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EDITORIAL COMMENT

Cathode - Ray

The Heart of Television

THE appearance of our present issue, devoted mainly to the subject of the cathode-ray tube, reminds us that the general public scarcely knew of the existence of such a device as the cathode-ray tube until, with the arrival of television, they constantly heard the name of " cathode-ray tube " coupled with every discussion on the new art. But the cathode-ray tube is not new in principle ; it was well known before 1897, and it was in that year that Braun produced a useful laboratory instrument from what had been merely an interesting experiment in physics. The Braun tube, although it may be regarded as the first of its dynasty, had a limited appeal, even to scientists. At that time it was not a very reliable or permanent instrument nor had valuable applications for it yet been found.

It was not until about thirty years later that the cathode-ray tube came to be regarded as an every-day instrument in the laboratory, although as long ago as 1902 Cossors, the valve manufacturers, were producing their first examples.

Wehnelt introduced the heated cathode to the tube in 1905, and this was an outstanding development. Other pioneers were van der Bijl and Johnson, the latter having been the designer of the Western Electric oscillograph produced about 1920. Von Ardenne, in Germany, has been responsible for several of the most important refinements of the modern tube, and his work has contributed to a very large extent in making these tubes suitable tools for use in television reception.

Television has given impetus to tube development during the past few years, and in just the same way it may be said that every fresh improvement in the tube has contributed to hastening the arrival of efficient television. If it had not been for television, the tube would probably still have remained an undeveloped instrument for the reason that the demand for it commercially would have been insufficient to encourage extensive research on it, nor should we to-day be enjoying a television service if the cathode-ray tube had not been available to us.

Great strides have been made in cathode-ray tube development, but finality has by no means been reached and we may look for important progress to continue for some time to come. Records at the Patent Office are, in themselves, an indication of the inventive effort which is being put into this instrument at the present time.

Information in this Issue

Technically speaking, there are two rival cathode-ray tube systems available for television, and both are being used commercially at the present time. One employs electrostatic focusing and electrostatic deflection, and the other magnetic focusing and deflection. Articles in this issue discuss these systems and point out their merits. Other contributions deal with various problems associated with the practical use of these tubes, both for television and laboratory requirements. Details of the various types of tube available to-day, with a key to their base connections, provides, in a convenient form, a great deal of information which has not, we believe, been available hitherto.

Hard-valve Time-bases

HOW ORDINARY VALVES CAN BE USED AND THEIR ADVANTAGES

By O. S. PUCKLE, A.M.I.E.E.
(Cossor Research Laboratory)

A TIME-BASE or, to give it its full title, a time-base oscillation generator, consists essentially of a condenser connected via a controlling resistance across a direct current source of supply. Across the condenser is connected a discharging device.

The simplest form of discharging device is an ordinary neon glow lamp. Such a simple form of time-base is inefficient because there is only a small potential difference between the striking and extinction potentials of the neon lamp and also because the charging curve is exponential and not linear.

The introduction of a grid into the neon lamp by Dr. Hull introduced a useful tool known as a Thyratron, which very greatly increased the difference between the striking and extinction potentials and thus increased the efficiency of the time-base Dr. Hull also replaced the neon gas by mercury vapour.

The linearity of the charging curve was slightly improved by replacing the resistance by a diode having a plain metal filament operated with the filament current reduced so that the space current is saturated, i.e., independent of the anode voltage. A further great improvement was effected by Bedford, whose substitution of the diode by a pentode operating on the flat part of its anode-volts—anode-current characteristic increased the linearity enormously.

The characteristic curve mentioned above is shown in Fig. 1, from which it will be obvious that, provided the anode volts are not permited to fall below about 50 volts, the anode current is substantially, though not completely, independent of the anode voltage.

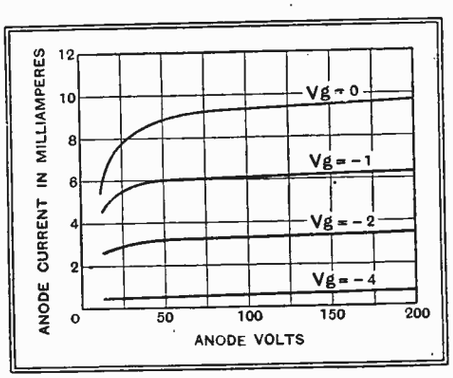


Fig. 1.—Typical anode-volts—anode-current curves for an RF pentode are shown here.

Bedford's later development[1] of applying a small potential, proportional to the anode current, to the grid-cathode circuit of the pentode provides almost perfect linearity of the condenser charging curve.

All these improvements, however, though of inestimable value, do not prevent the soft-valve time-base from lying open to the charges of erratic behaviour and of an inability to function at all except at relatively low frequencies. Furthermore, the soft-valve time-base refuses to function at rapidly varying frequencies, a condition which is sometimes necessary, e.g., for velocity modulation television.

ALTHOUGH gas-filled triodes are widely used in time-bases, ordinary hard valves can be employed and offer certain advantages at high frequencies. In this article, circuits of several types are given and their mode of operation explained

The reason for the above mentioned failures of the soft-valve time-base is that before the gas or vapour can conduct a current it must become ionised. Ionisation takes place when the potential across the electrodes immersed in the gas is raised to a certain critical value. This critical potential depends upon a number of factors:—

a. The actual gas or vapour used and its purity.
b. The pressure of the gas.
c. The temperature.
d. The rate of rise of potential.
e. The time which has elapsed since the gas was last ionised.

It will be obvious that the temperature of the valve will rise after the circuit is switched on and hence the pressure of the gas will vary. In the same way a draught of air will tend to upset the operation of the time-base. Since the ionisation potential varies with the rate of rise of potential a soft-valve time-base does not function satisfactorily in a velocity modulation television system where the time taken to charge the condenser, and hence the rate of rise of potential, is constantly varying.

As the time between successive discharges is reduced a limiting condition is reached in which the gas has not sufficient time to become deionised, so that the discharge valve continues to carry current and the condenser cannot charge. There is thus a limiting frequency at which the time-base can function with a given pressure and temperature of the gas or vapour in the discharge tube. This limiting frequency is normally about 30,000 discharges per second.

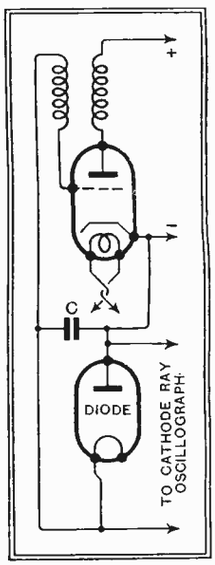


Fig. 2.—A time-base in which a saturated diode is used to maintain linearity.

It is believed that the first hard-valve time-base was that due to Watsôn-Watt and Herd of the Radio Research Board.

The Watson-Watt Herd time-base (Fig. 2) consists of a RF oscillator which is made to oscillate very violently. A grid blocking-condenser C is shunted by a diode, the former becoming charged when the grid of the oscillator is driven towards zero grid volts. The condenser acquires sufficient potential to stop the oscillations and these do not recommence until the charge on the condenser is greatly reduced by leakage through the diode. The rate of leakage is controlled by varying the temperature of the diode and the resultant potential variations across the condenser are normally fed to the horizontal deflecting plates of a cathode-ray tube in order to produce a motion of the spot which is proportional to time.

Time-base Circuits

The diode shown in Fig. 2 may, of course, be replaced by a pentode in order to improve the linearity, as described above.

Notice that in the case of the Watson-Watt Herd time base the condenser is *discharged* by the diode or pentode. This arrangement is the opposite to that normally used, but it should be borne in mind that a time-base potential may be obtained by a slow charge of the condenser followed by a rapid discharge or alternatively by a rapid charge followed by a slow discharge. The effective portion of the charge-discharge curve is normally the slow portion.

Other time-bases using hard valves have

[1] British Patent Specification No. 451117, A. C. Cossor and L. H. Bedford.

Hard-valve Time-bases

been developed, notably by Knoll, Freundlich and Turner. Several of these consist of a condenser charged from a DC source of supply, the condenser being discharged by the application of a potential between the grid and cathode of a valve connected across the condenser. The grid of the valve is normally biased beyond anode-current cut-off so that no current flows through the valve during the charging period and the condenser is discharged when required by making the grid positive. Such a time-base is known as a "single stroke" time-base and is of great value for examining transients and other phenomena which occur at rare intervals. It is, of course, usual to make the transient apply the positive bias and so trigger the time-base.

In order to make such a time-base self-acting it is necessary to make it provide a potential which is suitable for application to the grid of the discharge valve. This has been done in the Cossor time-base.[2]

The fundamental circuit of the Cossor time-base is shown in Fig. 3, in which V1 is a pentode valve arranged to charge the condenser C, and V2 is the discharging valve. The valve V3 functions chiefly as a phase-reverser and may be replaced by a transformer, although this considerably reduces the flexibility of the time-base.

Assuming that the condenser C is in the discharged condition there is then no potential across the valve V2 and hence no anode current flows. For this reason the valve V3 will be at zero grid potential and will pass a heavy current so that the voltage on its anode will be low. The resistance R2 in the anode of V3 is a high

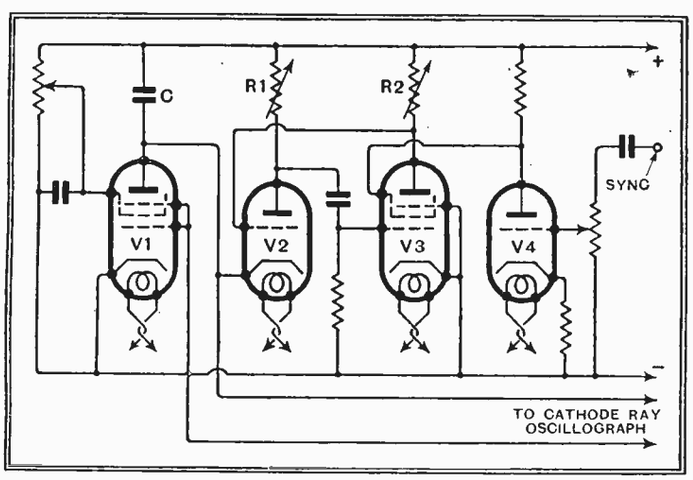


Fig. 3.—In this time-base circuit, V1 is the charging valve, while V2 and V3 form the discharging device; V4 is for synchronising.

one and when the grid of V3 is at zero potential its anode voltage will be about 100 volts when the high tension supply is 400 volts. There is thus a voltage drop of, say, 300 volts across R2 and this is applied directly to the grid of V2.

As the condenser C commences to charge, the voltage across V2 increases until the charge rises to nearly 300 volts, when the valve V2 commences to pass anode current. The passage of anode current through the resistance R1 applies a negative potential to the grid of V3 and causes the potential on the grid of V2 to rise with a consequent increase of anode current through the resistance R1. The effect is thus a cumulative one and brings about an extremely abrupt change from the charging to the discharging condition. When the potential across the condenser has fallen to a low value the anode current through V2 and R1 falls, since the potential has become insufficient to maintain it, and a positive pulse is fed to the grid of V3. As a result of this action the potential on the anode of V3 and hence on the grid of V2 falls, thus biasing V2 beyond cut-off and allowing the condenser C to become charged once more.

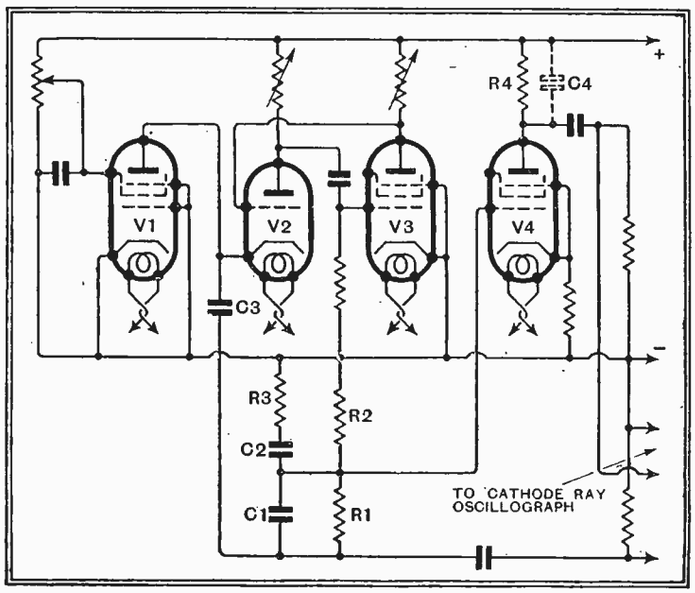


Fig. 4.—A hard-valve time-base with push-pull output is shown here. Again the RF pentode V1 ensures a linear change of voltage across the condensers C1 and C2.

The resistance R1 controls the rapidity of change-over from the charging to the discharging condition and vice-versa, and at the same time it controls the rate of discharge since it tends to limit the anode current of V2.

The resistance R2 controls the potential of the grid of V2 during the charging period and hence determines the potential to which the condenser shall charge.

The application of a negative pulse to the suppressor grid of V3 (in which case V4 may be omitted) or of a positive pulse to the grid of V4 will initiate the discharge of the condenser C. Hence, if the wave form being examined, or the synchronising portion of a television signal, be applied to either of these points the time-base can be synchronised.

This time-base has a frequency range extending from several seconds or more per cycle to 250,000 cycles per second. This high frequency compares very favourably with the 30,000 cycles per second obtainable with a gas-filled valve time-base, and permits of the examination of individual waves having a frequency as high as 5 or 10 megacycles per second. Furthermore, this time-base is considerably more stable and flexible in operation than is a gas-filled time-base. A more detailed account of the circuit will be found in the Journal of the Television Society, Vol. 2, Part V, June, 1936.

When a time-base is used in conjunction with a high-vacuum cathode-ray tube it is necessary to resort to push-pull operation of the time-base. This may be carried out in several ways. A condenser may be charged in a linear manner to a small potential which may be amplified by means of a paraphase amplifier to provide a push-pull output.[3] Alternatively, the condenser may be charged in a linear manner to a high potential and a single stage amplifier having unity gain may be added to function as a phase-reverser. Such a scheme is depicted in Fig. 4.

The condenser C is replaced by a potentiometer consisting of two condensers which are *charged* by V2 and *discharged* by V1, and these are shunted by resistances so that no frequency distortion is introduced. This condition exists when $\frac{C1}{C2}=\frac{R2}{R1}$. The condenser C2 includes the stray grid capacity of the valve V4 and the wiring thereto. C3 is a blocking condenser and is intended to keep DC from the grid of V4. The ratio $\frac{C2}{C1}$ is made equal to the gain of the valve V4 in order that the voltage swing on the anode of V4 shall equal that on the anode of V1. The resistance R4 has necessarily a stray capacity C4 across it and this tends to reduce the gain of V4 at the higher frequencies. This effect is almost completely compensated by the insertion of the resistance R3. The latter resistance is adjusted so that the time-constant R3C2 is equal to that of R4C4. Alternatively, the stray capacity C4 may be compensated by an inductance in series with it.

A further method of obtaining a push-pull output is to charge the condenser in a non-linear manner, thus saving expense,

[2] British Patent Specification No. 419398, A. C. Cossor and O. S. Puckle.

[3] *Television Reception*, Manfred von Ardenne. Chapman and Hall, London.

Hard-valve Time-bases

since the condenser may be charged through a resistance instead of a pentode, and to straighten the characteristic curve by amplifying in a non-linear manner as shown in Fig. 5.

Assume that the condenser charging curve is as shown in Fig. 5. If the difference between this curve and a straight line is plotted the resultant amplifier output curve will be found to be similar to a valve curve, and it is, therefore, possible to make a valve having a characteristic which is suitable for linearity correction.

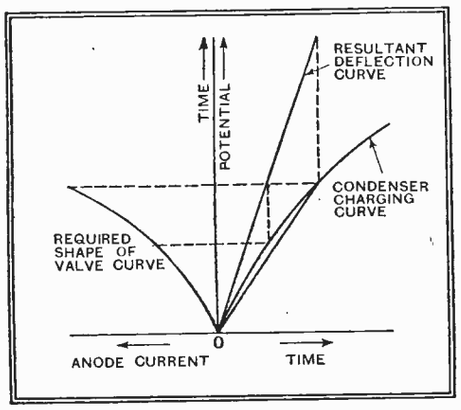


Fig. 5.—Instead of using a charging valve to obtain a linear output, the subsequent amplifier can correct for non-linearity if its characteristic is suitable.

Another form of hard-valve time-base, due to Kobayashi,[4] is shown in Fig. 6. A valve oscillator discharges the condenser in this instance, a reversal of the procedure adopted by Watson-Watt and Herd. The condenser C is charged through the high resistance R and when the potential across it is sufficiently high the valve, which is normally biased beyond cut-off, commences to pass anode current so that the transformer applies a positive potential to the grid and so brings about a rapid increase of anode current. This circuit when

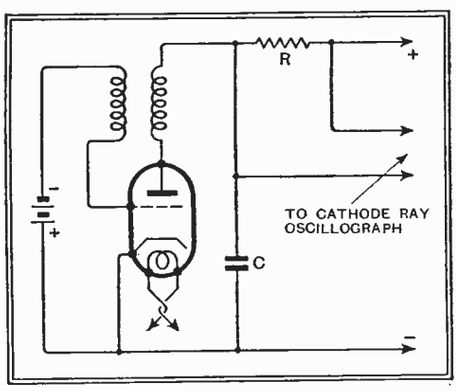


Fig. 6.—One of the simplest of hard-valve time-bases is shown here. It employs only a single valve.

arranged to give a push-pull output is useful for television reception, but it tends to be limited in frequency range and flexibility and is not particularly suitable for general oscillographic work.

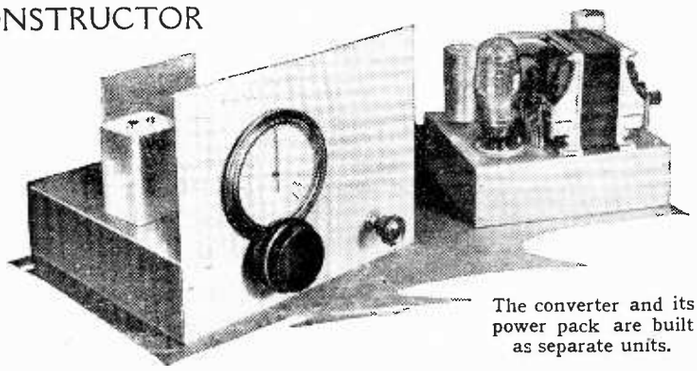
[4] U.S.A. Patent Specification No. 1913449, Kobayashi.

In Next Week's Issue

AC Short-Wave Converter

FOR THE CONSTRUCTOR

Waverange 12.5 to 62.5 Metres



The converter and its power pack are built as separate units.

THIS is a superheterodyne short-wave converter designed for AC mains operation, and it can be used with any type of broadcast set, though in the case of straight sets at least one RF stage must be included.

It covers a waveband of 12.5 to 62.5 metres in three ranges, and the coils and switches are contained in a separate unit, though this unit actually forms a part of the main chassis.

A triode-hexode frequency-changer is used with the signal circuit tuned, and its condenser is ganged with that of the oscillator. Fixed series tracking condensers are employed, and only the parallel padding condensers require adjusting to give the correct coverage on each range.

A separate power supply unit is provided in order to render the converter independent of other supply sources, and this also ensures that the correct voltages are applied to the various electrodes in the valve.

LIST OF PARTS.

Certain components of other makes but of similar characteristics may be used as alternatives to those given in the following list.

2 Variable condensers, 100 mmfds. **Eddystone 900**

2 Flexible couplers **Eddystone 1009**

1 Condenser drive, two-ratio **Eddystone 1070**

2 Stand-off insulators **Eddystone 1019**

1 Valve holder, 7-pin, without terminals **Clix Chassis Mounting S.W. Type V5**

1 Group board, 5-way **Bulgin C31**

Condensers:

3 0.1 mfd., tubular	T.C.C. 250
2 0.01 mfd., mica	T.C.C. "M"
1 0.0001 mfd., mica	T.C.C. "M"
2 0.001 mfd., mica, tolerance ± 5 per cent.	T.C.C. "M"

Resistances:

1 50 ohms, ½ watt	Erie
1 25,000 ohms, ½ watt	Claude Lyons
1 30,000 ohms, ½ watt	Claude Lyons
1 50,000 ohms, ½ watt	Claude Lyons
1 400 ohms, 1 watt	Claude Lyons
1 10,000 ohms, 1 watt	Claude Lyons
1 70,000 ohms, 1 watt	Claude Lyons
1 10,000 ohms, 2 watts	Claude Lyons
1 15,000 ohms, 3 watts	Claude Lyons

1 Trimming condenser, single type, 500 mmfds. max. **Hunts 3276TD**

1 Connector, four-way **Bryce Light Pattern**

1 Plug-top valve connector **Belling-Lee 1175**

2 Switches, 2-pole 3-way with earthing plate and tag **B.T.S.-B123FET**

1 Switch rod and locator, 7in. long **B.T.S.**

2 Multiple strip condensers, 3-way, 30 mmfds. **Bulgin SW101**

2 Coil formers, ½in. dia. × 2½in. long, threaded 12 tpi. **B.T.S.**

2 Coil formers, ¾in. dia. × 2½in. long, threaded 14 tpi **B.T.S.**

2 Coil formers, ¾in. dia. × 2½in. long, plain **B.T.S.**

1 Coil former, 1in. dia. × 2in. long, plain **B.T.S.**

2 Terminals, ebonite shrouded **Belling-Lee "B"**

1 Aluminium coil screen, 2 × 2 × 3in. **Goltone R9/238**

1 Battery cable, 4-way **Bulgin BC2**

1 Plug, 4-pin **Bulgin P9**

1 Length screened sleeving, 2 mm. **Goltone R39/281**

Miscellaneous: **Peto-Scott**
3 lengths systoflex; small quantity Nos. 18 and 20 enamel wire, Nos. 20 and 34 D.S.C. wire, Nos. 16 and 18 tinned copper wire, Aluminium for coil unit, chassis, partitions, valve bracket, condenser support and panel. Small ebonite bracket for condenser, 6BA studding, etc. Screws: 24 ¼in. No. 6 R/hd., 12 ½in. No. 6 R/hd., 8 1in. No. 6 R/hd., all with nuts and washers; 2 6BA with 8 nuts and washers.

