th>INSTRUMENTS C.R.T.'s.</th>
<th>VOR177 (Inc.)</th>
<th>VOR167 (14L)</th>
<th>VOR167B (16L)</th>
<th>VOR167C (18L)</th>
<th>VOR167D (20L)</th>
<th>VOR167E (22L)</th>
<th>VOR167F (24L)</th>
<th>VOR167G (26L)</th>
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<tr>
<td>£13.91</td>
<td>£15.91</td>
<td>£17.91</td>
<td>£19.91</td>
<td>£21.91</td>
<td>£23.91</td>
<td>£25.91</td>
<td>£27.91</td>
<td>£29.91</td>
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**4-SPEED RECORD PLAYER**

Latest Turntable, together with lightweight Motor Drive with additional turntable pick-up head. Amazing value at £24.99.

**RECTIFIERS - For Charges with maximum, full wave bridge.**

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<tr>
<th>Valve</th>
<th>Price</th>
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<tr>
<td>356 V. 80 mA.</td>
<td>£1.95</td>
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<tr>
<td>550 V. 60 mA.</td>
<td>£2.85</td>
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<tr>
<td>1100 V. 15 mA.</td>
<td>£3.65</td>
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</table>

**100 RESISTORS 7/10-100 OHMS 10%**

A good lot of miniature silver wire and ceramic condensers 3-10,000 PF. List value over £2.

**ALL CRYSTALS**

Famous high sound quality, bonded to dot finish. Economy valves, lightweight. List prices £24.95, £19.95, £14.95, £9.95, £4.95, £2.95.

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<tr>
<th>Crystal</th>
<th>Price</th>
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<tbody>
<tr>
<td>£13.95</td>
<td>£15.95</td>
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**FREE INSURANCE.** ALL valves are new or of fully guaranteed ex-Government or ex-supplier origin. Satisfaction or Money Back Guarantee on return if found unsuitable. Order by telephone.

**POSTAGE.**

<table>
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<th>Weight</th>
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<tr>
<td>2lbs. 1/4</td>
<td>4 lbs. 2/4</td>
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**TECHNICAL TRADING CO., 350-352 FRATTON RD., PORTSMOUTH**

List of 1000 Special Offers 6d. Callers always welcome.
HEAVY DUTY AUTO TRANSFORMERS

All ratings tropical and in perfect condition.

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No. 5. Pri. 200-250 v. Sec. tapped 28, 29, 30, 31 v. 21 A. $4/17/6, carr. 7/6.


No. 12. Pri. 220 v. Sec. 65 v. 2 A. 17/6, carr. 7/6.

No. 13. Pri. 230 v. Sec. 50 v. 2 A., 6.5 A., 4.5 A., 2 A., 2.5 A., 1 A., 0.5 A. 0.5 A. 5.6 A. 5.5 A. 3 A. Brand new. $39/6, carr. 5/-.


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- T.165, 2-50 amp. LOW loading, 6,000 ohm, 23%, P.P. 20.
- T.165, 2-50 amp. 100 ma, 6,000 ohm, 23%, P.P. 20.
- T.45, 10 ma & 30 ma. R.A.P.S. TRANSFORMERS (Primarys 240-245 v., 150 ma., 15 v. 1 m.m., P.P. 20).
- T.30, 5-10 amp. & 100 ma., 300-350 v., 10 ma, 6.3 v. 2 m.m., P.P. 9.
- T.50, 250 v. x 15 ma., 200-250 v., 10 ma, 6.3 v. 4 m.m., P.P. 10.
- T.50, 250 v. x 50 ma., 250-350 v., 10 ma, 6.3 v. 2 m.m., P.P. 8.
- T.50, 500 v. x 15 ma., 300-350 v., 10 ma, 6.3 v. 4 m.m., P.P. 15.
- T.50, 500 v. x 50 ma., 250-350 v., 10 ma, 6.3 v. 2 m.m., P.P. 10.
- T.50, 600 v. x 15 ma., 250-350 v., 10 ma, 6.3 v. 4 m.m., P.P. 15.
- T.50, 600 v. x 50 ma., 250-350 v., 10 ma, 6.3 v. 2 m.m., P.P. 10.
- T.B. Trans. and Rectifier, 250 v. D.C. 100 ma., 6.3 v. 3.5 m.m., P.P. 10.
- T.B. Trans. and Rectifier, 250 v. D.C. 500 ma., 6.3 v. 2 m.m., P.P. 10.

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0210 MICRO AMETERS, 5 in. dia., moving coil type, flush panel mig., un-calibrated scale. **PRICE ONLY 25c.**, post paid.

LENSFLASHER BROADS. 8 in. x 10 in. new equipment, 3 ohm moving coil type. **PRICE ONLY 10c.**, post paid.

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TELEPHONE SET TYPE “A.” Ringing and Speaking both ways on a four-core cable. Carry the voice loudly and clearly over any distance. Two handsets are supplied as illustrated and the set is complete with Pushes, Buzzers, Battery, Plugs and Sockets. We can supply 4-core PVC cable at 10d. per yard of 2-core at 3d. per yard extra. Price 7/6, set 1/6.

