BICC are world famous for their electrical and radio products. The Anti-Interference Aerial maintains this reputation.

What it does  It has been specially designed to alleviate interference caused by radiation from electrically-operated transport, vehicle ignition systems, electrical appliances using commutator motors, lighting systems, etc. A high signal level is obtained and this ensures better listening on all broadcast wave-lengths, giving maximum choice of programmes against a quiet background.

What it is A 60-ft. polythene-protected dipole complete with insulators and matching transformer, 80-ft. coaxial screened downlead with polythene plug moulded to each end, and a receiver transformer. All the necessary components for the Aerial are included in the complete kit.

Write for Publication No.221-S giving further information. Obtainable only from recognised dealers. £6.18.0

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A comprehensive instrument built into one compact and convenient case, which will test any standard receiving or small power transmitting valve on any of its normal characteristics under conditions corresponding to any desired set of D.C. electrode voltages. A patented method enables A.C. voltages of suitable magnitude to be used throughout the Tester, thus eliminating the costly regulation problems associated with D.C. testing methods.

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- Complete Valve Characteristics including $I_a/V_g$, $I_s/V_a$, $I_s/V_g$, $I_a/V_a$, Amplification Factor, Anode A.C. Resistance, 4 ranges of Mutual Conductance covering mA/V figures up to 25 mA/V at bias values up to +100V, together with "Good/Bad" comparison test on coloured scale against rated figures.

"Gas" test for indicating presence and magnitude of grid current, inter-electrode insulation hot and cold directly indicated in megohms, separate cathode-to-heater insulation with valve hot. Tests Rectifying and Signal Diode Valves under reservoir load conditions, and covers all the heater voltages up to 125 volts.

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"Radio Times," Sept. 24, 1948

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Telegram "Audio Wolverhampton"

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A positive connection without solder - simply press & release
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Wireless World July, 1949

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Marconi’s first wireless messages did more than enable nation to speak to nation. They drew closer the world’s boundaries, quickened the tempo of existence and turned distant acquaintances into next-door neighbours. Broadcasting has helped still further to increase our knowledge of our neighbours; wireless navigational aids and radar have brought greater safety and faster travel between Continents. And so Marconi’s will continue to pioneer. Their engineers are busy today on developments which will make the world a closer community tomorrow.

Marconi the greatest name in wireless
MARCONI'S WIRELESS TELEGRAPH COMPANY LTD., MARCONI HOUSE, CHELMSFORD, ESSEX.
DAILY DEMONSTRATIONS
of the “BARKER 148A” mounted in the
“RD” BASS REFLEX CABINET in con-
junction with the “RD” JUNIOR or
“WILLIAMSON” AMPLIFIERS.

Full details forwarded on request.

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Patience, Perseverence, and Good Temper above all;
but also Skill and Intelligence.

The ultimate performance of a speaker unit—
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the intelligence of the user as on the skill of the designer.

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pursuing an Ideal, then we know we can help you.

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J. H. BRIERLEY (Gramophones and Recordings) LTD.,
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In December 1947 we were complimented by the Wireless World on
some features of the Barker 148. These were: the excellent balance at
comparatively low levels; the homogeneity of high frequency response;
low frequency response sensibly uniform down to 40 c/s with no major
bass resonance.

Of the new 148A, with its better magnet and new cone treatment, owners
and critics have remarked: the attack and transient response give the
impression of contrast expansion; so wide a range of frequencies with
apparent evenness of output produces an aural naturalness which has to be
heard to be appreciated; it is the best baffle loaded speaker we have
ever heard.

We ourselves believe it to be the most NATURAL, satisfyingly truthful
and pleasant to live with sound reproducer made anywhere.

The unique constructional features,
patented in many countries and
exclusive to BARKER, contribute
to this performance. First is the
DUAL DRIVE shown on the left,
and second the cone LOGA-
RITHMIC CORRUGATIONS.

These produce a very smooth
highly damped acoustic generator
of exceptionally wide frequency
range and remarkable clarity. They
are described fully in a new leaflet
obtainable at the specialists who
join us in this announcement, or

from your usual dealer, or from our
monomark address

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The 148A is being sent to many
countries overseas.

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MOST NATURAL SOUND REPRODUCER

ALWAYS THINK OF GOODSELL LTD.
FOR STANDARD AND SPECIAL
HIGH FIDELITY AMPLIFIERS

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from radio or the Brierley pick-up. You
will doubtless endorse our opinion that this
is an outstanding loud-speaker.

(Webb’s hire-purchase facilities
available on all equipment.)

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MORDAUNT, VOIGT, LEAK,
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ALL “HI-FI” EQUIPMENT.

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Oscilloscope Type 1/B
Time-base: 10—350,000 c.s.
X.Plates: Direct or Amplified.
Y.Plates: Direct or Amplified.
Miniature Valves and 1½" diameter C.R.T.
Dimensions: Height 7½" Width 5½" Depth 11"

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Output Voltage: 4V. R.M.S.
Nominal Frequency: 1.2 Mc/s.
Frequency Deviation: 0 to ±40 Kc/s.
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The two units clip together and are priced at

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Collaro's new Model RC49 more than fills a long felt need . . . . it brings you a reasonable priced record changer incorporating all the refinements hitherto associated only with expensive instruments . . . . plus many new features not to be found in any other record changer.

The RC49 loads, unloads, selects, plays repeats or rejects 10" or 12" records mixed in any order, by the operation of one single control knob.

The powerful induction-type MOTOR is suitable for 100/130 and 200/250 volts A.C., and incorporates the new "Rim Drive." Beautifully simple and completely reliable, the RC49 will give years of trouble-free service.

The

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RC49

Automatic Record Changer

COLLARO LTD.,

RIPPLE WORKS, BY-PASS ROAD, BARKING, ESSEX

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MINIATURE PULSE
AND R.F. BEAM TETRODE

The Mazda 6F17 is an indirectly heated miniature pulse and R.F. Beam Tetrode having an anode dissipation of 3.5 watts.

RATING

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heater Voltage (volts)</td>
<td>Vh 6.3</td>
</tr>
<tr>
<td>Heater Current (amps)</td>
<td>Ih 0.3</td>
</tr>
<tr>
<td>Maximum Anode Voltage (volts)</td>
<td>Va(max) 600</td>
</tr>
<tr>
<td>Maximum Screen Voltage (volts)</td>
<td>Vs(max) 600</td>
</tr>
<tr>
<td>Mutual Conductance (mA/V)</td>
<td>Rm 8.3</td>
</tr>
<tr>
<td>Maximum Anode Dissipation (watts)</td>
<td>Pa 13.5</td>
</tr>
<tr>
<td>Maximum Screen Dissipation (watts)</td>
<td>Pg2 0.7</td>
</tr>
</tbody>
</table>

* Tested under pulse conditions and taken at Va - Vg2 = 250v; Vgl = -6.25v; Ia = 64mA (approx.)
† If used in a can at maximum rating the can must be matt black both internally and externally.

Further details given on application to the Radio Division.

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are unsurpassed in performance

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Ex-demonstration and experimental equipment, shop soiled and redundant stock to be sold at “give away” prices. A few examples are as follows:

- **RDI High Fidelity Amplifier**. Ex. dem. model. (List £32 10s. 0d.) ………………………. £12 10 0
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- **Goodmans “Axiom 22,” high flux version of the “Axiom 12”** ………………………. £12 13 0
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A full description and photograph of the “RD Junior” cabinet will be forwarded on request.

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**THE FIRST AND MOST SUCCESSFUL TRIPLE REFLECTOR ARRAY**

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Established 1934
"... Productivity bears an important relationship to the amount of energy available per employee. In the United States this figure is approximately twice that in the United Kingdom..."

Asked to comment, our Managing Director (the sly old thing) said (in what he fondly imagined to be the courtly accents of old Virginnny): Ah sho will suh! What that grand ole Council says right now, those same verry words is what ah've bin a-tellin' and a-tellin' you-all ev'eh since old Methoosalem. That po' ole British Workin' Man he jes' sweats and strains body all achin' and racked with pains; lifts dat screwdriver, totes dat brace... Uh! Uh! Uh! Lawdy, lawdy, you-all sho must give that po' fella mo' hoss-power. Yassuh! Hoss-power. Nothin' else but.

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An insulating material of Low Di-electric Loss, for Coil Formers, Aerial Insulators, Valve Holders, etc.

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In aluminium tube

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Wireless World

July, 1949

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H.S.40. Windings as above. 4 v, 4 amps. 4 v, 2 amps. ... 15/6

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H.S.30. 200/250 v, 300/0/300 v. 80 ma. ... 17/6

H.S.1. 250/0/250 v, 250/0/250 v. 100 ma. ... 17/6

H.S.2. 250/0/250 v, 250/0/250 v. 100 ma. ... 19/6

H.S.30. 200/250 v, 300/0/300 v. 100 ma. ... 19/6

H.S.1. 250/0/250 v, 250/0/250 v. 100 ma. ... 19/6

F.5.2. 750/0/250 v, 250/0/250 v. 80 ma. ... 19/6

F.S.30. 200/250 v, 300/0/300 v, 100 ma. ... 19/6

F.5.3. 750/0/250 v, 250/0/250 v. 80 ma. ... 19/6

F.2. 250/0/250 v, 250/0/250 v. 100 ma. ... 19/6

F.5.30. 200/250 v, 300/0/300 v, 100 ma. ... 19/6

F.3. 750/0/250 v, 250/0/250 v. 100 ma. ... 21/6

All above have 6.3-4.0 v, at 4 amps. 5-40 at 2 amps.


200 ma, 6.3 v, 4amps C.T., 6.3 v, 4 amps C.T. ... 42/6

5 v, 3 amps. ... 42/6


250 ma, 6.3 v, 4amps C.T. ... 42/6

2 amps, 4 v, 3 amps. ... 49/6


250 ma, 6.3 v, 2 amps. C.T., 6.3 v, 4 amps C.T.,

6 v, 3 amps. ... 77/6

5 v, 3 amps. ... 77/6

F.36X. Input 200/250 v. Output 300/300 v.

200 ma, 6.3 v, 7 amps. 5 v, 2 amps. ... 26/6

E.H.T.2. 2,000 v, 5 ma., 2-0-2,7 v, 2, 4 v, 1.1 amps. ... 35/-

F.4. Filament Transformer. Input 200/250 v. ... 7/6

4 v. 2 amps. ... 7/6

F.4. Filament Transformer. Input 200/250 v. ... 7/6

6 v, 3 amps. ... 7/6

F.24. Filament Transformer. Input 200/250 v. ... 15/6

24 v. 24 v. 24 v. 24 v. 24 v. 24 v. 24 v. 24 v. ... 21/6

C.W.O. (add 1/- in £ for carriage), all orders over £2 carriage paid.

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The first public appearance of the "Soundmirror"—at the B.I.F.—was an overwhelming success. Hundreds of serious enquirers, from home and overseas, crowded the Stand each day. During the whole Fair the "Soundmirror" was viewed and demonstrated to thousands who were unanimous in their opinion that it was the outstanding feature of the show.

To enumerate the host of compliments paid to this remarkable machine would take a catalogue of considerable dimensions, but here are its salient features:

- 30 minutes' continuous recording.
- Highest fidelity reproduction without scratch or extraneous noises.
- One single finger tip control provides for play—record—rewind—or fast forward requirements.
- Automatic erasure as each new recording is made.
- Recordings are permanent—can be played an indefinite number of times.
- Uses reels of "Magic Ribbon Paper Tape"—easily handled, easily stored, inexpensive.

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Recordon Dictating Machine

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TR9 TRANSMITTER/RECEIVER
LESS VALVES
complete in transit case as illustrated.

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Model 1200B

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- Dimensions: The overall size of the two instruments is only 7" wide, 11" high, 9" deep.

**Early Deliveries**

<table>
<thead>
<tr>
<th>PRICE:</th>
<th>Model 1400B Unit £8. 10. 0.</th>
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<tbody>
<tr>
<td></td>
<td>Model 1200B Oscilloscope £32. 0. 0.</td>
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**Wireless World**

July, 1949

**Wharfedale**

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WITH OR WITHOUT R.F. STAGE—NINE WAVEBANDS

<table>
<thead>
<tr>
<th>EXPORT</th>
<th>SIZE WITH R.F. STAGE 8¼&quot; x 43¼&quot; x 2&quot;</th>
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<tr>
<td>13 mrs.</td>
<td>19 &quot;</td>
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<tr>
<td>16</td>
<td>23 &quot;</td>
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<tr>
<td>19</td>
<td>31 &quot;</td>
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<tr>
<td>22</td>
<td>41 &quot;</td>
</tr>
<tr>
<td>13-43</td>
<td>Moulded formers with Iron Cores—air 43-140</td>
</tr>
<tr>
<td>14-40</td>
<td>dielectric trimmers employed throughout 175-570</td>
</tr>
<tr>
<td>175-570</td>
<td>Gram L.W., Gram</td>
</tr>
</tbody>
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Wireless World
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<table>
<thead>
<tr>
<th>Capacity (Mfd.)</th>
<th>D.C. Working Voltage</th>
<th>External Size</th>
<th>Price</th>
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<tr>
<td>4</td>
<td>450v</td>
<td>1/4&quot; x 2 1/2&quot;</td>
<td>3/3</td>
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<tr>
<td>8</td>
<td>450v</td>
<td>1/4&quot; x 3 1/2&quot;</td>
<td>4/9</td>
</tr>
<tr>
<td>16</td>
<td>450v</td>
<td>1/2&quot; x 3 3/4&quot;</td>
<td>4/9</td>
</tr>
<tr>
<td>4</td>
<td>450v</td>
<td>1/8&quot; x 2 1/2&quot;</td>
<td>2/6</td>
</tr>
<tr>
<td>8</td>
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<td>450v</td>
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<td>7/6</td>
</tr>
<tr>
<td>16—16</td>
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<td>25</td>
<td>50v</td>
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<td>50v</td>
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</tr>
<tr>
<td>8</td>
<td>150v</td>
<td>1/8&quot; x 1 1/2&quot;</td>
<td>2/6</td>
</tr>
</tbody>
</table>

* Fitted with 1/2" tags each end.
Photographic highlight

Electronically, the Mullard LSD3 is an extremely efficient light source device. Photographically, it is the ideal tube for lightweight portable equipments because of its compact dimensions, stable triggering and low trigger voltage, and very long life.

Some data is given here, and if you would like full details, including recently published articles on flash circuits, please write to the address below.

**PRINCIPAL CHARACTERISTICS OF LSD3**

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- Operating Voltage: 2,000-2,700V
- Trigger Voltage: 3,000-3,500V
- Approx. Flash Duration: 150 microseconds
- Peak Light Output: 40 mega-lumens
- Integrated Light Output: 4,000 lumens
- Base: 4-pin UX
- Light Quality: Closely resembling daylight

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<table>
<thead>
<tr>
<th>Type No.</th>
<th>Primaries tapped 210-330-250v.</th>
<th>Price</th>
</tr>
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<tbody>
<tr>
<td>A6</td>
<td>350-0-330v 75 m/a 6.3v 3a 5v 2a</td>
<td>28/d.</td>
</tr>
<tr>
<td>A4</td>
<td>or 4v 4a 4v 2a</td>
<td></td>
</tr>
<tr>
<td>B6</td>
<td>350-0-330v 100 m/a 6.3v 3a 5v 2a</td>
<td>34/d.</td>
</tr>
<tr>
<td>B4</td>
<td>or 4v 5a 4v 2a</td>
<td></td>
</tr>
<tr>
<td>C6</td>
<td>350-0-330v 150 m/a 6.3v 4a 5v 3a</td>
<td>46/d.</td>
</tr>
<tr>
<td>C4</td>
<td>or 4v 6a 4v 2.5a</td>
<td></td>
</tr>
<tr>
<td>S/28/1</td>
<td>425-0-425v 200 m/a 6.3v 4a</td>
<td>57/d.</td>
</tr>
<tr>
<td></td>
<td>or 6.3v 2a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5v 3a</td>
<td></td>
</tr>
<tr>
<td>S/28/2*</td>
<td>350-0-330v 250 m/a 6.3v 6a</td>
<td>90/d.</td>
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<td>or 4v 8a</td>
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<td></td>
<td>0-2-6.3v 2a</td>
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</tr>
<tr>
<td></td>
<td>0-4.5- 3a</td>
<td></td>
</tr>
<tr>
<td>S/24/1</td>
<td>1000v 10 m/a</td>
<td>49/d.</td>
</tr>
<tr>
<td>S/24/2</td>
<td>1500v 10 m/a</td>
<td>55/d.</td>
</tr>
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<td>S/24/3</td>
<td>2500v 10 m/a</td>
<td>55/d.</td>
</tr>
<tr>
<td>S/24/4*</td>
<td>4000v 5 m/a</td>
<td>65/d.</td>
</tr>
<tr>
<td>S/24/5*</td>
<td>5000v 5 m/a</td>
<td>75/d.</td>
</tr>
</tbody>
</table>

* For "Electronic Eng." Televisor.

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★★★ OUR CDR49A RECORDER UNIT complete and self-contained, measuring only 22in. x 14in. x 15½in., incorporating 8-valve amplifier, recorder unit, light-weight pick-up, speaker and microphone and with many exclusive features, is now ready for early delivery.

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Valves and their applications

The DL93 as a Power Amplifier at V.H.F.

In the rapidly expanding field of low power V.H.F. communications for Business Radio and similar purposes, the designer often has difficulty in obtaining satisfactory transmitting valves for his equipment, since the choice of valves suitable for many such applications is severely limited in this country. In particular there still exist few directly-heated miniature types capable of an efficient performance when used as power amplifiers in battery-operated V.H.F. "walkie-talkie" transceivers.

At the lower V.H.F. frequencies, the designer’s requirements for an efficient directly-heated power amplifier are met by the DL93. This valve is a miniature pentode on a B7G pressed glass base and has a low filament consumption. A table of maximum ratings is shown in Table I.

In the 60-80 Mc/s Business Radio band, the valve has a very satisfactory performance. When operated as a conventional Class C amplifier at 80 Mc/s, and driven by another DL93, the valve has a power output of approximately 1.5 watts and an anode efficiency approaching 55%. Figure 1 shows a suitable circuit for use at this frequency.

The circuit contains no unconventional features, and is simple to adjust. Moreover the layout of the components is not critical, although all leads should be kept short. An efficient screen between the grid and anode circuits should be provided. The grid anode capacitance of the DL93 is low and consequently neutralisation is not essential; a neutralised circuit is somewhat easier to adjust, however, and in this case the neutralynie (Hazeltine) circuit is recommended.

In semi-portable equipment the existing Business Radio regulations allow the DL93 to be operated at its maximum ratings. In "walkie-talkie" transceivers a maximum of 1 watt input to the final stage is permissible, and an anode potential of 90 volts is therefore adequate. Two 45-volt hearing aid dry batteries may be used to provide the H.T. supply.

Since quartz crystals with a natural resonant frequency as high as 80 Mc/s are not yet generally available, frequency stabilisation entails the use of a master oscillator of comparatively low frequency (15 Mc/s for example) followed by a multiplier chain. Since it is of major importance to minimise the power consumption of the multiplier stages, hearing aid subminiatures such as the DL72 may be used with advantage. The final power amplifier may then be operated from another DL93 as driver. Alternatively, if a reduced power output can be tolerated, the amplifier stage may profitably be driven directly by the final multiplier.

The variation in performance of the DL93 with frequency may be summarised as follows. At frequencies below 100 Mc/s the efficiency and output remain virtually constant, the required drive decreasing with the frequency. It is noteworthy that at frequencies of the order of 5 Mc/s the drive required for full output is unusually low (1.2mA approximately). Thus at these lower frequencies the valve is capable of its optimum performance when driven by a DL72 buffer stage. Above 100 Mc/s the performance deteriorates; the valve will nevertheless give a satisfactory performance in the 144-146 Mc/s amateur band.

The efficiency of the DL93 when used in the 156-184 Mc/s Business Radio band is of the order of 15%, to 25%. Details of Mullard miniatures and subminiatures suitable for operation in this and in the 460-470 Mc/s bands will be published in later articles.

![Diagram](image)

**TABLE I**

<table>
<thead>
<tr>
<th>SERIES</th>
<th>PARALLEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vf</td>
<td>1.4 V (D.C.)</td>
</tr>
<tr>
<td>I f</td>
<td>0.2 A</td>
</tr>
<tr>
<td>Vg1</td>
<td>150 V</td>
</tr>
<tr>
<td>Vg2</td>
<td>135 V</td>
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<tr>
<td>Vg3</td>
<td>30 V</td>
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<tr>
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<td>0.25 mA</td>
</tr>
<tr>
<td>I k</td>
<td>25 mA</td>
</tr>
<tr>
<td>P a</td>
<td>2.0 W</td>
</tr>
<tr>
<td>P g2</td>
<td>0.9 W</td>
</tr>
</tbody>
</table>

The above limiting values are for intermittent operation as an R.F. power amplifier.

Reprints of this report from the Mullard Laboratories, together with additional circuit notes, can be obtained free of charge from the address below.

**MULLARD ELECTRONIC PRODUCTS LTD., TECHNICAL PUBLICATIONS DEPARTMENT, CENTURY HOUSE, SHAFTESBURY AVE., W.C.2**

M696
MONTHLY COMMENTARY:  

International Television Argument

Writing on the possibilities of rivalry between American, British and Dutch firms in international markets for television equipment, our U.S. contemporary, Electronics (May, 1949, issue), says, editorially:

"The crux of the matter is the standards to be adopted. Should they follow American or British practice? Evidently, the adoption of one or the other might give a preferred position in the market. So far as studio and transmitting equipment is concerned, it is not difficult to meet the customers' desires regarding standards without major increase in cost. But receivers are different; if foreign standards depart too widely from those used by the manufacturer in his domestic product, the cost of exported sets may rise substantially, possibly enough to price them out of the market."

That is a fair statement of the position. Any competent designer and manufacturer, whether American or European, can provide foreign customers with transmitting equipment for working to any reasonable standards that they may fancy. With receivers, on the other hand, standards are commercially much more important and we enter the realms of Big Business. The country whose standards are adopted by others will have a ready-made export market for its domestic production.