Valve:
1 AC/TH.1 **Mazda**

POWER PACK.

1 Mains transformer: 250-0-250 volts, 60 mA., 4 volts, 2.5 amps., centre tapped, 4 volts, 2/3 amps. **All Power PT/AP**

1 Smoothing Choke, 15 henries, 25 mA **Bulgin LF17S**

1 Condenser, dry electrolytic, 8 mfds., 500 volts peak **Polar-N.S.F.**

1 Condenser, dry electrolytic, 4 mfds., 500 volts peak **Polar-N.S.F.**

2 Valve holders, 5-pin, chassis type **Bulgin VH13**

Miscellaneous: **Peto-Scott**
3 lengths systoflex; small quantity Nos. 16 and 20 tinned copper wire, aluminium for chassis, etc. Screws: 22 ¼in. No. 6 R/hd., 6 ½in. No. 4 R/hd., all with nuts and washers.

Valve:
1 UU4 **Mazda**

Current Topics

NEWS OF THE WEEK IN BRIEF REVIEW

Warning to Pirates

THE fact that several portable trans-receivers have appeared on the market both in this country and abroad has apparently led many people to believe that they can be purchased and used with no more formality than an ordinary receiver. The G.P.O. is anxious to emphasise the fact that not only are transmitting licences necessary before such apparatus can be used, but that these licences are only granted for bona fide experimental purposes.

Japanese Wireless Merger

THE two great radio communication concerns in Japan, namely, the Japanese Wireless Telegraph Co. and the Japan International Telephone Co., are to join forces. This amalgamation is taking place at the express wish of the Government, which desires to unify the control of Japan's international communications.

Denmark Reorganises

ON April 1st Danish broadcasting passed under the control of a new director-general assisted by three other directors. The new director-general, Mr. F. E. Jensen, is an ex-Government official and his attention will be mainly directed to the business side of broadcasting. Although Mr. Jensen is practically unknown to the man-in-the-street he has long been a popular figure at Danish broadcasting headquarters.

Air Force Amateurs

THOSE overseas members of the R.A.F. who indulge in radio transmitting as a hobby will shortly be able to keep in touch with the Home Country through the new amateur experimental station at Cranwell. This station has been erected by members of the Air Force who belong to the Cranwell Amateur Radio Transmitting Society. Its call sign is G8FC.

R.S.G.B Activities

A DEAD-HEAT occurred in the 1.75 Mc. competition held by the Radio Society of Great Britain in January. The operators of G5ZT (Preston) and G6BQ (Gravesend) both scored 70 points and will each hold the Society's Challenge Trophy for six months.

The Society's fifth national field-day, an annual event to make amateurs familiar with the use of portable apparatus under conditions of emergency, will be held during the first week-end in June. In addition, a new event will be held this year, namely, a five-metre national field-day. This will be held on July 4th.

The P.M.G. Recognises Scotland

MANY years ago Scottish amateurs used to employ the letter "C" (Caledonia) following the official British prefix "G," but this was entirely unofficial. The P.M.G. has now recognised the separate existence of Scotland by issuing call-letters with the letter "M" following the "G." Amateurs in Northern Ireland use "GI," but Wales still has no distinguishing letter, being compelled to share the plain "G" with England.

Fire Engine Radio

THE latest use to which wireless has been put is to enable fire engines to keep in direct touch with headquarters so that they can report the extent of fires which they are attending and so enable the powers-that-be to determine whether engines from other depots should be sent to help. Cape Town is the city responsible for this innovation. The apparatus is operated from a motor-generator, driven from a storage battery.

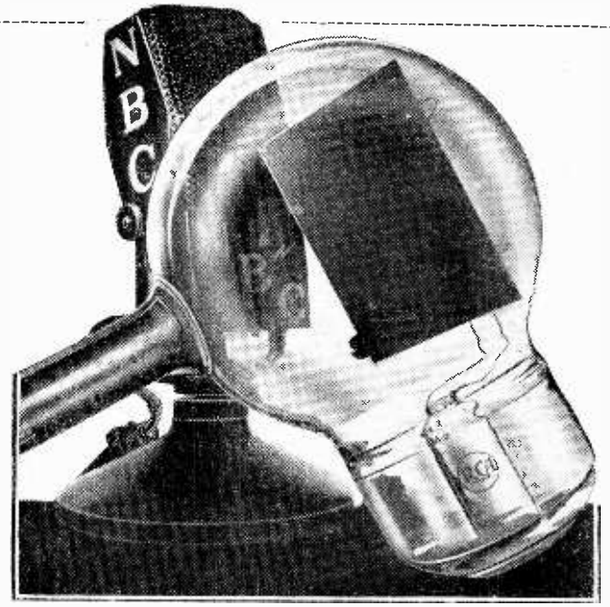
Automatic Alarm Device

FOLLOWING the example set by this country many years ago America is now to bring her marine radio up to date by installing an automatic alarm device on ships carrying one operator. This arrangement sounds an alarm bell on the bridge and elsewhere should a distress signal be picked up during the operator's watch below. Actually it is set to take account of a series of dashes, each of four seconds' duration, separated by an interval of one second. The great disadvantage of this type of apparatus when first introduced on board British ships was that it was prone to sound the alarm at times when no distress signal was coming in. This naturally tended to discredit it, and after the operator had been needlessly roused from his bunk several times during the night he was sorely tempted to disconnect it.

Cup Final Commentary in Swedish

SO great is the interest taken in British football in Sweden that a special commentator is to be sent over to Wembley on May 1st to give a running commentary in Swedish. The microphone will, of course, be connected by a wire with the Swedish broadcasting headquarters. Similar arrangements have been made in connection with the commentary on the Coronation, although in this case, of course, the Swedish broadcaster will be only one among many others describing the Coronation in their own language.

THE EAR AND THE EYE of N.B.C. Television. The R.C.A. Iconoscope may look simple but it is the link between the real and the radio picture in America.



No Free Wireless for the Bedridden

REPLYING to a question in the House of Commons the P.M.G. stated that it had not been found possible to extend the issue of free wireless licences to the bedridden and other classes of the community deserving of sympathy. The whole question was, he added, reviewed by the Broadcasting Committee of 1935 which advised against the issue of free licences to persons other than the blind.

More Dishonest Servicing

IT was reported recently that several dishonest servicemen had been prosecuted in Denmark as a result of the attention drawn to the matter by reports appearing in *The Wireless World* concerning dishonest servicing practices in New York. Further investigations in Denmark have revealed the fact that Danish listeners are being robbed of at least £5,000 sterling every year by these radio rogues.

Television Programmes

FROM the commencement of the regular public television transmissions on November 2nd to the middle of March the B.B.C. radiated some 900 programme items covering a period of 240 hours. Forty-three per cent. of this time was taken up by variety, drama, ballet and other stage entertainments. Twenty-five per cent. was devoted to "illustrated" talks on general, topical and special subjects. Film items accounted for 22 per cent. of the time, women's interests occupying 6 per cent. Art topics accounted for the remaining time.

It is reported by the G.E.C. that over 65,000 persons have attended the demonstrations given by the Company and its dealers. At Magnet House, Kingsway, where free shows are given daily, there have been 5,000 visitors, over 90 per cent. of them being men.

I.E.E. Lectures

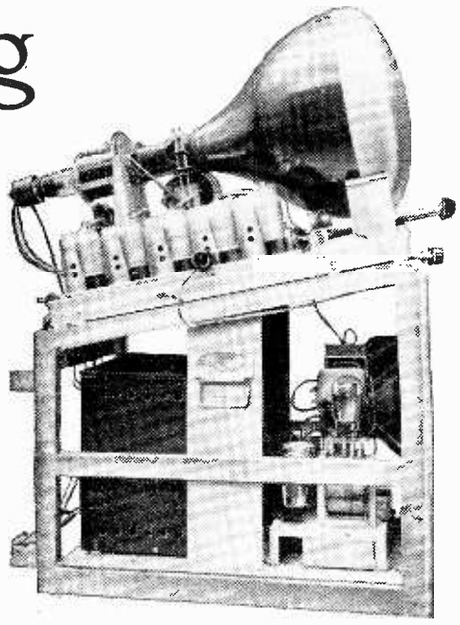
NEXT Wednesday (April 7th) at 6 p.m. a lecture on some aspect of a wireless subject not yet announced will be given by Dr. B. van der Pol. On Thursday evening at 6 p.m. Mr. D. Robertson, M.A., B.M., M.R.C.P., will give a lecture on the "Examination and Recording of the Human Electrocardiogram by Means of the Cathode-ray Oscillograph."

Magnetic Focusing

ONE OF THE TWO METHODS OF CATHODE-RAY CONTROL USED IN TELEVISION RECEIVERS

By H. WOOD (Television Research, Ferranti, Ltd.)

OF the two methods of focusing which are applicable to television-type tubes, electro-magnetic is the less widely known. The principle upon which it depends and its practical advantages are discussed in this article.



One of the Ferranti experimental television receivers.

BEFORE giving an explanation of the method used, and the theory of the action of the magnetic focusing coil, it might be useful to consider the construction of a television type CR tube. In Fig. 1 K is the emitting cathode, W the Wehnelt cylinder or control electrode, and A the single anode of a tube suitable for magnetic focusing and scanning. This is the whole of the simple electrode system. But although the electrodes are few in number considerable thought has been given to their design. The Wehnelt cylinder which is used to control the intensity of the electron beam has to be designed so that the tube has a good linear characteristic for light intensity against Wehnelt potential with a sharp cut-off at each end.

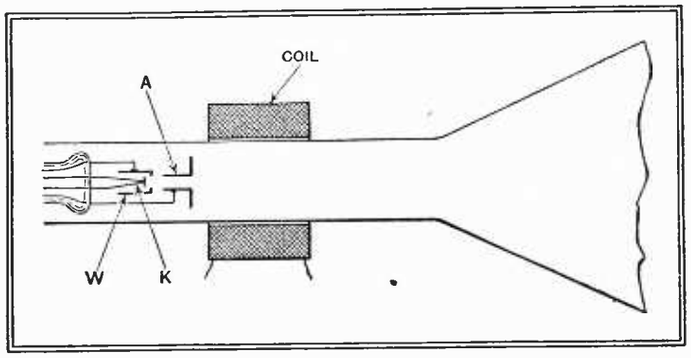


Fig. 1.—The relative positions of the electrodes and focusing coil are shown in this drawing.

Fig. 2 gives the characteristic of a Ferranti tube. The curve is nearly straight over the working range and the voltage base is short, only 25 volts from white to black, thus giving good sensitivity. At the same time, the cut-off at −50 volts is very sharp, ensuring really good blacks on the picture.

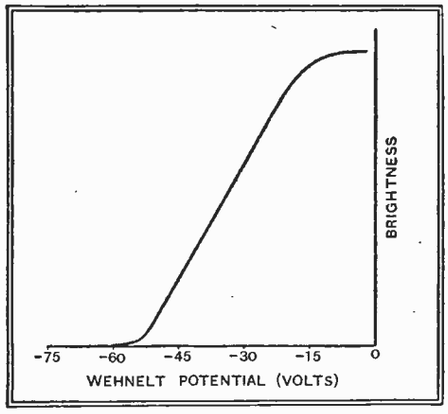


Fig. 2.—This curve shows the relation between the brightness of the spot and the grid voltage.

With regard to anode design, it is essential that the electron beam, which is accelerated by the anode and emitted from it as a conical divergent beam, shall be of the greatest possible intensity as this gives the brightest screen illumination. At the same time, the angle of divergence of the extreme edges of the beam must not be too great, otherwise the focusing cannot be good. The actual beam emitted in the Ferranti tube is such that, when unfocused, it produces a disc of light about 3 inches in diameter on the screen at full brilliance.

Method of Focusing

Focusing involves producing a magnetic field which will cause the electron beam, initially diverging symmetrically from the anode, to become convergent in such a way that the whole beam meets the screen at a point, thereby producing an intense light-spot. The desired field is produced by surrounding the neck of the tube immediately in front of the anode with a solenoidal coil of about 200-300 ampere turns. In a quite suitable design the coil is 3 inches long.

The coil may be energised by connecting it in series with a variable resistance across the HT supply of the receiver.

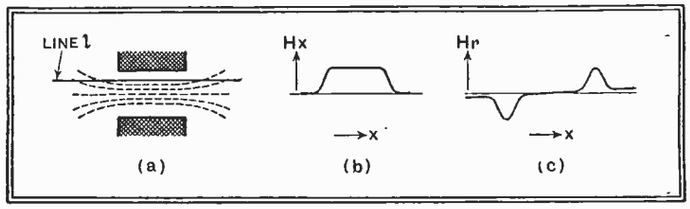


Fig. 3.—In these drawings the shape of the field produced by the focusing coil is shown.

It is quite easy to see how the field of this solenoid causes the beam to become convergent. Fig. 3 (a) and (b) and (c) show the characteristics of the field of the coil. Fig. 3 (b) is a curve showing the field strength along the axis at all points.

Fig. 3 (c) shows field strength radially outward from the axis for points at a given small distance from the axis, i.e., pts. on line l in Fig. 3 (a).

Bearing in mind these curves, we now consider the behaviour of an individual electron which leaves the anode travelling

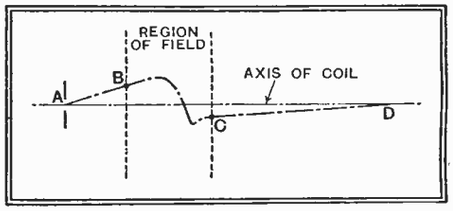


Fig. 4.—The path of an electron passing through the field is shown here.

Magnetic Focusing—

slightly away from the axis (see Fig. 4), and at a small distance from the axis enters the field.

We must first enunciate the law giving the force acting on a charge moving in a magnetic field. In its simplest form it relates to the case where the velocity of the charge and the field direction are perpendicular. In this case the force acting on the charge is $F = Hev$ where H is field, v velocity and e the charge. The direction of the force is perpendicular to both H and v, and its positive direction is given by Fig. 5.

Now in our particular case the velocity of the electron may be split into two components, a large velocity Vx along the axis and a small one Vr away from the axis.

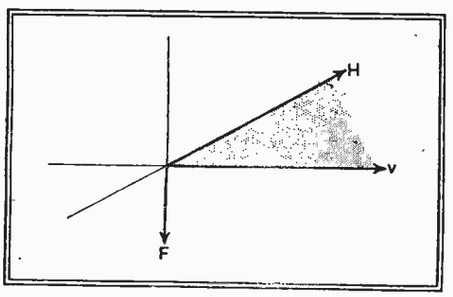


Fig. 5.—The force acting on a charge has two components acting in different directions.

Similarly, the field at any point may be split into two components Hx along the axis and Hr away from it, the values being given by Fig. 3 (b) and (c).

The components Vx and Hr are responsible for a force acting on the charge in the direction shown in Fig. 6 (a). Also, the components Vr and Hx are responsible for another force acting in the same or opposite direction (Fig. 6 (b)), depending upon the signs of Vr and Hr (i.e., + ve or − ve). Under the action of these forces the electron rotates about the axis, and Fig. 7 shows the path as seen along the axis. The point X corresponds to where

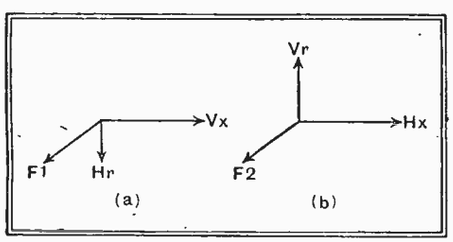


Fig. 6.—The forces which produce a rotational movement of the electron are shown here.

the charge leaves the field, after which it travels in a straight line. A complete investigation of the equations of motion of the electron shows that on emerging from the field it is going either directly towards or directly away from the axis, i.e., it cannot be going along any straight line which does not meet the axis. The same investigation shows that if the field is strong enough the electron is going towards the axis and meets it at a point which is the same for all electrons leaving a common anode with the same velocity, provided that all these electrons are

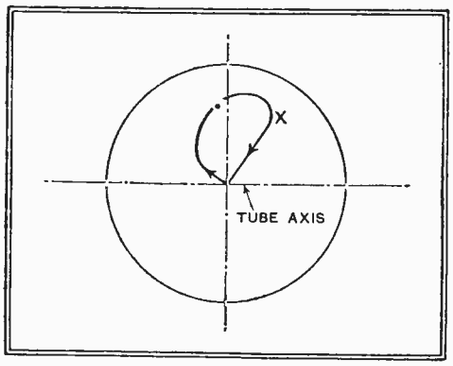


Fig. 7.—The path of the electron has a rotational movement as shown in this drawing.

initially only diverging at small angles from the axis.

In practice it is found desirable to put the coil in such a position that the anode is just within the fringes of the field. This probably has the effect of confining the beam to a rather smaller dimension, although theoretically it should not give perfect focusing. As we shall see later, the actual diameter of the beam at various points is of considerable interest and importance.

There is a distortion which may occur in practice. If the anode of the tube does not lie on the axis of the coil then the spot on the screen is not circular and cannot be focused properly. Fig. 8 shows the reason for this.

An electron on path AB1C1D1 focuses as though it had come from an anode A1, whilst one on path AA2B2C2D2 focuses as though it had come from an anode A2, i.e., the two electrons focus at different points, D1, D2. The effect on the screen as the focusing current is varied is that the "spot" changes continuously from a small straight line in one direction to a similar line in a perpendicular direction. This, of course, spoils definition in the picture.

Influence of Magnetic Deflection

This type of deflection is particularly suitable for use with magnetically focused tubes. It is, of course, effected by surrounding the neck of the tube in front of the focusing coil by a pair of coils carrying a saw-tooth current and arranged to have a uniform field across the section of the tube. This causes the linear deflection of the spot on the screen which is required for the "scanning" of the tube in either direction. In connection with this, the beam diameter is important. To take a practical instance, suppose the beam diameter is $\frac{1}{3}$in. as it passes through the deflecting coils. Then, unless the field of the coils is uniform over the whole cross-sectional area of the beam, different parts of the beam will receive different deflections and the spot will be drawn out into a line. This is one reason why the coils must have a uniform field.

A serious defocusing occurs if the coils are definitely unsymmetrically positioned in such a way that their field has a component along the axis.

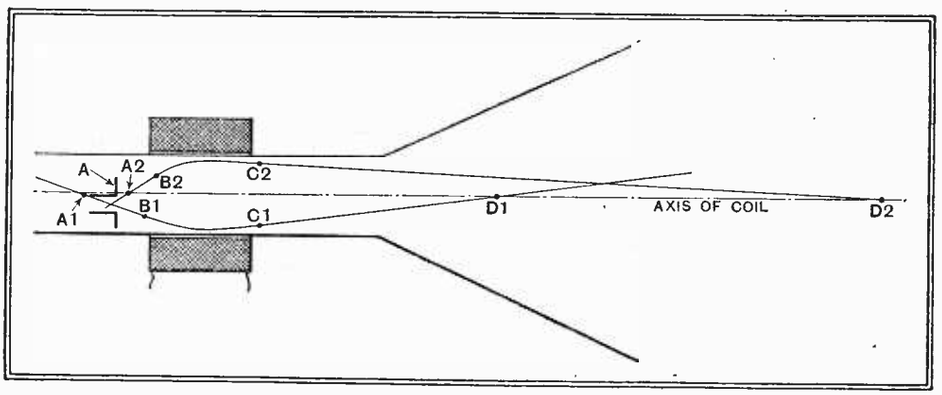
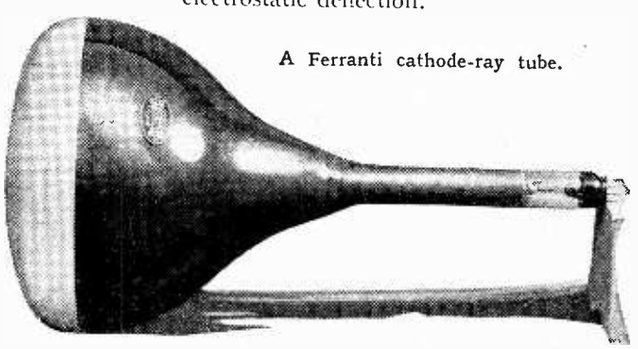


Fig. 8.—When the anode of the tube does not lie on the axis of the coil it is possible to secure neither a circular spot nor proper focusing.

There are several other small effects of the deflecting fields which may show as astigmatism, or defocusing, but with suitable deflecting coils the results appear to be superior to those obtained with electrostatic deflection.

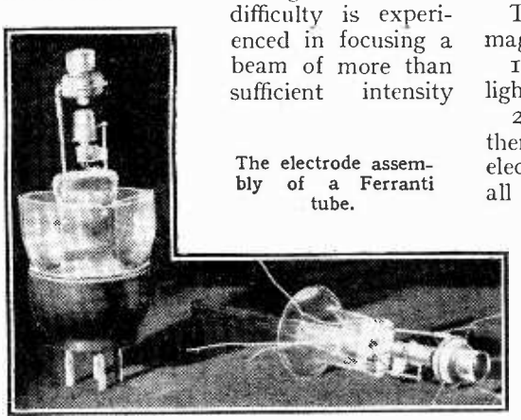


A Ferranti cathode-ray tube.