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BATTERIES. Portable Lead Acid type, 5 volts 125 amperes hours. In metal case 16in. x 18in. x 11in. Two will make an ideal power source for our 12 volt Rotary Converters.) Uncharged 6/-10/-, each, carriage 1/6, 25 volts 50 amperes, 1/- each, carriage 1/6.

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Solenoids suitable for remote control, mechanical indicators, etc. 12 v. D.C., 400 M.A., 31/2, 31/2, arm. 41/2, movement, 5/- each, post 1/6.

RESISTORS EX STOCK, IN QUANTITY WIRE WOUND, HIGH STABILITY CARBON ETC., BEST MAKES AT LOWEST PRICE.

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Counting to 9999. 2.4 v. D.C., 15/- each, post 1/6.
75-220 v. D.C. 15/- each, post 1/6.
HIGH SPEED TYPE No. 100. 35/-, post 1/6.

VEEDER-ROOT MAGNETIC COUNTER. General purpose type with zero reset. 800 counts per minute up to 999999. 48 volt D.C. 5/-, post 2/6.

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ROOM THERMOSTAT. Adjustable between 45 and 75 deg. Fahr. 250 v. 10 amp. A.C. Ideal for greenhouses etc. 35/-, post 2/6.

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MIFE BATTERIES. Nickel Cadmium 12 volt 18 amperes hours cased and complete with alkaline filled. Brand New 27/6 each, carriage 10/- Also available 2.4 volt 10 amperes hours, 20/- each, post 3/6.

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Electronic Technology is an article which dis-
cusses the characteristics of common-emitter
amplifiers in relation to the specific require-
ments of communication systems.

Practical methods of stabilizing both the bias
point and the gain of a single stage are con-
sidered, together with the gain and bandwidth
achievable with the common-emitter connec-
tion. A two-stage feedback circuit is analyzed
in detail, the behaviour being illustrated by
means of flow graphs.

Finally, consideration is given to the problem
involved in applying large amounts of feed-
back over several stages and of obtaining the
desired input and output impedances. A
practical design is given of a 25-dB amplifier
suitable for five telephone channels and a
further illustrative example is also given in the
design of a typical channel amplifier.

Electronic Technology covers all technical interests in electronics, using this word in its widest
possible sense. All the familiar features of Electronic & Radio Engineer are retained, including,
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ARTICLES
IN THE SEPTEMBER ISSUE INCLUDE:

PIEZOMAGNETIC FERRITES
This article surveys modern piezomagnetic ferrite materials and
their applications in mechanical bandpass filters and high-power
ultrasonics.

RECORDING ATMOSPHERIC RADIO NOISE
The detailed study of atmospheric radio noise normally requires
complex equipment and skilled personnel, both of which present
a limitation to the gathering of information. This article des-
cribes an investigation which has been made of the technique
for tape-recording the noise at field stations, using simple
equipment, with a view to the recordings then being sent to a
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**TRANSFORMERS.** Primary 500 ohms imp. Sec. to match two 805s in push-pull drives. £7/6. P. & P. 5/.

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FOR RADIO AND ELECTRONIC ENGINEERS

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Radio and electronic engineers without a sound knowledge of Laplace Transforms and their applications to electrical circuits find themselves seriously handicapped; their difficulty has been to find an introductory text catering for their need, that of being able to use Laplace Transforms as a tool to solve their particular technical problems. This book, written specially for them by a radio engineer, presents the transformation theory in a language they will understand, dealing with electrical circuits from the very first paragraph and building up to the stage when transforms are used to investigate transient conditions.

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Hours of Business 9-6.
Callers welcome.
Terms: Cash with order or C.O.D.

No. 19.
SUPPLY UNITS

<table>
<thead>
<tr>
<th>No.</th>
<th>Mark III</th>
<th>Ref. ZA</th>
<th>15208.</th>
<th>Input: 12 volts.</th>
<th>Output Dual: 250 volts at 125 mA.</th>
<th>490 volts at 65 mA.</th>
<th>Non Tropicalised.</th>
</tr>
</thead>
</table>

No. 2 Ref. ZA 10572.
Input: 12 volts or switched to 24 volts.
Output Dual: 285 volts at 120 mA. 500 volts at 26 mA.
Also, 12 volt vibro Pack Rectified O24 Valve.
Mallory Type G6434 Vibrator.
All these units are smoothed.

Type ZA 3018.
No. 19 Mark II.
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All these units are smoothed and fused on both H.T. supplies.
All at 57/6. Plus 7/6 carriage.

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Carriage and Packing 7/6.

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SUPPLY UNIT VIBRATORY

<table>
<thead>
<tr>
<th>Type</th>
<th>ZB</th>
<th>0380.</th>
<th>Input 6 v. Output 230 v. 100 mA. BRAND NEW.</th>
<th>Completely enclosed.</th>
</tr>
</thead>
</table>

22/6 Post free.