It is less easy to agree with the substance, and still less with the implications, of the paragraph that follows. It reads:

"We feel strongly that whatever standards are adopted in foreign lands, they should not restrict the utility of the service. Further, at the risk of starting an international argument, we venture to remark that two important aspects of the British standards are restrictive. One is the use of a 2.5-Mc/s video band, as compared with the 4.0-Mc/s standard in the U.S.A. The choice of a narrow bandwidth must inevitably restrict the detail of the images provided to foreign customers. The second is the 25-per-second picture transmission rate, adopted in Britain to conform with the 50-c/s power supply frequency. This limits the brightness of flicker-free images to a value substantially lower than that possible with the 30-per-second American rate."

It is implied here that the ratio of bandwidths is a measure of relative picture quality between the British and American systems. Of course, it is fundamental—even platitudinous—that the information content of any form of radio communication is determined by bandwidth. May we say, then, if the American 4-Mc/s bandwidth is good, the French 10-Mc/s system must be potentially better and a hypothetical 20-Mc/s better still? And where are we to stop? It is hardly practical engineering to argue along these lines, so long as the availability of communication channels is limited and economy must be considered.

In any case, the comparison made by Electronics is factually incorrect. First, the British system employs 2.75-Mc/s—not 2.5 as stated. Secondly, the ratio of bandwidths can only be taken as an indication of relative picture quality if the frame frequency is the same. If the Americans used a 25-frame rate, they would need only a 3.3-Mc/s bandwidth for their present picture quality. The relative quality of British and American pictures is in the ratio 3.3 : 2.75 and not 4 : 2.5 as implied by Electronics.

As to the alleged reduction of flicker resulting from the 30-per-second American picture rate, are we seriously asked to believe that it was chosen for that reason? Surely, with the American 60-c/s supply frequency there was no other practicable choice. The use of a frame frequency differing from the mains frequency calls for much more extensive smoothing of receiver h.t. supplies and so increases receiver cost.

With the notable exception of the American continent the world's electrical supply systems are predominantly 50-c/s; for this reason the lower picture rate will generally be preferred. Any advantage in freedom from flicker offered by the higher rate is largely academic.
TELEVISION STATION SELECTION

A Look to the Future

By W. T. COCKING, M.I.E.E.

Up to the present British television receivers have been designed for the reception of one station only—the vision and sound channels of Alexandra Palace. When the Birmingham station opens there will be two stations in operation and, according to the present plan, there will eventually be five.

Since all stations are intended to transmit the same programme each receiver will need to receive only one of the stations except perhaps, in certain fringe areas mid-way between two of them. Even here one station will, in general, afford a better signal than the other and so it is necessary only for the receiver to be able to receive this better one.

Even under the new plan, therefore, it will not be necessary for any individual receiver to be suitable for more than a single station. However, there are certain obvious difficulties in manufacturing only single-station receivers; if this course is continued, each manufacturer will eventually have to produce five different models.

This alone will increase production costs and, in addition, he will have to regulate the relative quantities made very nicely.

Then viewers do occasionally move their homes and those changing from the service area of one station to that of another will not expect their receivers to become obsolete.

It is, therefore, likely that the receiver of the future will have to be suitable for any of the five stations. There are many possible ways of doing this and it is interesting to consider their relative merits.

In the first place it is clearly unnecessary for the means of station selection to be operable by the user. If such a control were provided he would use it only on those rare occasions when he moves to a different service area. There is no objection to such a control if it proves the most economical way of arranging the selection, of course, but it is not a necessary control. All the user requirements can be met by providing a form of station selector which can be adjusted by any competent technician.

One method, which is already being applied, is to build the set so that the signal-frequency circuits, and the oscillator if the receiver is a superheterodyne, form an accessible and replaceable sub-unit. One such sub-unit can be made for each channel and the selection effect by changing these sub-units.

The method is obviously better suited to the superheterodyne than the straight set, for it requires only two or three tuning circuits, whereas the latter needs ten to fifteen. The disadvantage of the method is that it is still necessary to manufacture different units for different areas and to arrange for their production in the proper quantities to meet the demand. Also the manufacturer must be able still to supply the alternative sub-units for many years so that the viewer who moves to another area can be provided for.

Trimming Range

From the manufacturing point of view it is much better if all sets can be alike in their components and if the differences can be merely ones of adjustment. At first sight, this seems easy, for it would appear to be necessary only to increase the range of the trimmers so that the set could be tuned to any station in the band. It should not be impossible to make inductances adjustable over a sufficient range for this. Allowing for stagger tuning, a frequency ratio of 1:6:1 is needed and this means an inductance ratio of 2.56:1. By using a very thin-walled former a simple metal or dust-iron slug should provide adequate coverage and there is always the possibility of increasing it by using a composite slug. A slug partly of metal and partly of dust-iron will reduce inductance when the one end is inserted and increase it when the other comes inside the coil, thus increasing the total variation obtainable.

A receiver designed on these lines could be tuned to any station in the band by a competent technician equipped with the proper apparatus. However, there is rather more in changing frequency than just re-trimming circuits. In the sound channel, changes in the Q of the coils with frequency may seriously affect the performance and, in particular, the amount of sound-channel rejection obtained. Towards the high-frequency end of the band an increase of Q is desirable to maintain the sound-channel rejection. With slug tuning, however, the Q is likely to decrease very considerably at this end of the band.

Then the input resistance of a valve decreases with frequency. It is approximately inversely proportional to the square of frequency. This may or may not be serious, for there is a possibility of devising a correcting network to mitigate this natural tendency. If this proves to be impracticable, however, there is no doubt at all that the changing input resistance will very seriously affect the performance and call for circuit changes for different frequencies. Couplings are another factor which may need alteration. There is the aerial feeder to first-grid coupling circuit for one, there are the sound-channel resector-circuit couplings for a second and there are the band-pass type couplings, if they are used, for a third.

It is clear, therefore, that the design of a straight set embodying ten to fifteen tuned circuits is by no means a simple matter. The superheterodyne scores heavily in this respect, for the bandwidth, sound-channel rejection and gain are obtained chiefly at the fixed intermediate frequency. Only the signal- and oscillator-frequency circuits need alteration for a different station,
and a considerable variation in their performance over the band is tolerable.

The superheterodyne, however, has its own troubles. It is well-known that even when only the reception of one station is being considered it is necessary to choose the intermediate frequency very carefully if the picture is to be free from a pattern produced by harmonics of the intermediate frequency being fed back from the output to the input. With an intermediate frequency of the usual order of magnitude—5–13 Mc/s—it is impossible to avoid this effect on all stations simply by selecting the frequency and it is necessary to employ very thorough screening and filtering to prevent the feedback. This is quite expensive.

There are, in addition, the possibilities of interference by signals operating in the i.f. band and on the second channel and it is necessary to take precautions against local-oscillator radiation. The attainment of adequate frequency stability in the oscillator is another difficulty which confronts the designer.

All these superheterodyne disadvantages are found in the ordinary broadcast receiver and in spite of them it has become almost universal. There are two reasons for this, one of which does not apply at all in the present-day television case and the other of special forms of interference if its intermediate frequency were made considerably higher than is now customary. If the intermediate frequency were lower than the lowest frequency of the signal band and higher than one-half of the highest frequency of the band, then i.f. harmonic interference would be impossible. The lowest signal frequency is 41.5 Mc/s, the highest 66.75 Mc/s. Therefore, from this point of view the intermediate frequency should be less than 41.5 Mc/s and greater than 33.375 Mc/s.

By choosing a frequency in the band 33.375–41.5 Mc/s, therefore, one drawback of the superheterodyne can be eliminated. It is quite a satisfactory frequency from the point of view of obtaining bandwidth, sound-channel rejection and gain, for all these can be secured adequately at the higher frequency of 45 Mc/s, as is evidenced by all the satisfactory straight sets now produced.

Since such an intermediate frequency is nearer the signal frequency than is at present usual the liability to the direct pick-up of signals on that frequency is increased. As a partial offset to this, signals on the higher frequency are usually rather weaker. Nevertheless, more care in the avoidance of this type of interference must be taken.

The liability to second-channel interference is reduced because of the higher frequency and its elimination should not prove very difficult.

The problem of the oscillator may be serious. If the oscillator frequency is higher than the signal frequency, the main trouble will be that of obtaining adequate frequency stability. Thus, suppose an intermediate frequency of 35 Mc/s is chosen, then the oscillator must cover from 45 + 35 = 80 Mc/s to 66.75 + 35 = 101.75 Mc/s. These frequencies are rather high for obtaining stability cheaply.

If the oscillator frequency is made lower than the signal frequency there is considerable danger of harmonics of the oscillator causing interference. This is shown by the diagram of Fig. 1 which indicates signal frequencies on one scale and intermediate frequencies on the other. The television channels are marked and the shaded areas represent interference bands, the order of the oscillator harmonic involved being marked in them.

If 35 Mc/s were chosen interference would be experienced from the third oscillator harmonic when receiving Channel 2. For instance, the vision carrier for Channel 2 is to be 51.75 Mc/s. The oscillator would be 51.75 – 45 = 6.75 Mc/s and its third harmonic 50.25 Mc/s. This would beat with 51.75 Mc/s to give a difference frequency of 1.5 Mc/s which would produce a most noticeable pattern on the picture.
Television Station Selection—

Examination of Fig. 1 shows that there is only one possible intermediate frequency for the avoidance of this effect on all channels. This frequency is 37 Mc/s. A vertical line at 37 Mc/s on the diagram does not cross any shaded area.

With this frequency the oscillator must cover 45—37 = 8 Mc/s to 66.75—37 = 29.75 Mc/s which is a wide range to cover in a single sweep. The relatively low frequency of the oscillator, however, greatly eases the problem of securing adequate frequency stability.

We cannot, however, say that this frequency will be satisfactory, for all the possible forms of interference have not been examined.

Since the oscillator frequency is lower than the intermediate frequency it is necessary to make sure that none of its harmonics falls in the intermediate frequency band. This can be taken as 37—2.75 = 34.25 Mc/s to 37 + 0.75 = 37.75 Mc/s with a sound channel at 37—3.5 = 33.5 Mc/s.

For Channel 1, the oscillator will be at 45—37 = 8 Mc/s and its harmonics will be 24, 32, 48 Mc/s. The third harmonic just misses the i.f. band.

For Channel 2, the oscillator will be at 51.75—37 = 14.75 Mc/s and its harmonics will be 29.5, 44.25 Mc/s. Again, they miss the i.f. band.

For Channel 3, the oscillator will be at 56.75—37 = 19.75 Mc/s and its harmonics will be 39.5, 59.25 Mc/s.

For Channel 4, the oscillator will be at 61.75—37 = 24.75 Mc/s and the second harmonic will be 49.5 Mc/s.

For Channel 5, the oscillator will be at 66.75—37 = 29.75 Mc/s and the second harmonic will be 59.5 Mc/s.

The frequency is then satisfactory in this respect.

There is next the possibility of interference from a station which is spaced from an oscillator harmonic by the intermediate frequency. It is similar in nature to ordinary second-channel interference but involves an harmonic instead of the fundamental of the oscillator. The possible interference frequencies, including the genuine second-channel frequencies, are listed in the Table. If these frequencies are compared with the signal bands it will be seen that with one exception none falls within the band of the station being received. The responses are, therefore, in principle capable of being eliminated by signal-frequency selectivity.

The exception is in Channel 4. The fourth harmonic conditions in the reception of a single-sideband transmission will not be very different, but they may not be quite the same.

Placing the oscillator higher than the signal in frequency is advantageous from nearly every point of view save that of the oscillator drift. In what follows it will be assumed that it is so placed.

The intermediate frequency is no longer critical and a frequency of about 35 Mc/s is suitable, so far as vision is concerned. The sound intermediate frequency now comes above the vision at 38.5 Mc/s, however, and there is here one possible cause of trouble for it is also 3 Mc/s away from the sound channel of Channel 1. The 3-Mc/s beat between the two may thus find its way into the vision channel by modulating the vision carrier in the frequency changer. It would be wiser to choose a frequency not less than 4 Mc/s below Channel 1. This would make the sound intermediate frequency 37.5 Mc/s and the vision 34 Mc/s.

True second-channel interference on vision could then arise only from stations in the band 113—134.75 Mc/s plus a small extension to cover the i.f. amplifier bandwidth. On sound it could come from the band 116.5—138.25 Mc/s.

If the bandwidth of the signal-frequency circuits is about 3.5 Mc/s, the second-channel frequency is about ten times the bandwidth away, or twenty times the half-bandwidth. A single resonant circuit which is down 1 db only at the edges of its band is therefore down 14 db at the second-channel frequency.

It is difficult to estimate how much attenuation is needed at signal frequency. The second-channel band is an aircraft communication band and so considerable field strengths from nearby

<table>
<thead>
<tr>
<th>Channel</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<tbody>
<tr>
<td>Frequencies (Mc/s)</td>
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<tr>
<td>37—12</td>
<td>29</td>
<td>22.25</td>
<td>17.25</td>
<td>12.25</td>
<td>7.25</td>
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<tr>
<td>25 ± 27</td>
<td>33 &amp; 21</td>
<td>68.5 &amp; 7.5</td>
<td>76.5 &amp; 2.5</td>
<td>86.5 &amp; 12.5</td>
<td>96.5 &amp; 22.5</td>
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<tr>
<td>35 ± 27</td>
<td>61 &amp; 13</td>
<td>81.25 &amp; 7.25</td>
<td>96.5 &amp; 22.5</td>
<td>101.25 &amp; 37.25</td>
<td>126.25 &amp; 52.25</td>
</tr>
<tr>
<td>45 ± 27</td>
<td>69 &amp; 5</td>
<td>96 &amp; 22</td>
<td>116 &amp; 42</td>
<td>136 &amp; 62</td>
<td>156 &amp; 82</td>
</tr>
<tr>
<td>55 ± 27</td>
<td>77 &amp; 3</td>
<td>110.75 &amp; 36.75</td>
<td>135.75 &amp; 61.75</td>
<td>160.75 &amp; 86.75</td>
<td>185.75 &amp; 117.75</td>
</tr>
</tbody>
</table>

Oscillator Frequency

From the interference point of view it seems much safer to have the oscillator higher in frequency than the signal. Frequency stability is then the difficulty and it is rather hard to estimate the requirement until the Birmingham station has been in operation and some experience of the single-sideband transmission has been gained. The requirements for the sound channel can easily be estimated and those for the single-sideband reception of a double-sideband transmission are known. It is to be expected that the co
aircraft and ground stations may be experienced. As a minimum an interfering signal should be 30 db below the television signal at the frequency changer input.

In a television receiver designed for limit range the interfering field strength might well be 40 db greater than that of the television signal and then the receiver should give 70 db discrimination. On the other hand, in areas of strong signals the interfering signal might never be more than 20 db below the television signal and only 10 db discrimination in the receiver would suffice.

Sensitivity

As very large numbers of receivers are used in areas of high field strength, where neither a maximum of gain nor the highest second-channel rejection are needed, it is clearly uneconomic to provide all receivers with them. The right course is surely to design the receiver to suit conditions in the major part of the service area, and to have a pre-amplifier which increases both gain and second-channel rejection for long-range reception.

Suppose, as a basis for discussion, that the basic receiver takes the form of a superheterodyne without a signal-frequency amplifier. The minimum useful signal at the input of the mixer will be of the order of 1 mV. This is a very approximate figure which might well be halved by careful design; it also depends upon how much noise is considered tolerable on the picture. Such a receiver with 30 db second-channel discrimination would be satisfactory over a very large part of the service area.

The simplest form of signal-frequency circuit would be a single resonant and damped circuit which would provide something like 14 db attenuation against second-channel interference. The remaining 16 db or so might be obtainable from the aerial, which is normally a resonant structure. However, it is very doubtful if it could be relied upon for this, especially in the case of the higher-frequency channels. For Channel 5, for instance, the aerial would be resonant at about 65 Mc/s in its half-wave mode. The second-channel band is 134-137.5 Mc/s and is quite close to 130 Mc/s at which frequency the aerial is again resonant on a full-wave mode.

It is therefore unwise to reckon on much selectivity from the aerial. Even if the aerial itself were usefully selective, it would probably be impracticable to make full use of it, for it would hardly be possible to keep the feeder properly terminated over the full band of frequencies involved. In the second-channel region, therefore, it is probable that the feeder itself would pick-up interference.

It is, therefore, good practice to include adequate second-channel rejection in the receiver itself and, in general, this will require the provision of two tuned circuits. There is, however, another possibility. Since the whole second-channel band lies outside the television band it is theoretically possible to secure the second-channel discrimination by means of a band-stop filter, which might be inserted between the feeder and the input circuit of the receiver.

If this proved economically possible a further step could be taken. The bandwidth of the input circuit itself could be made very wide to cover the whole television band—26 Mc/s—and the station selection accomplished by varying only the oscillator. This would be a form of single-span tuning.

Increasing the first-circuit bandwidth nearly 7.5 times would result in a considerable loss of sensitivity. The signal/noise ratio would also deteriorate at least as much. It would probably become considerably poorer because of inter-modulation effects in the frequency changer.

In practice, therefore, it would probably be better to retain signal-frequency tuning supplemented as necessary by fixed-tuned band-rejection filters.

Oscillator Radiation

One other factor must be considered: oscillator radiation. This can be very serious on these high frequencies, especially if a signal-frequency amplifier is not used. In the case considered with the vision intermediate frequency at 34 Mc/s, the oscillator operates at one of five frequencies in the band 79 Mc/s to 100.75 Mc/s.

At high-frequencies control-grid injection usually works best in the frequency-changer and the oscillator may provide about 2 V on the grid of the valve. Since the first circuit impedance may be 2 kΩ, this is very roughly a power of the order of 2 mW. A single tuned circuit may reduce this by 8-9 db and the feeder will introduce a further 1-2 db loss.

The oscillator power fed to the aerial may thus be as much as 200 μW. The signal power collected by the aerial may be only 0.05 μW. The radiated field strength in the immediate vicinity of the aerial may thus be 20 times as great as the field of the television signal.

In the example taken it will not interfere with other television receivers, but it may do with other services, including f.m. broadcasting. It must be very seriously considered, therefore, and the use of a band-stop filter in the aerial circuit is one way of preventing it.

This matter of using fixed filters to reduce interference and radiation is simpler than it may at first appear. Separate band-stop filters for the second-channel and oscillator bands are not necessary; a single low-pass filter can be used instead. If such a filter is given a cut-off frequency of, say, 70 Mc/s it will have little effect, in the television band, but give some 12-16 db attenuation per section in the second-channel band. In the oscillator band such a simple filter is less good and may introduce no more than 5 db attenuation per section. It could, however, be greatly increased by using one or two more-derivated sections (this is nothing but filter terminology for one or two tuned rejector circuits!).
Television Station Selection

The basic filter equations are \( LC = \frac{1}{\pi f^2} \) and \( L/C = R^2 \) where \( R \) is the terminating resistance, in this case the feeder impedance of 70 \( \Omega \). From the two \( C = \frac{1}{\pi f} \)

\( = 65 \text{pF} \) and \( L = \frac{1}{\pi f} C = 0.317 \mu \text{F} \).

The basic form of a filter which should be suitable for the job is shown in Fig. 2. It comprises two prototype low-pass sections and one \( m \)-derived; the last is split into two half-sections, one at each end of the filter, since this improves the termination. Four coils and five capacitors are needed.

A filter of this sort looks as if it would be very cheap and easy to manufacture, but it is not safe to conclude that this is so without further investigation. It is not improbable that very close component tolerances would be needed, but it may be that normal tolerances could be used for some or all of the capacitors if the others, and in particular the coils, were adjustable in manufacture. The coils will need only four or five turns and might well be self-supporting and adjusted in production in the filter unit by squeezing the turns closer together or further apart.

In view of all this it looks as though the television set of the future might well take the following general form:

1. Superheterodyne with 34-Mc/s intermediate frequency and local-oscillator frequency above the signal-frequency.
2. No signal-frequency amplification.
3. One signal-frequency circuit trimmable to any television channel.
4. From 1 and 2, only two trimmers for channel selection, both of which are easily adjustable with very little apparatus.
5. Low-pass filter unit for 70-\( \Omega \) impedance with coaxial input and output connectors, for second-channel interference and oscillator-radiation elimination.
6. Separate one- or two-stage pre-amplifier, also with coaxial input and output sockets, for insertion between the low-pass filter and the receiver in order to increase the sensitivity, second-channel rejection, and signal-noise ratio in areas of low field strength. Such a unit could be trimmable to any station in the band with perhaps three or four trimmers; it might also need changes in the values of damping resistors.

The writer feels that a scheme of this nature if carefully worked out might well prove to be the most satisfactory way of dealing with the problem of station selection. As he has pointed out there are other ways of solving it. It is probably impossible to decide the best way from theoretical considerations only and a good deal of experimental work will be needed. In particular, with the superheterodyne it is never safe to dogmatize for there are so many possibilities of interference with it that it is very easy to overlook one which becomes painfully evident when the set is tried.

In any case, television receiver design of the next few years will be especially interesting and there will doubtless be many different methods tried.

One final suggestion; the solution of the problem of oscillation stability might well be the use of an a.f.c. system operated by the sound signal.

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**DIVERSITY F.M. TRANSMISSION**

*New System With Synchronized Carriers*

These were arranged as a master station and two unattended satellites situated 10 and 17 miles respectively from the main station. The venue was London, the main transmitter being in Kingsway with one satellite at Mill Hill to the north and the other at Knockholt on the southern fringe of Greater London.

Unlike the majority of multistation a.m. systems, the G.E.C. f.m. version operates on a single radio frequency for all operational messages to and from the mobile vehicles. Separate frequencies are, however, employed for the radio links between the main and satellite stations. The schematic diagram reproduced here gives the various frequencies employed for this particular system.

The use of a common frequency at the main and satellite stations necessitates very accurate synchronization of these transmitters and this is achieved by employing a single master oscillator at the main station, using an appropriate multiple of it for the "broadcast"
transmitter there and another multiple, giving a somewhat higher frequency, which is radiated over link paths to the satellites. Here the frequency is converted to the actual multiple radiated from the main station's broadcast transmitter, and after suitable amplification, is radiated from the satellites' broadcast transmitters.

At no point in the chain is the actual multiple of the master oscillator lost, neither is the link signal, which carries the audio, demodulated.

From the schematic diagram it will be seen that this system is particularly economical in regard to the number of radio frequencies required. The common broadcast frequency employed on this occasion was 97.8 Mc/s, the outgoing control link was on 146.7 Mc/s and the incoming links on 154 and 155.4 Mc/s respectively. More will be said of these two later.