We have mentioned the beam diameter and intensity in one or two places. This is specially important because it is not easy to obtain a large beam intensity (or beam current as it is called) with a beam of very

Magnetic Focusing—

narrow cross-section. This accounts for the relatively poor light intensity of some electrostatic tubes. In magnetic tubes no difficulty is experienced in focusing a beam of more than sufficient intensity because this intensity can be obtained by using a comparatively wide-angled beam. But magnetic deflection is necessary for such a beam, as its diameter is too large to allow of sensitive electrostatic deflection in the usual manner by a pair of plates within the tube neck.



The electrode assembly of a Ferranti tube.

To sum up, the chief advantages of magnetic focusing are:—

1. It is easy to combine very great light intensity with good focusing.

2. The electrode system is very simple; there is only one anode, whereas in the electrostatic tube there are three anodes, all at different high potentials. Furthermore, there is the difficulty of ensuring that all these anodes are in perfect alignment. The focusing coil, however, is adjustable for alignment as it is outside the tube.

And finally, the advantages of magnetic deflection are:—

Reduced cost of the scanning oscillators, simplified tube supplies, ability to scan a beam of high cross-sectional area, and external components making for easy adjustment.

RANDOM RADIATIONS

By "DIALLIST"

Playing Up

ONE of the most annoying things that can happen to the wireless set is the development of an intermittent fault. If you've a full equipment of testing instruments, some skill in tracking down defects, and the leisure and the energy to tackle the trouble just when it occurs it isn't so bad. What usually happens is that the owner of a set which sometimes goes all crackly, or puts up a display of "self-generated fading" every now and then, calls in a service man, who arrives ready and willing to do his best. The set is switched on. It functions perfectly. It continues to do so, no matter how the expert bangs it or shakes it or prods its innards. No test discloses anything wrong. The service man packs up and goes. Hardly has the door closed behind him when the set begins to play up. In one case that I came across a set was taken away for observations and kept for a week without doing anything that it shouldn't. But within a few hours of its being returned it was up to its old tricks again.

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What Will the P.M.G. Say ?

IT is expected that the Postmaster-General will have something interesting to say about anti-interference measures next Thursday, when he is down to reply to a Member's enquiry whether he has yet decided to introduce legislation compelling the "silencing" of electrical machinery that radiates interference. Something of the kind will have to be done eventually, and surely the best time to do it is now. Every day sees the installation of fresh domestic or commercial electrical appliances which are actual or potential radiators of the nasty noises that mar radio reception. Hence every day that is lost makes the problem a bigger one. One thing that most certainly should be done without any delay at all is to make it an offence to manufacture, sell and install new appliances which are not fitted with effective suppressors. As regards existing machinery, the authorities now have ample data to work upon. They must know that in many localities interference is growing steadily worse and that, generally speaking, it can be cured by simple and comparatively inexpensive methods. But there won't be a complete cure until compulsion is introduced.

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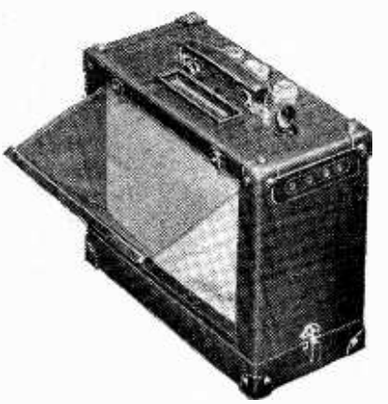
And About Licences

HEAPS of people are rather hazy about the scope of the wireless receiving licence. Everyone knows that if you have a set in your home you must have a licence; but what happens if you take a seaside or country bungalow for a holiday and hire a wireless set while you're in it? The P.M.G. has ruled that, though normally each tenant of the said bungalow should take out a licence, a temporary tenant is covered by his home licence provided that he "dismantles" his own set before setting out for his holiday. Dismantling presumably means no more than disconnecting the set from mains (or batteries) and aerial and earthing the latter. Here are one or two other points that may be of interest. Your licence covers the use of a portable. Hence you can take one of these out with you in your car. But if you have a built-in car radio set a separate licence is necessary, the "address" of the receiving station being the number of the car. Your family and your servants can operate sets of their own in your home under your licence; but if you have a lodger his rooms are regarded as a separate establishment and he needs a licence to work a set in them.



PICNIC PORTABLE: A LEIPZIG FAIR NOVELTY. The receiver is a 5-valve all-wave superheterodyne; a hinged plate in front of the loud speaker acts as a sound deflector.

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Up She Went

MOST of us have been given to understand that it isn't wise to bring naked lights too near to accumulators owing to the hydrogen that they give off, but until the other day I'd never come across an instance of an accumulator going up in the proverbial blue flames. This one did its stuff pretty thoroughly. Here's what happened: Its bitumen top covering had become cracked and the owner thought he'd make a neat repair with Chatterton's compound. Thoughtlessly he removed it from the charging bench, and was proceeding to heat up a sticky mess over the flame of a spirit lamp when all of a sudden there was a report like the detonation of a six-inch shell. The glass case was blown to smithereens (there wasn't a fragment bigger than a broad bean) and he found himself the recipient of an acid shower-bath. Luckily help was at hand. Still more luckily his eyes weren't touched and he wasn't cut by the flying glass splinters. But it was a narrowish squeak. In future I shall treat gassing accumulators with considerable respect!

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B.B.C. Hard Up ?

SO the B.B.C. isn't too happy about the next ten years. It fears that receipts from its share of the licence fees and the profits on publications are approaching the saturation point, and it knows that a huge expenditure on new plant, renewals and developments of all kinds has to be faced. Television certainly is going to cost a mint of money unless the erection of the network of transmitters necessary to cover the country is to be held up—and held up it must not be. The only solution so far as television is concerned is probably to be found in a bigger Government grant from the 25 per cent. of the licence revenue which it now retains.

The time may be coming when our broadcasting organisation will have to be pretty radically overhauled. I'm not saying that the B.B.C. doesn't tackle a big job well. It does But I'm not sure that it couldn't obtain equal efficiency for a considerably smaller expenditure.

Checking Piracy

Meanwhile it seems rather important to ensure that all those who make use of the broadcast programmes pay their whack, and that certainly is not now the case.

Just how many "pirates" there are no man can say, but to judge by the G.P.O.'s successful prosecutions of the unlicensed there must be a tidy few. Tracking them down by means of sleuths, detector vans and so forth is good enough up to a point, but

Random Radiations—

only up to a point. I've often wondered why the production of a receiving licence should not be made compulsory when sets, kits, or even accessories such as loud speakers, headphones, valves and batteries are purchased. This wouldn't entail any hardship on the man who already pays his way, but it would very soon put an end to radio piracy, particularly if dealers were made liable to a fine for supplying this or that without having seen the licence. This suggestion is only, after all, an adaptation of the firearms scheme, which works quite well. You can't buy a rifle or a revolver without producing a firearms permit. And every time you want a fresh supply of cartridges for them it must be handed to the dealer.

Other Ideas

It would probably be well worth while to rope in the pirates, for some people estimate their number at 500,000 or more, and their payments would make a useful addition to the funds available for broadcasting. Several ideas for dealing with them have been put forward, some of which undoubtedly have their points. One of these is that all receiving licences should run to the end of the year or to the end of a quarter, as motor car road fund licences now do. On the receiving set there would be a small licence holder like that which cars display. It would thus be obvious at a glance whether any set had or had not been licensed. Attractive though it is at first sight, there are difficulties about this scheme. Many people have more than one set. A few, like myself, have a constant stream of sets flowing in for test purposes and flowing out when tested. Still, these objections aren't insuperable. There's another aspect. I've always believed that the majority of pirates are those who simply can't afford to put down ten shillings all at once. They probably use little home-made crystal sets or the simplest of valve apparatus. Couldn't they be allowed, as motorists now are, the pay the licence fees quarterly?

They Don't Like Fiddling

WHAT a pleasure it is to turn from an "all-wave" set with only one short waverange to one which has two. The dial is so much easier to read and tuning becomes less of a feat of hair's-breadth juggling. I'm using just now one which goes from 15 to 39 metres on its shortest range and from 37.5 to 90 on the next. I'm sure that manufacturers would be well advised to give this season's models two short wavebands at the old price (or a little more, if need be) rather than stick to one band and bring the prices down. For the beginner at short-wave reception it must be very difficult with a single-range set to pull in anything but the most strongly received stations; with two clearly marked ranges on the dial he'd find both himself and the set far better performers. How often one finds that those who have bought "all-wave" receivers and are disappointed with them owe their lack of success to a natural inability to fiddle with the very fine adjustments that may be needed when a set covers from about 16 to 60 or 70 metres in one sweep!

Service Problems

FROM time to time I have criticised the doings of the bad radio service man; I've also had more than one good word to say about the man who really knows his job. The position is very complicated. As matters stand, there are not a few wireless shops which offer so many months' free service with the sets that they sell, and try to cut costs by taking on service men at low wages. That's probably as good (or as bad!) an instance as you could find of false economy. There's an old saying which is to-day as true as ever it was: You get what you pay for. Offer a small wage, and you can't expect a man who is thoroughly efficient. Now, the inefficient service man probably costs his employer indirectly a good deal more than is "saved" directly on his wages. People who find that every breakdown means sending the set back to the makers soon lose faith in the man who should be their mentor and guide. That is why those who live in villages or small towns are apt to leave the local wireless dealer and to transfer their custom to the bigger shop in the bigger town.

Experts Wanted

Here's a true example of the kind of thing I have in mind: a set of well-known make had for some time been giving poorer and poorer results. The service man came in several times, but made no improvement. On his last visit he removed the set, kept it for a fortnight and returned it as bad as ever. It had to go to the makers before the trouble (faulty alignment of the IF circuits) could be diagnosed.

I believe that a capable and well-trained man could make a good living in many districts by setting up on his own as a curer of radio troubles. He might, perhaps, be best advised to begin in a small way by doing odd jobs in the evenings or in other spare time. Once he had established a bit of a reputation for good work and fair charges he should be able to make wireless servicing a whole-time occupation.

Skip Distance for Atmospherics ?

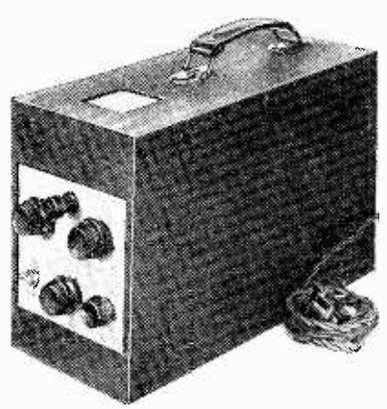
SOME time ago I mentioned in these notes that more than once I had found very little atmospheric interference when a thunderstorm was in progress quite close, and suggested tentatively that there might be a skip area for atmospherics. An Australian reader writes: "I have noticed the same thing here. The most striking instance was during a very violent thunderstorm accompanied by rain, hail, and wind of almost hurricane force—altogether a specimen of atmospheric disturbance of the first magnitude. As there was a broadcast item that I particularly wanted to hear I decided to leave the set on till atmospherics should make reception impossible. To my surprise, atmospheric interference was very mild, only a sharp crack from the loud speaker coinciding with each lightning flash, many of which were very close, the thunder occurring within one second." Subsequent observations have gone to show that far worse interference may be produced by a fairly distant storm than by one which is almost overhead.

Chain Listening

NOT long ago I was staying with some friends who are veritable chain listeners. The cigarette chain smoker uses each stub to light a fresh one, and is hardly conscious that he is smoking; the chain listener keeps his set switched on hour after hour, and often hasn't the least idea of what is coming from the loud speaker. When I pulled my friends' legs on the subject they indignantly denied that they did anything of the kind. A little later on I asked whether they could tell me what the broadcast talk that had just ended had been about. They were surprised when I informed them that it had been on a highly technical agricultural subject! I believe that chain listening is pretty common Many people seem to like a slight background of noise—it doesn't matter whether it's speech or music—as an accompaniment to whatever they may be doing. I wonder what our great grandfathers would think of life in the modern home if they could see and hear it!

Portable Oscillograph

ONE of the most useful tools developed in recent years is the cathode-ray tube, especially when it has associated with it a linear time-base so that it forms a complete oscillograph. The apparatus under review contains a high-vacuum tube, mains equipment and time-base in a case which measures only 5¼in. by 7½in. by 11¾in.



The viewing window in the oscillograph can clearly be seen in this illustration.

The tube is viewed through an opening 1⅞in. square in the top of the case, and the front panel carries the controls, of which there are five. One is for focusing and another for varying the intensity of the image; a third is the on-off switch, and the remaining two control the frequency of the time-base. The frequency is continuously variable by means of a resistance which is used in conjunction with a range-selector switch which varies the circuit capacity in steps.

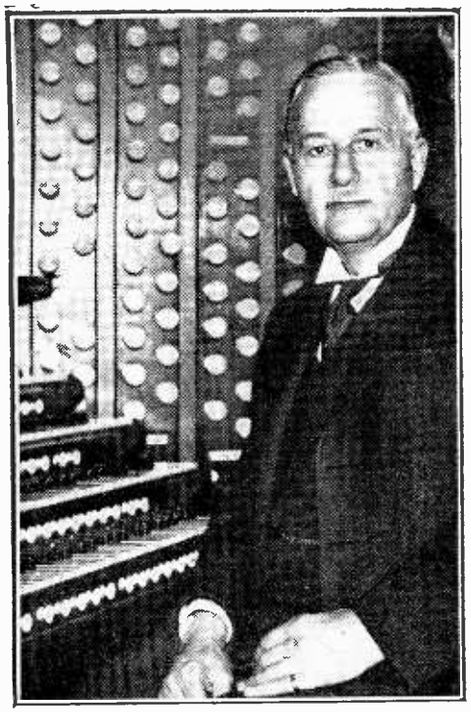
The time-base is of the gas-filled triode type, and an amplifier is used so that the deflecting plates are fed in push-pull. The input voltage is fed to the other pair of plates, and a portion of it also to the time-base, so that synchronising is obtained.

The apparatus is extremely compact and easy to handle, and on test proved capable of a satisfactory performance. Focusing is easy to carry out and quite definite, and the sensitivity is adequate for most purposes. About 35 volts is needed for full deflection, so that a good picture is obtained with 5 volts or so input only.

The oscillograph is made by Furzehill Laboratories, Boreham Wood, and is priced at 14 gns.

Listeners' Guide

Outstanding Broadcasts at Home and Abroa



CORONATION ORGANIST. Sir Walter Alcock, who played the Abbey organ at the last two coronations and has been invited to play at that of King George VI, will give a recital in Colston Hall, Bristol, which will be heard by Regional listeners on Tuesday at 8.30.

A VARIETY of sporting events comes into the current week's programmes. Certainly Mr. S. J. de Lotbinière, the Director of Outside Broadcasts, is exploring every avenue of sport in an endeavour to provide new material for O.B.s.

On Saturday three venues will be visited for National listeners. The first, at 2.55, will be the Worcestershire Hunt's Point-to-point meeting at Crowle, where the principal event, the race for Lady Dudley's Cup, will provide a running commentary. Immediately following this, at 3.20, H. M. Abrahams will describe for ten minutes the final stages in the A.A.A. Seven Mile Walk which will be in progress at the White City. Then at the close of this, at approximately 3.30, the switch will be put over to Belfast, where, at Ravenhill Park, the second half of the International Rugger match between Ireland and Wales will provide the third commentary.

On Monday and Tuesday, at 2.30 and 3 respectively, Tommy Woodrooffe will be at the Queen's Club, West Kensington, to give National listeners a running commentary on the progress of the games in the Amateur Squash Racquets Singles Championship.

Then on Wednesday evening John Snagge and Tommy Woodrooffe will be present at the Albert Hall to give Regional listeners an account of the fights for the Amateur Boxing Association's Championships.

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SPRING SONG

ALTHOUGH of a different category to sporting events, an O.B. on Sunday further demonstrates the resourcefulness of Mr. de Lotbinière and his satellites. Headed, "The Approach of Spring," a fifteen-minute broadcast from a wood near Horley, Surrey, will, it is hoped, bring to Regional listeners at 5.15 the songs of the birds.

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"IN TOWN TO-NIGHT"

ON Saturday, for the last time until Coronation Week, London's traffic will "stop" to bring to the microphone personalities who are in town to-night. It may be of interest to record that, during the 122 half-hour broadcasts, some 3,000 characters have come to the microphone. A. W. (Bill) Hanson will be busy in the coming weeks making arrangements for the Coronation Week's programmes, when "In Town To-night" will be broadcast each weekday evening except on Coronation Day. It is, of course, difficult to make final arrangements, in what is essentially a surprise item, until the last minute, but it is proposed that five continents will be represented by interesting and picturesque personalities visiting the metropolis.

Details of the week's Television programmes will be found on p. 337.

NATIONAL HEALTH

THE nation-wide movement for improving the physique of adults and children should gain impetus from an important series of talks, "Towards National Health," which are to be broadcast during the next three months. Eminent authorities will discuss problems of food and fitness from two standpoints, nutrition and physical culture. The first speaker will be Lord Horder, Physician-in-Ordinary to H.M. the King, whose subject on Monday at 8 (Nat.) will be "All this talk about health."

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"WHAT A WORD"

FEW subjects would seem more inherently suitable for discussion at the microphone than that of words. Since the development of broadcasting, the speech of the average man is affecting the language even more quickly than did Caxton's invention, which brought the printed word. The first speaker in a new series of talks, "Words Fail Me," will be Professor A. Lloyd James, Chairman of the B.B.C.'s Spoken English Committee. He will be heard at 8.40 (Nat.) on Thursday.

MORE ADVENTURES of Mr. Penny will be related by Richard Goolden during the series "Monday at Seven."

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HEARING TELEVISION

THE sound transmission of the television programmes will be enjoyed by Regional listeners on Tuesday at 9. This will be the first occasion on which the television programmes have been tapped to provide entertainment for listeners. The artistes who will be heard include Frances Day and Irene Prador.

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SUNDAY TALKS

THREE new series of talks commence in Sunday's National programme. At 4.0, Howard Marshall opens the series of investigative talks headed "What is the Church Doing?" by relating an interview he has had with the Rev. Leslie Weatherhead, Minister of the City Temple. An hour later the Rev. Canon H. Anson gives the first of the series, "Fifty Years of Religious Experience." Then, at 6.15, J. A. Spencer will talk about Gladstone in "I Knew a Man."

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"MONDAY AT SEVEN"

A NEW style of entertainment cocktail with the above title comes into the National programme on Monday and each succeeding Monday at 7. Leslie Henson will be heard with Norah Howard in a series of sketches. Carroll Gibbons will be at the piano for ten minutes, and the Variety Orchestra will give a novelty interlude.

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MUSIC

THE Russian tenor Alexander Smirnoff, who has not hitherto broadcast in this country, will be heard by National listeners on Saturday at 8.10. He will sing the famous arias from Tchaikowsky's "Queen of Spades" and "Eugen Oniegin," and will be joined by his wife in a duo from Massenet's "Manon" and the Fountain Scene from "Boris Godounov." Once a captain of Lancers in Tsarist Russia, he began his professional career as a singer after the Revolution.

or the Week

BARBARA BURNHAM, the talented B.B.C. producer, who this week handles the production of "The Cherry Orchard," a Russian play featuring Jeanne de Casalis, and "I Made you Possible" a modern play by Ivor Brown.

A programme of English part-songs sung by the Fleet Street Choir will be broadcast Regionally on Monday at 9. On the same day, at 8.20, Clifford Curzon, one of the best-known English pianists, who already has a great reputation abroad, will play the Brahms F Minor pianoforte sonata. Another English pianist and composer, Dora Bright, will be on the air on Thursday at 6.40 (Nat.), when she will give the first performance of her own Theme and Variations for pianoforte and orchestra, with Clarence Raybould conducting. Dora Bright was the first woman to receive the Lucas Medal for composition at the Royal Academy of Music.

OPERA

Home: Two relays from foreign opera houses grace the Regional programme this week. The first, to-night (Friday) at 8, when Act I of Kurt Atterberg's "Fanal" comes from the Royal Opera House, Stockholm. The second on Thursday, when Act II of Wagner's "Die Meistersinger" will be relayed from the Berlin State Opera House at 7.35.

Abroad: The week's opera programmes from abroad commence with de Falla's "La vida breve," the work which was the foundation of the composer's world fame. It will be heard from Brussels I at 8 to-night (Friday), relayed from the Théâtre Royal de la Monnaie. Manuel de Falla is justly considered the foremost figure in the modern Spanish school. Königsberg's Friday opera transmission at 8.10 brings a new German work, "Licht," by Mirsch-Riccius.

The ultra-modern German opera, "Aennchen von Thaurau," given by Breslau at 7.10, is the outstanding opera programme for Saturday.

Sunday brings a gala performance of "Madame Butterfly" from the Théâtre de la Monnaie, relayed by Brussels I at 7. The Berlin opera programme for the same hour brings the work of a graceful and pleasing composer of the last century, "Tsar and Carpenter," by Lortzing. It was produced at the Gaiety Theatre, London, as "Peter the Shipwright" in 1871. Needless to say, it deals with the life of that amazing person Peter the Great, Tsar of Russia, who worked for a time as a common shipwright in Amsterdam and Deptford to amass knowledge for the good of his country.

FOR C.B.S.

A CONCERT of Danish folk-songs, arranged for relaying by the C.B.S. of America, will be heard in the Copenhagen-Kalundborg programme on Thursday at 7.45. This should give listeners an opportunity of hearing a representative programme of Danish folk music with English commentaries.

NORWEGIAN

FOUR leading lights of swing-music in Norway with Jules de Vries, the international saxophone player, will give a programme of swing music from 6.50 to 7.40 on Monday, from Oslo.