MALLORY VIB

12v. 4 pin. No. 626C 2/6
6v. 5 pin. No. 534C 4/6
6v. 6 pin. No. 560 5/6
6v. 4 pin. No. 650 4/6
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LARGE STOCKS ALWAYS AVAILABLE

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TYPE 3,000

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COMPONENT PARTS ALL PLATED

Yokes, 4½ each. Top plates, 3d. each Armatures, 1½ each. Bottom Plates, 3d. Adjusted, ⅝ each. Spindles, ⅝ each. Armature Screws, adjustable, 6d. each.

BUILD UPS CONTACTS

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 v.</td>
<td>5v. 50p each.</td>
</tr>
<tr>
<td>6 v.</td>
<td>5v. 25p each.</td>
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</tbody>
</table>

COIL VALUES

<table>
<thead>
<tr>
<th>Type</th>
<th>Single Twin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver Platinum</td>
<td>100 Ohms 3/- 5/-</td>
</tr>
<tr>
<td>Copper</td>
<td>50 Ohms 2/- 4/-</td>
</tr>
</tbody>
</table>

BUILDUPS TO ORDER;

5/2-25p ohms Twin Coils

G.E.C. MINIATURE SEALED RELAYS

No. 7/6
Price 17/6 Post 1/6.

FIELD TELEPHONE SETS

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Supplied in two types
250 watts to carry 25amps. Resistance 0.4 ohms, worm drive, also 125 watts, 25 amps. Resistance 1 ohm, slider. Suitable for charging board, etc. Size 9 x 4 x 6in. high. Brand new, boxed.

Price 12/6 Post 3/6.

HEADPHONES.


SLIDING RESISTORS

<table>
<thead>
<tr>
<th>Type</th>
<th>2C26C</th>
<th>1/O.</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>28/6</td>
<td>2/6</td>
<td>2C26C</td>
<td>2C26C</td>
</tr>
<tr>
<td>17/6</td>
<td>2/6</td>
<td>2C26C</td>
<td>2C26C</td>
</tr>
</tbody>
</table>

NEW, BOXED, 4/10/- carriage extra.

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Due to continued expansion, International Business Machines, the largest company of its kind in the world, requires Customer Engineers to be responsible for the installation, maintenance and efficient working of IBM’s whole range of Data Processing equipment including computers, calculators and electro-mechanical accounting machines. Applications are invited to fill the following vacancies for the September and November Schools:

1. **COMPUTER ENGINEER** Applicants (age 21–30) should be of H.N.C. (Electronics) standard or have a sound background in general electronics with emphasis on pulse circuitry. A knowledge of computer or calculator techniques would be an advantage but is not essential. Computer Engineers selected for the IBM 700 series machines must be prepared to spend a training period of 5/6 months in France or the United States. For the IBM 650 and RAMAC systems, training given in the United Kingdom or Germany. Excellent starting salaries are offered based on qualifications and experience.

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Preliminary interviews for all grades will be conducted at the IBM offices which are located throughout the United Kingdom. Application should be made in writing to the Personnel Manager, IBM United Kingdom Limited, 101, Wigmore Street, London, W.1. quoting reference 60/77
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**TRANSFORMER DESIGNER (TEAM LEADER)—**An experienced Transformer Designer of special purpose Transformers for use in G.W. and other defence projects is required. The qualifications required are H.N.C. and an imaginative engineering outlook, together with a sound theoretical and practical knowledge of Transformer design. Several years' experience in this field is essential. **Ref: Sa/2/5**

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**Personnel Manager,**

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**UNIVERSAL**

**ATOMIC ENERGY AUTHORITY**

**THE RADIOCHEMICAL CENTRE**

**AMERSHAM, BUCKS.**

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**POST I Instrument Foreman**

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Range of centre frequencies: 2800-4000 Mc/s.
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Peak Power:* 2.5 MW.
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Isolation at centre frequency: Not less than 12 db.
Isolation over the band: Not less than 9 db.
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Input V.S.W.R.: Less than 1.5
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★ Some financial assistance towards the cost of removal to the London area will be offered where appropriate.
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The rate of pay is £12.12.0d. for a 44-hour, 5-day week. Housing will be available for married men. Promotion prospects are good and there is a superannuation scheme.

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Electrical/Electronic Maintenance Engineers for Electronic Data Processing Equipment. Both Valve and Transistor Techniques as well as Magnetic Drums and Cores are involved with a variety of input and output equipment.

Only young men between 22 and 30 in possession of H.N.C. in Electronic or Electrical Engineering including Electronics are invited to apply. The positions are permanent and the prospects excellent.

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Post would suit lecturer.

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I.—A thorough knowledge of electronic theory as applied to telecommunications, preferably to degree or H.N.C. level. Practical experience of telecommunications desirable.

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Previous experience essential. This is a responsible position in a rapidly expanding organisation. Contributory pension scheme. Salary according to age and experience.

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Chief Engineer,
FIELDEN ELECTRONICS LTD.
Paston Road, Wythenshawe,
Manchester 22.

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A leader for a team required in microwave tube field. He will control fundamental work leading to new devices and work on new devices. Freedom to develop new ideas.

Must have good honours degree and some published work in the microwave field.

Post would suit lecturer.

Details of education, subsequent experience, age and published papers should be sent to Dept. G.P.S., Marconi House, 336/7, Strand, London, W.C.2, quoting reference WW 1595C.
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