Thus this three-station F.M. scheme is operated with a total of four frequencies only. Some time ago we described a three-station a.m. system, which might be said to be comparable in many respects, since it was operated in the same area, and for this no fewer than nine frequencies were employed.

It may be argued, of course, that the different method of modulation does not wholly account for this saving of channels and that an a.m. system could be operated also with synchronized transmitters. But that as it may, the fact remains that the number of frequencies mentioned was employed at the time and a more recent two-station scheme, also using a.m., absorbed six radio frequencies.

The main radio frequency is produced by a temperature-controlled crystal oscillator on approximately 1,527 kc/s, and this is multiplied 64 times to produce the broadcast frequency of 97.8 Mc/s at the main station.

A separate train of multipliers is used for the link transmitter and these raise the master frequency 96 times to 146.7 Mc/s. The ratio between broadcast and link frequencies is thus 2 to 3. Similar results can be obtained with other master oscillator frequencies, thus starting at 1,358 kc/s multiplies of 72 and 108 will yield virtually the same broadcast and link frequencies.

Modulation is applied separately to the broadcast and link channels at a very early stage, but in order to compensate for the distance between the main and satellite stations, a pre-determined delay is introduced into the channel going to the main station's broadcast transmitter.

The amount of delay needed to both by aural tests and by examination of the waveforms of an 800-c/s tone on an oscilloscope, taken in a locality where the field strengths from the main station and one of the satellites was approximately equal.

The r.f. output from the link transmitter is fed to a vertical dipole aerial giving omni-directional radiation. Variations of this are possible and the link transmitter could, if required feed two separate aerals beamed on their respective satellite stations.

At the satellite the master station's broadcast frequency, in this case 97.8 Mc/s, is extracted from the 146.7-Mc/s signal by first mixing with the 12th harmonic of a local oscillator, dividing the output by three, then mixing in the 4th harmonic of the local oscillator; what emerges is a signal carrying the modulation but at half the required broadcast frequency. A doubler and power amplifier are all that are needed before the signal is radiated.

It should be noted that the link

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Diversity F.M. Transmission—signal on the outgoing path has not been demodulated. This may appear to be a rather complicated process, but it ensures that the actual frequency radiated by the satellite is independent of the stability of the local oscillator.

As already explained the mobile vehicle talks back on the common broadcast frequency and its signals may be received at any or all of the fixed stations. When the signals are received at a satellite station they are demodulated and used to modulate a separate link transmitter for relaying to the main station.

The main station might conceivably be receiving the same message from a vehicle simultaneously on three different frequencies, (a) direct on the broadcast frequency, (b) via one of the satellites on its link frequency and (c) from the other satellite on still another frequency. The output from these three receivers are passed to a mixing unit where the one which has the best signal-to-noise ratio is selected and fed into the loudspeaker. This is, of course, quite automatic.

Several miles of London’s busiest streets were covered in a radio-equipped vehicle during the course of a demonstration and at no period was the car ever out of touch. Signals were adequately loud and quite free from distortion during the whole time. From the immediate replies that were forthcoming it was evident that all outgoing messages were being received satisfactorily.

Some distortion was apparent when the delay network was removed from the main station’s audio circuit, but this was much less than might have been expected and caused very little deterioration in intelligibility.

Finally, a brief description of the mobile equipment may not be out of place, although the transmitter-receivers used for the demonstration are not newly developed models.

The complete set measures 18 x 8 x 8 in. and weighs 35 lb. A double frequency changing superhet circuit is used for the receiver with the second i.f. on 455 kc/s. The first i.f. is dependent on the operating frequency, as this is adjusted to give the required input to the second mixer using the most suitable harmonic of the crystal-controlled oscillator. The i.f. bandwidth is approximately ±15 kc/s for 6 db attenuation. Any single channel within the band 30 to 170 Mc/s can be employed, but the circuit would of course have to be pre-set as the equipment is remotely controlled. The audio output is about 1.25 watts.

The r.f. output from the transmitter varies somewhat according to the operating frequency, but at the worst it is not less than 10 watts and at the best 20, the larger amount being obtained at 100 Mc/s and below. The output valve is a new double tetrode, the T51. The deviation is ±12.5 kc/s for the equivalent of 700 per cent. modulation, which also is the deviation used for the fixed stations.

Power to operate the set is supplied by a 12-volt battery—with optional 6-volt if required—and the consumption is 55 watts for the receiver alone, 95 watts on stand-by position with receiver on and transmitting valves alight and 175 watts on transmit.

The h.t. is supplied by two small motor generators, one for the receiver and another for the transmitter and filtered air for cooling is circulated through the set by fans on the motor generator.

Transmitter, receiver and power supplies are separate sub-assemblies easily removed for servicing. Miniature parts are used extensively and the whole of the equipment is fully troposphorized.

**MANUFACTURERS’ LITERATURE**

Leaflet describing "Aralite" synthetic resin for surface and wire coating, etc., from Aero Research, Duxford, Cambridge.

Lists of components and kit sets for crystal receiver construction from the British Distributing Co., 66, High Street, London, N.8.

Illustrated leaflets describing the TV1Z table television receiver and BAXII battery broadcast receiver from Bush Radio, Power Road, W.4.

Descriptive leaflet relating to the AC24Q automatic record changing unit from Electrical and Musical Industries, Blyth Road, Hayes, Middlesex.


Supplementary list of "Instanta" relays from Magnetic Controls, 48, Old Church Street, London, S.W.3.


"Flux Facts" (Leaflet Ref. FF449) giving details of the properties of fluxes now available in cored wire solders made by Multicore Solders, Mellor House, Albermarle Street, London, W.1.

Technical specification of wide-range signal generators (Model 64B, 100 kc/s-45 Mc/s, and Model 65C, 100 kc/s-150 Mc/s) from Taylor Electrical Instruments, 479-480 Montrose Avenue, Slough, Bucks.

Illustrated leaflets of sound-amplifying equipment and commemorative brochure of testimonials relating to the 1948 Olympic Games from Philips Electrical, Century House, Shafesbury Avenue, London, W.C.2.

Price list of amateur transmitting and receiving equipment from Radiocraft Ltd., 25, Bead Street, London, S.E.19.

**DOMESTIC RECEIVERS**

The new "49" series of receivers made by Pye, Cambridge, comprises a console (Model 49C), table radio (Model 49TG) and console radiogram (Model 49RG). The prices are £17 17s, £26 5s and £26 15s respectively, excluding tax.

The basic circuit comprises a triode hexode frequency changer, pentode-diode i.f. amplifier and detector, and a pentode output valve. New versions of the Baby "Q" all-dry battery portable and Model 15D receiver are also announced. The latter now incorporates the trawler waveland in place of the 13-metre band. Prices are £14 14s and £22 2s respectively, excluding tax.

Pye Model 49TG table-model radiogram.
TRANSITRON SYNC SEPARATOR

FOR good interlacing there are two major requirements which a sync-separator circuit must satisfy:
(1) the generation of a steep-fronted frame synchronizing pulse from one—preferably the first—of the sequence of broad pulses that form the frame synchronizing signal;
(2) the complete elimination of line synchronizing pulses from the frame synchronizing circuits.

It is not easy to separate two pulses of similar amplitude and shape but of different durations such as the line- and frame-synchronizing pulses, whose durations are respectively 10 microseconds and 40 microseconds. Hitherto, very elaborate circuits with several valves, or incorporating costly delay lines, have been necessary for this purpose and consequently good interlacing has been achieved only at considerable cost. It was with economy in mind that the idea of using a transitron circuit, operating under specific bias conditions, first occurred to the author.*

In the following description of the circuit and its behaviour it is assumed that the reader is conversant with the "flip-flop" action of the transitron. The "flip" occurs when the screen grid draws excessive current and drives the suppressor grid sufficiently negative to cut-off anode current. This is followed by the "flop," which occurs when the suppressor-grid potential has again risen to the point at which anode current starts to flow and the screen current is suddenly reduced.

The signal waveform, inverted

Fig. 1. Circuit of the transitron separator. 5MΩ

so that the synchronizing pulses are positive, is d.c. restored at the control grid (see Fig. 1). The valve is cut off by black-level and picture signals, and conducts only during the synchronizing pulses, as is customary in most receivers. When a ten-microsecond positive-going line-synchronizing pulse appears on the control grid, the screen grid draws current and instantaneously drives the suppressor grid sufficiently negative to prevent the anode from drawing current. This action corresponds to the "flip" of the transitron cycle. The "flop" occurs when capacitor C1, connected between the screen and suppressor grids, has charged sufficiently to allow anode current, as well as screen current, to flow. The time constant C1R1 is, however, so chosen that the line-synchronizing pulse finishes before the "flop" action can take place, and the valve consequently returns at the end of the line-synchronizing pulse to its original state with anode and screen currents cut off by the control-grid potential. Thus the anode remains at full h.t. potential throughout the whole period of the line-synchronizing pulse, and no pulse is produced there. A steep-fronted pulse of considerable amplitude is, however, produced at the screen grid, and this pulse is used to switch the line timebase.

When the first frame-synchronizing pulse appears at the control grid, the "flip" action takes place as before, but this time the "flop" occurs before the 40-microsecond frame pulse has ended. This is contrived by making the time constant C1R1 less than 40 microseconds. The result is that the circuit produces not only a negative-going pulse at the screen grid but also a steep-fronted negative-going pulse at the anode. This pulse at the anode is used to trigger the frame timebase. The waveforms at the various electrodes are shown in Fig. 2.

* Patent Application 4260/49.

Fig. 2. The waveforms on the electrodes of the valve during line and frame pulse periods are shown here.
ZOOM LENSES
Their Use in the Television Camera

By H. H. HOPKINS, Ph.D., F.Inst.T.

A RECENT innovation in television outside broadcasts has been the introduction of a zoom lens, which is an attachment for converting any ordinary fixed-focus camera lens into a lens of continuously variable focal length. The new lens has been made by W. Watson and Sons, of Barnet, and was used for the first time at the televising of the Cup Final at Wembley this year.

The zoom lens is mounted on the front of the television camera and is operated by rotating an outer cylinder which imparts axial movements to the two inner component lenses, 2 and 3, by means of cam slots, the outer components, 1 and 4, remaining stationary. If suitable movements are given to 2 and 3, the final image remains in focus on the photo-cathode of the television camera, and the focal length of the combined optical system varies. The result is that the size of details in the picture is altered, creating the illusion that the camera is moving towards or away from the scene. The zoom lens at present being used for television enables the image of any detail in the scene to be varied over a range of 4:1 in area, and it will work in conjunction with any camera lens having a front diameter not greater than 2 in and covering an angle of field that is not more than 30 degrees. During zooming, the relative aperture of the combined optical system remains constant, and consequently the brightness of the image also remains constant.

The aberrations of the system are corrected by balancing the positive and negative aberrations contributed by the different surfaces. Any change in the relative positions of the component lenses will, in general, upset this balance, and so it is necessary to restrict to a minimum the movements of the inner components 2 and 3. The conditions that result in minimum movement have been worked out and are satisfied by the lens. In addition, the optical conditions resulting from the refractions by the moving components have been studied and a relatively simple mathematical treatment for calculating them has been worked out. This treatment reveals the conditions that must be fulfilled if a satisfactory lens is to be produced, taking into account the inaccuracies, small but optically significant, that are unavoidable in the best available non-geometric cams.

Zoom lenses have previously been very complicated. Simplicity is one of the principal factors contributing to the success of the new lens, which has only four components and yet gives excellent definition. Furthermore, this economy of components results in a greater efficiency of light transmission and also in the elimination of stray light, compared with certain other zoom lenses.

Semi-Automatic Morse Key

RADIO amateurs and many professional operators on this side of the Atlantic are beginning to acquire a liking for the semi-automatic type of morse key so popular in the U.S.A. Once the technique of handling it has been mastered it does unquestionably permit of sustained high speed sending with far less wrist fatigue than with most other types of key.

It gets its description from the fact that the dot constituents of the morse characters are formed automatically by a vibrating spring, the speed of sending being governed by the position of "bob" weights.

The Eddystone model of the key is very well engineered and lends itself for adjustment to almost any speed of sending likely to be required by amateurs and most professionals. It is not a key that would normally be used for slow sending as its special properties show up best at high speeds. None the less it is quite capable of operation at 8 w.p.m. if required. This key has two "bob" weights for coarse and fine adjustment.

A heavy die-cast base is used with rubber feet and there are also two holes for screwing it down. Actually the rubber feet counter any tendency to wander, but a more secure fixing is really desirable. It has a short-circuiting switch and the whole is enclosed by an attractive cover finished in black crinkle enamel and chromium.

The makers are Stratton & Co., Ltd., Eddystone Works, Alvechurch Road, West Heath, Birmingham, 31, and the price is £4 17s 6d.
When these special types arise you'll find it best to BRIMARIZE!

Types 6SA7 and 12SA7 are pentagrid frequency changers of specialised design, widely used in American radio receivers. They have now been superseded by the miniature types 6BE6 and 12BE6, but this substitution requires a change of socket.

Good results may often be obtained by the use of types 6K8GT and 12K8GT respectively, a slight connection change and a lead to the top cap being required. In all cases it will be necessary to re-align the receiver, preferably throughout.

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TEST REPORT

REDIFON MODEL R50
Wide-Range Tropicalized Communications Receiver

As one of the many functions of the general-purpose communications receiver with which we are here concerned is for merchant ship work, it has been designed to comply with certain requirements laid down by the Postmaster-General as to specification and performance.

One of the requirements for a set of this kind is that it must provide a continuous frequency coverage over the band 100 kc/s to 25 Mc/s. For certain ships a curtailed range may be permissible but in order to cater for all requirements the full coverage has been provided. In addition, an extra-low range of from 13·5 to 26 kc/s is included.

With this wide coverage the problem arises of where to place the intermediate frequency. Below 100 kc/s is not very satisfactory, especially for reception over about 1 Mc/s. In this receiver the problem is neatly circumvented by providing two i.f.s and selecting the most suitable for the band of signal frequencies in use.

The actual coverage of the receiver is somewhat greater than the minimum requirements for ship-borne apparatus. There are eight ranges marked, for convenience, A to H inclusive. A is the highest frequency range and H the lowest. H covers 13·5 to 26 kc/s; G, 95 to 250 kc/s; F, 240 to 600 kc/s; E, 585 to 1,550 kc/s; D, 1·5 to 4 Mc/s; C, 3·8 to 8 Mc/s; B, 7·7 to 16 Mc/s and A, 15·5 to 32 Mc/s. It will be seen that for ranges G to A inclusive there is a useful overlap in all cases.

As regards the use of the intermediate frequencies, on ranges H and F an i.f. of 110 kc/s is used since it is well outside the coverage of either. On ranges G, E, D, C, B and A, one of which includes the 95- to 250-kc/s band, an i.f. of 405 kc/s is employed. This i.f. could not, for very good reasons, be used on range F which covers 240 to 600 kc/s. Nothing is to be gained by employing 110 kc/s on the higher frequency ranges as the image signal discrimination would be somewhat unsatisfactory.

The changeover from one i.f. to the other is automatic, being performed by the waveband switching so that the operator has no need to concern himself with it and, of course, mistakes cannot arise. Two complete sets of i.f. transformers and two crystal filters are embodied in the i.f. unit. The arrangement of the circuit between the mixer valve and the first i.f. stage is given in Fig. 1 which shows also the circuit switching for the two narrowest bandwidths.

Fig. 1. Arrangement of the circuit between the mixer and first i.f. stages in the Redifon R50 receiver. This includes part of the bandwidth switching and i.f. switching.
Redifon Model R50—
In all there are five bandwidth positions; two include the crystal filter and give either 150 kc/s or 1.5 kc/s. The three other positions without the filter give 4, 11 and 17 kc/s respectively.

The narrowest bandwidth is obtained with the crystal filter working into a high-impedance load which in Fig. 1 is the 1 MΩ resistor in the subsidiary circuits A or B. The next widest, 1.5 kc/s, is obtained by modifying the load into which the crystal works, in the case of either of the subsidiary circuits A or B, the former on 110 kc/s and the latter on 465 kc/s, they are adjusted to provide an impedance of the order needed to open the bandwidth to 1.5 kc/s.

With the waveband switch set to any of the other three positions the crystals are short-circuited and the bandwidth is determined by the coupling between the primary and secondary circuits of the transformers in the latter part of the i.f. amplifier. The couplings can be varied by switching in the appropriate parts of tertiary coils which augment the inductive coupling between the primary and secondary windings.

Looking down on to the top of the chassis with the screens removed can be seen, on the right, the i.f. sub-assembly; in the centre the ganged tuning unit and on the left the subsidiary units. The switch assembly in the right-hand front corner is the metering network.

In order to achieve adequate selectivity with the crystal filters, twelve high Q tuned circuits are employed in the i.f. amplifier on either 110 kc/s or 465 kc/s. Each of the 24 circuits—12 only are, of course, in use at any time—are temperature compensated, the dust iron cored coils having two padding capacitors across them, one of a negative and the other of a positive temperature coefficient. Trimming of the i.f. circuits is effected by adjustable dust cores.

In all, three stages of amplification are employed in this unit, the valves being EF39s. Two only are included in the a.g.c. system and they receive a portion only of the total a.g.c. voltage available.

The rear end of the set is reasonably orthodox, a double diode (EB34) acting as detector and a.g.c. stage with another EB34 functioning as an optional noise suppressor. It can be switched in or out as required and there is also a control for setting the threshold point at which the suppressor begins to operate.

D.C. voltage for automatic gain control is derived from the primary circuit of the last i.f. transformer and applied, after some delay, to the two r.f. stages, and as already mentioned, in part to two of the i.f. valves but leaving the mixer and last i.f. uncontrolled.

In some communications receivers the a.g.c. system becomes inoperative when the b.f.o. switch is set for c.w. reception, but in the Redifon R50 a.g.c. continues to operate, but with a much longer time constant than for telephony.

A.G.C. can, however, be suppressed if desired and this facility is embodied in a four-position switch marked "AVC-NS." In one position a.g.c. functions as usual, in another it is inoperative and all control of volume is by the r.f. and a.f. gain controls, in a third position a noise silencer with a.g.c. is brought into circuit while in a fourth position the
noise silencer is used without a.c.

Audio amplification is provided by an EF37 voltage amplifier and a 6V6 power valve with some negative feedback from the anode circuit of the 6V6 to the anode of the EF37.

Because alternative i.f.s are provided, the b.f.o. stage must generate heterodyne oscillations for either the 110- or 465-kec/s channels as required. An EF37 valve and a parallel-fed Hartley circuit, with entirely separate circuits for each frequency, is employed for this purpose. Both circuits are temperature compensated and the change from one to the other is synchronized with the i.f. selector. Details of the b.f.o. oscillator and of the noise silencer are given in Fig. 2.

In order to obtain a good signal-to-noise ratio and, perhaps what is of greater importance, an adequate image signal discrimination on the higher signal frequencies, two r.f. stages with EF39 valves are provided. These are followed by a mixer consisting of the hexode part of an ECH35 and a separate oscillator, which function is performed by a L63 triode with its grid joined to the normal oscillator grid of the ECH35 for voltage injection. The triode anode of the ECH35 is earthed.

There is little out of the ordinary in this part of the circuit except that each tuning capacitor has dual sections of 224-pF maximum. One section only is used on the three highest ranges but both are used in parallel on all other bands. These circuits, and those in the local oscillator, are frequency stabilized by a combination of negative and positive temperature co-efficient capacitors. The sectional circuit in Fig. 3, which shows the local oscillator, indicates these compensating capacitors, the negative temperature type having a short horizontal bar below the capacitance value. Also included is the dual tuning capacitor and the oscillator waveband switching.

This receiver has provision for remote control and also for diversity reception if required. The screen grid supply lead for the i.f. and r.f. valves is accessible at the output socket and by simple switching, or by a relay, periods up to this speed of sending.

Power supply for this receiver is provided by a separate unit and normally this will be a.c. operated. In addition to the usual rectifying and smoothing circuits the power

The voltage can be reduced so that the receiver is desensitized to such a degree that it can be employed to monitor a telegraphy or telephony transmission. It can also be arranged for "break-in" operation when required up to a speed of about 40 words per minute. The time constants of the receiver permit recovery to full sensitivity in the "break" unit contains a voltage regulator tube giving a stabilized h.t. supply to the mixer g, grid and the oscillator anode. The a.c. consumption is 80 watts. For battery operation there is another power unit and this has a rotary converter for h.t. supply. There are also available supply units with rotary converters for various d.c. voltages up to 220.
Redifon Model R50—
A receiver of such high selectivity as the R50 must of necessity possess extremely good frequency stability. From the brief foregoing description it will have been seen that quite a lot has been done to ensure that this condition prevails by the judicious use of temperature compensated circuits and stabilized voltages. But these precautions alone would be of little value unless they were supplemented by good mechanical rigidity. It is unusual to find quite such a massive construction as in the R50.

The individual sub-assemblies, as well as the main framework, are well braced to withstand the hazards of transit and to stand up to the stresses that must be imposed during rough weather on board ships at sea. Rubber suspension is used for the r.f. unit, which is incorporated in the ganged tuning capacitors, largely to combat any likelihood of microphony.

Although light alloy is used extensively in the construction of the set, it is not a light-weight receiver. The chassis alone weighs 50 pounds and, enclosed in a sturdy metal cabinet it weighs 92 pounds. The dimensions are 14½ x 21 x 22¾ in.

The set is fully tropicalized and while miniature components are included no attempt is made at miniaturization. When out of its cabinet every part of the set is readily accessible which makes for easy maintenance and testing.

In order that a quick check can be made on the set under working conditions a comprehensive metering system is embodied. A single meter is employed and this can be switched to measure the anode currents of r.f., oscillator and i.f. valves and the cathode currents of the a.f. amplifiers.

The performance of the R50 is fully in keeping with what might be expected of a set of this kind. With a little care in tuning and judicious selection of the bandwidth, a weak signal can be separated from between two quite powerful ones and held almost indefinitely provided the transmitter frequency is fully stabilized. After the initial warming up the oscillators settle down to their work and remain remarkably steady.

The h.t. smoothing is quite adequate and on the highest frequency range in the 30-Mc/s region, c.w. signals are receivable with pure beat notes and without a trace of ripple due to mains frequency modulation.