ANKER SKJOLDBORG and his band who will be heard in the Danish programme at 10.10 to-night (Friday) playing from The Prater, a popular Copenhagen restaurant.

HIGHLIGHTS OF THE WEEK

FRIDAY, APRIL 2nd.

Nat., 5.15, Yascha Krein and his gypsy orchestra. 8, The Air-do-Wells.

Reg., 6, B.B.C. Orchestra (E) and Leslie England (piano). 8, Act II of "Fanal," from the Royal Opera House, Stockholm. 9.20, Songs You Might Never have Heard—VI.

Abroad.

Radio-Paris, 8.45, "France in Song": gala programme with Maurice Chevalier and Jean Sorbier.

SATURDAY, APRIL 3rd.

Nat., 5.15, The B.B.C. Dance Orchestra. 8, Music Hall, including Vic Oliver, the Two Leslies and Flanagan and Allen.

Reg., 4, The Air-do-Wells. 9.20, Discussion: Wages and Conditions in Retail Trade.

Abroad.

Sottens, 7.30, Symphony Concert from the Salle de Conférences.

SUNDAY, APRIL 4th

Nat., 7, Victorian Melodies—13. 9.5, "The Cherry Orchard" (Tchekov).

Reg., 5.15, Leslie Jefferies and the Grand Hotel, Eastbourne, Orchestra. ¶Albert Sammons in the Sunday Orchestral Concert.

Abroad.

Frankfurt, 8, Paul Lincke's operetta music.

MONDAY, APRIL 5th.

Nat., 7, "Monday at Seven." 8, Talk: "Towards National Health." ¶"I Made You Possible" (Ivor Brown).

Monday, April 5th (*continued*)

Reg., 7.30, Mozart musical biography: Midland Orchestra. 9, The Fleet Street Choir.

Abroad.

Beromünster, 7.15, Tonhalle Orchestra of Zürich with Erna Sack (soprano).

TUESDAY, APRIL 6th.

Nat., 5.15, Frank Biffo's Brass Quintet. ¶Musical Comedy, "The Girl Behind the Counter." 9.40, Gaby Valle and the New London Trio.

Reg., 6, Reginald King and his orchestra. 8.30, Organ Recital: Sir Walter Alcock. 9, From the television programme.

Abroad.

Brussels II, 7, Die Fledermaus (Johann Strauss).

WEDNESDAY APRIL 7th.

Nat., 6.40, Music from the Movies. 8.15, Queen's Hall Symphony Concert.

Reg., 8.15, "Palace of Varieties." 9, Recital, Peter Dawson.

Abroad.

Leipzig, 8, "A Night on the Lido"—orchestra and soloists.

THURSDAY, APRIL 8th.

Nat., 7.40, The Fol-de-rols. 8.40, Talk: Professor A. Lloyd James, "Words Fail Me." ¶Orchestre Raymonde.

Reg., 6, Musical Comedy, "The Girl Behind the Counter." 7.35, "Die Meistersinger" from the Berlin State Opera House.

Abroad.

Brussels II, 7, Symphony Concert; orchestra, male voice choir and carillon.

Some of Bela Bartok's pianoforte works will be played by a relative, Ilonka Bartok Kopsland, from the Norwegian network at 8.25 on Thursday.

SPRING

THE annual spring concert by the famous Swedish Students' choir, Stockholms Studentsangerforbund, will be heard from the Swedish stations at 7.5 on Saturday. The concert, which is to be held in the Koncerthaus, Stockholm, will include a number of Swedish songs which, according to my Scandinavian Correspondent, should not be missed.

HAMS

ALTHOUGH at a time when few readers will be able to listen-in, an O.B. in the Finnish programme on Thursday at 4.0 is noteworthy. Headed "Grasshoppers of the World," it will consist of microphone visits to Finnish short-wave amateur transmitters. This will be radiated by Helsinki.

THE AUDITOR.

The Cathode-Ray

ITS APPLICATION AND USE AS AN INSTRUMENT FOR LABORATORY MEASUREMENT

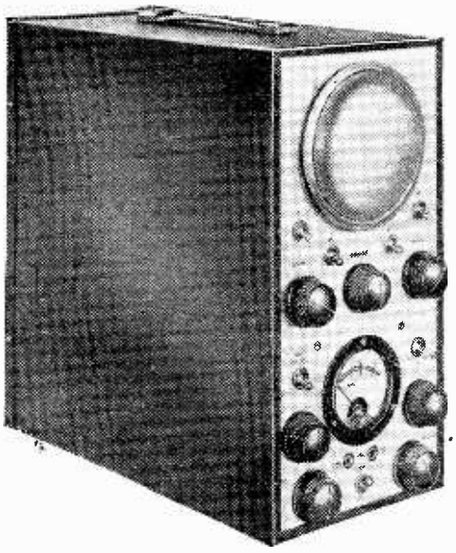


Fig. 1. The Standard Telephones cathode-ray oscillograph.

THE cathode-ray oscillograph is a comparatively new tool, but it is already as indispensable to a radio or communication laboratory as a voltmeter or a pair of headphones, and incomparably more powerful than either. When it is considered that an alternating current or voltage is characterised by four variables, viz., magnitude, frequency, wave-form and phase, and that while a meter will only deal with the first of these an oscillograph will deal with all of them at once, we wonder how our predecessors managed before the days of oscillographs. For a long time, of course, we have had the mechanical oscillograph, but it never became the popular and almost commonplace instrument that the cathode-ray oscillograph is becoming. This was due partly to the limitations of the older instrument, but even more, perhaps, to its weight and cost. Few laboratories could have more than one, and it was only used deliberately and for special investigations. Now that a laboratory may have half a dozen portable oscillographs, an engineer will use them with the same freedom as he uses a voltmeter.

An oscillograph may be used in two ways. As an oscilloscope it gives a pictorial view of phenomena, and helps an investigator to an insight into what is happening. As a measuring instrument it can be looked on as a kind of two-dimensional voltmeter or ammeter. Probably the former application is the more generally useful, for the reason that understanding a phenomena qualitatively generally comes before a quantitative study. Qualitative studies, however, are easily made quantitative by calibrating the deflections from an external source.

The photograph in Fig. 1 shows a suitable oscillograph manufactured by Standard Telephones and Cables, Ltd. It contains a 4½in. gas-focused tube, a linear time-base, and a single stage low-distortion amplifier, and all necessary mains supply apparatus.

This instrument will deal with frequencies from 30 c/s to about 500,000 c/s, and has a maximum sensitivity, when using the amplifier, of about 7 mm. per volt.

It is not possible to deal exhaustively with the applications of such an instrument. New applications, and adaptations of old ones, will occur constantly to the user. Indeed, almost any electrical phenomenon which can be represented in a two-dimensional graph can be drawn on the screen, i.e., wave forms, resonance curves, modulation envelopes, frequency characteristics, B-H curves, etc. A few of the more usual applications will be briefly touched on here.

ONE of the most noteworthy events of recent years has been the development of the cathode-ray oscillograph from an expensive and highly specialised piece of apparatus into a relatively cheap and easily handled laboratory tool. So flexible has the apparatus become that there are few operations in design and research which are not made easier by its assistance. A few of the more important applications are described in this article

One of the commonest uses is the examination of wave forms, using the linear time-base. Thus, if a modulated input is applied to a radio receiver, the audio wave form may be traced as it passes through the radio-frequency portion of the set (as a modulated envelope) and as a simple audio wave in the low-frequency part of the set.

Receiver Measurements

If the LF input to the modulator be connected to one pair of plates and the actual signal be applied to the other pair, a series of interesting pictures results. In the audio part of the set a straight line is produced if the signal and the input are in phase and an ellipse if they are out of phase, so that the changes in phase through the amplifier can readily be studied. In the RF portion the same connection produces a trapezium diagram from which the depth of modulation and its linearity may be read off at once as well as the phase changes of the envelope.

For many purposes it is useful to convert the linear time-base into a frequency base. Fig. 2 shows in principle how this may be done. A valve such as the AC/SP1 is bridged across the LC circuit of an oscillator. The valve is easily seen to be equivalent to an inductance of RC/g henries where g is the mutual conductance of the valve, which can be varied by altering the suppressor potential. If the suppressor is supplied with voltage taken from the linear time-base it will be seen that to each position of the spot in its horizontal traverse of the screen, there will correspond a particular inductance of the AC/SP1 and a particular oscillating frequency. The circuit shown is suitable only for a fairly narrow frequency range, the Q of the valve circuit becoming bad if the range is pushed too far. However, by using the principles of a heterodyne oscillator, the range may be extended.

The commonest application of the frequency base is to trace a resonance curve, by applying the frequency base to the horizontal plates and the voltage across the tuned circuit to the vertical plates. A radio receiver may be lined up more accurately and quickly by this method than by any other, and the effects on the shape of the curve of any proposed modifications to the circuit can be seen instantly.

The frequency base can also be used for analysing distorted waves into their component harmonics. Suppose the LC circuit of Fig. 2 included in the triode portion of a frequency-changer valve to whose signal grid a distorted wave of fundamental frequency f_0 is applied, and suppose a resonant circuit is included in the plate circuit which selects a particular side-band frequency f_s. When the oscillator is generating a frequency

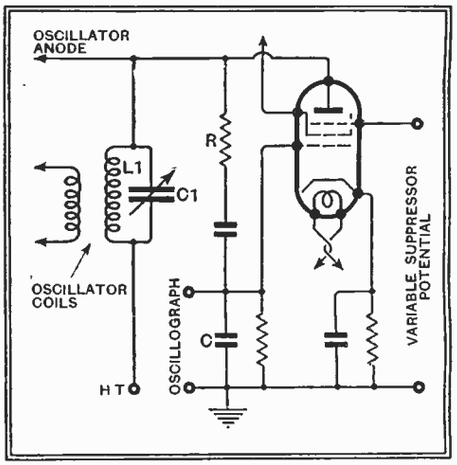


Fig. 2. A circuit is shown here which enables the frequency of an oscillator to be suitably varied for depicting resonance curves on a cathode-ray tube.

$f_s + f_0$, it will beat with the fundamental f_0 to produce side-bands of $f_s + f_0$ and f_s. The latter will be selected

Oscillograph

By S. HILL

Standard Telephones and Cables Ltd.

and applied to the cathode-ray oscillograph where it will draw a line proportional in length to the amplitude of the fundamental f_0. At some different oscillator frequency, i.e., at some other definite part of the screen, a line will be drawn representing the magnitude of the second harmonic and similarly for other harmonics. A similar principle might be used to analyse a noise spectrum into its component frequencies or even to draw a complete frequency characteristic of an amplifier.

The linear time-base incorporated in the oscillograph forms the most generally useful means of viewing phenomena, but for some purposes an elliptical base is preferable. This can very easily be arranged if a sinusoidal voltage is divided into two

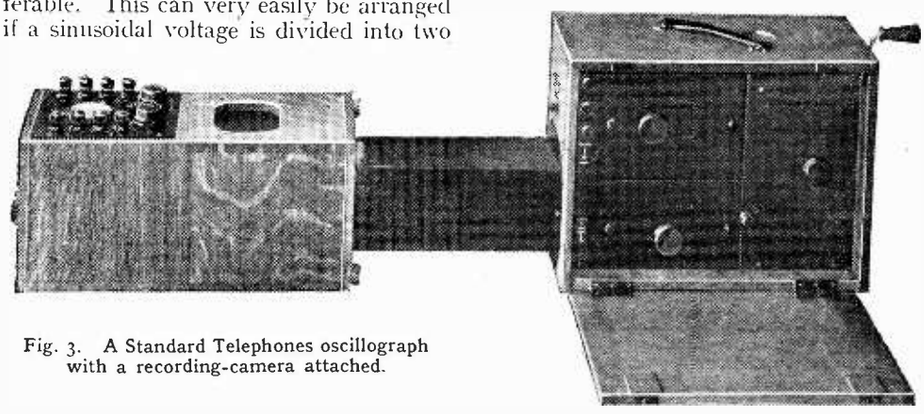


Fig. 3. A Standard Telephones oscillograph with a recording-camera attached.

quadrature components by means of a resistance and a condenser, and these two voltages applied to the two pairs of plates. A second frequency injected into the circuit feeding one of the plate-pairs produces a closed figure the pattern of which is a very accurate indication of the ratio of the two frequencies. An application of this principle is very useful for calibrating laboratory oscillators over a wide frequency range from one frequency standard.

The usefulness of an oscillograph is greatly extended by photography. Not only can permanent records be made of such phenomena as are discussed above, but switching and fusing surges which are too rapid to be studied as they appear on the screen can be recorded and measured. For such purposes a film camera such as the one illustrated in Fig. 3 can be used.

Special Oscillographs

The above applications need only a general purpose oscillograph such as that illustrated in Fig. 1. It is not possible, however, to make the instrument universal, and many special applications present themselves which require special oscillographs, or special auxiliaries. Some of the more usual of these applications are catered for by commercial instruments. Thus Standard Telephones and Cables manufacture a transportable high-speed transient-recorder for photographically recording such phenomena as lightning surges which may last from three or four microseconds up to about 1,000 microseconds. Again, a triple unit is made for photographing three phenomena at once and a dual-wave unit for throwing two phenomena in succession on to one tube so quickly that the eye perceives them as if they were present together. The engineer, however, frequently has to build his own auxiliaries for his own special purposes. In building special oscillograph circuits he often has to decide whether he will use a high-vacuum tube or a gas-focused tube. It is often supposed, because of the universal use of the former in television sets that the gas-focused tube is an older and obsolete form of the high-vacuum tube. Both forms, however, have their uses.

The Choice of Tube

In general, the high-vacuum tube has wider possibilities than the gas-focused tube, but more circuit elaboration is needed to realise these advantages. Where, for example, a linear time-base is used which limits the frequency range to about half a megacycle, the extended range of the hard tube is of no value, as a gas-focused tube will handle this range and offers, in addition, the advantages of lower voltage, greater sensitivity and a finer trace. The gas-focused tube has also the advantage that it can be applied without defocusing to unbalanced circuits, i.e., to circuits which have one "earthy" terminal. It is for reasons such as these that the gas-focused tube was used in the general purpose oscillograph described.

The applications dealt with above show how powerful a tool a cathode-ray oscillograph has become in a laboratory. Its high impedance, the direct appeal of its pictorial information, and above all, its absence of inertia make it particularly adaptable to the study of wave phenomena, which is one of the principal occupations of communication engineers. The inventive effort which television has brought to bear in the cathode-ray tube will certainly continue to react on the tube as a laboratory instrument and will lead to a freer use and to further applications.

Television—A Guide for the Amateur.—By Sydney A. Moseley and Herbert McKay. 144 pages. 31 photographic plates and 50 other illustrations. Oxford University Press, Amen House, London, E.C.4. Price 5s.

ANYBODY who, picking up this book and glancing through the introduction and the first chapter or so, rejects it on the ground of being too elementary and "popular," is advised not to form his judgment in this way, but to go farther.

With Chapter III it plunges right into the most modern and highly technical devices, and, so far from shying at the particularly sticky patches such as electron optics and the supersonic light-relay, it deals with them in considerable detail.

It is unfortunate, therefore, that one comes across considerable inequalities both of clarity and accuracy. There is a brilliantly lucid explanation of the usually rather difficult phenomenon of polarisation of light, but the treatment of electron optics is confused almost beyond intelligibility by a serious error in Fig. 32. Explanations of the Iconoscope and the electron multiplier also are not everywhere too happy.

The error, which one has come to expect almost as a matter of course, of stating that a Kerr cell *rotates* the plane of polarisation of the light ray duly appears and is reiterated. The explanation of the working of time bases by means of a *diode* (the now accepted use of the pentode is not mentioned) is muddled and quite wrong.

The following are some typical extracts:—

"In broadcasting sound we are dealing with waves of comparatively low frequency; the maximum for sound is about 10,000 vibrations per second. In television we are dealing with frequencies ten thousand times as great."

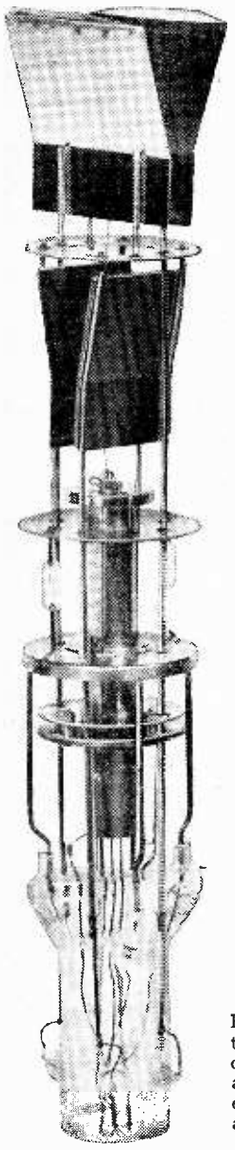
"For television we have to use rapid waves, almost as short and rapid as light waves." (To be precise, ten to twenty million times as long.)

"Light waves are so short that modulations due to them would be lost on the long waves used in ordinary wireless transmission."

A reader who already knows something of the subject may be conscious of much repetition, but, of course, the novice may grasp the second time what he missed the first. The only danger is that he may fail to realise that the two matters are identical.

An excellent feature of the book is that no single system is given undue prominence and that mechanical systems receive their rightful place. Not only are recent devices of the Scophony system—including the Jeffree relay—explained, but also the Mihaly-Traub system; and large-screen pictures are given a whole chapter. It is therefore obviously up to date.

The photographic illustrations demand a special word of praise, being numerous and well-reproduced, and (as is so seldom the case) relevant to the text. M. G. S.



Electrostatic Focusing

THE PRINCIPLES OF ELECTRON OPTICS AS APPLIED TO THE CATHODE-RAY TUBE

By G. PARR
(Radio Division, The Edison Swan Co.)

THE electron beam in a cathode-ray tube must be focused on the screen if satisfactory results are to be secured. There are several ways of doing this, and one widely adopted is to pass the beam through suitable electrostatic fields which affect it in a manner analogous to the way in which light is modified by lenses

Fig. 1.—In this view of the electrode assembly of an Ediswan tube the anodes and plates for electrostatic focusing and deflection are clearly shown.

OF the three methods of focusing the electron beam — magnetic fields, traces of gas in the bulb, and electrostatic fields, the latter is the most recent discovery, and yet within a few years it has acquired an extensive bibliography and the dignity of a separate classification under the title of "Electron Optics."

It is curious that in view of the original theory that light consisted of corpuscles emitted from a luminous body the analogy between electrons (which are most definitely particles emitted from a luminous body!) and light rays should not have been apparent at an earlier date. The first complete investigation, however, appears to be that of Knoll and Ruska*, who constructed electrical equivalents of glass lenses in 1932 and succeeded in focusing a stream of electrons to a point, the whole system imitating almost exactly the action of a convex lens.

Further development showed that it was not necessary to imitate the glass lens in physical construction and that the beam could be focused with equally good results by passing it through a series of perforated discs or cylinders to which a suitable potential was applied. From this has arisen the complicated-looking structure of the modern electrostatically-focused cathode-ray tube (Fig. 1) in which the focusing electrodes are mounted rigidly one above the other on the glass pinch, extra care being taken in the insulation of each anode. The terms anode and grid have been adopted from standard valve practice to denote the equivalent electrodes in the cathode-ray tube, and in the electrostatic tube there are usually three anodes numbered outwards from the cathode.

* See Bibliography at end.

How the Beam is Refracted.

To understand the focusing action of a positive potential applied to an electrode in the path of the beam it is convenient to consider the simple case of Fig. 2, in which an electron is travelling at an angle a to the axis and enters an electrostatic field at PP'.

The initial velocity of the electron as it enters the field can be resolved into the two components parallel with the axis and at right angles to the axis, v cos a and v sin a, where v is the velocity. As soon as the electron enters the field its axial velocity is increased since this is proportional to the accelerating potential (or more correctly, to the square root of the potential). The component v cos a will thus be increased while the vertical component v sin a remains as before. As a result the path of the electron on leaving the field will be at a lesser angle a', the amount of refraction of the electron path being governed by the applied potential. The optical equivalent of this change of direction of the electron is given in Fig. 2 (b), giving us the familiar equation for the refractive index of the medium through which the ray passes as:

$$\mu = \frac{\sin a}{\sin a'}$$

If the initial velocity of the electron beam is due to a potential V_0, and the potential of the field through which it passes is V, we can calculate the electron path "index of refraction" which works out to

$$\mu = \sqrt{1 + \frac{V}{V_0}}$$

It will be seen that by giving suitable high values to V the index of refraction can be made much higher than is the case in ordinary optics, and, in fact, lens systems with a refractive index of 100 have been constructed.

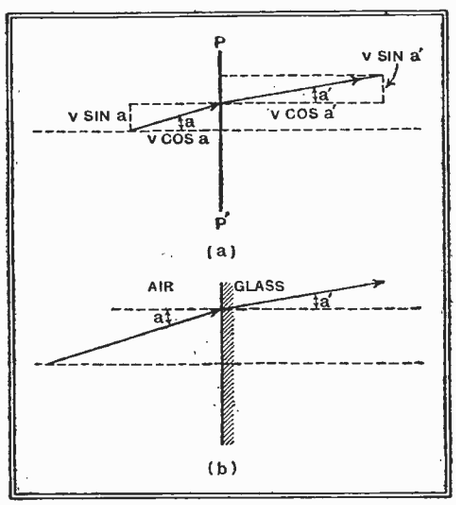


Fig. 2.—The analogy between electrostatic focusing and the refraction of light is clearly brought out in these diagrams.