An epicyclic drive giving an 80 to 1 reduction is employed for the main tuning control. It incorporates a spring-loaded chain of gears driving a subsidiary logging dial, which, in conjunction with an additional scale on the main dial, enables any station to be accurately logged. The logging dial is visible through an aperture just above the main scales and a single division represents about a 10-kc/s coverage at 30 Mc/s. At lower frequencies it is considerably less. Frequency calibrated scales are provided for each of the eight ranges.

The R50 is made by Rediffusion Ltd., Broomhill Road, Wandsworth, London, S.W.18, and the price of the cabinet model is £180. The set is also available with a panel for mounting in the standard 19-in rack.

REMOTE CONTROL EXTENSION LOUDSPEAKERS

TWO of the three new models in the "Stentorian" range of extension loudspeakers, made by Whiteley Electrical Radio, Mainsfield, Notts, are fitted with push-button switches for remote control of the receiving set.

The system is the Whitely "Long Arm" remote control in which a relay controlling the mains supply to the set is operated through three-wire extension leads from any loudspeaker position. When the set is switched on from another room, only the loudspeaker in that room is operative, all the others remaining silent. Alternatively, when the set itself is switched on manually, none of the extension loudspeakers will work unless specifically required.

Six-inch permanent-magnet units with die-cast chassis are used in the "Bristol" loudspeakers which have plywood fronts with rounded corners and are enclosed at the back with perforations in the covers to relieve back pressure. Constant-impedance volume controls are fitted and a choice of output impedances is provided.

The frontal dimensions of the "Beaufort" are 12¾ in x 10½ in and of the "Bristol" 10½ in x 6½ in; both are 3½ in deep. Prices, with and without transformer, are: "Beaufort" £3 15s, £3 7s 6d; "Bristol" £2 15s 6d, £2 13s 6d. A cheaper model, the "Bedford," with 5½ in unit, but without the "Long Arm" control, features costs £2 5s 6d or £1 19s 6d without transformer.

MORE COPIES OF "WIRELESS WORLD"

As announced last month, the Government's decision to increase the allowance of paper for technical periodicals makes it possible to print more copies of Wireless World. Starting with the August issue (published 26th July) there should be enough for all anticipated requirements. But the number of copies will still be limited, and so it will be necessary for an order to be placed with a newsagent.

NEWS FROM THE CLUBS

Brighton.—Meetings of the Brighton and District Radio Club are now held on Tuesdays at 7.30 in the club's new headquarters at the Eagle Inn, Gloucester Road. Sec.: L. Hobden, 17, Harlington Road, Brighton, Sussex.

Exeter and District Radio Society is organizing a 7-Mc/s d.c. contest on Woodbury Common on July 3rd, which is open to other clubs. Sec.: E. G. Wheatcroft, 27, Lower Uplands Road, Exeter, Devon.

Slough.—Readers in the Slough, Bucks, area who are interested in the formation of a radio society in the district are invited to a meeting to be held at 7.30 on July 3rd at the Slough Public Library. Acting Sec.: F. J. T. Tuckfield, 13, Quaves Road, Slough.

Southend.—The transmitter, G2XK, of the Southend and District Radio Society will be demonstrated at the Leigh-on-Sea Horticultural Society's Show at Chalkwell Park, on July 9th and also at the Scout's International Jamboree at Rochford from August 14th to 20th. Sec.: J. H. Barrance, M.B.E., Swanage Road, Southend-on-Sea, Essex.
INDOOR TELEVISION AERIAL

Compressed Dipole for Strong-Signal Areas

By N. M. BEST and P. J. DUFFELL (Antiferaence Ltd.)

WITHIN a radius of approximately five to ten miles from the television transmitter at Alexandra Palace, the standard dipole-and-reflector aerial system, mounted at chimney level, provides a greater signal than is absolutely necessary for the operation of a receiver. For installations nearer to the Alexandra Palace, even a single dipole without reflector may be sufficient to overload the set at its lowest sensitivity level. The insertion of an attenuator between aerial and receiver then becomes necessary.

In practice, it is found that an aerial mounted indoors gives satisfactory results over a fairly wide area. The physical dimensions of the standard H-type aerial may be unsuitable for indoor installation, and the indoor aerial is usually made physically smaller than the standard dipole, with some attendant loss in electrical efficiency.

The most important factors to be considered are:

(a) Sensitivity.
(b) Bandwidth (the aerial must cover sound and vision channels).
(c) Feeder matching (normal receiver input is approximately 70 ohms and the feeder must have the same impedance).

The first two factors (a) and (b) may be affected by altering the shape of an aerial, and (c) is affected by any change of aerial input impedance.

There are several possible ways of constructing small television aerials.

The grounded quarter-wave aerial is one in which the earth is replaced by a half-wave horizontal rod, the centre of which is at earth potential. It is shown diagrammatically in Fig. 1 and in practice, using co-axial cable, the inner conductor is connected to the bottom of the vertical quarter-wave rod, and the outer conductor to the centre of the earth rod.

The input impedance of this type of aerial is approximately 40 ohms, and the effective height is half that of a standard dipole. Although it is suitable for installation in a loft, it is physically cumbersome because of the earthing system.

A second form of aerial is known as the bent-rod type, and is probably patterned on an American type of aircraft antenna. The effect of bending the rod is an increase of bandwidth and a loss of sensitivity. Commercial types of this aerial are made to be installed in the V of the roof. The sensitivity is usually low because the pick-up portion is the projection of the inclined rod on the vertical plane.

A dipole of normal shape may be physically shortened by capacitance end loading or inductance loading. Capacitance loading involves mechanical difficulties and may be ignored, but an inductively loaded aerial is comparatively simple to construct.

The first two kinds of aerial referred to are only really suitable for installation in a loft. Many set owners, however, live in blocks of flats and similar buildings, and are often not permitted to install outside aerials. One disadvantage of an aerial installed in a living-room is that it is particularly susceptible to alterations of the electrical field due to movement of persons in the room; but with a careful choice of aerial position this effect can be greatly reduced.

In any case, during a television broadcast it is hard fairly likely that there will be sufficient movement of persons to cause annoyance. A useful type of indoor aerial, there-
Indoor Television Aerial—

Fig. 2. The variation is substantially linear over the frequency band under consideration.

Below the frequency of resonance, the aerial is capacitive (physically too short) and above this frequency it is inductive (physically too long). In order to improve the bandwidth of a given aerial it is necessary to provide, in some manner, reactance which will cancel out the aerial reactance over the band. It is hardly practical or possible to do this over the frequency band required for television work, but investigations show that some considerable compensation is possible using a short-circuited stub transmission line, resonated in the middle of the frequency band.

Fig. 2 also shows the reactance variation of a short-circuited length of transmission line, which is a quarter-wavelength long at the resonant frequency of the aerial; and it can be seen that the two components have reactances of opposite sign at frequencies on either side of resonance.

If the aerial covers the television band of 41 to 47 Mc/s, and is resonant at 44 Mc/s in the middle of the band, it is possible with a suitable stub-line to cancel the capacitive reactance of the aerial at 41 Mc/s, and also the inductive reactance of the aerial at 47 Mc/s. At these frequencies the aerial impedance is a pure resistance.

The stub must be a quarter-wavelength at 44 Mc/s. The cancellation occurs because the aerial and stub reactances vary with frequency in opposing ways.

![Resistance and reacance of combination of dipole and stub.](image)

The two curves in Fig. 2 cannot, of course, be simply added together, for the aerial reactance is in series with the radiation resistance and the transmission line is in parallel with this complex impedance. At the centre frequency the transmission line has an infinitely high reactance and will not affect the radiation resistance.

The resultant curves of reactance and resistance vary in the manner shown by the curves in Fig. 3 (not to scale). At the middle frequency, the input reactance is zero and the input resistance has a minimum value equal to the dipole radiation resistance. The maximum values of input resistance occur at each end of the band (i.e., at the frequencies where reactance cancellation takes place). In Fig. 3 the dipole radiation resistance is assumed to be constant over the band; in practice this is not the case and the curves are slightly asymmetrical.

The foregoing is an outline of the theory on which the aerial investigations were based, and the actual design and construction of a loaded aerial incorporating a stub compensating line will now be treated.

The Compensated Loaded Dipole

It was decided that elements of 2 feet 6 inches in length and 1 inch in diameter should be used, giving, with the loading coil, an aerial of approximately five feet six inches long.

The aerial was coil loaded at the centre to resonate at 44 Mc/s and at this frequency was found to have a radiation resistance of approximately 13 ohms. The reactance varied from $-757$ ohms to $+757$ ohms. Therefore the equivalent parallel capacitive reactance to be cancelled out at 41 Mc/s was approximately $-766$ ohms. The compensating stub was to be a quarter-wavelength at 44 Mc/s and with polythene dielectric ($\varepsilon = 2.3$) this would be 112.5 cm.

From the well-known formula for a short-circuited length of transmission line:

$$ Z_N = j \frac{Z_K}{\tan \frac{\pi x}{\lambda}} $$

where $Z_N =$ input impedance of line $Z_K =$ surge impedance of line $x =$ length of line $\lambda =$ wavelength

it can be seen that the reactance of this length of line at 41 Mc/s depends purely on its characteristic impedance.

The variation in reactance over the band for a length of line with a characteristic impedance of 70 ohms, is shown in Table 1, column (a). Column (b) shows the behaviour of a line with an impedance of 7 ohms, and the re-

<table>
<thead>
<tr>
<th>Frequency (Mc/s)</th>
<th>70-ohm line</th>
<th>7-ohm line</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>660</td>
<td>66</td>
</tr>
<tr>
<td>42</td>
<td>1001</td>
<td>100</td>
</tr>
<tr>
<td>43</td>
<td>2000</td>
<td>200</td>
</tr>
<tr>
<td>43.5</td>
<td>3339</td>
<td>333</td>
</tr>
<tr>
<td>44</td>
<td>$\infty$</td>
<td>$\infty$</td>
</tr>
<tr>
<td>45</td>
<td>2000</td>
<td>200</td>
</tr>
<tr>
<td>46</td>
<td>1001</td>
<td>100</td>
</tr>
<tr>
<td>47</td>
<td>660</td>
<td>66</td>
</tr>
</tbody>
</table>
acitance curves are shown in Fig. 4.

It can be seen that the reactance of the 70-ohm line is too high even at the edge of the band, but that a 7-ohm line would provide a suitable cancelling reactance at 41 Mc/s.

The problem, therefore, became one of constructing a low-impedance transmission line and was solved by utilizing flat brass strips or tapes insulated by polythene.

The next difficulty was that of finding a convenient mechanical arrangement and this was overcome by winding the aerial-loading coil itself with brass tape and using one-half of the loading coil as one conductor of the transmission line. Fig. 5 illustrates the mechanical construction of the aerial. The ordinary aerial element was constructed of hollow aluminium tube. The former for the aerial-loading coil was made of paxolin tubing in which was cut a spiral groove for the brass tape coil. One half of the winding has two layers of brass tape insulated by polythene and with the electrical connections shown in Fig. 6(a) is equivalent to the coil-loaded dipole with a short-circuited stub line connected across it shown in Fig. 6(b). In practice, the length of the double winding, if short-circuited at the point of connection to the aerial rod, is not sufficient to provide a quarter-wavelength line at the required frequency, and the extra length is obtained by constructing the aerial rod from two hollow D-shaped aluminium tubes insulated down the centre by polythene (to give the correct characteristic impedance), one rod being connected to each of the two tapes and a short circuit being made at a suitable distance from the end of the coil. This method of lengthening the stub line is also shown in Fig. 5.

Investigations showed that it is an advantage to make the quarter-wave stub resonant at approximately 49 Mc/s, instead of 44 Mc/s. This has the effect of shifting the maximum resistance point to the centre of the pass-band [(Fig. 7, curve (c)]. Figs 7 and 8 show the results of measurements made on a standard dipole [curves marked (a)] and the compressed or inductively-loaded dipole with and without stub line compensation [curves marked (c) and (b) respectively].

The comparison between the aerials is shown in these diagrams in terms of the aerial input resistance and reactance over the frequency band 41 Mc/s–47 Mc/s.

The slotted transmission-line method of r.f. measurement was used for all impedance measure-

![Fig. 4. Reactance curves of 70Ω and 7Ω lines at 44 Mc/s.](image)

![Fig. 5. Mechanical construction of loading coil and stub line.](image)

![Fig. 6. Connections of loaded dipole with stub.](image)
Indoor Television Aerial—
in Fig. 8. The uncompensated compressed dipole, curve (b),
shows a reactance varying from
$-57\$ ohms to $+57\$ ohms and
considered in conjunction with
curve (b) of Fig. 7, shows a very
poor ratio of reactance to resis-
tance at the edges of the band.
The compensated compressed dipole,
curve (c) is inductive throughout the band varying from
$+72\$ ohms to $+14\$ ohms. It
can be seen that the ratio of re-
actance to resistance compares
favourably with that of the
standard dipole, and provided
that the measured input resistance
is mainly useful radiation resis-
tance and not loss resistance, the
aerial bandwidth should be com-
parable with that of the standard
dipole. Actual field strength
measurements showed the com-
pressed dipole to be $-6\$ db ± $1\$
db down in sensitivity on the
standard dipole throughout the
band, thus substantiating the
results expected from impedance
measurements.

In order to match the com-
pressed dipole to a $70-$ohm feeder
a series resistor of approximately
30 ohms was added, but as the
aerial was only intended for use
in high signal-strength areas the
additional loss is tolerable. The
dotted curve (d) in Fig. 7 shows
the input resis-
tance presented
by the combination,
and the aerial-
to-line matching
($70-$ohm feeder)
is shown for the

Fig. 7. Curves of aerial input re-
actance.

![Fig. 8. Curves of aerial input reactance.](image)

TABLE 2
Comparison of aerial to line matching of normal dipole and compressed dipole
(Z of line = 70 ohms).

<table>
<thead>
<tr>
<th>Frequency (Mc/s)</th>
<th>Reflection Coefficient (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal dipole</td>
</tr>
<tr>
<td>41</td>
<td>44%</td>
</tr>
<tr>
<td>42</td>
<td>29%</td>
</tr>
<tr>
<td>43</td>
<td>19.7%</td>
</tr>
<tr>
<td>44</td>
<td>6.3%</td>
</tr>
<tr>
<td>45</td>
<td>11.6%</td>
</tr>
<tr>
<td>46</td>
<td>21.8%</td>
</tr>
<tr>
<td>47</td>
<td>22.6%</td>
</tr>
</tbody>
</table>

As the aerial is mainly intended
for use in areas of good signal
strength the loss of sensitivity is
tolerable and is far outweighed by
the advantage of the reduced size,
approximately to one-half of that
of the ordinary dipole.

"DIALLIST'S" PROBLEM

This should not be read until the
simple problem set in "Random
Radiations" (page 279) has been tackled.
The correct answer is (b). When capaci-
tors are connected across a source of h.t.
voltage the p.d.s across them depend on
their leakage resistance and not on
their capacitance. Suppose 2,000 V
is applied to two series capacitors, one
of which has an insulation resistance
of 300 MΩ and the second an insulation
resistance of 100 MΩ. Then there will
be a p.d. of 1,500 V across the first
and of 500 V across the second. If both
are rated at 1,000 V d.c. working the
first will soon break down. The full
voltage will then be applied to the
second, which will also break down.
In practice it is not possible to manu-
facture capacitors of identical insula-
tion resistance. In France, at any rate,
the provision of individual shunt resis-
tors is compulsory. The resistance of
these is less than the insulation resistance
of the capacitors, but high
enough to ensure negligible losses.

Owing to the presence of these resis-
tors it does happen that the
 capacitors are discharged rapidly
when the source of h.t. voltage is switched
off. Hence, if you plumped for (c) you
may award yourself a gentle pat on the
back.

Civil Aviation Communications.—A
second edition of the Civil Aviation
Communications Handbook (MCAp5)
has been published. It contains the
international regulations and commu-
nications procedures with which aircraft
registered in the United Kingdom have
to comply. It is obtainable, price
7s 6d, from H.M. Stationery Office.
The pamphlet "Radiotelephony Pro-
cedure" (MCAp40) continues in use as
the standard reference document for
Part I of the qualifying examination
for the Flight Radiotelephony Opera-
tor's Certificate of Competency.
The Siting of Aerials

We claim that "Belling-Lee" television aerials are mechanically and electrically superior, but if erected without due regard to local interference, and/or the proximity of a corrugated iron shed or gas holder, then the "Belling-Lee" best is no better than the cheapest worst.

No aerial is a "cure all," some are made better than others, and up to the weather, without leaning away from the prevailing winds, etc. Some have had superior electrical knowledge built into them, which tells when used in fringe areas.

We consider it bad practice to recommend the most expensive aerial of a range when a cheaper model will suffice.

Both the "H" type *1 and the "Veerod"*2 (inverted "V") are, in their own way, ideal for the elimination of interference, the "H" is the most expensive in our range and the "Veerod" one of the cheapest.

We have seen an announcement in a Midland paper to the effect that it is not possible to know what will be the best television aerial to erect until the Midland Transmitter is on. "Belling-Lee" have put up many hundreds of aerials for the Midland Transmitter and many hundreds more have been erected by worthy competitors. If the installations are entrusted to recognised firms with plenty of experience of this work in the London and home counties, then there is no need to worry.

If however, someone without the necessary experience puts up a television aerial, then there may be trouble from double images or "ghosts.*3

or the obvious local source of interference may be ignored and consequently the wrong type of aerial installed. To take a case in point, the "Belling-Lee" "Veerod" has sharp minima at right angles to the direction in which it is pointing, whereas the "H" type has a minimum behind the dipole: one experienced in these matters makes full use of such characteristics for the removal of "ghosts" or interference. Again, sometimes it is advantageous to use the building on which the erection is being carried out to screen the dipole from obvious interference such as a busy cross road, and in other cases height is the most important thing. Experience of hundreds of such cases is most useful.

The average wireless Dealer will not make mistakes that he cannot rectify when the time comes.

A "Veerod" television aerial mounted on a chimney.

Hum in the Receiver.

We have heard a lot about humming aerials, and we have cured this trouble, but we have recently had a number of requests to cure hum in the receiver. Now, this is a form of interference that we do not claim to cure. The hum is a low frequency phenomenon which may be mains borne on D.C. mains or an inherent property of the receiver itself.

Our interests are in radio frequency interference, which, as readers of this page know, shows up on the picture of a television receiver as "ghosts," spots, feathering, or bars, and on the sound channel, or on broadcast receivers as crackles, plops, bangs and sizzling noises which may be eliminated from the receiver by the use of one or more of the following methods:

1. Correct choice and siting of an outdoor aerial.
2. For broadcast reception, an anti-interference aerial*3.
3. Fitting a mains filter*4.

Wires that carry and re-radiate interference.

We have recently been asked to confirm whether or not wires used for wired wireless radiator interference. The answer is that they can and do. So do telephone wires, and overhead fire alarm wires, but of course the worst offenders are overhead mains, in villages where the houses are wired with V.I.R. taken in at roof level.

*1. "Veerod" television aerials for Midland frequencies. L65/2LM "H" type with Sft. light alloy mast and chimney lashings, £6/5/-.

L65/2C "H" type with mast head cap for customer's own wooden mast, £2/17/6.

L65/2L "H" type with mast head cap and chimney lashings (less mast), £5/7/6.

The London equivalents for items 2 and 3 are L502/C, £4/8/-, L502/L, £6/6/-.


*3. "Skyrod" vertical collector with "Eliminoise" anti-interference transformers and cable. 1638/K chimney mounting, £10/-.

L608/CK Mast mounting (less mast), £8/15/-.

L308/K "Eliminoise" kit with 60ft. wire span and cable etc. Complete £6/6/-.

*4. Set lead suppressors. L300/3 amp, £2/19/6. L305 (2 amp), sometimes suitable for television, £3/3/-.

"Veerod," "Skyrod" and "Eliminoise" are registered trade marks. "Veerod" registration applied for.
S.R.E. for all purposes

Philips have supplied through traders and others throughout the world S.R.E. for almost every conceivable application. While specialized equipment is produced whenever necessary, a very wide range of standard apparatus units minimizes the need for this, and simplifies installation and maintenance.

As it can be shown to be much better engineering practice to use one large amplifier instead of a lot of little ones to feed one load, the standard range includes three large rack amplifiers.

Features include triode valves throughout, four push-pull stages, no electrolytics, and three separate anode supplies.

250 watt ... List Price £255
500 " ... List Price £325
1,000 " ... List Price £425

S.R.E. available through the trade on hire purchase or rental terms.

PHILIPS ELECTRICAL LIMITED

You MUST get this List...

This is the new list giving descriptions of the 162 Standard types of "Somerford" Transformers and Chokes together with details of 28 types of Replacement components suitable for commercial receivers

This COMPLETE range will meet ALL your normal needs

The requirements of the Electronic Industries are many and varied. It is to meet such demands that the "Somerford" range of Transformers and Chokes exist. No matter whether you are engaged in radio, the manufacture of industrial or domestic appliances, or laboratory work, if you are looking for components that will give you accuracy and dependability at an economical cost, you will do well to choose GARDNER products. Research, skill and modern manufacturing methods have been combined to produce components that will withstand the most arduous working conditions and meet the exacting demands of present day standards. The "Somerford" range comprises 162 different types—a type for every normal need.

Ready for IMMEDIATE DELIVERY

Full details and specifications will be sent on request

GARDNERS RADIO LTD
SOMERFORD : CHRISTCHURCH : HANTS
ELECTRONIC CIRCUITRY

Selections from a Designer’s Notebook

By J. McG. SOWERBY (Cinema Television Ltd.)

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Electronic Circuitry—
pulse can be derived from any one
of the anodes for three input
pulses, and the circuit divides
pulses by three. The buffer stage
discussed last month is quite
suitable for driving this ring, and
also for extracting an output
pulse.

A ring of greater number than
three can be derived directly from
Fig. 1 provided it is remembered
that there must be a symmetrical
d.c. connection from every grid
to every other anode, and at first
sight there seems to be no reason
why a ring of any number should
not be made. There is a practical
limit here, however, because con-
duction in one valve must provide
a potential change at all other grids
sufficiently large to hold all other
valves at or beyond cut-off. If we
make the simplifying assumption
that the resistances $R_4$ of Fig. 1
are infinite, it is found that the
potential available to cut off each
valve other than the conducting
one is only $a \frac{R_4}{R_3}$

and $a$ is the number of valves in
the ring. Hence the larger $a$ is
made, the more difficult does it
become to design for entirely
reliable operation. In practice,
however, the resistances $R_4$
are not infinite, so that the position
is rather worse than is indicated
above.

The maximum number $a$ which
is attained in practice depends
on factors additional to those
mentioned. For example, by
making the $R_4$ resistances of Fig. 1
very large the anode potential
change of the conducting valve
can be increased, but as this
resistor is shunted by stray capaci-
tance a reduction in maximum
counting rate must be expected.

With sufficient care in design and
using modern high-slope valves
with a very short grid base, a ring
of ten, capable of operating at
50-100 kc/s, could probably be
constructed successfully.

In practice, of course, there is
little point in attempting a ring of
ten directly, as it is both easier and
more economical to use a scale of
two and a ring of five in cascade.
A scale of 12 might be constructed
from two scales of 2 and a ring of
three. A scale of 100 could con-
veniently be made up thus:—
$2 \times 5 \times 2 \times 5 = 100$; and a
scale of a gross:—$2 \times 2 \times 3 \times 2
\times 2 \times 3 = 144$.

Since any
number other than a prime can be
reduced to a product of primes,
next month we shall consider how
the missing numbers may be
filled in.

**Thyratrons** are frequently
used in d.c. circuits as sensi-
tive relays, firing on the applica-
tion of a small voltage pulse. It
is a property of a thyratron that
once the valve has broken down
the grid has no further control.

Extinguishing

To extinguish the

arc it is usual to

break the h.t.
supply tempo-

rarily, as shown in Fig. 2(a),

with the resetting switch $S$.

An alternative method of re-

setting a thyratron, which is
occasionally useful, is shown at
(b). A resistance $R_i$ is placed in
series with the load, and a condenser $C$ is momentarily short-
circuited to the negative h.t. line
with the switch $S$. The time
constants $CR_i$ is long enough to
maintain the potential across $C$
less than the running voltage of the
thyratron for the time required
to ensure de-ionization—generally
200 microseconds is sufficient. The
resistance $R$ is used to ensure that
$C$ is discharged immediately prior
to the closure of $S$. This arrange-
ment is sometimes useful, for
example when only a single-pole
change-over contact is available
for resetting, and some secondary
circuit must be reset with the
other contact as shown at (b).

There is nothing very novel about
this arrangement; the same method
of arc extinction is often used
in d.c./a.c. converters.
CATHODE-RAY TUBES FOR TELEVISION
Diameter of Tube Neck

By HILARY MOSS, Ph.D., M.Brit. I.R.E. (Chief Engineer, Electronic Tubes, Ltd.)

(Concluded from p. 205 June issue)

In all the foregoing work, when comparing tubes of different sizes, it has been assumed that all linear dimensions except those of the actual triode have been multiplied by \( k \). This assumption does not wholly agree with normal commercial practice, since it is customary to maintain constancy of neck diameter.

It was stressed in the introduction that the solution of these cathode-ray tube problems depends entirely on the postulates made. However the complexity of the solutions varies greatly with the postulates. We saw for example that to postulate constancy of cathode loading involves appreciably more working than the assumption of constant beam current. And if we inject the still additional requirement that the neck diameter is to be constant then the treatment is still further complicated.

This arises because we cannot longer use postulate (1); that is, the principle of geometrical scaling. This principle requires that all the linear dimensions of the system must be scaled and we are now deliberately departing from this by multiplying the screen diameter by \( k \), while maintaining constancy of size in the deflector-coil region.

A solution therefore demands special knowledge of the effects of deflection. The following additional fact is necessary and sufficient to solve the problem of change of screen size at constant resolution.

"If the beam width, coil shape and size, and the scanning angle, are all kept constant, then the deflection defocusing is proportional to the distance between the centre of deflection and the screen." [24]

In this statement the term 'deflection defocusing' means the difference in the linear size of the spot at the centre and the edge of the screen. The application of postulate (2) enables us to deduce that the deflection defocusing is independent of the anode potential. [25]

We now illustrate this by repeating the solution of the first problem, with the additional requirement that the neck diameter and scanning coils are to be unchanged. The general theory is a little too cumbersome to be given here, but the method can be seen by reference to Fig. 3. In the original tube the crossover at \( T \) is imaged by the thin lens at \( XY \) on to the screen at \( S \). \( CD \) represents the centre of deflection. The derived tube has its screen at \( S' \), where it is assumed that the axial position of \( S' \) is such that for constant scanning angle the diameter of \( S' \) is \( k \) times the diameter of \( S \). Now the resolution of the derived tube is to be the same as that of the prototype. Therefore the deflection defocusing is to be \( k \) times as great as on the prototype just as the beam angle from the triode, the new position for the focusing coils is found by projecting back lines from \( S' \) through \( C \) and \( D \). These cut the rays from the triode at \( X' \) and \( Y' \) which is the new position for the focusing coil.

On the prototype tube the linear magnification between the triode and spot is \( M_1 = \frac{ES}{TE} \) and on the new tube it is \( M_2 = \frac{AS'}{TA} \). Let the crossover diameter on the prototype tube be \( \lambda \). Then with the previous notation, the requirement of constant resolution gives

\[
\frac{M_1d}{\sqrt{V_1}} = \frac{M_2d}{\sqrt{V_2}} \quad \ldots (8)
\]

Equation (8) compares with (2) and differs only on account of the change in geometrical magnification brought about by the alteration of the position of the focusing coil.

As in the first problem equation (1) defines the condition of equality of screen brightness, so that (1) and (8) permit us to calculate \( V_2 \) and \( \lambda \). \( M_1 \) and \( M_2 \) are most easily found graphically.

Fig. 3. Geometrical derivation of tube of larger screen diameter keeping neck diameter and scanning angle constant. Note that only the conical portion of the glasswork is changed.

Approximation based on the value of \( M_2/M_1 \)

Provided that the process of extrapolation is not carried too far, examination of the geometry of typical television cathode-ray tubes will convince the reader that the ratio \( M_2/M_1 \) is very nearly equal to \( k \). If we now insert this value in equation (8) we immediately get, after cancellation of common terms,

\[
1/\sqrt{V_1} = \lambda/\sqrt{V_2} \quad \ldots (8a)
\]
Cathode-Ray Tubes for Television
which oddly enough is exactly the same equation as that relating to
the earlier case where the neck
diameter was varied in proportion
to the screen diameter and the
spot size was to be held constant.
The solution of this equation
together with (1) has already been
given (2nd column, Table 1) this
being the case of constant beam
current. The solution of (8a)
with (3), (4), (5) and (7) has also
been given (column 4, Table 1) this
being the case of constant cathode
loading.
However to avoid any possible
confusion this working is repeated in
Table 2, since the postulates are
entirely different, and the
identity of
the
previous
equation is merely coincidental.
One important fact emerges from a
comparison of Table 1 and 2.
Column 2 in Table 2, which
 CORRESPONDING
Column 2 in Table 1 with
Column 1 in Table 2. Both
operations result in a picture
linearly in k times
as
large as on
the prototype
and of the same
surface brightness.
Both
operations require the same
increase in
anode voltage
and the same increase in
cathode loading. But
the operation on Table 1
where the neck
diameter is increased in propor-
tion to the screen diameter gives
no increase in spot size, whereas
the operation on Table 2 maintain-
ing constant neck diameter results
in the spot diameter being multi-
plied by k. We are entitled to
conclude that the operation on
Table 1 yields a tube of higher
intrinsic performance than that
given by Table 2, since we
normally seek to obtain the
smallest spot size, all other factors
being constant. This fact is a
result of the use of a larger neck diameter (and greater neck length)
on the tube derived by Table 1. It
is a valid general deduction that
the absolute electrical performance of a tube of given screen size can be improved by an increase in neck length and neck diameter.

APPENDIX
Grid voltages are always referred to cathode potential. The triode is said to be modulated when the grid potential is such that cathode current flows. For any fixed geometry and fixed anode voltage, denoted by V, there is a definite negative grid voltage, denoted by V, at which cathode current just ceases to flow. V is termed the cut-off voltage. The grid voltage V is always assumed to lie between the cut-off voltage and zero, but positive grid voltages are excluded. The grid drive, V, is defined as the magnitude of the difference between the cut-off voltage V and the actual grid voltage V. It is the grid voltage measured with respect to the cut-off voltage. It is clear from the above definitions that negative grid drive has no useful meaning and that we are only concerned with positive values of V.

### TABLE 2

<table>
<thead>
<tr>
<th>Basic Operation</th>
<th>Screen Diameter multiplied by k</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associated Operations</td>
<td></td>
</tr>
<tr>
<td>Neck diameter, scanning</td>
<td></td>
</tr>
<tr>
<td>coils constant.</td>
<td></td>
</tr>
<tr>
<td>Position of triode in</td>
<td></td>
</tr>
<tr>
<td>neck constant. Focus</td>
<td></td>
</tr>
<tr>
<td>coil moved towards triode</td>
<td></td>
</tr>
<tr>
<td>(if k&gt;1) Scanning angle</td>
<td></td>
</tr>
<tr>
<td>constant, see Fig. 3.</td>
<td></td>
</tr>
<tr>
<td>Geometrical Changes Made</td>
<td></td>
</tr>
<tr>
<td>Triode Dimensions</td>
<td>$k^{1/n}$</td>
</tr>
<tr>
<td>$k^{1/(1+n)}$</td>
<td></td>
</tr>
<tr>
<td>Cathode-grid Spacing*</td>
<td>$k^{2/n}$</td>
</tr>
<tr>
<td>$k^{2/(1+n)}$</td>
<td></td>
</tr>
<tr>
<td>Anode Voltage</td>
<td>$k^{3/n}$</td>
</tr>
<tr>
<td>$k^{3/(1+n)}$</td>
<td></td>
</tr>
<tr>
<td>Cut-off Voltage</td>
<td>$k^{4/3(1+n)}$</td>
</tr>
<tr>
<td>Grid Drive</td>
<td>$k^{1/(1+n)}$</td>
</tr>
<tr>
<td>Scanning-Coil Current</td>
<td>$k^{1/n}$</td>
</tr>
<tr>
<td>$k^{1/(1+n)}$</td>
<td></td>
</tr>
<tr>
<td>Effects Produced</td>
<td></td>
</tr>
<tr>
<td>Beam Current</td>
<td>$k$</td>
</tr>
<tr>
<td>$k^{2/(1+n)}$</td>
<td></td>
</tr>
<tr>
<td>Spot Diameter</td>
<td></td>
</tr>
<tr>
<td>Beam Angle $\alpha$</td>
<td>$k$</td>
</tr>
<tr>
<td>Screen Brightness</td>
<td></td>
</tr>
<tr>
<td>Cathode Loading</td>
<td>$k^{1/n}$</td>
</tr>
<tr>
<td>$k^{1/(1+n)}$</td>
<td></td>
</tr>
</tbody>
</table>

* This adjustment to be made additionally to that effected by the scaling of the whole triode.

### TABLE 3

<table>
<thead>
<tr>
<th>Anode potential (kV)</th>
<th>Grid potential (V)</th>
<th>Width of raster lines just merge (S) (mm)</th>
<th>$S\sqrt{V}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>-30</td>
<td>73</td>
<td>127</td>
</tr>
<tr>
<td>4</td>
<td>-40</td>
<td>69</td>
<td>138</td>
</tr>
<tr>
<td>5</td>
<td>-50</td>
<td>62</td>
<td>139</td>
</tr>
<tr>
<td>8</td>
<td>-80</td>
<td>48</td>
<td>136</td>
</tr>
<tr>
<td>9</td>
<td>-90</td>
<td>45</td>
<td>135</td>
</tr>
</tbody>
</table>
For all practical purposes the cut-off voltage \( V_c \) is proportional to the anode voltage \( V_a \), geometry being held constant. Furthermore the author has shown elsewhere that to useful engineering accuracy, the cathode current \( I_k \) in most normally proportioned triodes is given by Equation (6). Thus the cathode current increases as the \( \frac{7}{2} \) power of the grid drive for constant cut-off voltage.

This equation, it will be noted, does not explicitly involve the triode geometry except in so far as this affects \( V_c \) for a defined anode voltage \( V_a \). In point of fact it would be astounding if so simple a law could accurately represent the cathode current for an arbitrarily wide range of triode shapes. Although it does not do this it is a useful guide. Reference 1 gives further information on the limitations of this formula.

When the grid of the tube is made more positive (i.e., the grid drive is increased) then the beam angle in Fig. 1(b) is also increased. Very roughly, the beam angle increases linearly with drive as shown in Fig. 4. Here the idealized shape of the beam angle/grid voltage curve for varying cut-off voltages is displayed, where the cut-off voltage variations are due to change in anode potential only and are not due to changes in triode geometry. It will be seen that the maximum beam angle occurs at \( V_a = 0 \) and is independent of the anode potential. This last fact is a consequence of postulate (2). It can further be shown\(^1\) that

\[
\sin \alpha = \frac{0.27}{1.34} \frac{D}{f} \frac{V_a}{V_c} \ldots \ldots \ldots (a)
\]

where \( D \) is the grid hole diameter and \( f \) the anode-to-grid spacing.

Another very important consequence of Fig. 4 and Equation (a) is that the beam angle \( \alpha \) remains constant if both the modulus of the grid voltage and the anode potential are multiplied by the same constant.

Fig. 5. The relation between tube anode voltage and screen brightness is shown here. The crosses represent measurement values for a raster 10 cm by 10 cm and a beam current of 30 \( \mu A \).

Postulate No. 3 depends on experimental evidence which is given in Fig. 5. This shows a typical screen-brightness/anode-voltage curve for a 10-in diameter television cathode-ray tube. The beam current and raster size were all maintained constant throughout. The fluorescent material was zinc sulphide (mixed components—blue and yellow—giving an approximate white response). The curve can be approximated by a straight line on log/log paper thus revealing an approximate "power" law. It will be seen that the curve bends over somewhat towards the higher voltages presumably due to partial onset of "screen piling." The value of \( \eta \), which averages \( 1.47 \), is considerably higher at the lower voltages. This emphasizes the necessity of not extrapolating the results of Tables 1 and 2 too far.

Postulate No. 4 depends on the assumption that the definition of current density at the 'edge' to maximum density at the centre. If screen saturation is negligible this is equivalent to a brightness ratio.

The measurement must therefore be based on a technique which is consistent with this definition. One such method is as follows.

A fixed number of lines is applied to form a raster, and the latter is contracted in a direction at right angles to the direction of each line until the lines just merge into each other. The width of the raster is then proportional to the spot diameter.

Table 3 summarizes such measurements for a 10-in television cathode-ray tube. 400 lines each 150-mm long were used. The last column indicates that \( S/V \) is nearly constant so justifying the principle. The latter however also has an appreciable basis in theory.

**PORTABLE TELEVISION**

The Baird Portable Television set which measures 18½ in x 17 in x 13½ in and weighs 37 lb, is of the transformerless type and is suitable for a.c. or d.c. mains. It is a super-heterodyne with one signal-frequency amplifier. There are two i.f. stages in the vision channel and one in the sound. Noise limiters are fitted to both channels. The e.h.t. supply is from the line flyback.

The unusual feature of the set, by which its title of portable is justified, is the use of the mains lead as an aerial. The mains lead is fitted with a filter unit at about one half-wavelength from the set. This effectively isolates the half-wave section from the mains and so enables it to function as an indoor aerial.

The set is listed at £47 15s 6d plus £10 17s 4d purchase tax and at a recent demonstration performed excellently under conditions of severe interference. It is manufactured by Scophony-Baird, Ltd., Lancelot Road, Wembley, Middlesex.

Another new product of this firm is a magnetic-tape recorder which is designed for use with 8, 9.5 and 16 mm cine-film projectors and permits a synchronized running commentary to be added to any silent film. The Cine-Soundmaster costs 75 gns, and can be used with 600, 1,200 or 4,800 ft reels of tape suitable for 200, 400 or 1,600 ft of film.

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WORLD OF WIRELESS

B.B.C. Charter * Teleciné Equipment at A.P. * Olympia Plans * Birthday Honours

Committee of Inquiry

SINCE announcing the constitution and terms of reference of the B.B.C. Committee of Inquiry the Lord President of the Council has stated that Sir Cyril Radcliffe, who was appointed chairman, had to resign owing to his appointment as Lord of Appeal. He is now Lord Radcliffe. His successor has not yet been announced.

The terms of reference of the Committee, which consists of eleven members including the chairman, are: "To consider the constitution, control, finance and other general aspects of the sound and television broadcasting services of the United Kingdom (excluding those aspects of the overseas services for which the B.B.C. is not responsible) and to advise on the conditions under which these services and wire broadcasting should be conducted after December 31st, 1945 [when the present Charter ends]."

N.P.L. Annual Visit

MUCH interest was shown by visitors this year in the Electronics Section, where component parts of the A.C.E. (automatic computing engine) are being developed and made to the requirements of the Mathematical Division. Generators of pulses of ½-μsec duration and 1-μsec spacing were demonstrated, and also a "dynamicizing" circuit for translating decimal numerals into binary form, in which the presence or absence of any power of 2 in sequence is indicated either by a pulse or space. With this system a number with 10 significant figures on the decimal scale is registered in 30 μsec, and can be kept in storage until required by circulating in a closed circuit, part of which involves the transmission of sound waves in a column of mercury.

Also in the Electronics Section was a display comprising the N.P.L. moisture meter and some simple devices involving photo-cells and capacitive effects to advertise the fact that the N.P.L. is willing to collaborate with manufacturers in the application of electronics to industry.

New Equipment at A.P.

TWO new sets of teleciné equipment, one made by Cinema-Television, and the other by E.M.I., have been installed at Alexandra Palace, where they are now being used for televising films.

The method employed is broadly the same in both sets. The principal components are a projection cathode-ray tube, an optical system, a film projector, and a photo-multiplier tube. A scanning pattern, with an aspect ratio of 5:2, is traced on the fluorescent screen of the cathode-ray tube by the electron beam, and two images of this pattern are projected by the optical system onto the gate of the projector.

The film runs continuously through the projector at a speed equivalent to 25 frames per second, and each film frame is exposed for 1/50th second first to one scanning image, and then to the other, by the action of a rotating shutter. The light that passes through the film is focused on to a photo-multiplier tube, which generates the picture signal, and the signals corresponding to the exposure of each frame to the two scanning images combine to give an interleaved signal. Though the aspect ratio of the scanning pattern on the face of the cathode-ray tube is 5:2, this is increased to an effective ratio of 5:4 by the motion of the film.

Radiolympia

PLANS for Radiolympia (Sept. 28th to Oct. 8th) are going ahead steadily and space has now been allocated to over 150 exhibitors—a reduction of some twenty on the 1947 figure. Although details of manufacturers' exhibitions are not yet known some of those to be shown by Government Departments have been announced.

A supersonic experimental tank demonstrating the principles of radar will be among the exhibits of the Radar Research and Development Establishment of the Ministry of Supply. T.R.E. will be showing a radiosonde balloon, which automatically transmits variations in the humidity, temperature and pressure during its ascent to 35,000 feet. The need for tropicalization of components and packages will be exemplified by samples having undergone tests at the Ministry's Tropical Testing Establishment in Nigeria.

The Dept. of Scientific and Industrial Research will be showing for the first time at this year's exhibition. The plotting of storm areas by radio—transmission of information received from four forecasting centres—will be shown by D.S.I.R. which will also be demonstrating the means employed for forecasting the maximum usable frequencies for radio communication.

The radio and radar control of aircraft at London Airport will be shown on a working model of the main runway.

TELEVISING FILMS. General view of the new teleciné apparatus recently installed at Alexandra Palace. On the left is part of the E.M.I. equipment and on the right that supplied by Cinema-Television.
B.B.C. Appointments

Consequent upon L. W. Hayes' resignation as head of the B.B.C. overseas and engineering information department to take up the post of vice-director of the Comité Consultatif International des Radiocommunications in Geneva, changes in the organization of the

O.B.E. He was deputy inspector from 1940-1944 and was in the G.P.O. overseas telecommunications department until 1948 when he was appointed inspector.

W. H. Oliver, controller of telecommunications in Malayasia, becomes an O.B.E.

S. A. Williams, A.M.I.E.E., engineer-in-charge of the B.B.C.'s high-power short-wave transmitter at Sidcot, Cumberla, is appointed an M.B.E.

J. Leiper, chief operator of the Cable and Wireless receiving station at Somerton, Som., has been awarded the British Empire Medal.

OBITUARY

We record with regret the death of N. R. Campbell, B.Sc., D., who was in the G.E.C. research laboratories from 1919 to 1944 when he retired. He was aged 69. Prior to joining the G.E.C. he was appointed to the Cavendish Research Fellowship at Leeds University and was for a short time at the National Physical Laboratory. His research work was very varied ranging from investigations into the mechanism of the discharge of spark plugs to the theory of "noise" in thermionic valves and circuits. It was on the latter subject that he contributed, with others, a number of articles to our sister journal, Wireless Engineer. He was a Fellow of the Institute of Physics.

We also record with regret the death of J. G. Wright, a founder member of Wright and Waire, Ltd. He retired in 1945 from active participation in the company which he formed in 1919. The death is also announced of R. E. Gale, who was manager of the high-frequency and instrument sections of Philips works at Tooting. He was aged 47 and had been with the company twenty years.

PERSONALITIES

Sir William Coates has been appointed chairman of the Government Television Advisory Committee in succession to Lord Trefgarne who has held the position for nearly four years. Sir William is also a member of the recently appointed B.B.C. Committee of Inquiry.

Kathleen A. Gough, B.Sc., A.M.I.E.E., chief physicist in the research and development laboratories of the Dubelier Condenser Company, has been elected a Fellow of the Institute of Physics.

Brigadier E. J. H. Moppet has been seconded from Army duties to become chief inspector of electrical and mechanical equipment in the Ministry of Supply. Most of his 26 years Army service has been in Royal Signals. He was in charge of signal communications during the evacuation of Palestine and has just vacated a Deputy Director of Signals' appointment at the War Office.

E. C. Cherry, M.Sc. (Eng.), A.M.I.E.E., has been appointed to the City and Guilds Readership in Telecommunications endowed by Standard Telephones and Cables to provide facilities for post-graduate teaching and research in this field. He was attached to T.R.E. during the war and has been on the staff of the City and Guilds College since 1945.

IN BRIEF

Increases of 63,700 "sound" licences and 6,750 television licences during April brought the total in Great Britain and Northern Ireland at the end of the month to 11,823,000.