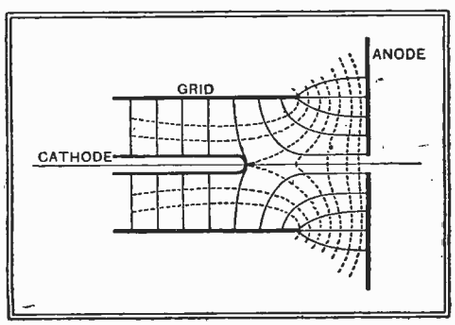


Fig. 3.—This drawing shows the field between the cathode, grid, and first anode.

The Practical Base

The simple theory outlined above is not sufficient to cover the practical focusing of electron beams for a number of reasons, the principal ones being that the field due to a charged disc or cylinder does not have a sharply defined boundary line but is graded off. The refraction of the beam therefore takes place in several stages. Secondly, the beam is of definite cross-section instead of a point source as we have assumed. This gives rise to complications where the electron is travelling from some point not on the axis of the lens system. Finally, there is the mutual electron repulsion which exists at all points on the path of the beam which limits the smallness of the focused spot.

As might be expected, the electron beam suffers from similar focusing defects to those met in optics, such as spherical aberration and astigmatism. To minimise spherical aberration the electron optical

Electrostatic Focusing—

lens system must be limited in curvature in a similar manner to glass lenses, and the divergence of the entering beam must not be too great. It is preferable, therefore, to refract the beam gradually by more than one potential surface rather than attempt to do it by a single large diameter lens. For this reason the majority of large television tubes employ three anodes in succession for the focusing of the beam, although with smaller tubes two are usually adequate.

The Lens System

A further advantage in the use of three anodes will be seen on examining the action of the Wehnelt cylinder, the electrode surrounding the cathode. This is an essential part in all tubes, whether magnetically or electrostatically focused, and in addition to controlling the electron current it acts as a pre-concentrator on the lines of the condenser lens of an arc lamp. The diagram of Fig. 3 shows the field between the grid (as the cylinder is usually called) and the cathode. The lines of equipotential, i.e., lines joining points at the same potential with respect to the cathode, are shown dotted, intersecting the field lines. The electron can be considered as tending to travel normal to the equipotential lines, and the beam emerging from the cathode will be constricted to pass through the hole in the anode as a compact jet. The field between the grid and the first anode, a disc or cylinder placed immediately above the grid, thus constitutes the first lens of the electron-optical system. A second lens is formed by a field between the first anode and the second, placed above it on the axis of the tube. In this simple lens system the grid not only acts as a modulator of the source of the beam but also as a lens electrode. It follows that extremes of modulation caused by large potential changes on the grid will be accompanied by loss of focus as the field between grid and first anode is altered. For this reason two-anode tubes are not desirable for television reproduction in which the focus of the spot must be constant, irrespective of its intensity. The addition of a further anode to the system, besides improving the gradual focusing of the beam, shifts the main lens system to the regions between the first and second and second and third anodes respectively, leaving the grid with the main function of controlling the beam intensity.

The diagram of Fig. 4 shows a complete electron-lens system (that of the R.C.A. tube type 903) and the path of the beam is shown by the outlined section. The actual potentials are marked against the equipotential lines. Note that the first anode here is called "grid No. 2," and has a fixed potential of 100 v. Corresponding British tubes have a first anode potential of 250-400 v., the second anode being at 900-1,200, and the third at 4,000-6,000. True focusing is accomplished by variation of the second anode potential, the first and third anodes being fixed. For a given first anode potential the intensity and sharpness of the spot are increased by increasing the potential of the final anode, and it is seldom desirable to reduce this below 3,500 volts for clear pictures.

The Potential Gradient

The potential of the first anode has an important bearing on the life of the tube, as, no matter how carefully exhausted, there are a certain number of positive ions in the region of the cathode. These will travel towards the cathode at a velocity proportional to the first anode potential, and since their kinetic energy is proportional to the square of the potential their impact will tend to destroy the emissive surface. Reduction in the first anode potential by reducing their velocity will thus considerably prolong the life of the cathode, and it is false economy to attempt to brighten the spot by increasing this anode voltage.

In designing electron-optical lens systems ingenious use is made of a large-scale model of the electrodes, which is immersed in a tank containing a conducting liquid. The appropriate potentials are then applied to the electrodes, and the fall of potential due to the passage of current between them is measured by a probe electrode connected to a bridge. By this means the equipotential lines can be plotted and the approximate path of the electrons predicted. An improved form of tank was shown by Dr. Gabor, of the B.T.H. Co., at the recent Physical Society's Exhibition, in which the paths of the electrons could be plotted directly on to a chart by means of a pantograph. The importance of such an instrument to the designer of cathode-ray tubes will be appreciated.

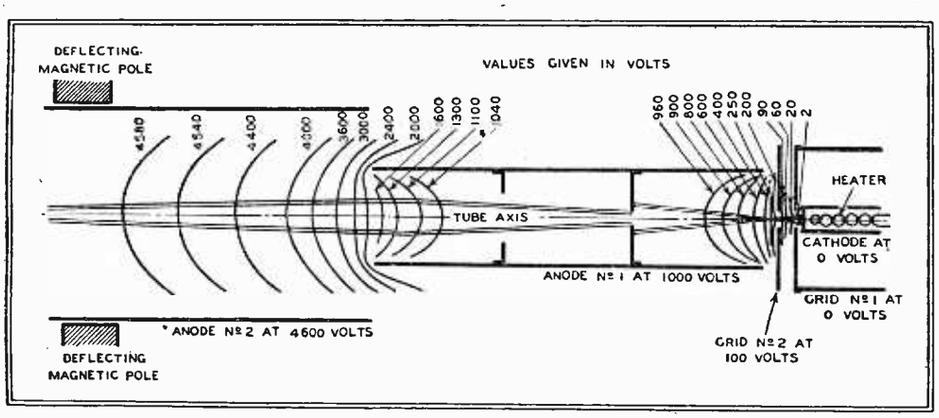


Fig. 4.—The potential gradient along a cathode-ray tube is well illustrated by this diagram, which also shows the path of the electron beam.

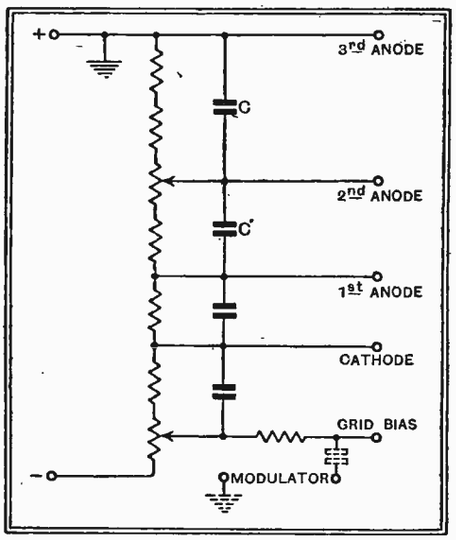


Fig. 5.—The voltage-divider used in providing the necessary potentials for electrostatic focusing is shown here.

Fig. 5 shows a typical circuit for the potential supply of a three-anode high-vacuum tube. The current taken by the tube, i.e., the beam current, can be regarded as negligible, and the calculation of the resistances is a simple application of Ohm's law, due regard being paid to the degree of variation in potential required. The by-pass condensers shown are not all essential and C and C' can be omitted in most cases.

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McArthur: "Electronics," June, 1932, p. 192.

The Radio Industry

REFERRING to a recently published letter from a reader, in which it was urged that radio dealers should provide a valve-testing service at a small fixed charge, the makers of Radiometers equipment tell us that they have always encouraged their dealers to conduct such a service. Practical assistance is given by supplying report forms, etc.

The annual report of McMichael Radio, Ltd., discloses that the past year's activities have been extremely successful. A profit of £29,731 is announced.

To avoid confusion with a firm of similar name, the S.P. Fidelity Sound System has changed its title to The Acoustical Manufacturing Company. Larger works have been obtained at 33, Sutton Road, London, N.W.10, where all communications should now be addressed.

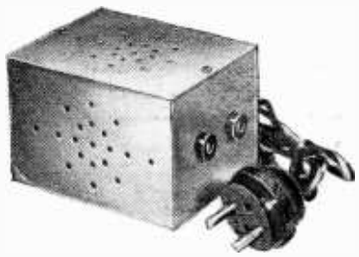
New Apparatus Reviewed

Recent Products of the Manufacturers

GNOME BATTERY CHARGER

THIS unit undoubtedly derives its description from the very compact form in which it has been found possible to compress it. Though it consists of a double-wound mains transformer and a metal rectifier, the overall size is only 3½in. × 2¾in. × 2⅜in. Its particular function is that of charging two-volt radio batteries from the AC mains, and it is rated to give a charging rate of 0.5 amp.

Tests were made on a 220-volt 50 c/s AC supply, and the charging rate, with a partially run-down accumulator, was 0.45 amp.



Gnome AC charger for two-volt radio batteries

A very slight hum was audible during operation, but the temperature rise was not above the normal for apparatus of this kind, as the case is well ventilated.

Finished in bright blue enamel this useful device costs 13s. 6d.

The makers are Gordon Equipments, Ltd., 25, Milton Street, London, E.C.2.

VELODYNE SUPREME MICROPHONE EQUIPMENT

SHAFTESBURY MICROPHONES, LTD., 24, Aldersgate Street, London, E.C.1, have introduced a new and improved model of the Velex velocity ribbon microphone, which is now described as the Shaftesbury Velodyne Supreme Microphone.

A considerably larger output than is usually obtainable from ribbon microphones is provided by this model, as in place of a single ribbon, which is customarily used, the Velodyne type is fitted with several ribbons arranged in series but with a common magnet system.

The output is such that a good three-stage amplifier suffices to give adequate volume for most purposes.

The equipment sent in for test comprised a table model Velodyne microphone and an AC/DC three-stage amplifier designed for use with it. This amplifier embodies two top-grid triode valves feeding a pair of Tungsram PP36 valves. Included in the full equipment are two loud speakers, but as these did not accompany our apparatus the test was made with a loud speaker of known characteristics and of about 15 ohms impedance.

The equipment is so arranged that it can be assembled in a few minutes, since the several parts are interconnected by cables with plugs.

Though only aural tests were made, these sufficed to show that the quality of reproduction is exceptionally good; speech is clear and entirely free from sibilant accentuation, while the sound of keys shaken and similar tests for fidelity left no doubt in the mind of the listener as to the nature of the items employed.

Shaftesbury new Velodyne ribbon microphone and universal AC/DC amplifier.

Characteristic sounds are faithfully reproduced, which is possibly one of the best tests for fidelity in any sound-amplifying equipment.

Despite the fact that the amplifier gives a high gain, the hum level is very low, and so also is the background of the microphone.

A final test, using the output from an AF beat oscillator, failed to reveal any resonances either in the microphone or in the amplifier from zero to 10,000 c/s.

Judging from the tests carried out, it can be said that the microphone is free from resonance and has an ostensibly flat characteristic up to at least 9,000 c/s, while even above this upper limit an appreciable output is evident.

The new Velodyne Supreme Microphone finished in chromium plate costs £12 12s., including a transformer, while the complete equipment, comprising the microphone mounted in a floor stand, a 10-watt universal amplifier, twin loud speakers, and all necessary cables, is available at £50.

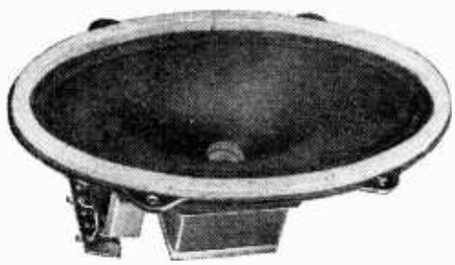
An axial response curve was not taken in this instance, but the performance as judged by ear showed that the balance of output between high and low frequencies remained substantially constant through an angle of at least 150 degrees in the horizontal plane.

The sensitivity is good, and the useful frequency range is from 60 to 9,000 cycles with a well-controlled fundamental resonance at about 75 cycles and a slight increase of output round about 2,500-3,000 cycles. Sounds rich in high frequencies are faithfully reproduced, and there is a remarkably good bass output for so small a diaphragm. The suspension is free, and the unit accepts powers up to at least 4 watts quite happily.

There are two models, one for mains excitation with the usual range of field resistances at 38s., and a PM type at 46s.; both types include a multi-ratio transformer.

GOODMAN'S ELLIPTICAL LOUD SPEAKER

SEVERAL advantages are offered by the elliptical cone over the normal circular diaphragm. Of these the wider angle of diffusion of high frequencies is, perhaps, the most important, but the shape is also very convenient to the designer when the layout of the cabinet has to be considered. The type is becoming increasingly popular with set manufacturers, and with the introduction of the Goodman's elliptical cone loud speaker the amateur constructor can also avail himself of its advantages.



Goodman's elliptical cone PM loud speaker.

A rigid cast aluminium frame supports the cone, which measures 10¾in. on the major axis and 5½in. on the minor axis. The sides of the cone are curved with a very steep rise on the minor axis which gives good efficiency at high frequencies.

Electrical Inventions, by Professor A. M. Low, pp. 124, 8 plates, published by Thomas Nelson and Sons, Ltd., 35-36, Paternoster Row, London, E.C.4. Price 2s. 6d.

MANY people who are constantly making use of electricity for various domestic purposes, such as lighting and heating, must often wonder "how it works." Text-books, even of the elementary kind, are usually far too technical and go into too much detail. This book is, however, the very thing for such people. Practically all uses of electricity are dealt with, including, of course, wireless and television.

Einführung in die physikalischen Grundlagen der Rundfunktechnik. By Dr. Otto Franke, Vienna. Pp. 272+viii. 167 figs. Julius Springer, Schottengasse, 4, Vienna. RM.9.60.

THIS introduction to the physical foundations of broadcasting is based on courses of lectures given to physicists and electrical engineers. It is a very thorough mathematical course, suitable for university students specialising in this subject. It is divided into four chapters under the headings: Electric oscillations, valves, electric waves, and radio telegraphy and telephony. It does not attempt to describe practical constructions, but is confined to the underlying principles. It uses the methods of vector analysis, and the treatment reminds one of Abraham and Föppl's "Einführung in die Maxwellsche Theorie." The diagrams are good, and it is a book that one can confidently recommend. G. W. O. H.

Cathode-Ray Tube Characteristics

Operating Data on Tubes for Television and Laboratory Equipment

OF recent years the use of cathode-ray tubes has been rapidly increasing in most fields of electrical research, and there are now few laboratories which do not include among their equipment some form of CR apparatus. For the visual examination of wave forms, the automatic plotting of resonance curves, and for phase measurements, the cathode-ray tube has few rivals; it is now even finding its way into service equipment.

Although it has long been known and used, it is only since the introduction of a high-definition television service that it has become widely known among those who are not professionally engaged in the wireless industry. Television has, in fact, been directly responsible for much development in CR tubes, especially in the production of large tubes.

Basically the tube consists of an electron-emitting cathode, which may be directly or indirectly heated, an accelerating electrode, and a fluorescent screen on the end of the tube. A high positive potential is applied to the accelerator, or anode as it is now more often called, and this accelerates the speed of the electrons so that they strike the screen with sufficient velocity to make it fluoresce.

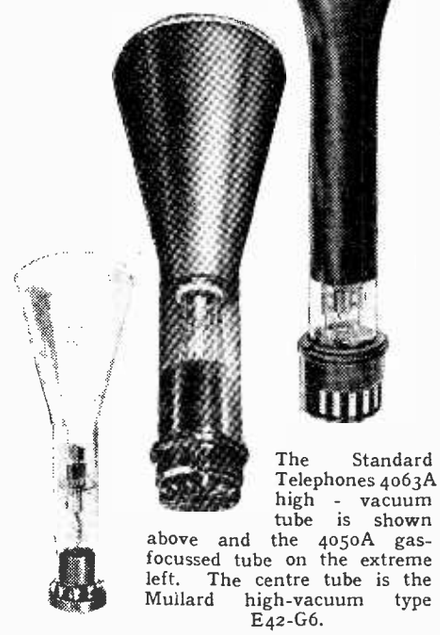
In practice, a shield, grid, or modulating electrode is fitted around the cathode, and maintained at a suitable negative potential. There are also in many tubes several anodes, in addition to deflecting plates.

With the three electrodes mentioned a stream of electrons from the cathode to the screen can be obtained, but for satisfactory results more than this is necessary. The electrons cannot be allowed to travel at random through the tube, but must be constrained into the form of a beam of small cross-section and focused on the screen so that a very small, bright spot is obtained.

The focusing of an electron beam is exactly analogous to the focusing of a beam of light, and the means adopted to this end is consequently often called an electron lens. Such lenses can reproduce in their own sphere most of the characteristics, and can have most of the defects, of optical lenses.

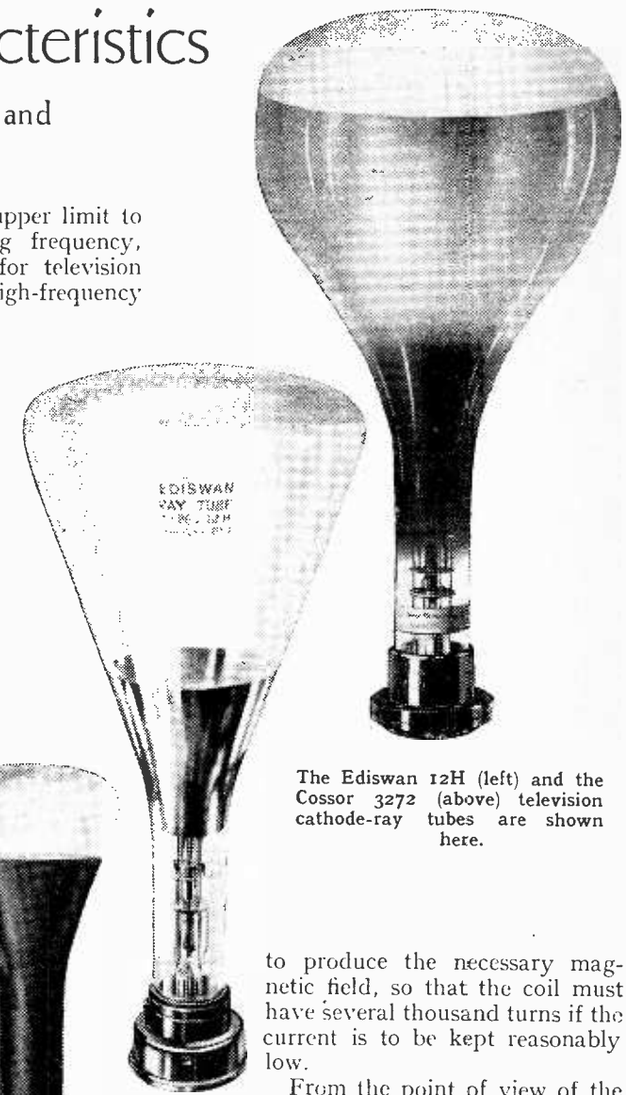
There are three distinct methods of focusing—by gas, magnetically, and electrostatically. With the last two systems the tubes are evacuated as much as possible and are known as high-vacuum types, but with the first a suitable amount of an inert gas is introduced during manufacture. Gas-focused tubes generally require lower voltages than high-vacuum types and are consequently widely used in oscillographs; the focus is critically dependent on the grid voltage, and this must be capable of variation by the operator. Partly because of this factor and partly because there is a definite upper limit to writing speed, or operating frequency, such tubes are unsuitable for television purposes and also for high-frequency wave form examination.

The majority of modern tubes are of the high-vacuum type, and of these the majority are focused electrostatically. Such tubes have two or three accelerating anodes, and focusing is carried out by varying the potential of anode 1 in a two-anode tube, or anode 2 in a three-anode tube. The brilliancy can be varied by changing the negative grid voltage, and quite a large variation is possible without any effect upon the sharpness of focus. The grid can thus be used to introduce a modulating voltage, and in television the vision signal is applied to it.



The Standard Telephones 4063A high-vacuum tube is shown above and the 4050A gas-focussed tube on the extreme left. The centre tube is the Mullard high-vacuum type E42-G6.

Magnetically focused tubes are not common at the present time, but several examples are to be found among the types suitable for television. Such tubes have only one anode, and focusing is accomplished by varying the strength of an electromagnet which consists of a coil around the neck of the tube. In practice, a variable resistance in series with the coil enables the current through it to be varied so that the proper focus is obtained. Several hundred ampere-turns are needed to produce the necessary magnetic field, so that the coil must have several thousand turns if the current is to be kept reasonably low.



The Ediswan 12H (left) and the Cossor 3272 (above) television cathode-ray tubes are shown here.

From the point of view of the user, electrostatic focusing is undoubtedly the simpler, for he has to do nothing but apply suitable voltages to the electrodes, whereas with magnetic focusing he has to provide an electromagnet correctly positioned round the tube. From the point of view of tube construction, however, the latter system is the simpler, and better focusing is sometimes claimed. With either arrangement it is important that the electron beam should pass through the centre of the lens, otherwise astigmatism will be produced. With electrostatic focusing this is controlled by the manufacturer, and depends upon the accuracy of alignment of the electrodes, but with magnetic focusing it is dependent upon the position of the external coil and is readily controllable by the user.

In practically all applications of the cathode-ray tube it is necessary to deflect the beam in two directions at right angles to one another. Again, this may be done electrostatically or electromagnetically. The former is practically universal in tubes intended for general purpose use, but among television types the two methods are nearly equally divided. A tube which is intended for double electrostatic deflection includes two pairs of deflecting plates at right angles; one pair is usually called

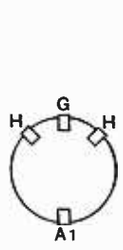
(*Continued on page* 334.)

CATHODE-RAY TUBE CHARA

	BAIRD	COSSOR								EDISWAN		
Type	15 WMI	3232	3234	3236	3237	3272	3273††	3274	3276¶	3277‡‡	5 H	7 H	10 H
Heater — Volts	1.7	0.6*	0.6*	0.6*	0.6*	0.6*	0.6*	0.6*	0.6*	0.6*	2.0	2.0	2.0
Heater — Amps.	2.4	1.25	1.25	1.25	1.25	1.2/1.4	1.2/1.4	1.2/1.4	1.2/1.4	1.2/1.4	1.5	1.5	1.5
Normal Operating Volts — Anode 3	—	—	—	—	—	4,000	6,000	4,000	3,000	3,000	—	2,500	4,000
Normal Operating Volts — Anode 2	—	—	—	—	—	700	1,000	700	500	500	2,500	800	1,200
Normal Operating Volts — Anode 1	6,500	1,500	750	1,500	750	250	250	250	250	250	800	400	400
Normal Operating Volts — Grid Bias	−110	−150	−75	−150	−75	−250	−250	−250	−250	−250	−200	−200	−100/25
Normal Operating Volts — Modulation†	70	—	—	—	—	60	60	60	60	60	—	—	20
Maximum Anode Volts‡	—	3,000	1,500	3,000	1,500	5,000	10,000	4,000	3,000	3,000	3,500	3,500	6,000
Amp.-turns for Magnetic focusing	¶¶	—	—	—	—	—	—	—	—	—	—	—	—
Type of Tube	HV	G	G	G	G	HV	HV	HV	HV	HV	HV	HV	HV
Deflection Sensitivity — X-plates (mm. per volt)	—	370/V.	—	370/V.**	350/V.**	750/V.	750/V.	580/V.	340/V.	340/V.	450/V.	700/V.	800/V.
Deflection Sensitivity — Y-plates (mm. per volt)	—	375/V.	350/V.**	375/V.**	350/V.**	820/V.	—	650/V.	400/V.	400/V.	450/V.	700/V.	800/V.
Deflection Sensitivity — Magnetic (mm. per amp.-turn)	2.0	—	—	—	—	—	—	—	—	—	—	—	—
Capacities ($\mu\mu$F.) — $X_1 - X_2$	—	1.5	—	1.5	1.5	1.0	0.5	1.0	1.0	1.0	—	—	4.0
Capacities ($\mu\mu$F.) — X_1 or X_2 − E	—	5.0	—	5.0	5.0	11.0	0.7	11.0	11.0	11.0	—	—	15.0
Capacities ($\mu\mu$F.) — $Y_1 - Y_2$	—	1.5	1.5	1.5	1.5	1.0	—	1.0	1.0	1.0	—	—	4.0
Capacities ($\mu\mu$F.) — Y_1 or Y_2 − E	—	5.0	5.0	5.0	5.0	11.0	—	11.0	11.0	11.0	—	—	15.0
Capacities ($\mu\mu$F.) — G − E	2.0	9.0	9.0	9.0	9.0	10.0	4.5	10.0	10.0	10.0	—	—	15.0
Dimensions (cm.) — Diam. of Screen	38.0	12.4	11.2	12.4	11.2	30.5	12.4	25.6	15.2	5.2	10.5	15.5	23.0
Dimensions (cm.) — Max. Diam.	—	13.5	11.4	13.5	11.4	34.2	13.5	28.0	16.0	5.2	12.5	17.5	25.0
Dimensions (cm.) — Max. Length	83.0	40.9	34.5	40.9	34.5	65.5	41.7	55.5	46.7	46.7	45.0	51.0	56.0
Screen Colour	White	Blue	Blue	Blue	Blue	White	Blue	White	White	Blue	White, Blue, Green	White, Blue, Green	White
Base	A	B	D	E	F	H	C	H	H	G	I	J	K
Price	—	£7 10s.	£4 15s.	£7 10s.	£5 10s.	£15 15s.	£12 12s.	£12 12s.	£8 8s.	£8 8s.	£8 8s.	£10 10s.	£12

* Directly-heated cathode. † Peak-to-peak volts between black and defocusing. ‡ Maximum voltage for A1, A2, or A3 in 1, 2, or 3
HV, High-vacuum tube. G, Gas-focused tube

CATHODE-RAY TUBE BASE CONNECTI



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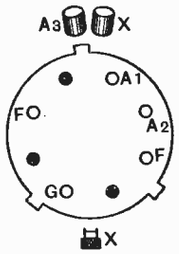

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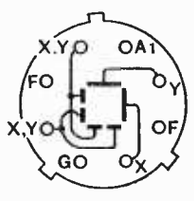

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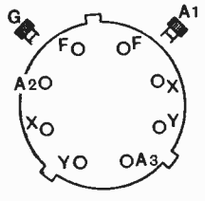

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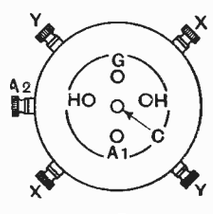

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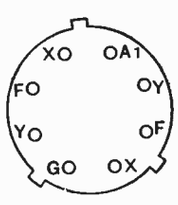

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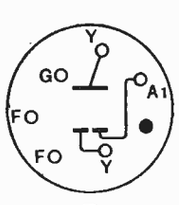

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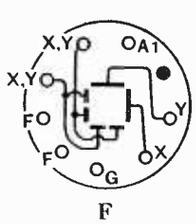

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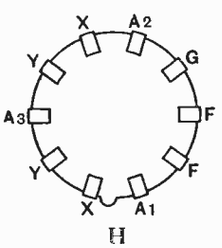


H

CTERISTICS

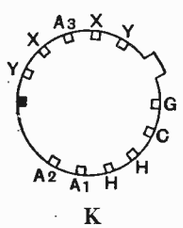
WORKING DATA ON TYPES FOR TELEVISION AND LABORATORY EQUIPMENT

	FERRANTI			H.M.V. and MARCONI		MULLARD								STANDARD TELEPHONES & CABLES		
H	T10	T12	T15	9″	12″	E40–G3	4002/ 4002A	4001/ 4001A	E42–G6 E42–B6	E46–G10 E46–B10	E46–12	EM46–12	E46–15	4050AG, 4050AB, 4050AD	4050BG 4050BB	4063AW 4063AB
.0 .5	2.0 1.5	2.0 1.5	2.0 1.5	4.0 1.3	4.0 1.3	4.0 1.0	4.0 1.0	4.0 1.0	4.0 1.0	4.0 1.0	4.0 1.0	4.0 1.0	4.0 1.0	0.75* 0.85/1.0	0.75* 0.85/1.0	2.0 2.0
ɔoo 200 400 ɔ/250 20	— — 4,000 —50 30	— — 4,000 —50 30	— — 4,000 —50 30	3,000 1,000 300 —24 8	3,000 1,000 300 —24 8	— 500 140 —0/25 —	— 1,000 200 —0/45 —	— 2,000 400 —0/35 —	— 2,000 400 —0/35 —	4,000 800 250 —0/60 —	4,000 800 250 —0/60 25	4,000 800 250 —0/60 25	4,000 800 250 —0/60 25	— — 350 +15/14§ —	— — 350 +15/14§ —	5,000 1,200 150 —0/30 30
ɔoo	5,000	5,000	5,000	6,000	6,000	800	1,000	2,000	2,000	6,000	6,000	6,000	6,000	750	750	5,000
—	¶¶	¶¶	200/300	—	—	—	—	—	—	—	—	—	—	—	—	—
ıV	HV	HV	HV	HV	HV	HV	HV	HV	HV	HV	HV	HV	HV	G	G	HV
ɔ/V. ɔ/V.	— —	— —	— —	— —	— —	150/V. 120/V.	440/V. 360/V.	640/V. 520/V.	640/V. 520/V.	550/V. 400/V.	550/V. 400/V.	1,500/V. —	550/V. 400/V.	275/V. 275/V.	275/V. 275/V.	650/V. 650/V.
—	§§	§§	2.54	§§	§§	—	—	—	—	—	—	—	—	—	—	—
4.0 5.0 4.0 5.0 5.0	— — — — —	— — — — —	— — — — —	— — — — —	— — — — —	3.7 — 2.9 — 6.7	2.0 — 2.0 — 7.0	3.0 — 2.0 — 10.0	7.0 — 6.0 — 12.0	5.0 — 4.0 — 15.0	5.0 — 4.0 — 15.0	— — — — —	5.0 — 4.0 — 15.0	0.75 6.5 0.75 6.5 —	0.75 6.5 0.75 6.5 —	1.5 12.0 1.2 10.0 15.0
9.0 1.2 5.0	22.8 25.4 61.0	27.9 30.5 61.0	35.6 38.1 71.0	21.6 22.8 57.0	28.0 30.5 70.0	7.0 7.5 16.5	9.5 9.8 35.0	16.0 16.7 45.0	16.0 16.7 45.0	25.0 27.0 55.0	30.0 32.0 66.0	— — —	38.0 40.0 68.0	10.0 11.5 33.0	16.5 18.0 46.0	14.0 15.6 53.5
hite	White	White	White	White	White	Green	Green, Blue	Green, Blue	Green, Blue	Green, Blue	White	—	White	Green, Blue, Delay	Green, Blue,	White, Blue
K	S	S	S	L	L	M	N	O	P	Q	Q	Q	Q	R	R	K
5 15s.	—	—	—	£11 11s.	£15 15s.	£4 15s.	£6 15s.	£8 8s.	£8 8s.	£12 12s.	£15 15s.	—	£21	£5 5s.	£6 10s.	£8 10s.

ɜ tubes respectively. ** Split-plates. †† Transmitting tube. ‡‡ Recording tube. ¶ Monitoring tube. § Shield focusing voltage.
Magnetic focusing. §§ Magnetic deflection.

S

Abbreviations: A1=1st Anode; A2=2nd Anode; A3=3rd Anode; C=Cathode; F=Filament; G=Grid; H=Heater; X=X-Plates; Y=Y-Plates.



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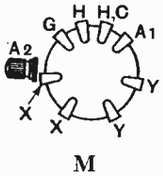

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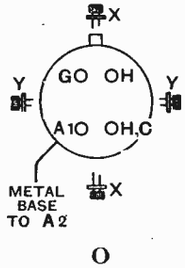

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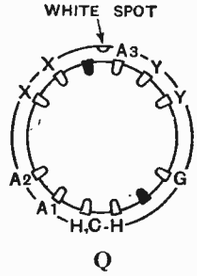

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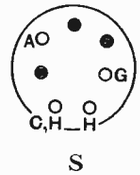

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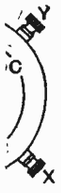

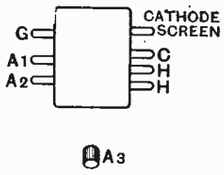

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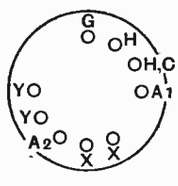

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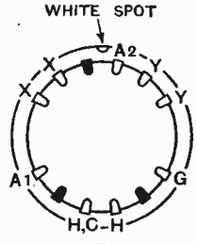

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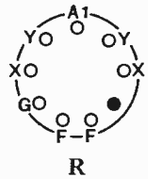


R

Cathode-Ray Tube Characteristics—

(*Concluded from page 331*)

the X-plates and the other the Y-plates.

The displacement of the spot on the screen measured in millimetres for one volt applied between the deflecting plates is called the deflection sensitivity. The sensitivity is inversely proportional to the voltage applied to the outermost anode (the second or third) so that in the tables it is expressed as, say, 600/V mms. per volt, where V is the anode voltage. If the tube is worked at 3,000 volts the sensitivity is 600/3,000 = 0.2 mm. per volt. With a large tube a deflection of 25 cms. may be needed and the voltage required is 250/0.2 = 1,250 volts. Were 6,000 volts to be applied to the anode, the sensitivity would be halved.

With magnetic deflection there are no plates in the tube and deflection is obtained by passing suitable currents through coils mounted alongside the neck of the tube. The beam is deflected parallel to the plane of the coil and it is usual to mount two coils with their planes vertical, one on each side of the neck, for the vertical deflection, while two more coils with their planes horizontal provide the horizontal deflection.

The sensitivity to magnetic deflection is less readily expressed than the sensitivity to electrostatic deflection, for it depends on the design of the external coils. As a guide, however, an approximate figure for ampere-turns is given in the tables.

In some cases, a combination of electrostatic and electromagnetic deflection is adopted. The tube then contains only one pair of deflecting plates and only one pair of external coils is necessary. For television, electromagnetic deflection is then invariably used for the frame scanning.

When a tube is required for television purposes the size of the screen is important, for as in most cases the size of the spot cannot be reduced below a certain limit, the screen must be large enough to accommodate the full number of lines without overlapping. In general, a screen of about 20 cms. diameter is the minimum for present-day television. This does not apply to transmitting tubes, however, which are generally operated with higher voltages and so have a smaller spot size.

The dimensions of the rectangular picture which can be accommodated on a screen of given diameter are readily calculated. If we denote the picture height and width by H and W respectively, the picture ratio W/H by r, and the screen diameter by D, it is a matter of simple geometry to show that $H = D/\sqrt{1 + r^2}$ and $W = D/\sqrt{1 + 1/r^2}$. For the present transmissions the picture ratio $r = 5/4 = 1.25$ and with one of the large tubes the screen diameter may be 30 cms., so that the picture size works out at 18.7 cm. x 23.4 cm. (7.4in. x 9.25in.). In practice a somewhat larger picture can be accommodated, for the corners are often allowed to overlap the edge of the screen.

Screen Colours

The screen colour is a matter of considerable importance and the best colour depends upon the use to which the tube will be put. Television tubes invariably have a white screen which gives a black and white picture. In general, however, the white is not pure but has a marked bluish tinge so that a plain raster appears in very pale blue. This is by no means noticeable in actual picture reception, however, and the pictures really do appear black and white. Tubes intended for oscillograph use generally have either a blue or a green screen and certain types of the former are especially suited for photographic work.

The base connections of cathode-ray tubes are by no means standardised as yet. Some attempt at standardisation has been made with the newer tubes, but even then it is not complete.

GAS-FILLED TRIODES

Base Connections

5A 5K 5L

The reference letters in the columns for base connections thus refer to the drawings of tube bases which appear below the tables.

Turning now to gas-filled triodes, the data given refers chiefly to operating conditions in time-bases. The maximum peak anode voltage rating places the upper limit to which the time-base condenser must be charged, while the column headed "Gas Voltage Drop" gives the minimum voltage to which the condenser can be discharged. The difference between these two voltages is the theoretical maximum peak-to-peak voltage of saw-tooth waveform obtainable. In practice, one should be content with an appreciably lower voltage.

The current through the valve is at its greatest in normal circumstances at the instant of discharge of the condenser. The condenser should consequently not be allowed to charge to such a high voltage that the discharge current exceeds the maximum rating.

The "Grid Control Ratio" is similar to the amplification factor of a hard valve. Briefly, if an increase of V volts in anode potential will cause the valve to strike, then a change of grid voltage in a positive direction of V/μ volts will have the same effect where μ is the grid control ratio.

The column headed "Maximum Operating Frequency" refers exclusively to time-base use, and for television purposes it is necessary to use a type suitable for operating at 10,000 c/s or more for the line-scanning circuit. For the frame time-base, however, the operating frequency is only 50 c/s and a greater latitude of choice is permissible.

In the operation of CR tubes it is, of course, necessary to guard against stray fields, especially from mains transformers, since these can cause serious deformation of the raster. To guard against this effect the tube is often enclosed in a metal screen which also serves to protect it against damage. For the same reason it is advisable to cover the screen with a sheet of plate glass. It must be remembered that the external air pressure on a large tube amounts to several tons and it is wise to guard against the danger of implosion.

Type	Heater		Max. Anode Volts (Peak)	Max. Anode Current (mA. Peak)	Grid Control Ratio	Gas Voltage Drop	Gas	Max. Operating Frequency (c/s)	Base	Price
	Volts	Amps								
Cossor. GDT4	4.0	1.5	500	500	25–30	15	Neon	15,000	5 K	50/–
Marconi and Osram.										
GT1	4.0	1.3	1,000	1,000	20–25	12–18	Mercury	—	5 A	40/–
GT1A	4.0	1.3	300	600	20	15	Argon	—	5 A	60/–
Mazda.										
T11	4.0	1.2	700	300	20	15	Mercury	5,000	5 K	35/–
T21	4.0	1.2	200	300	20	17	Argon	15,000	5 K	60/–
T31	4.0	1.5	400	300	20	45	Helium	15,000	5 K	35/–
Mullard. GT4H	4.0	1.3	750	1,000	42.5	42	Helium	10,000	5 L	30/–
Standard Telephones & Cables. 4039A	4.0	1.0	500	200	30–50	10–20	Mercury	10,000	5 A	40/–

On The Short Waves

NOTES FROM A LISTENER'S LOG

TWO B.B.C. engineers, E. J. Alway and C. G. Philips, pointed out in 1934 for the first time that the effect of visible sunspot was apparently greatly to increase the ionisation levels of the F, or Appleton, layer without materially increasing the levels of the E, or Kennelly-Heaviside, layer. This result was deduced from many observations made on short-wave stations transmitting on frequencies ranging from some 30 to 40 Mc/s (10-75 metres) and from information based on the performance of the Empire station at Daventry.

It was not possible at the time, however, to support this contention with definite measurements of E and F layer ionisation levels, but recently it is interesting to record that Prof. Appleton is credited with saying that during this year the ionisation level of the F layer has increased some 300 per cent. above its sunspot minimum value, whereas the percentage increase in the case of the E layer has been very much lower.

By the way, how many readers listened to Prof. Appleton's very interesting talk on "Sunspots and Radio" in the National programme on Sunday, March 21st?

Sunspot activity remained fairly high during the first week of the period under review, that is, from March 11th, declining to a minimum on Monday, March 22nd, only suddenly to jump into activity again on Tuesday, March 23rd, evidently the beginning of a new 27-day cycle.

The sunspots visible during the end of February reappeared again in March, but in a rather attenuated form, most of the activity being in the form of flocculi or the débris of the active spots.

To review conditions, however, we find that U/SW signals were quite good in the evening of Thursday, March 11th, a new police transmitter on 31.6 Mc/s, W2XIJ, being heard at R9+ at about 7.30 p.m. At this time, too, W9XAZ, on 26.4 Mc/s, was exceptionally good, equal, if not superior, to W3XAL and W2XAD at times, although not consistently so.

The quality of W9XAZ is really good, except that speech at times shows the typically boomy quality associated with ribbon (velocity) microphones not operated under ideal conditions.

A little later, at 7.50 p.m., a terrific heterodyne was noticed in the 11 Mc/s band, which was traced to DJO and JZJ both working on 11.80 Mc/s.

At 8 p.m. DJO ceased working point-to-point with New York, and after this JZJ was a very good signal with a programme of native Japanese music; W2XAD was really excellent about this time, too.

Conditions were again good on Friday, but reception was poor on 28 Mc/s.

Although some signals were audible on the ultra-high frequencies on Saturday, March 13th, signals were much poorer later in the evening.

Conditions were similar on Sunday, when the two best 28 Mc/s signals were probably W4FT and W9BRZ; W2XE was also strong on 21.52 Mc/s, but apparently over-modulating.

Fair results were obtained from W3XAL on 17.78 Mc/s at 7.15 p.m., but W2XAD was very good, so also was Lisbon CSW on 11.04 Mc/s.

Conditions were moderately good on Monday, March 15th, and better still on Tuesday.

An interesting signal in the 28 Mc/s amateur band at 8 p.m. on Wednesday was intercepted from a portable transmitter W3BSY working in the 4th District, and conditions in this band, although good at 8 p.m., failed shortly afterwards; W9XAZ was poor by comparison with the amateurs.

Excellent results were once more obtained from W2XAD who is now working on an extended schedule to 11 p.m.

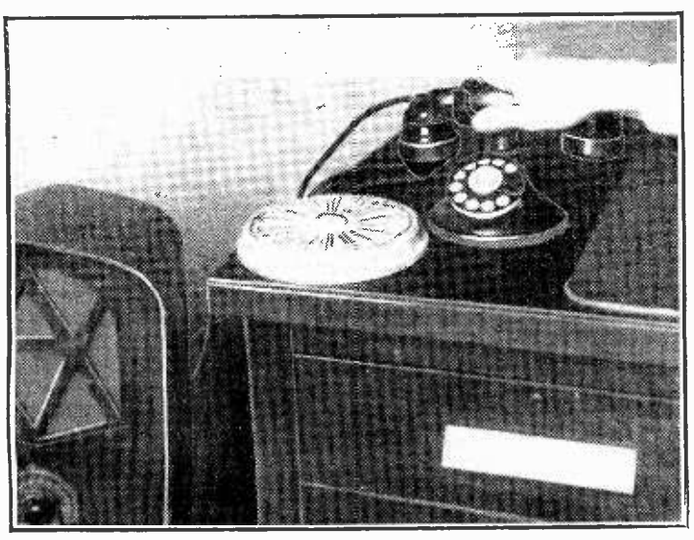
Conditions continued to remain good throughout the period under review, W2XAD being the best signal and generally of local station quality.

An interesting newcomer during the past fortnight was the German "Communist Party's" station on 10.07 Mc/s, which was particularly a strong signal on March 17th at 9.24 p.m.

Variable signals have been experienced from the remaining U.S. stations, though W1XK on 9.57 Mc/s and W8XK on 15.21 Mc/s have been good at times.

During the coming weeks we shall probably see the last of the bursts of 28 Mc/s activity before their return in the autumn, but it will be instructive to see this year whether the greatly increased sunspot activity will outweigh the fall in ionisation of the F layer due to its summertime expansion with the rising temperature.

ETHACOMBER.



SILENCING THE RECEIVER—This device, which serves as a stand for the domestic telephone, is wired to the receiver in such a way that the loud speaker is silenced by removing the instrument; a call can then be made or answered without disturbance.