St. Paul's Sound System.—A sound reinforcement system has been installed in St. Paul's by Panton Reproducers, a subsidiary of Pye, to combat the famous echo of the cathedral. This has been done by fitting the loud-speakers under the chairs. To obviate the need for connecting wires, an induction system has been adopted. The output from the amplifiers is fed via a control desk in the nave to large wire loops on the ceiling of the crypt. Copper bands round each of the rows of chairs equipped with speakers provide the necessary pickup.

"Radio Valve Data".—This publication is now available in a second impression (with amendments to date of issue). It gives characteristics of 1,000 British and American receiving valves and replaces the former Valve Data Supplement which, in pre-war days, was much appreciated annual feature of Wireless World. The price is 3/6, or, by post from our Publisher, 3/9.

F. C. McLEAN, M.B.E., B.Sc.

B.B.C. engineering division have been announced.

The overseas engineering information department, the engineering secretariat, and the engineering training department have now been formed into what is to be known as the engineering services group with F. C. McLean, M.B.E., B.Sc., as head of the group and E. L. E. Pawley, M.Sc., as his assistant. H. Wilkinson, B.Sc., becomes head of O.E.I.D., and F. Williams, B.Sc., head of the training secretariat. Dr. K. R. Sturley continues as head of the engineering training department.

BIRTHDAY HONOURS

H. Faulkner, B.Sc., M.I.E.E., deputy engineer-in-chief, G.P.O., has been appointed a C.M.G. He joined the designs section of the G.P.O. engineer-in-chief's office in 1913 and after serving in the Royal Engineer's Signal Corps (1914-1918) he was transferred to the G.P.O. radio section. He was a member of the team responsible for the design of the Rugby station and was its first officer-in-charge (1923). He has held a number of executive offices and is now responsible for the radio development and radio maintenance branches. He was joint leader of the British delegation to the recent high-frequency broadcasting conference in Mexico.

C. S. Franklin, M.I.E.E., the "creator of beam wireless" who was recently awarded the Faraday Medal by the I.E.E., has been appointed a C.B.E. He retired from Marconi's W.T. Co. after 40 years' service, in 1939.

T. A. Davies, inspector of wireless telegraphy, G.P.O., is appointed an E. L. E. PAWLEY, M.Sc. (See "B.B.C. Appointments").
World of Wireless—guarantee period on the original tube. It has now been decided that for a trial period of twelve months from June 1st, any tubes, including those for replacements, shall carry the full six months’ guarantee.

S.T.C. Endowment.—Standard Telephones and Cables has endowed a Readership at the University of Birmingham, known as the Henry Mark Pease Readership in Telecommunications, in the City and Guilds College of the Imperial College of Science and Technology, South Kensington. Mr. M. W. Marconi was managing director of S.T.C. until 1928 and took an active part in the formation of the British Broadcasting Company, being one of its original directors. E. C. Cherry, M.Sc., has been appointed to the Readership. (See Personalities.)

Moulded Insulating Materials for use at frequencies greater than 10 kc/s are covered by a new British Standard (B.S. 1540:1940). It deals with six classes of materials—fused silica, vitreous carbon, asbestos, mica, gaseous textiles, and rubber-base materials and synthetic resins. It specifies tests for the mechanical strength, and electrical properties of each class. The Standard is obtainable from the British Standards Institution, 24 Victoria Street, London, S.W.1, price 6s.

Receiver Cabinet Design will be among the subjects illustrated at the exhibition provided by the Chicago Institute of Design which will be held in Manchester House, P etty France, London, S.W.1, from June 28th to July 29th.

Electronics Exhibition.—The fourth annual electronics exhibition organized by the North-Western Branch of the Institution of Electronics will be held at the College of Technology, Manchester, on July 19th from 2.30 to 9 p.m. and on July 20th and 21st from 10 a.m. to 5 p.m. An exhibition of scientific films arranged by the Manchester Scientific Film Society, will be included. Admission will be ticket obtainable from Dr. J. A. Darbishire, 1 Kendal Road, Fallowfield, Manchester.

“The Ionosphere and the Propagation of Radio Waves” is the main subject for consideration at the summer meeting of the Physical Society to be held in Cambridge from July 14th to 16th. The speakers will include Professor S. Chapman (Queen’s College, Oxford), J. A. Rate (Radio Laboratory, Cambridge), Dr. A. C. B. Lovell (Manchester University), G. Millington and S. B. Smith (Marconi’s W.T. Co.) and representatives from the Radio Research Board and the B.I.C. The fee for non-members is 10/- per day. Further particulars are obtainable from the Physical Society, 1 Lower Gardens, Lisboa, S.W.7.

Television Construction.—A constructors’ group of the Midlands Centre of the Television Society has been formed and particulars of the monthly meetings, which are informal, are obtainable from the Secretary, R. Baxendale, 50, Alcester Road, Birming-

Cavity Magnetron Award.—The Royal Commission on Awards to Inventors has granted £3,000 to be shared among the scientists responsible for the development of the cavity magnetron. They are Professor J. T. Randall, Professor of Physics, London University, S. A. B. Bashall, and Professor J. Sayers, both of Birmingham University.

Radio Navigation.—The Thomas Gray Memorial Prize (1948) of £50 was awarded by the Royal Society of Arts to J. K. L. Ward as consultant of the D.H. A. H. R. Board, for his essay on “The Applications of Radar to Navigation.”

Eddystone “600”—A typographical error appeared in Straton’s advertisement on page 3 of the June issue. The length of the scale was given as “equal to nineteen inches per range.” This should be ninety.

Scottish Branch of the Engineers’ Guild was inaugurated at a meeting held in Glasgow recently. This is the fifth branch of the Guild to be formed during the past few months.

FROM ABROAD

Italy has ordered 46 high-constant crystal-drive equipments from Marconi’s for synchronizing its many broadcasting stations which will have to share wavelengths as, under the Copenhagen Plan, Italy has only three exclusive frequencies. The monthly frequency drift of these equipments is given as not more than 2 in 10^6.

Finland is to install a new 100-kW medium-wave Marconi broadcasting transmitter. The special aerial coupling and tuning units for the directional aerial to be used in conformity with the provisions of the Copenhagen Plan are also to be provided by Marconi’s.

Pakistan’s Director of Radio is proposing to install receivers in schools and for community listening and is desirous of securing information from British manufacturers on sets that they are in a position to supply for the purpose. Most of the sets will need to be battery fed. Particulars should be forwarded to Z. A. Bokhari, Radio Pakistan (H.Q.), Karachi, Pakistan.

Exporting Television.—Scophony-Baird have appointed D. E. Wiseman, who was, until recently, the company’s production and sales director, as overseas representative and he is now visiting North America to investigate potential markets for the Baird transformerless a.c./d.c. television set which employs the Baird principle.

South Africa.—Four more 5-kW medium-wave transmitters, making ten in all, are to be supplied by Marconi’s to the South African Broadcasting Corporation.

India.—The Indian Minister of Industry and Supply has stated that the output of the four firms manufacturing broadcast receivers is 25,000 a year. He also stated that it is proposed to establish a factory for the manufacture of a variety of equipment ranging from transmitters to components and valves.

South Africa.—Provisions are made in the amended Broadcast Bill now before the South African Government for the South African Broadcasting Corporation to be permitted to erect transmitters outside the Union. Under the existing Act the activities of the S.A.B., are restricted to within the Union. Tenders have been invited by the Corporation for the supply of transmitters for the new commercial programmes which it is intended to radiate by the end of the year.

Denmark.—Transmissions from Denmark’s experimental television station began on May 1st. Some details of the Philips transmitter were given in our May issue.

Nairobi’s bilingual broadcasting service, which is provided by Cable and Wireless, Ltd., is to be augmented by the addition of a new 2-kW medium-wave transmitter ordered from Marconi’s.

INDUSTRIAL NEWS

Marconi’s marine communication receivers “Mercury” and “Electra” have been granted the P.M.G.’s certificate of type approval as conforming to the recently issued specification for ships’ general purpose receivers.

Welwyn Electrical Laboratories.—All departments of this company, except the London sales office, are now at the new factory at Bedlington Station, Northumberland. (Tel.: Bedlington 2121.)

Ekco.—The Public Hall, Hadleigh, Essex, which was purchased by E. K. Cole in 1946 for use as a store, is to be used by the company for the production of broadcast receivers thereby releasing space at the main factory for the additional production of television sets.

Advance Components, Ltd., advise us that the damage caused by the recent fire at their factory at Back Road, Sherrnhall Street, Walsall, W.2, is not as extensive as was at first estimated. Production has been resumed but deliveries of some types of ceramic signal generator and constant voltage transformers may be delayed a little.

Lee Products (Great Britain), Ltd., have transferred their head office and main distributing centre to 90 Great Eastern Street, London, E.C.2. (Tel.: Bishopsgate 3093.)

Kaysales, Ltd., manufacturers of “Precision” receivers, have taken over the Electronics Section of the business of S. A. Muffett, Ltd., of Mount Ephraim Works, Tunbridge Wells, Kent, and M. R. Barber has joined the company as chief engineer.

G.E.C. Research Laboratories have taken a 21-year lease of a building in the Ashley Exhibition Grounds as an additional laboratory.

Industrial Finishes Exhibition.—The exhibition of industrial finishes planned to be held in September has been postponed to September, 1949. Details are obtainable from the Organizing Secretary, 26 Old Brompton Road, London, S.W.7.
"SUPER FIFTY WATT" AMPLIFIER

This AMPLIFIER has a response of 30 c/s. to 25,000 c/s. within 1 db, under 2 per cent. distortion at 40 watts and 1 per cent. at 15 watts, including noise and distortion of pre-amplifier and microphone transformer. Electronic mixing for microphone and gramophone of either high or low impedance with top and bass controls. Output for 15/250 ohms with generous voice coil feedback to minimise speaker distortion. New style easy access steel case gives recessed controls, making transport safe and easy. Exceedingly well ventilated for long life. Amplifier complete in steel case, with built-in 15 ohm mu-metal shielded microphone transformer, tropical finish. As illustrated, Price £36 1/2 Gns.

FOUR-WAY ELECTRONIC MIXER

This unit with 4 built-in, balanced and screened microphone transformers, normally of 15-30 ohms impedance. Has 5 valves and selenium rectifier supplied by its own built-in screened power pack: consumption 20 watts. Suitable for recording and dubbing, or large P.A. Installations since it will drive up to six of our 50 watt amplifiers, whose base dimensions it matches. The standard model has an output impedance of 20,000 ohms or less, and any impedance can be supplied to order. Price in case with valves, etc., £24

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Wireless World
July, 1949

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Greatly Reduced Price

In view of the rapidly increasing interest in Television
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by 25%. At the same time the scope of the course has been
increased by including comprehensive material dealing
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The course covers the examination for the Television
Service Engineer’s Diploma set jointly by the Radio Trades
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How Many Kinds Are There?

By "CATHODE RAY"

This symbol (presumably short for "quality factor") has become generally accepted as the prime virtue where r.f. components are concerned. It has been incorporated in trade names. So recent statements that Q-meters don’t read Q may have sounded to some like a tampering with the eternal verities.

What exactly is Q? Although it has been in common use for so long it has been slow to be officially recognised. Perhaps that is because a thing that has gone about with several different meanings seems hardly respectable in official circles.

Its roots lie in the early days of broadcasting, when transmitters were low-powered and none too easily heard with the single-valve or crystal receivers of that period. So the demand was for tuning coils that would make the most of the feeble r.f. voltages picked up. Next, when stations multiplied in number and power, the problem was not so much to tune in the wanted station as to tune out the unwanted ones. All this time the wireless amateurs’ papers were full of advice on coils—practical advice on how to wind better coils, and theoretical advice on the underlying principles. It was shown that the coil which could give the strongest signals was also the most selective (though the optimum tapping or coupling depended on which quality was needed most).

The first prescription for achieving this double benefit was to reduce the r.f. resistance as much as possible. While quite true so far as it went, this was not the whole truth—it was soon realised that coil A might have a lower r.f. resistance than coil B and yet be less efficient in the two essential respects of sensitivity and selectivity. A resistance of 20 ohms would be bad in a medium-wave coil, but good in a long-wave coil. To make a fair comparison one had to take into account their inductances, and the frequencies at which they were used. So the need was felt for a single figure that would include all the factors concerned.

As a matter of general principle a standard of goodness, or a "figure of merit," is preferable to a standard of badness such as r.f. resistance.

That was where the term "circuit magnification" or "magnification factor" (abbreviated to \(m\)) came in.* It was based quite simply on the elementary principle of resonance, as shown in Fig. 1. If the frequency of the "input" or series voltage, \(v\), is adjusted to make the reactances of \(L\) and \(C\) equal, they cancel one another out, leaving \(R\) as the sole impedance of the circuit so far as \(v\) is concerned. The current is therefore equal to \(v/R\). But this current flows through \(C\) and \(L\), and sets up voltages across them, equal to the current multiplied by their reactance. As the reactances are equal and the current is the same, the voltages are equal, and can both be denoted by \(V\).

Reckoning from the inductive reactance, \(2\pi f L\) (abbreviated to \(\omega L\), we have:

\[
V = \frac{v \omega L}{R}
\]

The interesting thing, of course, is the ratio of \(V\) to \(v\), because \(V\) is the "output" voltage, which can be used or passed on to the next stage; \(v\) being the input, derived perhaps from an aerial or a valve coupled by a primary winding. In any reasonable tuning circuit \(V\) is considerably greater than \(v\), so it was natural to call \(V/v\) the magnification. We have, then:

\[
m = \frac{V}{v} = \frac{\omega L}{R}
\]

If we reckon from the capacitive reactance, \(1/\omega C\), we get:

\[
m = \frac{1}{\omega CR}
\]

which comes to the same thing—in Fig. 1, at least.

Instead of approaching the matter in this theoretical way, one may prefer to inject an actual voltage into a real tuned circuit and measure the output voltage across it; \(m\) is then directly:

\[
m = \frac{V}{v}
\]

In the course of time the Americans, thinking on similar lines, began to use the expression "Q". As it was usually defined as \(\frac{\omega L}{R}\), it was generally assumed to be another name for "\(m\)" which it has tended to out. But some slightly different definitions of \(Q\) appeared from time to time; and in the absence of prompt and firm action by acceptable authority, a state of uncertainty set in, and the term "Q" was generally avoided by the most precise people. Everybody else, however, found it too convenient for such scruples to prevail, and a Q-meter became one of the most used tools in almost every radio laboratory, while lots of people who hadn’t the least idea what it really meant discovered in Q a

*As far as I have been able to trace, the earliest use of voltage magnification as a standard of coil efficiency was made by S. Buttenworth (Experimental Wireless and Wireless Engineer, May, 1926, p. 267).
Q—valuable addition to their sales talk.

Many people in the radio business can get along quite well with the single easily-absorbed fact that a high Q means good selectivity and signal amplification. That is the great merit of the expression; it means something in terms of practical results. One does not need a university education to grasp its general significance. I take it, however, that if you were content with rough ideas you wouldn’t be reading this; so we will now proceed to consider the meaning of Q in greater detail.

Most of the controversy on the subject arises from the fact that no actual circuit is so simple as Fig. 1. L, C and R are shown there as separate components, but of course that is a theoretical simplification. R represents the total of the various forms of resistance and loss throughout the circuit. Normally most of it is the resistance of the coil, so L and R together are often assumed to represent the coil; but the capacitor is bound to have some resistance, so for more exact analysis one would divide R into two portions, attached to L and C respectively. We shall see later that if R is not substantially smaller than ωL and 1/ωC it is necessary to be particularly careful how m and Q are defined or measured.

Other complications occur because in practical circuits the

input voltage v is brought into the circuit.

At very high frequencies there is not even an appearance of L and C being separate—the tuning circuits are composed of parallel rods or cylinders, or of hollow spaces, in which L and C are inextricably mixed up and distributed. What about Q then?

We shall leave that question until later, and assume first that the frequency is moderate enough to let us represent the actual tuned circuit reasonably accurately by a diagram made up of separate lumps of L, C and R. That being so, it is usually satisfactory to consider the coil as if it were composed as shown in Fig. 2, in which C₀ is the self-capacitance. Comparing this with Fig. 1 we see that the coil is itself a complete resonant circuit. It is not possible to open the circuit to insert a signal source directly in series as in Fig. 1—the dotted line is a reminder that the items within it are only theoretically separable—but its equivalent can be performed by inductive coupling. The frequency at which a coil resonates on its own is called the self-resonant frequency. Although coils (especially if permeability-tuned) can be employed in this fashion, it is unusual to do so, because it allows the resonant frequency to be affected so much by stray capacitance. Nearly always the coil is used with a separate tuning capacitance.

Although the r.f. resistance of a capacitor can be kept very much smaller than that of a coil, it may not always be negligible. So it is necessary to make quite clear whether one is considering the Q of the coil alone, of the capacitor alone, or of the whole circuit. Just now we shall assume that the capacitor is perfect (zero resistance; infinite Q), so the Q of the coil is the same as the Q of the circuit.

Assuming also that the voltage v is introduced in series with L (in practice, by inductive coupling) connecting a perfect tuning capacitor across the terminals in Fig. 2 makes no difference in principle. It comes directly in parallel with C₀, and for purposes of calculation two capacitances in parallel can always be replaced by one equal to their combined values; so the actual circuit is unchanged. But if the signal source is connected in series with the coil (which is not just L, but the whole combination inside the dotted line), we have a different circuit arrangement, Fig. 3. The question then arises; are we concerned with the true inductance of the coil (L), or the inductance as it appears to be at that particular frequency, supposing that the

dotted line contained only inductance and resistance is in Fig. 4? The apparent inductance (L') is not quite the same as L—it must be greater, to make up for ignoring C₀—and R' is not the same as R. If they both differed in the same ratio, then the value of Q (taking it to be ωL/R) would be unaffected, but as it happens they are not. The textbooks show that

\[ R' = R \left( \frac{C + C₀}{C} \right) \]

and

\[ L' = L \left( \frac{C + C₀}{C} \right) \]

so what we may call the apparent Q, denoted by Q', and equal to ωL'/R', is

\[ Q' = \frac{\omega L'}{R' \left( C + C₀ \right)} = \frac{C}{C + C₀} \]

When the external tuning capacitance C is very much larger
than the self-capacitance \( C_0 \) the difference between \( Q \) and \( Q' \) is not worth bothering about. A typical self-capacitance is 6pF, and if the added capacitance were, say, 300pF, \( Q' = \frac{300}{300-90} = 0.98Q \); the difference would be only 2%, which is less than the probable error of most Q-meters. But if no C is used the apparent Q is zero, no matter how high the true Q may be! So the distinction ought not to be completely ignored.

Opinions have differed as to which Q is the right one, or in fact whether either as defined above is right. To settle the question some people appeal to basic principles and others to practical sense. To serve its purpose of expressing the goodness of a tuning circuit or component it would obviously be a great advantage if the definition corresponded to the method of use. So we had better consider how tuning circuits are used.

In a typical broadcast receiver there are three main kinds of tuned circuits, shown in rough outline in Fig. 5. There is first the r.f. circuit, \( L_1C_1 \), into which the input voltage is inductively injected from the aerial, and the output taken from across \( C_1 \). Next there is the i.f. primary, in which the mode of operation is reversed; the input is received directly across the terminals of \( C_2 \) and the output is imparted inductively, proportionately to the current flowing in \( L_2 \). Lastly the secondary, \( L_2C_2 \), which works similarly to \( L_1C_1 \).

None of these tuned circuits corresponds to Fig. 3; in all of them the self-capacitance of the coil is effectively in parallel with the external tuning capacitance, making a total of \( C + C_0 \) tuned by the true inductance \( L \) and damped by the true r.f. resistance \( R \). There is no need to bother about \( L' \) or \( R' \) or \( Q' \). The typical examples just shown cover the vast majority of tuned circuits in actual use. It is clear then that \( Q \) corresponds to practical affairs more closely and more often than \( Q' \).

But what about the methods used for measurement? The bare bones of the usual type of Q-meter are shown in Fig. 6. A variable-frequency oscillator is provided to pass a measurable current (I) through a known low resistance \( r \). The r.f. voltage developed across \( r \) is therefore \( Ir \), and it corresponds to the signal source in Fig. 3. The output voltage \( V \) is measured by a valve voltmeter across \( C \), when \( C \) or the frequency of the oscillator has been adjusted to cause resonance, indicated by maximum \( V \).

We must conclude, then, that the quantity which applies to the commonest methods of use is \( Q \), but that the quantity actually measured by the commonest method is \( Q' \). And therefore that when these methods giving \( Q' \) are used, the readings should be multiplied by \( \frac{C + C_0}{C} \) to bring them to \( Q \). The instruments are, or should be, calibrated in \( C_0 \) and can be used to measure \( C_0 \). As we have already seen, the correction is hardly worth applying when \( C \) is many times greater than \( C_0 \); but omitting to apply it when \( C \) is not much greater than \( C_0 \) gives results which differ largely from the true \( Q \).

A Q-meter is very handy to use, but is subject to another error—serious at the higher radio frequencies—due to \( r \), which makes the instrument read lower than it should by increasing the resistance of the circuit being tested. Even if \( r \) were directly in series with \( R \), so that it could just be deducted from it, one would have to calculate \( R \), which is a nuisance with an expensive instrument that is supposed to read \( Q \) directly without any need for calculation. But actually \( r \) is in series with \( R' \), so to be strictly correct one would have to apply the factor relating \( R \) to \( R' \). In fairness to Q-meters I must admit that \( r \) is usually small enough to be neglected except in high-Q, very-high-frequency circuits, and also that some Q-meters work on different principles. When measuring very good coils one might also have to allow for the losses due to the valve voltmeter and the tuning capacitor. So it is as well not to be too impressed by the apparent direct-readiness of an instrument having a pointer moving over a scale marked "Q." Its great advantage is that it does give quite quickly and easily a figure that can be used for comparing one coil with another, even though that figure may often differ appreciably from the true \( Q \). The instrument can also be used for a variety of other measurements if one is prepared to do a few simple calculations.

But if one is prepared for that there is a lot to be said for an alternative method—the method in which the frequency of the oscillator is read at resonance and also at the two settings, one on each side of resonance, at which the voltage across the tuned circuit is 70.7% (i.e., 1/\sqrt{2}) of its maximum reading (Fig. 7). Then if \( f_1 \) is the resonant frequency and \( f_1 \) and \( f_2 \) respectively the higher and lower of the other two:

\[
Q = \frac{f_r}{f_1 - f_2}
\]

In this method, the oscillator...
is loosely coupled to the coil under test; there is no need for the r.f. ammeter or the resistance \( r \); the result is given directly in true \( Q \); and the method can be used in circumstances where the Q-meter fails. And of course it is very much cheaper.

The reason why it gives true \( Q \) is that the input voltage is inductively coupled to the coil under test, so is in series with the tuned circuit as a whole. In Fig. 6, by contrast, the input voltage is in series with only one of the two capacitance branches; \( C_q \) forming a sort of bypass.

There is another feature about Fig. 6, which is of practical importance only when \( Q \) is exceptionally low, but is interesting theoretically. We have not defined "magnification factor," and I have yet to come across a really water-tight definition, but it seems to be generally agreed that it is \( V/V_i \) in Fig. 4 when the circuit is at resonance, as indicated by a maximum reading of \( V \). If you ask whether this is not identical with what we have been calling \( Q' \), the answer is—not exactly. If you look up any good textbook that deals with resonance you will see that the frequency at which the voltage across the resonant circuit is maximum is not quite the same as the frequency giving series resonance. As a matter of fact, it depends on whether the maximum is arrived at by adjusting the frequency or by adjusting the tuning capacitance. Now \( Q \) (and \( Q' \)), as we saw in connection with Fig. 1, are based on the theory of series resonance. But Q-meters, which are the practical embodiments of Fig. 4, are so arranged that resonance is judged by the maximum reading of \( V \). So really they are magnification-factor meters.

The relationship between \( m \) and \( Q' \) can be worked out. The calculation is rather involved, but as a matter of interest the result, assuming resonance is obtained by varying the frequency of the oscillator, is:

\[
Q' = \sqrt{m^2 - 1} + m \sqrt{(m^2 - 1)}
\]

For example, if \( m = 2 \), \( Q' = 1.8 \)—a 10% discrepancy; but if \( m = 10 \), \( Q' = 9.66 \)—only 0.4% different.

If resonance is obtained by varying \( C \):

\[
Q' = \sqrt{(m^2 - 1)}
\]

The discrepancy is slightly larger in this case, but is still utterly negligible for normal tuning circuits. It should not be forgotten when dealing with very "flat" circuits, however.

In the alternative (Fig. 7) method, too, resonance is judged by maximum \( V \); but the resulting error is even smaller than in the previous cases. The calculation still have to be 12 kc/s, but the \( Q \) to give that selectivity would be 1200/12 = 100.

For constant selectivity, then, \( Q \) has to be proportional to frequency; so the quantity that indicates narrowness of bandwidth is not \( Q = \frac{CL}{R} \), but \( \frac{L}{R} \) the "time constant." At any given frequency, however, it is true to say that selectivity is directly proportional to \( Q \).

This may be a good moment at which to point out another advantage of \( Q \) as a standard, compared with \( R \). We have already seen that it is a fairer guide to the effectiveness of a coil because it takes into account its inductance, and also it is a measure of goodness rather than badness, and directly tells one the output voltage produced at resonance by a given input voltage. The other thing is that \( R \), unlike ordinary d.c. resistance, is by no means constant. Most of the losses included in it tend to increase with frequency. Over a limited range of frequency, such as that covered by a tuning coil, the resistance \( R \) is usually roughly proportional to frequency. So, since \( Q = \frac{2\pi fL}{R} \), over the same range of frequency \( Q \) is roughly constant. Only roughly; but at least it is more nearly constant than \( R \).

So far we have been considering \( Q \) as a property of a coil, which is the same thing as the property of the whole tuned circuit, if losses outside the coil are negligible. But one often sees references to the \( Q \) of a capacitor or other component. The same principle holds: it is the ratio of reactance to series resistance; with capacitive reactance, \( Q = \frac{1}{\sqrt{\omega C R}} \).

When considering a resonant circuit it is often useful to know its equivalent parallel resistance, or dynamic resistance. Denoting it by \( R_d \), and the reactance (inductive or capacitive) by \( X \), the ratio \( R_d/X \) is the same as \( X/R \), which is what we know as \( Q \). So if we know that the reactance of a tuning coil in the anode circuit of a valve is, say 1000 \( \Omega \), and its \( Q \) is 100, then it acts as a coupling resistance of 100,000 \( \Omega \). (Because \( R_d = QX \).) And of
course its series r.f. resistance is 10\( \Omega \) (= X/Q).

Nowadays most of the interest is focused on those frequencies which the Editor conveniently gathers together under the single abbreviation “e.h.f.” (i.e., everything over 30 Mc/s). At such frequencies the concept of a circuit composed of lumped L and C more or less breaks down. That being so, the concept of Q, if it can be made to apply, is more useful than ever, because of the difficulty of measuring L and C and of knowing what they signify when one has measured them. So Q has recently been redefined in more general terms as:

\[
2\pi \text{ times the energy stored} \frac{\text{energy dissipated}}{\text{in the circuit per half-cycle}}.
\]

Simple lumped circuits such as Fig. 1 are particular cases, in which Q as defined in this general way simplifies to \( \omega L/R \) or whatever is appropriate. So accepting the newer definition doesn’t make it necessary to unlearn the old. There are, however, a few bogus definitions, such as the reciprocal of the power factor, that ought to be scrapped, however nearly right they may be in most cases.

You may ask how the energy stored per cycle in an e.h.f. circuit can be measured. Well, the most convenient form for definition is not necessarily the most convenient form for measurement; and in this case measurement is best tackled indirectly. It is sometimes possible to measure the decrement, or rate of dying-away of oscillations. But the most generally convenient is the Fig. 7 method, which holds good even with resonant cavities for centimetre waves. Frequency is the most accurately measurable quantity there is; so the only other thing to provide is an indicator to show when the voltage or current amplitude is 70% of maximum—roughly 3 db down.

Summing up the main points:

1. The modern definition of Q, completely general in its application, is based on the ratio of energy stored to energy dissipated in the circuit.

2. Applied to lumped circuits, this is equal to the ratio of the reactance (purely inductive or capacitive) to the series resistance (in its widest sense, covering all losses).

3. This X/R ratio is also equal to the ratio of V, the voltage across the whole reactance of one kind in a circuit at series resonance, to \( \nu \), the voltage injected in series—the ratio known as circuit magnification factor (m). But when, as is usual, resonance is judged by the maximum parallel voltage, there is a discrepancy between m and Q, which is negligible unless Q is in the lower single-figure range.

4. If Q or m is measured by the type of circuit shown in Fig. 3, (such as the usual type of Q-meter, Fig. 6), the result is the apparent Q, or Q', equal to \( Q' \left( \frac{C}{C+2c} \right) \). Since this is almost the only practical way of directly measuring m, in practice m is the same as Q' (neglecting the discrepancy mentioned above).

5. Q, however, can be measured by other methods (such as the frequency-variation method, Fig. 7) which give true values directly, and these correspond with the conditions under which tuned circuits are most commonly used (Fig. 5).

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NEW RADIO-GRAMOPHONE

A two-position tone control gives normal and extended frequency range on gramophone records in the latest Marconiophone Model ARG19A. The auto-changer handles up to ten 10in or 12in records. On the radio side, a four-valve plus rectifier superhet. covers short, medium and long waves. Three extra positions on the waverange switch give two preset stations on medium and one on long waves. The price is £84 11s. 4d. including purchase tax.

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TRIODE-DIODE VOLTOMETER

Made from War Surplus Parts

By T. A. LEDWARD, A.M.I.E.E.

A general view of the voltmeter

INTENDED for audio-frequency work, the voltmeter to be described has a linear scale from 0.1 to 1 volt. It is not suitable for d.c., but this limitation enables a stable zero to be obtained without special balancing arrangements.

The instrument was constructed from ex-Government components, including the metal case, at low cost.

A Type No. 194 receiver provided the case and valves. This receiver contained many additional parts, including two further valves, a VR91 and an EF50. The 0-100 microammeter, ex-Admiralty pattern W6022, had a special marked scale which required repainting and scaling.

The circuit arrangement was considered with some care and it will be useful to explain the reason for certain features. The first requirement was an approximately linear scale of 0-1 volt. The second was a reasonably high input impedance.

The linear scale requirement was met by the use of a diode, but a range of 0-1 volt with diode only and a 0-100 microammeter would have meant an input impedance of only about 5,000 ohms.

A pre-amplifier valve was therefore used. The input impedance now depends upon two things: the grid shunt resistance and the effective input capacitance of the valve. The latter factor, of course, lowers the input impedance as the frequency is raised.

A value of 1 megohm was chosen for the grid shunt resistance. The effective value of the input capacitance, using a VR65 valve is approximately 75 pF.

An important feature is the arrangement of circuit whereby the stray capacitance to earth from the anode circuit of the amplifying valve is maintained as low as possible.

Consider Fig. 1: in order to deal satisfactorily with the lower frequencies, the condensers $C_1$ and $C_2$ must be large, say $4\mu$F. They must also have a very high insulation resistance, which rules out electrolytics. The bulk will, therefore, be appreciable, and the capacitance to earth will be fairly high. Fig. 1 is, therefore, unsatisfactory for a wide range of frequency. Now consider Fig. 2: by placing $C_1$ and $C_2$ on the earth side of the circuit, the stray capacitance from anode to earth is unaffected by the size of these condensers. The indicating instrument is now raised to about 180 volts d.c. above earth potential, but the a.c. potential above earth is negligible and there will be no hand capacitance effects.

The final circuit of the voltmeter, together with values of components, is shown in Fig. 3. Separate 6-3 volt heater supplies will be required and the h.t. supply should be approximately 7 mA at 250 volts.

Higher voltage ranges may be included, if desired, by adding a voltage divider similar to that described in Wireless World dated June, 1944.

BOOK RECEIVED


This book is of American origin and treats electromagnetic waves mathematically. There is an introductory chapter explaining vector algebra which is freely used in the subsequent text. The book finishes with a chapter on radiation in which simple forms of aerial are considered.
DURING May, maximum usable frequencies for this latitude decreased very considerably by day, in accordance with the normal seasonal trend. The night values, however, instead of showing the usual increase, decreased very slightly, perhaps owing to the disturbed conditions during the first half of the month.

The month was slightly less disturbed than April, ionosphere storms being observed on 2nd-9th, 11th-14th and 31st, 12th and 13th being exceptionally disturbed, and a very great magnetic storm also being recorded during that period.

Working frequencies for the month were, on the whole, very low, relatively few contacts being established over 30 Mc/s. Thus long-distance communication on the 28-Mc/s band was seldom reliable, particularly in eastward and westward directions. During the night no frequencies below 7 Mc/s were really necessary.

There was a marked increase in the rate of incidence of Sporadic E, in accordance with the usual trend, and many amateur openings via this layer have been recorded for the first time this year, mostly from Eastern and Southern Europe. Frequencies as high as 50 Mc/s were occasionally propagated by this medium.

Four “Dellinger” fades were recorded in May, on 5th, 7th, 8th and 9th, the fades on 5th and 7th being particularly violent.

Sunspot activity in May was considerably less than in April. Three large sunspot groups crossed the central meridian of the sun (on 8th, 11th and 31st), and all of them were associated with reception disturbances which occurred around those periods, the disturbances following the second group being particularly intense.

Long-range tropospheric propagation was observed on a number of occasions, particularly in the second half of the month.

Forecast.—It is probable that there will be very little difference between the m.u.s for July and June, as in the Northern Hemisphere daytime and night-time m.u.s usually reach their respective annual minimum and maximum values during this period.

As in June, although daytime communication on very high frequencies, like the 28-Mc/s band, is not likely to be frequent, over many circuits frequencies like 15 and 17 Mc/s will remain regularly usable until midnight. During the night frequencies lower than 11 Mc/s will seldom be required. For medium distances, up to about 1,800 miles, the E and F1 layers will control transmission for considerable periods during the day.

Sporadic E is usually very prevalent in July, and communication over distances up to 1,400 miles may be possible by way of this medium on frequencies greatly in excess of the m.u.s for the regular E and F layers. Frequencies as high as 60 Mc/s may be occasionally reached for a short time. However, it is impossible to predict when such communication may occur, owing to the irregular behaviour of Sporadic E.

Below are given, in terms of the broadcast bands, the working frequencies which should be regularly usable during July for four long-distance circuits running in different directions from this country. (All times GMT). In addition, a figure in brackets is given for the use of those whose primary interest is the exploitation of certain frequency bands, and this indicates the highest frequency likely to be usable for about 25 per cent of the time during the month, for communication by way of the regular layers:

<table>
<thead>
<tr>
<th>Montreal</th>
<th>0000 15 Mc/s</th>
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<tr>
<td>0100 11</td>
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<tr>
<td>Buenos Aires</td>
<td>0000 17 Mc/s</td>
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<td>1600 17</td>
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<tr>
<th>Cape Town</th>
<th>0000 15 Mc/s</th>
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<tr>
<td>0100 11</td>
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<tr>
<td>0500 17</td>
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<td>0800 21</td>
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<td>1000 17</td>
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<th>Chungking</th>
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<td>0500 10</td>
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<td>0800 17</td>
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Ionospheric storms are not very common in July, and relatively undisturbed conditions may be expected. At the time of writing it would appear that storms are more likely to occur during the periods 1st-2nd, 6th-9th and 27th-29th, than on the other days of the month.
Unbiased

Nauseating Nomenclature

A GREAT many laymen, led astray by glib-tongued and facile-fisted lay journalists, seem to have got into their heads that there is some subtle difference between radio waves and what they call radar waves. It is difficult to explain to them that there ain’t no such animal as a radar wave, any more than in the realm of sound there are such things as echo waves, or aurad waves, as I have little doubt that some of these cliché conmen would term them.

Loathsomely learned.

I was trying to explode the radar wave superstition the other day by means of a mechanical analogy—always a dangerous thing, as invariably it breaks down and brings the creator down with it, as it did in this particular case in more senses than one.

To lend force to my argument I used a punch-ball to demonstrate my analogy. In an unguarded moment, carried away by my enthusiasm, I was floored physically by what I termed the ball’s radar wave, and metaphorically by a bespectacled and loathsomely learned-looking schoolboy who pointed out, quite rightly, that the ball’s return was not due to any reflection effect but to the release of the energy which my original blow had caused to be stored within its spring support. This regrettable contretemps and consequent collapse of both myself and my analogy had the unfortunate result of destroying faith in my main thesis and establishing “radar waves” still more firmly in the minds of my youthful audience.

This incident made me give up further attempts to educate the technically illiterate masses, but a recent report from the U.S.A., which states that cooking is now being carried out by what it calls “radar waves,” has brought my missionary zeal to the fore once again. I can stomach this sort of thing with as little success as I can stomach the results of this offensive inside-out sort of cooking. According to the newspaper report the innerds of a chicken, instead of being first removed, were cremated, and the flesh done to a turn, whatever a turn may be.

Apart from my aesthetic objections to this sort of cookery, which causes my physical gorge to rise as much as the misuse of the term radar causes my technical gorge to perform the same evolution, I object strongly to it being termed new. I, myself, was privileged to be present, over three years ago, at a private demonstration of this sort of inverted cookery by one of its pioneers, which I duly reported in these columns (March, 1946). For the benefit of those of you who have perverted gastronomic tastes, I would mention that the American demonstration was on a frequency of 23 MHz; but to me giblets are giblets, whether cremated or not, and I will have none of it.

Wrist Radio

The vogue of the personal portable or miniature receiver threatens to develop into an epidemic or even become a permanency as more and more manufacturers give us their versions of it. Quite frankly, I don’t like any that have so far appeared. My complaint is that none of them is small enough to shove into one’s pocket without making an unsightly bulge. The ignorant and ill-informed may well ask “why do you want to shove one into your pocket anyway?”

This is, of course, precisely the question which was asked of an ancestor of mine when he made a similar complaint about the bulkiness and unpocketability of turnip watches. My point is that the whole idea of the personal portable is that it is intended to be carried on one’s person. It should, therefore, be no larger than a watch or a cigarette lighter.

Seven years ago (March, 1942) I published in these columns a photograph illustrative of the American trend in portable design, which was towards something like a Leica camera. Both British and American “Leica” models of an improved type are now available, but they would be still more improved if they were made less conspicuous to carry and protected from damage by means of an ever-ready leather case like their photographic counterparts.

But now that ultra-midget valves, components and batteries are available for pocket hearing aids surely we can get down to something smaller than the Leica camera. In my opinion, it can be done by once more borrowing an idea from the photographic world; there is no shame in it, or at any rate the photographic fraternity do not think so as they don’t hesitate to borrow the micro-ammeter and the photocell from us and call the combination an exposure meter.

Apparently the Germans regard the Leica as a bit old fashioned as they now go in for a “wristwatch” camera weighing less than a couple of ounces and giving a negative of 4 x 3 millimetres. I need hardly say that this puts users of conventional miniature cameras into the same class as they have so often contemptuously consigned me and my old wet-plate outfit.

What I would like to see is British radio manufacturers following this thoroughly praiseworthy example and turning to the production of wrist radio. The volume from such a set would enable me to hear, without disturbing others, all that I wanted to when away from my home receiver. This surely is the sole aim and purpose of a “personal” receiver.

Radio manufacturers please copy.

Whilst on the subject of miniaturization there is another piece of equipment which could more readily be carried on one’s person if suitably adapted. I have often wondered why the practice of the Melanesian native, who carries his graphic counterparts, pierced and extended lobe of his ear, has not been copied by users of hearing aids.
LETTERS TO THE EDITOR

Export Opportunities • Why Record Supersonic Frequencies? • Circuit Diagram Conventions • Measuring Circuit Magnification • Simple Wobbulator • B.B.C. South Coast Service

Canadian Trade Possibilities

There would appear to be little effort on the part of many British manufacturers of electronic apparatus and components to realize the market potential for their products here in Canada.

I came to Canada eighteen months ago from the U.K., and, in my present work as Senior Communication Engineer, the Canadian prospects for many British lines have been brought forcibly to my notice.

Contrary to expectations, some American products retail at higher prices than their British counterparts and are frequently of inferior quality.

In view of Britain's present economic plight and the favourable import position applying to British products in the general class of electrical, wireless and radio apparatus (with the important exception of domestic radio receivers) the apparent sales lethargy on the part of many manufacturers in my opinion warrants the strongest censure.

Some British manufacturers have done nothing, possibly overawed at entering the arena with the American juggernaut; others have blindly accepted the first Canadian agency enquiry without regard for status or coverage. Where basic designs have been given to Canadian firms of standing there appears to be little control over the Canadian selling price, which rises steeply.

In view of this adverse selling factor, direct British group representation would appear to have many points in its favour. In short, is there any valid reason why bodies such as the Radio Component Manufacturers’ Federation, S.I.M.A., etc. should not set up their own Canadian distributor units?

Such a step should ensure more effective representation to the retailer and customer with more reasonable distribution overheads. It would also permit more adequate range or spare stocking and customer service than can be expected from an agent handling a product for the most profit with least effort.

In conclusion, may I stress the part that Wireless World itself could play in fostering increased electronic exports to Canada. Every effort should be made to increase the Canadian circulation with paper restrictions eased on this account. I can assure you that your coloured issue for March last agreeably surprised Canadian colleagues and, in particular, many of the advertisers and prices. In a country where American periodicals serve as a buyer's guide, the vital role of Wireless World cannot be over-estimated and, indeed, wider Canadian circulation is a vital prerequisite to increased British exports in this field.

T. S. DUTTON
Valois, Quebec, Canada.

Thévenin’s Theorem

In my recent article on Thévenin’s Theorem (March issue), I showed, perhaps, some disrespect towards M. Thévenin in suggesting that he was something of an interloper and that credit for the theorem really belonged to Helmholtz.

M. Simon, of “SOTELC,” Paris, gently implied as much in sending me a copy of his biographical appreciation of Thévenin, something of an American reproduction of Thévenin’s original paper setting out the theorem in question.

As a result of correspondence with M. Simon and with Prof. G. W. O. Howe (on whose Wireless Engineer Editorial of July, 1943, my remarks were based), the following concise summation in the words of Prof. Howe seems to be a fair statement of the facts:

“(a) Thévenin deserves the credit for setting out the theorem very clearly and making it generally known, and

(b) Helmholtz had described and used it thirty years before.”

To which may be added that Thévenin, like nearly everybody else, was unaware of Helmholtz’s statement.

I am indebted to M. Simon and Prof. Howe for kindly contributing from their knowledge to an agreed conclusion on what seemed at first rather controversial.

“CATIODE RAY.”

Recorded Supersonic Frequencies

In the report of the discussion on commercial disc recording, following the lecture by Mr. Mittell (Wireless World, February, 1948, p.)
Letters to the Editor

67), it was stated that "even when the response of the reproducer, or of the ear of the listener, was restricted, the subtle improvement resulting from the records of high, even ultrasonic, frequencies could be detected. It was thought that this might be explained on the basis of improved transient response."

If the ear responds to a transient sound by virtue of its waveform, as seems to be substantiated by certain evidence, then it is conceivable that a person who is deaf to high frequencies could hear a steep-fronted transient almost, if not quite, as well as a person with normal hearing.

The conventional explanation in terms of Fourier Analysis would lead to the conclusion that a person whose hearing is deficient in high frequencies would be unable to hear a steep-fronted transient.

The quoted improvement which occurs with the recording of inaudible frequency can be explained by either of two mechanisms. First, it might be through hearing the intermodulation products of two or more frequencies, of which at least one is above audibility. Alternatively it might be through the greater fidelity with which the transients are recorded.

It should not be difficult to devise tests, if this has not been done already, to determine (1) whether the ear responds to transients by virtue of their waveform and (2) whether intermodulation products or transients or both are responsible for the improvement from supersonic recording.

Can any of your readers give a lead in this direction?

F. LANGFORD SMITH.
Amalgamated Wireless Valve Co.,
Sydney, New South Wales.

"Drawing Circuit Diagrams"

BAINBRIDGE-BELL, in the May Wireless World, appears to be boggling a horse that has already passed the post. Precise recommendations on all the subjects raised have been made in British Standard 530:1948, which he himself quotes; surely it is better to accept these recommendations as they stand.

It is because of individual preferences, both in circuit-drawing practice and in symbols generally, that so much confusion has arisen in the past. This confusion can only be reduced by general acceptance of recommendations made by a fully representative body. If, for some particular reason, a given organization finds it necessary to depart from a specific British Standard, by all means let it do so; it is a different matter if such an organization or individual tries to foist its preferences on others.