Fluorescent Screens—DIFFERENT TYPES AND THEIR APPLICATIONS

Contributed by the Cossor Research Laboratory

DURING the past 30 years fluorescent screens have been made for use in connection with X-ray tubes. They are used in X-ray photographic practice for two purposes. The screens are placed between the subject and the photographic plate so that the plate is affected not only by the X-rays themselves but also by the visible luminescence of the screen. When a fluorescent screen is used in this way it is known as an intensifier. The other method of using the screen is to place it between an observer and the subject to render the X-ray shadow of the subject visible to the human eye.

When the cathode-ray oscillograph was brought to a form in which it could conveniently be used for measuring purposes by J. B. Johnson in 1925, the fluorescent screen was of Willemite. Willemite, which is zinc silicate, gives a green luminescence of relatively low efficiency, but it has the property of emitting light under the impact of low-speed electrons (300 to 500 volts). It should be noted, in passing, that the velocity of electrons is proportional to the square root of the accelerating potential.

ALTHOUGH primarily a chemical problem, the subject of fluorescent screens is of extreme interest to electrical engineers not only for television reception but for measurement purposes in connection with most branches of industry. For this reason, engineers, no matter whether they belong to the electrical, mechanical, or civil branches of the profession, cannot afford to ignore the subject.

Johnson's development of the hot-cathode, low-voltage cathode-ray tube led to an increase in the number of uses to which the instrument could be put, and therefore led to a great increase in the number of people who were familiar with its peculiarities. As a result of this, the development of the tube and of fluorescent screen materials proceeded rapidly.

Fluorescent screens consist generally of fine crystals having a diameter of 0.1 mm. or less, which are spread on the large end of the cathode-ray tube and held in position by means of an adhesive. There are now available some 30 different materials and mixtures having various properties and colours.

When electrons strike a fluorescent material some of the electrons forming the atoms of which the material is composed are ejected from the orbits in which they move into other orbits having a higher energy level. When these electrons return to their usual orbits they return to a lower energy level with a resultant loss of energy. The law of the conservation of energy tells us that energy cannot be lost, but that it may be changed from one form to another, and, in the case under discussion, some of the energy lost by the electrons is changed into luminous energy. For this reason, the point of impact of the electrons on the fluorescent screen becomes visible to the eye.

Although the time required to eject an electron from its orbit and for it to return again is extremely short, it is, nevertheless, not zero, and, in certain cases, the time required for the process is of great importance. Furthermore, certain fluorescent materials having complicated atomic or crystal structures behave in a more complicated manner than that already described.

It is also of interest to note that the luminescence rises and decays in an exponential manner, and may therefore be expressed in the form of a time constant. In the case of materials having complicated atomic structures there may be a number of time constants involved, and the luminous energy may not be all of the same colour. Levy and West[1] have discovered that the longer time constant components of the luminescence may be suppressed by the addition of minute quantities of nickel to the fluorescent material. For many purposes the long time-constant components of illumination (known as afterglow) are a distinct disadvantage, since they tend to blur the image obtained. There are, however, certain instances in which the long time-constant component is of great value, e.g., in cases where the rate of travel of the cathode-ray spot is either so fast that the approximately instantaneous response cannot be seen, or so slow that persistence of vision is unable to aid the eye to see the image as a whole. A method of measuring these time constants has already been described, and will not further be discussed in this article.[2]

Fluorescent screens can be made to emit light of practically all colours, some of which are extremely actinic, and are consequently in general use for photography. Other screens give a white light, which is of great value for television reception. The peculiar qualities of several screen materials are discussed later.

The list, which is given below, of fluorescent materials in general use for cathode-ray tube screens will be of interest.

It will be noted that the zinc sulphide and zinc-cadmium sulphide screens are of extreme interest, since the colour may be varied by the processes adopted for their manufacture. Moreover, they are extremely brilliant, and their brilliancy rises rapidly with voltage. (See Fig. 1.) This fact is of particular interest, since some other substances exhibit brilliancy saturation at relatively low voltages, so that they are of very little value for television reception. For certain low-voltage oscillographic work, however, these substances are quite satisfactory.

The Screen Materials

Calcium tungstate screens are very actinic, and are particularly suitable for photographic recording of oscillograms.

Zinc phosphate screens are often used for the examination and photography of high-speed transients, such as atmospherics. The presence of the relatively long afterglow enables the oscillogram of the transient to be photographed after it has ceased.[3]

Screens consisting of zinc sulphide combined with copper have a very important application, that of cardiography[4] (the

[1] "Fluorescent Screens for Cathode-Ray Tubes for Television and Other Purposes," Leonard Levy, M.A., D.Sc., and Donald W. West, Journal I.E.E., Vol. 79, No. 475, July, 1936.

[2] "The Transient Aspect of Wide-band Amplifiers," O. S. Puckle, *The Wireless Engineer*, No. 140, Vol. 12, May, 1935

[3] "Cathode-Ray Photography of Random Electrical Transients," F. W. Chapman, *Nature*, Vol. 131, page 620, April 29th, 1933.

[4] "A New Electrocardiograph Employing the Cathode-Ray Oscillograph as the Recording Mechanism," Proc. Roy. Soc. Medicine 1934, Vol. 27, page 1541.

Materials.	Colour.	Remarks.
Willemite	Green	Afterglow time approx. 1 millisecond.
Calcium Tungstate	Blue	Very actinic. Afterglow time constant less than 5 microseconds.
Cadmium Tungstate... ...	Pale Blue	Rather inefficient due to low luminosity.
Zinc Phosphate	Red	Afterglow (Red) time constant approx. 0.25 second.
Zinc Sulphide with Copper ...	Blue	Afterglow (Green) time constant approx. 30 seconds.
Zinc Sulphide	Various	With or without afterglow. Very brilliant.
Zinc-Cadmium Sulphide ...	Various	With or without afterglow. Very brilliant.

Fluorescent Screens—

examination and recording of heart-beats). Cathode-ray electrocardiographs are being increasingly used by hospitals and doctors. This is an instance where the rate of traverse of the cathode-ray spot is very slow, about an inch a second, and it is only the presence of a very long afterglow component which makes it possible for the observer to examine the complete trace.

Zinc sulphide screens can be made in almost any colour, and the afterglow is controllable. An excellent zinc sulphide screen has been developed which gives a brilliant black and white image for television reception.

It is of interest to note that, although the light obtainable from a television cathode-ray tube is more than sufficient to enable one to read a newspaper, the actual amount of light is only about 5 per cent. of the input energy to the tube.

The photographic recording speeds (expressed at the fluorescent screen) obtainable with various screen materials and with a lens aperture f/1.0 using a high photographic reduction ratio are given in the table below. The figures refer to high vacuum tubes.

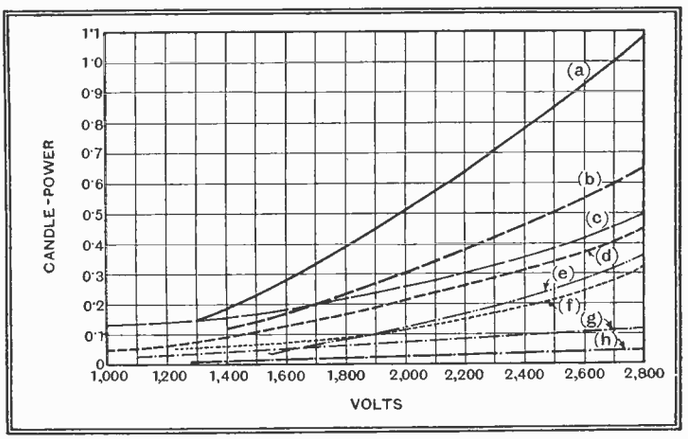


Fig. 1.—Curves showing the variation in brilliancy of the screen with changes in the applied voltage for a constant current of 150 μA. (a) zinc sulphide and zinc-cadmium sulphide; (b) and (c) zinc sulphide; (d) and (e) zinc-cadmium sulphide; (f) Willemite; (g) cadmium tungstate; (h) zinc phosphate.

When different values of photographic reduction and/or aperture are used, the above figures should be divided by the following expression:—

$$N^2\left(1+\frac{1}{M}\right)^2$$

where N = f number

M = linear reduction ratio of object to image.

The theory of operation of fluorescent screens is not yet fully understood, and it is probable that further advances in manufacturing technique will be made as the mechanism concerned becomes more clearly appreciated.

Material.	Emulsion.	Recording Speed.
Calcium Tungstate	Ilford Golden Iso-Zenith, Selo Ortho B or Ilford Oscillograph Paper F.P.1.	10 Km. per second at 3,000 Volts.
" "	" "	40 Km. per second at 6,000 Volts.
Zinc Phosphate ...	Hyper-sensitive Panchromatic.	2.5 Km. per second at 1,500 Volts.

Television Programmes

Transmission times are from 3-4 and 9-10 daily.

Vision	Sound
45 Mc/s.	41.5 Mc/s.

FRIDAY, APRIL 2nd.

3, Stanelli. **3.10,** Fashion Forecast: a dress parade. **3.25,** British Movietonews. **3.35,** Theatre Parade: scenes from a play now running in the West End.
9, Repetition of 3.10 programme. **9.15,** Constable's Centenary: an illustrated talk on Constable and his works. **9.30,** Gaumont-British News. **9.40,** After Supper: a revue of evening entertainments.

SATURDAY, APRIL 3rd.

3, At the Nets: cricket broadcast from the Alexandra Palace Indoor Cricket Club. **3.30,** Gaumont-British News. **3.40,** The Oxford University Opera Players present "Venus and Adonis."
9, Repetition of 3.40 programme. **9.35,** British Movietonews. **9.45,** Cabaret.

MONDAY, APRIL 5th.

3, Demonstration of Ju-Jitsu. **3.15,** Sea stories: Commander A. B. Campbell. **3.25,** Gaumont-British News. **3.40,** Cosmopolitan Café.
9, Repetition of 3 programme. **9.15,** Beatrice Harrison ('cello). **9.25,** British-Movietonews. **9.35,** Cosmopolitan Café.

TUESDAY, APRIL 6th.

3, "The Proposal": a jest in one-act. **3.20,** Filming a Devil Dance; talk by T. A. Glover, an explorer who has "shot" film in almost every part of Africa. **3.45,** Starlight.
9, Cabaret including Frances Day, Irene Prador and Lydia Sokolova. **9.20,** Gaumont-British News. **9.30,** Repetition of 3.20 programme. **9.45,** Music Makers.

WEDNESDAY, APRIL 7th.

3, Light entertainment. **3.20,** Gaumont-British News. **3.30,** Forty-third Picture Page.
9, Forty-fourth Picture Page. **9.30,** British Movietonews. **9.40,** A dress demonstration. **9.50,** Light act.

THURSDAY, APRIL 8th.

3, Musical act. **3.10,** Architecture. **3.25,** British Movietonews. **3.35,** Extracts from "And so to Bed."
9, Repetition of 3 and 3.10 programmes. **9.25,** Gaumont-British News. **9.35,** Repetition of 3.35 programme.

Broadcast Brevities

NEWS FROM PORTLAND PLACE

The New Empire Station

SIR NOEL ASHBRIDGE, Chief Engineer of the B.B.C., is to meet a large gathering of Press representatives at Broadcasting House on April 6th to explain the progress that has been made with the new Empire transmitters at Daventry and to tell of the prospects of getting everything ship-shape in time for the Coronation broadcasts. The sooner these high-power transmitters are in operation the better; not for the Coronation in particular, but for policy reasons in general. The amount of jamming by foreign stations of the Empire programmes is causing some anxiety in the Dominion of Canada, and representations have been made to the Government on the strength of complaints received by the B.B.C. Lady Bridgeman, a B.B.C. Governor, spilt the beans when she admitted the need for counter-propaganda; but the kind of propaganda that the Empire station will feature will be by way of giving Empire listeners more and better entertainment programmes.

TELEVISION ACTIVITY on Coronation procession route. Engineers outside Buckingham Palace laying the co-axial cable between Whitehall and Hyde Park Corner in preparation for probable television transmissions.

Coronation Broadcast Plans

BROADCASTING plans for Coronation Week can now be seen in bold perspective. The first impressive item will be at 8 p.m. on Sunday, May 9th, when the Archbishop of Canterbury conducts a "Service preparatory to the Coronation" in the Concert Hall of Broadcasting House. This will be radiated nationally. "Merrie England," Edward German's light opera, will also be included in the National programme on the same evening. The story of the "King's Anointing" will be told on the Regional wavelengths.

The King's Broadcast

Sir James Barrie's play, "Dear Brutus," will be heard on Monday, and on the Tuesday there will be a gala revue lasting an hour and a half.

On May 12th, in addition to the Coronation broadcast lasting over three hours, there will be a "Round the Empire" programme in the evening culminating at 8 o'clock with a personal broadcast by His Majesty the King.

Dancing Round Britain

Guests at a Grand "Coronation Party," starting at 8.15 p.m., will include Clapham and Dwyer, Elsie and Doris Waters, and The Two Leslies, and the fun will go on till 9.30. To wind up the day and begin the next there will be a dance band tour round Britain lasting until 1 a.m.

Return of A. J. Alan

Coronation music through the centuries will be heard in a special concert by the B.B.C. Orchestra, Chorus and Singers, conducted by Sir Adrian Boult, on May 13th. The one and only A. J. Alan will come out of his shell at 9 p.m. on May 14th to give Regional listeners a Coronation story, Nationals will get it at 10.30 p.m. on May 15th.

Expensive Dance Music

IT is estimated that after having paid increased fees for broadcasts by outside dance bands running annually into five figures, which was the result of the recent negotiations between the Dance Band Leaders' Association and the B.B.C., the Corporation will still save some £15,000 a year through dispensing with a dance orchestra of its own. This gives an idea of the enormous cost involved in keeping a combination like the B.B.C. Dance Orchestra going. It is an open question whether the smaller combination which Henry Hall was given when he went to Broadcasting House five years ago should not have sufficed permanently for studio purposes, thus avoiding any question of having to save on the swings what must compulsorily be paid out on the roundabouts.

Filling the Gap

How will the B.B.C. spend this £15,000? Definitely, it would appear, on dance band broadcasts, without diverting any portion of it to other programme interests. We may expect to have more studio performances by leading dance band organisations, such as those of Jack Hylton, Ambrose, Billy Cotton, Van Phillips, and Jack Payne. It should be a matter for self-congratulation by Henry Hall that it is likely thus to take a host of contemporaries to fill the gap which he will leave.

Pamphleteers' Dilemma

THE twin dangers facing people who prepare booklets about broadcast talks are (a) that the booklets may be uninformative and likely to repel rather than attract listeners, and (b) that they may be so informative and attractive as to make it unnecessary to listen to the talks.

By skill or chance, or a mixture of both, the new Summer Talks booklet steers between Scylla and Charybdis, with room to spare.

What Do They Want?

A sad note is struck in a foreword written by Sir Richard Maconachie, the new Director of Talks: "I shot an arrow into the air, It fell to earth I know not where," quotes Sir Richard, in explaining how difficult it is to gauge the needs of the unseen and generally unresponsive audience. But he hopes that the measures now being taken by the Corporation to ascertain the needs and desires of the unknown millions may give him and his assistants the data which may help them to correct their range and aim. May such magnificent hopes not be confounded.

The Broadcast Talks pamphlet can be obtained free from the B.B.C. Publishing Dept., 35, High Street, Marylebone, London, W.1.

Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

Reception on 28 Mc/s

I FOUND the article by R. A. Watson Watt, "Wireless and the Atmosphere—a new chapter," very interesting. For some time I have been observing frequencies higher than 25 Mc/s, particularly the 28 and 56 Mc/s amateur bands, and possibly the newly discovered low level layers will explain the rather puzzling effects observed on 28 Mc/s. I refer to the reception of signals over distances of between 50 and 500 miles. Signals from amateur stations at these distances are heard with surprising regularity and very little fading. The chief points distinguishing this type of signal (a) from those received in the summer over similar distances by high angle refraction (b) are these:

(a) Exceptionally reliable, very little fading, low values of signal strength, audible throughout day until two or three hours after dark in winter and summer? (see note later), apparently not affected to any great extent by general conditions for longer distances.

(b) Spasmodic, considerable fading, temporary high values of signal strength, audible at irregular times, mostly during daylight in summer months, considerably affected by general conditions.

The type (a) signals have been so reliable that we have come to term them "elongated ground waves"! There is some doubt as to whether they are receivable in summer, due

to the lack of amateur activity at this time of year, but it is hoped to obtain further information on this question during the coming summer. At present signals are heard daily from most parts of England and the nearer continental countries up to 500 miles, approximately.

Some time ago, before we heard of these new low level layers I put forward the suggestion that the type (a) signals were heard only after they had been completely round the world, for the following reasons: Code signals from stations situated between 25 and 100 miles distant on certain days are heard with echoes which are so strong as to make their ground waves unreadable, as the echoes are practically as strong and of about $\frac{1}{8}$-$\frac{1}{6}$ second delay. It has been noted that signals from 100-500 miles distant have been particularly good when conditions have been good for Japan and New Zealand, and at the same time the nearer stations have echoes (i.e., 25-100 miles). The former signals are seldom heard with echoes. It is obvious, therefore, if the ground wave were not audible we should be able to read the echo! For a signal to go completely round the world it is, presumably, necessary that the ionisation over the route be fairly uniform and not too intense, so that the signal is not refracted back to earth, but gradually bent round the earth's periphery. This condition is fulfilled in the mornings in the Northern Hemisphere during autumn, winter and spring if the signal follows a route north-east from, say, England. If we trace a great circle in this direction it will be seen that the signal will pass over Northern Europe, Russia and Siberia during the period of maximum daylight, but here the ionisation will be low. Continuing the great circle we come to Japan and New Zealand, where it is evening, and although nearer the equator the ionisation will not be too great since the sun's effect is removed. Next we come to the Southern Pacific and South America, where it will be midnight (but during the summer there), and this will be the region of lowest ionisation, but even here it appears to be sufficient to bend the signal, since signals have been heard from South America in the early mornings here. Thus the signal would return to England!

There is still, I think, reason to suspect that some of the signals are "round the world" type, but it certainly appears that the new low layers will explain the reception of the majority of them. As a contrast to the above discussed 28 Mc/s signals transmissions on 56 Mc/s are not heard over distances far in excess of the optical range (except by high-angle refraction and spasmodically during summer months, also very occasionally over long distances at other times of year, i.e., over 1,000 miles).

D. W. HEIGHTMAN.

Gt. Clacton, Essex.

"Flutter"

AS one who has spent some time investigating this subject, I was interested in your correspondent's letter on this subject in your issue of February 26th.

While the writer seems to have discovered most of the remedies, I cannot agree that his explanation of the trouble is the correct one, since this trouble does occur in receivers employing single AVC or no AVC at all.

In my opinion, it is due to the use of heptode and similar frequency changers, probably caused by internal capacity change of the valve with varying anode voltages.

The remedy is to employ a frequency changer which has an entirely separate oscillator section, an additional advantage, of course, being the reduction of wander due to the same cause.

I append a copy of part of my report on the subject which may interest other readers faced with the problem.

G. H. BRADBURY, Chief Engineer,
Ewell, Surrey. Fourwave, Limited.

"FLUTTER" AND "WANDER" IN SHORT-WAVE RECEIVERS.

"Flutter" occurs on all models employing a single output valve and consists of a periodic variation of signal strength at frequencies above approximately 9 Mc/s. The defect becomes more acute as the signal strength is increased or the volume control turned up, until a stage is reached when the signal alternately ceases and recommences about five times per second.

"Wander" refers to the variation from the original tuning position of stations working on frequencies above 9 Mc/s (approx.) occurring on all models but to a greater extent on receivers with single pentode output stages.

It has been found that a peculiarity of the heptode is the variation of oscillation frequency with changing anode volts; i.e. at 17.8 Mc s an anode voltage variation of 15 per cent. causes complete detuning of the signal so that it is inaudible till retuned. The same anode voltage change at 15.3 Mc/s so detunes the signal as to make it unintelligible.

It is clear, therefore, that any change in the total anode supply due to changing signal strength or loading of the output valve *must* affect the oscillating frequency of the heptode and it is this peculiarity therefore which causes the above-mentioned defects.

A brief description of the cycle of operations will make this clear. A signal of good strength will so swing the grid of the output valve as to cause a large current variation in this valve, and consequently a momentary change of anode voltage. When this occurs the heptode ceases to oscillate at the correct frequency and the signal stops. When the signal ceases the original anode voltage is restored and the heptode then oscillates once more at its correct frequency, again swinging the output valve grid and repeating the trouble, thus producing the "flutter."

"Wander" is caused by the fading of the signal itself, causing, by means of the AVC, increasing demands on the anode supply and therefore a reduction in the voltage. Automatic volume control at the higher frequencies therefore defeats its own object, often causing a complete cessation of the signal which might still be at good strength.

Undoubtedly the best cure is to replace the heptode with a valve not subject to the trouble, and by employing a triode-pentode the trouble has been overcome. A receiver employing a triode-pentode as oscillator does not detune at all even when the voltage is varied as much as 35 per cent.: and flutter and wander do not occur at any frequency or volume.

When a heptode frequency-changer is employed, the following remedies will be effective

1. If a push-pull output stage is used the anode voltage is maintained constant at loud volume, since an increased anode current in one valve is compensated by a corresponding reduction in the other; hence the absence of flutter in push-pull models. The use of two output valves biased from the negative HT supply also reduces the wander since they automatically take less current as the demand by the RF valves increases.

If the current variation in the field coil at the bias tap is 4.4 milliamps per volts (equal to the slope of the two output valves), the HT voltage will remain constant whatever the signal strength, but it would be difficult to obtain this condition in practice.