Bainbridge-Bell over-stresses the risk of draughtsmen's errors. The danger of a blob at a junction being obscured can be avoided by making the blob big enough to be seen. Ordinary letter stencils provide the means; thus, the "O" of a standard No. 1 stencil, fully inky, is admirable for most purposes, though when the drawings are used for line blocks the size must be related to reduction wanted.

Such innovations as that suggested in Bainbridge-Bell's penultimate sketch are commendable provided the reader knows what they mean; generally an explanation is necessary. In the instance quoted "the path BC" is sufficiently explanatory without resorting to a symbol which is meaningless to those not in the know.

London, N.W.
J. W. GODFREY.

"Q-Meter Controversy"

I WAS interested in the correspondence printed in the June Wireless World concerning "Q" meters. As my firm are the manufacturers referred to by "P. H." as making the first British instrument of this kind, may I add two further comments?

Our instrument was called a Circuit Magnification Meter as, like "P. H.", we felt that the use of the term "Q Meter" was, to say the least, inappropriate and rather smacking of technical jargon. We continue to use the longer title.

Dr. Sheridan notes with surprise the use of an injection resistor and points out its shortcomings at higher frequencies. This type of circuit is used in our Circuit Magnification Meter, but its defects are well realized. By careful design it will give reasonable performance up to about 30 Mc/s, but begins to fall off above that. In a high-frequency circuit magnification meter covering 15 to 170 Mc/s, the system has been abandoned and an inductive injection method is used. This is shown in the attached functional diagram. Series injection is still used, but the virtual injection resistance is made so small that the reactance of its residual inductance L3 is very much greater than its resistance, even at the lowest working frequencies. To facilitate measurement of the voltage applied to the test circuit, the injection inductance L3 is tapped down to a much greater inductance L4 so that a known fraction of the voltage is taken. The voltage across L4 is measured by one diode voltmeter and that across the tuned circuit by another.

A further interesting arrangement is that by feeding suitable fractions of the d.c. outputs of the two voltmeters in opposition to a d.c. amplifier with a meter in its anode circuit used as a null detector, the values of Q factor may be read off from the dial of a calibrated potentiometer (range Q 75 to 1,200). The advantages of this system are that the calibratable element in the circuit carries only d.c.; there is no necessity to know the absolute value of the e.m.f. injected into the test circuit; only one meter is required and the null reading system inherently has good stability and independence from supply voltage fluctuations. This circuit is covered by British Patent Application No. 25208/48.

E. D. HART.
Marconi Instruments, Ltd.
St. Albans, Herts.

Calibrating a Wobbulator

WITH reference to the article by K. C. Johnson on his new wobbulator circuit, I feel he has over-emphasized the difficulty of calibrating it on the television band.
I have the circuit in use, and have devised a simple but very accurate method of continuous calibration, or "strob ing," as it might be termed.

The normal circuit is set going, with the unit feeding the receiver and the receiver feeding the 'scope; then the signal generator is loose coupled to the input tuned circuit of the receiver. As the wobbulator sweeps through the signal generator frequency a "blip" is produced on the curve of the 'scope; this marker pip moves along the curve as the generator is tuned through the band, and enables the exact frequency of any hams, etc., to be read instantly, and also enables the scope to be used without any paper scale.

The accompanying sketch was drawn from a 'scope trace, using a normal t.r.f. vision receiver.

As will be seen from the sketch, the heterodyne pip is fairly sharp and narrow. This is due to the narrow frequency response of the 'scope amplifier, which, for this purpose, is clearly desirable.

DOUGLAS M. GIBSON.
Ashford, Kent.

"Copenhagen Comments"

I SHOULD like to reply to the comments of Mr. R. Cleghorn (Wireless World, May, 1949).

Germany not having been represented in the Broadcasting Convention at Copenhagen did not get three channels, but two for each zone of occupation; i.e., in total eight channels. Indeed, none of them is a clear one, and, moreover, the limit of power to 10 Kw each is very unfavourable.

Whether the consequence Mr. Cleghorn is afraid of will appear and whether Germany will annex some further channels must be doubted. Germany will remain occupied for many years to come and the broadcast branches of military governments surely will supervise the German Broadcasting System in future.

The allocated channels are insufficient and the German broadcasting companies like Nordwestdeutscher Rundfunk and Bayerischer Rundfunk are preparing schemes to procure proper possibilities of reception to their listeners by erecting e.h.f. (f.m.) stations. About 20 of such stations, each with 10 Kw power, are provided for the British Zone alone. In the meantime, in Hanover, Hamburg and Munich f.m. transmitters with 0.1 Kw each have been erected for testing purposes; further ones will follow.

KARL TETZNER.
Emden, Germany.

B.B.C. Coverage

MAY I appeal for improved facilities for high fidelity reception in this area?

Including as it does fairly large centres of population, the coastal strip of Sussex is very badly served on the Light and Home Services, although the recent opening of the Third Programme transmitter at Kingston-by-Sea has provided signals of good quality, but of appeal to only a limited taste. It will hardly be contested that the large proportion of recorded items on the Third Programme limits quality. The signal strength from the longwave Light Programme is fairly good, but reception is marred by atmospheric interference during the summer months in particular. On the medium waves, the West Regional transmitter at Start Point provides the strongest signal, but fades, whilst the quality appears generally slightly inferior to that from Brookmans Park, on the same programme, presumably due to landline defects. The latter transmitter is free from fading since the installation of the new mast aerial, although the signal strength does not appear appreciably greater, and is certainly inadequate to stand out from the many sources of interference, whether man-made or natural.

Would it not be possible, even if the need for economy prevents the installation of any further transmitters, for the Kingston transmitter to radiate the Home or Light Programme during those hours when it is not needed for its own service?

D. C. SMITH.
North Lancing, Sussex.

CORRECTIONS

The last paragraph of the article "When Negative Feedback Isn’t Negative" (May issue) should read “... try using a high anode coupling resistance for the middle stage and lower values for the two outer ones.” Incidentally, the reference to the article by C. F. Brockelsby in Wireless Engineer should have been to the February, 1948, issue.

In “Contrast Expansion” (June issue) in the 5th line of Col. 3, “40Y/4” should read “40-50Y/4”.

The price of the Labgear electronic relay (advertisement on p. 22, June issue) should be £5 5s.

In the Varadio advertisement on p. 60, June issue, the model number should be 290/116 for “H.F. and R.F.” read “R.F. and A.F.”
RANDOM RADIATIONS

By “DIALLIST”

DX Television

Spending a few days recently at a little place on the Suffolk coast which is just about 100 miles as the crow flies (or the wave waggles) from Alexandra Palace, I was surprised to notice quite a sprinkling of the H-type television aerials, which are now such familiar objects of the sky line of Greater London and the Home Counties. In this small East Anglian town I counted five during casual strolls and probably the number would have been doubled or trebled had I set out on a determined search for them. The owner of one television set told me that reception, though chancy, was quite excellent at times. He was kind enough to invite me to “look in.” Unfortunately, it was just one of those days. A hazy image might appear for a second, but it could not be held; most of the time there was nothing on the screen but “noise.” He and the other owners of television receivers in the locality have, I imagine, something of the thrill that old hands used to get out of long-distance radio in the early days of medium-wave and short-wave broadcasting. All of us were very certain that DX work was worth while, no matter how many profitless vigils into the small hours it entailed; for there were wonderful periods of loud and clear reception, which made up for everything.

They Want It

The fact that people living in places far beyond the normal service area of the London television station think it worth while to install televisions is clear proof of the urgency of the demand for television services all over this country. People definitely want television; they are prepared to pay for receiving sets and they will put up with poor or chancy reception rather than have nothing at all. To me, at any rate, it seems that the B.B.C.'s progress in providing a network of transmitters should be speeded up. All sites should have been selected by now, or should anyhow be chosen within the next few months. Since the Powers That Be have guaranteed the continuance of the 405-line, 50-frames-per-second transmissions, the B.B.C. would do well to decide upon a standard design for its transmitters and to place orders right away for ten or a dozen of them. If these and the necessary radio links were ordered in bulk, both time and money would be saved. There's a point, too, about those radio links. The main centres will presumably have their own studios, O.B. equipments and so on; interconnections will enable any of them to originate programmes to be radiated by all or any of the others. But has it occurred to anyone to combine some or all of the radio links (or coaxial cable repeater stations) with small, unattended and automatically operated transmitters? Were this done, to take one example, in the country traversed by the London-Birmingham links, the whole service area might have the form of a dumb-bell —circles of 30 or more miles radius round London and Birmingham and between them an area of approximately rectangular shape some 15 to 20 miles in width. There are, of course, difficulties; but are they too formidable to be overcome?

Aerials and Amplifiers

It would, I feel sure, pay those concerned with the manufacture of television aerials and of signal-frequency amplifying units not only to study reception conditions in outlying districts, but also to conduct instructional campaigns in “fringe” areas and those still farther from transmitting centres. In talking to people living in such parts of the country I've found, first of all, that the ordinary man who buys a televisor and hopes for the best does not realize that there are means whereby his chances of good reception could be improved; secondly, that not a few of the radio dealers who supply the sets are not much better informed. One of them assured me that the multiple aerial array was just a stunt of no real value, and another was equally sceptical about signal-frequency amplifying units. I'm not going to say that any kind of complex aerial, even with a perfectly matched feeder, will make good re-

ception a certainty in places where it is now the exception rather than the rule. Nor would any sensible person claim that additional s.f. amplification will always do the trick. Either or both, however, may so much increase the chances of good reception in such places as to make all the difference between its being worth while or not to invest in a television receiving set.

A Tricky Business

The New York Magazine Radio-Electronics has just inaugurated a scheme which may have interesting results. Publishing a letter from a resident in Borneo, who wants to buy American components and so on but can't owing to currency export restrictions, the Editor suggests that the only way out of the difficulty at the moment is a return to primitive bartering methods by making swaps. He fully appreciates the difficulties and the exasperation of those radio addicts who yearn to possess this American gadget or that, but can't get leave to send so much as a lone dollar abroad. To help them he proposes to run free of charge a section of classified advertisements by radio folk living in such countries. In these adver-

CONSOLE RECORD PLAYER

Designed primarily for use with the “500” series of radio receivers, this record player cabinet by Ace Radio, Tower Road, London, N.W.10, contains an automatic record changer and provides storage for records. The price is £35 13s. 6d., including tax.
tisements (which must not exceed 40 words) the dweller in a currency-restricted country can state what he wants and what he has to offer in exchange. It's a grand idea and a generous one in these hard times. The big snag, though, may prove to be the fact that most of the currency-restricted countries have also a mass of complicated import regulations. Were you to succeed in swapping this or that for, say, an f.m. receiver kit, you might find it impossible to steer your prize through the offshore minefield of import licences, etc.!

Effects

A cousin of mine who writes plays for the B.B.C. invited me recently to go to a rehearsal of one of hers. I had a good many surprises, not the least of which was that, for a half-hour item due to be broadcast at 5 p.m., morning rehearsals took place from 10.30 to 1 o'clock and that these were followed by another lot from 2 to 4. The effects in particular have to be rehearsed most carefully for timing. Most of them were produced from records on the four turntables of a play-back instrument and I was able to see the working of the apparatus which enables any part of a record to be selected with absolute certainty. The pick-up is held by a rigid arm mounted tangentially to the grooves of the disc and travelling along a finely graduated scale. Shortly before a particular effect is required the needle is lowered into the groove; the controller then fades it in and out at the proper moments.

Another One to Try

In its June issue Toute la Radio had a quiz which contained one poser that may be of interest to readers of Wireless World. Here it is. If the output terminals of a high-voltage d.c. supply have two or more capacitors connected across them in series, these capacitors are always shunted individually by resistors of high values. This precaution is necessary:

(a) To reduce ripple;
(b) To prevent the capacitors from "blowing up";
(c) To discharge the capacitors when the h.t. voltage is switched off and so to guard against accidents.

What's your view? The answer is given on page 258.

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**Automatic Muting**

Valve noise produced by inherent thermal effects is utilized to short-circuit the loudspeaker automatically when no signals are present. It is known that the noise voltage is considerably increased during such times, and this is stated to be due to the action of the automatic volume control in the case of amplitude-modulated signals, and to the fact that the presence of the carrier shortens the actual duration of the thermal effect in the case of frequency-modulated signals.

In the "no-signal" condition shown, a circuit LC in parallel with the anode of the a.f. amplifier V1 collects the noise voltage, which lies well above the normal signal frequencies fed to the loudspeaker LS, and passes it through rectifier circuits D and Dr Ri to the grid of a valve V, to operate a relay S controlling short-circuiting contacts Si on the speaker. When a signal is received, the charge built up on the condenser C quickly leaks away through the rectifier D and low resistance Ri. The charging of the condenser takes place more slowly through the rectifier D and high resistance Ri, so preventing the relay circuit of the super-regenerator to negligible proportions, and for this purpose the circuit is usually damped by a low-resistance shunt. This involves a serious loss of power in the response signal, since the same tuned circuit is used both for transmission and reception.

According to the invention, the difficulty is solved by using as the damping device a diode which is connected across the tuned circuit, and also to a source of positive potential. During standby conditions, the positively biased diode has a comparatively low resistance; but when the super-regenerator is triggered into transconductance oscillation, the diode rises to a high level and then serves automatically to "open-circuit" the diode by charging a condenser connected between its anode and the tuned circuit.


**Television Cabinets**

The cabinet is made in two parts, the upper of which contains the viewing screen and is arranged to telescope inside the lower or main casing, with a vertical movement, so as not to disturb anything that may normally be placed on top of the cabinet.

The main casing contains the cathode-ray tube, which is mounted to project the picture downwards on to a spherical mirror, from which it is reflected back through a correcting lens or to an inclined plane mirror, fixed in the upper part of the casing, and finally on to a vertical ground-glass or opalescent viewing screen. The lifting and lowering movement of the upper part is conveniently controlled by means of a small electric motor, through worm gearing and vertical guide rods, an automatic stop and slip clutch unit being provided to prevent damage to the equipment.

Marconi's Wireless Telegraph Co., Ltd. (Assignee of R. V. Beshgetoor). Convention date (U.S.A.), October 18th, 1944. No. 607231.

**Super-regenerative Circuits**

Relates to the type of circuit that is designed to respond to the receipt of a pulsed signal, as used in radar, by the instant transmission of an identification signal. To ensure satisfactory threshold conditions, it is necessary to reduce the free oscillations that normally occur in the tuned circuit of the super-regenerator to negligible proportions, and for this purpose the circuit is usually damped by a low-resistance shunt. This involves a serious loss of power in the response signal, since the same tuned circuit is used both for transmission and reception.

According to the invention, the difficulty is solved by using as the damping device a diode which is connected across the tuned circuit, and also to a source of positive potential. During standby conditions, the positively biased diode has a comparatively low resistance; but when the super-regenerator is triggered into transconductance oscillation, the diode rises to a high level and then serves automatically to "open-circuit" the diode by charging a condenser connected between its anode and the tuned circuit.


**Intervalve Coupling**

The grid of the amplifier V1 is coupled to the anode of the previous stage V through a step-down tapping on a coil L, which is chosen so that the impedance of the whole coil bears the same ratio to the impedance of the part of the coil between the tapping T and the ground, as the capacity between the grid and all the other elements of the amplifier V1 bears to the capacity between the anode and all the other elements of the amplifier V. More particularly, the grid-cathode capacity of V1 is reflected by the coil as a smaller capacity between the anode and cathode of V. The sum of the capacities concerned is represented in dotted lines at Cg, and is calculated to resonate with the coil L at the working frequency. The normal coupling condenser C is being too large to have any appreciable effect.

A useful increase in effective amplification is secured by the arrangement shown. In an eight-stage receiver for pulsed signals the overall gain is stated to be more than three times that normally given.

The British Thomson-Houston Co., Ltd. Convention date (U.S.A.), May 20th, 1945. No. 612472.

**Remote Control System**

Signals transmitted in the form of televised symbols, grouped into characteristic patterns, are used for the selective control of distant apparatus. A chequered arrangement of black-and-white squares will, for instance, provide a very large number of distinctive patterns by suitably re-grouping the unitary squares. Further variety can be introduced by the stepped rotation of any given pattern. At the distant end, a photograph relay is operated only when the pattern reproduced on the viewing screen of a television receiver conforms to a predetermined code. In order to ensure secrecy, provision is made to vary the line and frame frequencies, and to switch over from progressive to interlaced scanning, from time to time, in accordance with master control signals radiated from the transmitter.


The British abstracts published here are prepared with the permission of the Controller of H.M. Stationery Office, from specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 5s. each.
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INDUSTRY is catching up with SCIENCE

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We manufacture a wide range of components for the Radio, Electronics and Television Industries. In addition to stock lines, a few of which are illustrated below, we can also manufacture special components designed for individual specifications.

- Clux Heavy Duty Spade terminals. Other types available to cover terminal diameters of from 1/8” to 5/8”. Black and red only.
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- Tag Strips. Types are available with from 1 to 9 Tags. Tropical or Commercial Grades in various combinations, also miniature types.
- Chassis-Mounting Socket Strips with from 2-6 Sockets in various standard markings or to Customers’ needs.
- 5-pin English Valve holder. Other types are available for most British and American valves.

BRITISH MECHANICAL PRODUCTIONS LTD.
(in association with General Accessories Ltd.)
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Eliminate Positive Feedback

(Mechanical) "EQUIFLEX" PATENT MOUNTINGS will eliminate Mechanical and acoustic Vibration from being amplified and a Black Spot on Quality Reproduction. Call at your Dealers to see a complete set of special "EQUIFLEX." Damped units with all fittings and assembly chart suitable for the GARRARD R C 60 Turntable.

GARRARD RC 60 UNIT

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Robust moving iron instruments. Suitable for the Electrical
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Size: 3½ x 2½ x 2½ overall complete with carrying strap.

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25V A.C. or D.C. ........................................... £24 0 0
25A A.C. or D.C. ........................................... £36 0 0

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Hundreds of other items too numerous to list at Bargain Prices. Please state requirements,
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**MAINS TRANSFORMERS**

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Coulphone Mains Transformers are made to the highest electrical standards and are fully guaranteed. We supply them to the Ministry of Supply Atomic Research stations, so they will no doubt meet your requirements.

Special quotations for quantities and types to order.

**Standard Replacement Types**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>A</td>
<td>300-0-300 60 mA 0.4/0.6 V 4 A.C.</td>
<td>16.00</td>
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<tr>
<td>B</td>
<td>200-0-250 60 mA 0.4/0.6 V 4 A.C.</td>
<td>15.00</td>
</tr>
<tr>
<td>C</td>
<td>200-0-250 60 mA 0.4/0.6 V 4 A.C.</td>
<td>15.00</td>
</tr>
<tr>
<td>D</td>
<td>300-0-250 60 mA 0.4/0.6 V 4 A.C.</td>
<td>15.00</td>
</tr>
<tr>
<td>E</td>
<td>300-0-250 60 mA 0.4/0.6 V 4 A.C.</td>
<td>15.00</td>
</tr>
<tr>
<td>F</td>
<td>300-0-250 60 mA 0.4/0.6 V 4 A.C.</td>
<td>15.00</td>
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<tr>
<td>G</td>
<td>300-0-250 60 mA 0.4/0.6 V 4 A.C.</td>
<td>15.00</td>
</tr>
<tr>
<td>H</td>
<td>300-0-250 60 mA 0.4/0.6 V 4 A.C.</td>
<td>15.00</td>
</tr>
<tr>
<td>I</td>
<td>300-0-250 60 mA 0.4/0.6 V 4 A.C.</td>
<td>15.00</td>
</tr>
<tr>
<td>J</td>
<td>300-0-250 60 mA 0.4/0.6 V 4 A.C.</td>
<td>15.00</td>
</tr>
<tr>
<td>K</td>
<td>300-0-250 60 mA 0.4/0.6 V 4 A.C.</td>
<td>15.00</td>
</tr>
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<td>L</td>
<td>300-0-250 60 mA 0.4/0.6 V 4 A.C.</td>
<td>15.00</td>
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<td>M</td>
<td>300-0-250 60 mA 0.4/0.6 V 4 A.C.</td>
<td>15.00</td>
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<td>N</td>
<td>300-0-250 60 mA 0.4/0.6 V 4 A.C.</td>
<td>15.00</td>
</tr>
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<td>O</td>
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<td>15.00</td>
</tr>
<tr>
<td>Z</td>
<td>300-0-250 60 mA 0.4/0.6 V 4 A.C.</td>
<td>15.00</td>
</tr>
</tbody>
</table>

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**FEEDER UNITS**

**Model No. De Luxe (Illustrated Above)**


**Model A**

Valves required, 6K50, 6K50, 0K70, 6K70, 6U3. Price for set of four valves, £13 11/6.

**Model A**


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Valves required, 6K70, 6K90, 6K70, 6K70. Price for set of five valves, £2 11/6.

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A wide range is now available in 1, 2, 3 or 4 gang types of various capacities.

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For Blocking and Bypass in High Frequency Heating and Radio Transmission; High Altitude Airborne Equipment; Delay Networks in Pulse Circuits; Voltage Dividers; Stabilising Units, etc.

<table>
<thead>
<tr>
<th>TYPICAL STANDARD UNITS</th>
<th>Full load: 70 kVA at 500 Kc to 10 MC per sec. Peak W/kg, 10kV.</th>
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<tbody>
<tr>
<td>Type M1A</td>
<td>Cap.</td>
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<tr>
<td>10,000 pf</td>
<td>6&quot; x 13&quot; x 1/2&quot;</td>
</tr>
<tr>
<td>5,000 pf</td>
<td>6&quot; x 13&quot; x 1/2&quot;</td>
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<tr>
<td>Full load: 9 kVA at 500 KC to 10 MC per sec. Peak W/kg, 15 kW.</td>
<td></td>
</tr>
<tr>
<td>Type M4A</td>
<td>150 pf</td>
</tr>
</tbody>
</table>

Full list and details on application.
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328/2.

**CONVERSION TYPE TV/11/1355.** Manufactured especially for Receiver
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E.H.T. CONDENSERS.

0.54mfd. 2.5xK D C. wip. Cyl. can type. 5mm. x 5mm.

1/8.

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It is to the best of our knowledge, the only unit on the market with an E.P.P. stage
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REMOTE CONTROL

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