2. The use of a very large capacity condenser (75 mfds.) to the oscillator anode resistance, in conjunction with an additional 5,000-ohm resistor, will maintain the voltage constant during the brief anode current variations in the output valves, provided these variations are not large (i.e. at about $\frac{3}{4}$ volume at 17.8 Mc/s).

Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

INTERVALVE COUPLINGS

AN intervalve coupling, suitable for passing a wide range of frequencies as in television, consists of two high-frequency chokes coupled together as tightly as possible. The natural frequencies of both windings are equal, and both are less than the unmodulated carrier frequency, whilst the inherent shunt capacity between the windings is made as small as possible. Damping resistances, of sufficient value to render the circuits non-oscillatory, are shunted across both primary and secondary windings.

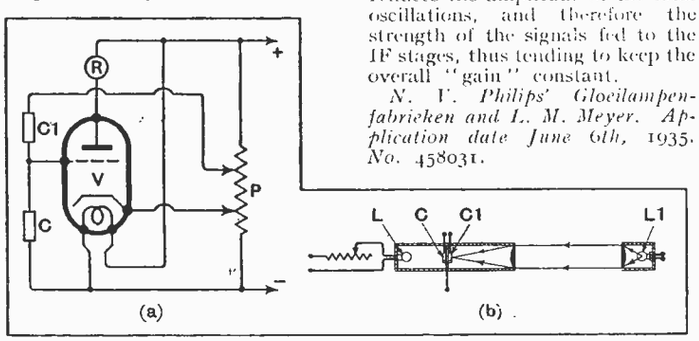
Radio Akt. D. S. Loewe. Convention date (Germany) June 5th, 1934. No. 457773.

o o o o

LIGHT RELAYS

TWO photo-electric cells are arranged, in conjunction with the same amplifier, so that "fatigue" effects are counterbalanced. As shown at (a) in the figure, one cell, C, is connected between the grid of the valve V and the negative end of the supply potentiometer P, whilst the second cell C1 is arranged between the same grid and a positive tapping on the potentiometer.

The two cells are mounted in a casing as shown at (b), so that each is subjected to the light from lamps L, L1, at opposite ends. The lamps are adjusted until the positive current through one cell balances the negative current through the other, on the grid of the amplifier V, so that the output from the latter remains constant. The combination will then respond to any additional source of illumination without showing any "fatigue." The resulting current from the amplifier is used to operate a relay, R.



Arrangement of photo-cells to balance out "fatigue" effect.

S. Vasilach. Convention date (France) June 6th, 1934. No. 458032.

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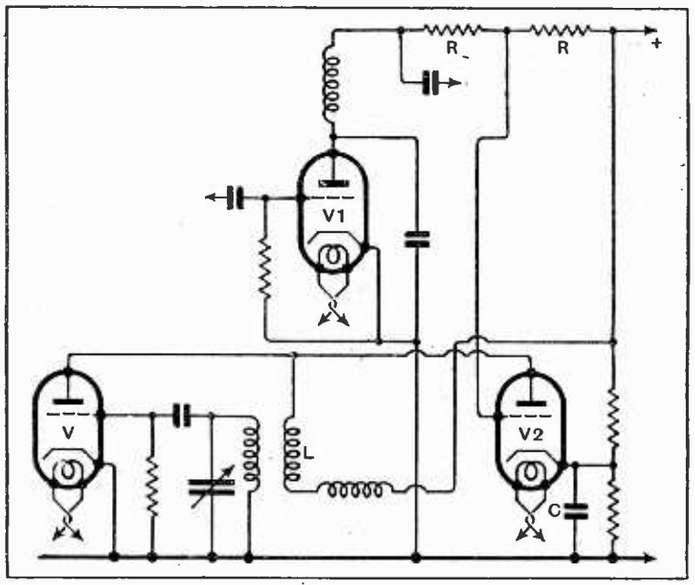
AVC SYSTEMS

THE "gain" of a wireless receiver is automatically controlled by regulating the effective amount of back-coupling in the circuit.

As shown the valve V is the local oscillator of a superhet set, whilst V1 is the second detector, and V2 the AVC valve. It will be seen that the valve V2, in series with a condenser C, is shunted across the anode coil of the local oscillator. The grid of V2 is biased through a tapping from a resistance R in the plate circuit of the detector V1.

For signals of normal strength the grid-bias is sufficient to render the valve V2 non-conducting, so that it is out of operation. As signal strength increases, however, the voltage from R throws the grid of V2 more positive, and so allows some of the output from the local oscillator V to be diverted throughout the condenser C. This reduces the amplitude of the local oscillations, and therefore the strength of the signals fed to the IF stages, thus tending to keep the overall "gain" constant.

N. V. Philips' Gloeilampenfabrieken and L. M. Meyer. Application date June 6th, 1935. No. 458031.



Method of obtaining constant amplification in a superhet receiver.

NAVIGATION BY RADIO

A KNOWN method of guiding an aeroplane in flight is to use a course marked out by the "overlap" between two directed beams of radiated waves. Each beam is differently modulated, so that in the overlapping section the two modulating notes combine to give a third characteristic signal, which is heard by the aviator so long as he follows the correct path.

According to the invention this system is elaborated in order to give a clearer indication of the required route. Instead of two beams, two pairs of beams are used. The first pair are transmitted on the same wavelength, though both are differently modulated. The area of overlap is made as narrow as possible, and is distinguished by a third signal produced by the merging of the two modulation notes.

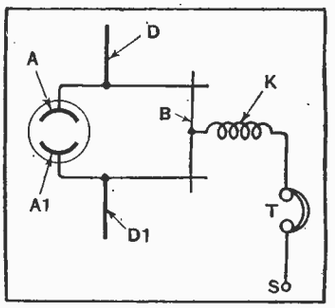
The second pair of beams is similarly arranged, except that both beams are transmitted on a different wavelength from the first. They, too, are differently modulated, and the characteristic signal formed in the overlapping area by the merging of the two notes is distinct from that produced along the overlapping part of the first pair of beams. Finally, the two pairs of beams are radiated at a close angle to each other, so that the two overlapping areas together enclose a narrow sector or navigation "course," the boundaries of which are more clearly marked out than in the system first described.

Telefunken Ges. fur drahtlose Telegraphie mbh. Convention date (Germany) August 3rd, 1935. No. 457176.

o o o o

SHORT-WAVE VALVES

A SPLIT-ANODE valve of the magnetron type is designed to have dimensions definitely related to the working wavelength. For instance, the diameter of the cylindrical anode, measured in millimetres, is greater than twice the received signal wave measured in metres, and is preferably twenty times as much, and the length of the cylinder is not greater than the diameter.



Valve and circuit designed for micro-wave reception.

As shown the signals are received on the two halves of a dipole aerial D, D1 which is connected to a Lecher-wire circuit bridged across the split anodes A, A1. The circuit is tuned by a sliding bridge B to which high tension is applied through a choke K from the source S. The telephones are inserted at T. The Lecher-wire circuit may be tuned to an harmonic of the signal frequency, in order to give super-regenerative or superheterodyne reception, the valve being brought to the point of self-oscillation by adjusting the filament heat.

C. Lorenz Akt. Convention dates (Germany) February 25th; April 10th; and August 16th, 1935. No. 457721.

o o o o

AUTOMATIC TUNING CONTROL

PROVISION is made for automatically correcting for any slow frequency changes, either of the incoming carrier wave, or of the local oscillations, in a highly selective type of superhet receiver. Frequency "drift," particularly of the local oscillator, may be caused by changes in temperature, and would in the ordinary way necessitate retuning of the circuits from time to time.

According to the invention, the output from the final high-frequency stage is fed to a balanced detector through two parallel paths, one of which is highly selective, while the other is more broadly tuned. The latter includes a phase-adjusting network, so that the two branches of the output reach the balanced detector in phase-opposition. The detector "bridge" remains balanced only so long as the circuits are accurately in tune. Any departure from this condition, due to frequency drift, unbalances the bridge and so varies the impedance of a control valve. This, in turn, develops a voltage which is applied to the screen grid of a pentode valve, used as the local oscillator, and varies its frequency in the sense necessary to restore the correct tuning of the receiver.

Kolster-Brandes, Ltd., and C. W. Earp. Application date, May 30th, 1935. No. 457485.

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CONTENTS

EDITORIAL COMMENT

Interference Measures

Confidence in the P.M.G.'s Attitude

AS we go to press we learn that the Postmaster-General will be asked in the House on Thursday, April 8th, what are his intentions with regard to the introduction of legislation to control electrical interference with broadcasting.

The Postmaster-General's reply will, no doubt, be generally known before this issue appears, but it is fairly safe to predict what this reply will be.

Ever since *The Wireless World* launched the campaign for legislation to control such interference, as far back as 1931, steady, though rather slow, progress has been made towards the goal we then had in view. The Institution of Electrical Engineers appointed a Committee to investigate the question following a direct incitement to do so contained in our issue of November 25th, 1932.

Legislation Recommended

The Institution Committee, after vacillating for some time on the issue whether or not legislation to control interference should be introduced or the matter left to peaceful persuasion, finally came down firmly on the right side of the fence in their report and recommendations, when they stated that "it became evident from the discussions of the Committee that the majority of members did not consider that effective interference suppression would result if the improvement of the position were to be left solely to voluntary effort."

Finally, the Committee recommended that the Electricity Commissioners should be given the necessary powers to enforce suppression.

It is known that the Postmaster-General has been prepared to support legislation, but has desired first to know that this would have the blessing of the various interests concerned. This assurance was given in the Committee's report, since the Committee was representative of all interests.

As we write, therefore, we feel confident that the Postmaster-General will express himself ready to introduce legislation and our hope is that this will be carried through with all speed in the interests of every listener.

Television

A New Era

HITHERTO the production of television programmes has been seriously hampered by reason of the fact that it has not been possible to televise subjects at distances of more than a few yards from the transmitter, except through the rather unsatisfactory medium of film.

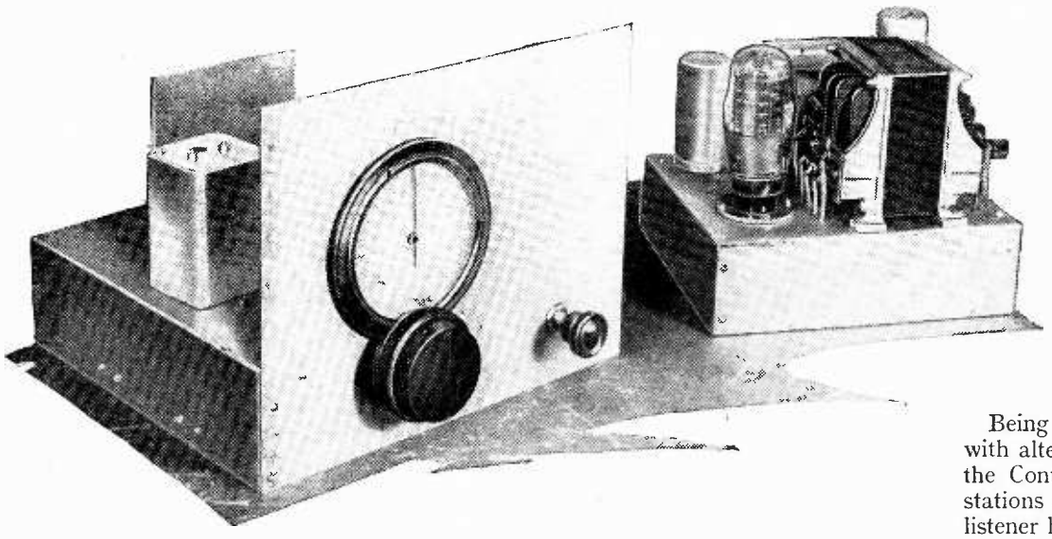
Now comes the news that technical arrangements are expected to be completed by the date of the Coronation to enable a television transmission of the procession to be carried out.

It seems likely, too, that the B.B.C. will have a choice of either using a new coaxal cable link to the transmitter or an ultra-short wave wireless link with a transmitter operating on the spot and feeding the main transmitter at Alexandra Palace.

The Coronation has provided the impetus to get these arrangements through in a short time, and once direct television of outside subjects has been made possible, the potentialities of television as a public entertainment will have increased enormously. Provided the cost can be met, the programmes will acquire an entirely new value, and a very great step forward will have been taken.

AC Short-Wave Co

A THREE-RANG MODEL WITH WAVEBAND SWITCHING COVERING 12.5 TO 62.5 METRE



DURING the past year or so many improvements have been effected in the technique of short-wave transmitter design, added to which there is a general tendency in all countries to increase the power of short-wave broadcast stations. Thus, it is becoming not only easier to tune in the more powerful of these stations, but the fact that they are now so well received has stimulated interest in this band where only a lukewarm curiosity existed hitherto.

The success that has attended the various rebroadcasts from the U.S. and from the British Empire in recent times provides convincing proof that distance is no obstacle to the short waves. Indeed, it is only by the use of these very high frequencies that great distances can be covered by transmitters of reasonable size and power.

Short Waves Popular

One outcome of the interest now to be found in the short-wave region is the introduction by most radio set manufacturers of an all-wave model. The inclusion of a short-wave band in a broadcast receiver was regarded as a novelty only a few years ago, and this feature was found only in the more expensive sets, and in specialised receivers designed for overseas and colonial use.

Being so well provided in these islands with alternative programmes—for most of the Continental medium- and long-wave stations are receivable in this country—the listener has not been forced to look to distant countries for broadcast entertainment, but those living in some of the more remote parts of the Empire have no choice, and the short waves are the only medium for news and for keeping in touch with every-day affairs of the world.

As matters stand at present it seems evident that the short-wave bands are going to come very much to the fore shortly, as there appears to be keen competition among nations to make themselves heard the world over, or at least one deduces as much from the giant power stations now in course of construction or contemplated in the near future.

Thus a receiver that has facilities for short-wave reception is going to provide a lot of fun within a short time. This does

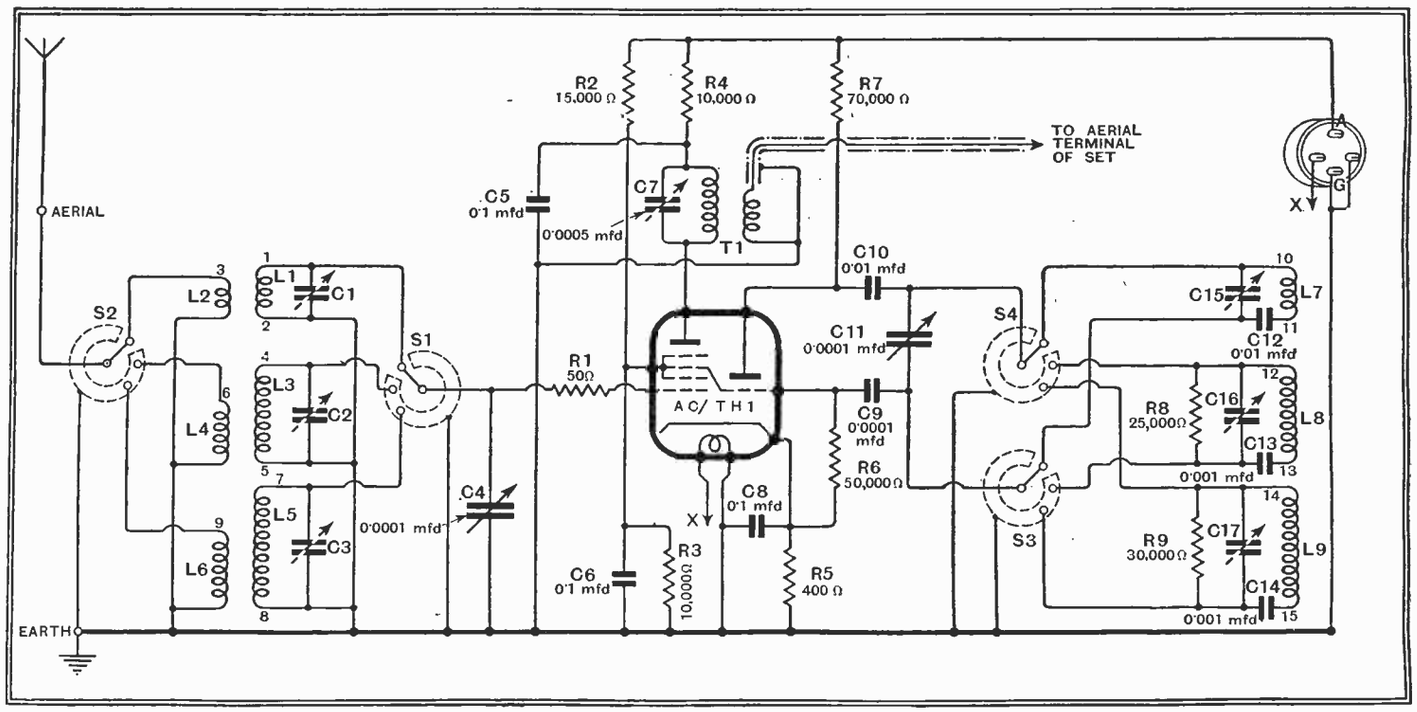


Fig. 1.—Theoretical circuit diagram of the three-range short-wave converter.

verter

By H. B. DENT

not infer that interest is lacking on the short waves at present; on the contrary, it is the only band that enables us in this country to tune in broadcast stations outside the confines of Europe. Those who have not yet explored this region will find plenty of interest there.

Some may regard broadcast matter as the principal fare to be derived from the short waves, but it is not by any means the only interest, for this depends on the individual's outlook. If he be of the experimenter class, for want of a better expression for those who take a keen interest in short-wave working, broadcast will not be the main interest, though its reception will find a place in the scheme of things as a guide to the conditions obtaining in various parts of the band. On the other hand, amateur signals may provide the main interest.

Having decided to explore the short waves, the next point to consider is the receiver. If a good broadcast set is available, then the addition of a converter unit will offer a ready and quite satisfactory solution. The one described here is fundamentally the simplest that can be expected to give satisfaction with conditions as they are at present on the short waves, and, as will be seen from Fig. 1, it consists of a triode-hexode frequency-changer with a tuned signal circuit.

It provides three wave ranges and covers a band of 12.5 to 62.5 metres. This does not seem very wide at first sight, but actually it is fourteen times wider in kc/s than both the medium and the long broadcast bands put together, despite the fact that tuning condensers of 100 mmfds only are used. Oscillator and signal circuit condensers are ganged. A wider coverage even in three ranges would render tuning too critical for comfortable handling even with a good slow-motion drive.

The precaution is taken to short-circuit all the coils not actually in use so as to prevent the idle coils resonating with the stray capacities and forming absorption circuits and thus reducing the efficiency. This is effected by employing a switch fitted with a centre metal plate that short-circuits the idle coils and having three "live" contacts and an additional one that is always in contact with the metal plate. This contact is joined to the earth line.

Colpitts Oscillator

Risk of shorting the HT in the oscillator section (for it will be seen that a modified Colpitts circuit is used) is avoided by shunt-feeding the oscillator anode through a 70,000-ohm resistance R7 and using a blocking condenser C10. Each of the six coils has a parallel padding condenser, and these are in banks of three, one bank being contained in each compartment of the coil box.

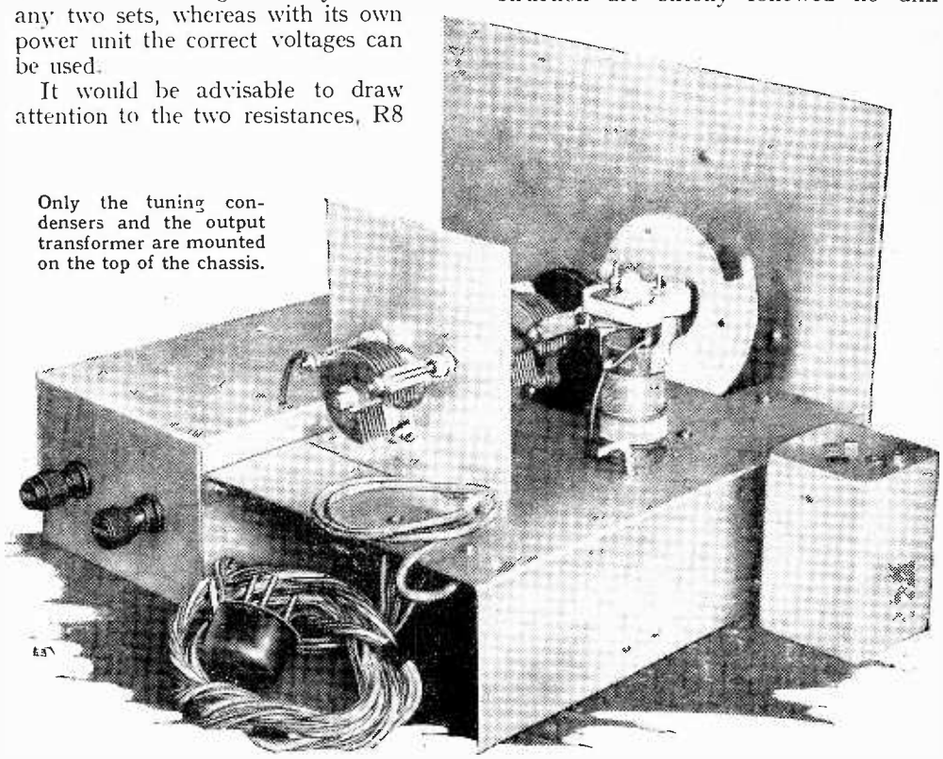
Attention is drawn to the 50-ohm resistance R1 close to the signal circuit grid of the frequency-changer. It is included as an anti-parasitic resistance, as a tendency was noticed for parasitic oscillations to appear at the lower part of range 1.

The anode or output circuit of the frequency-changer is tuned to the intermediate frequency, which in this case is 550 kc/s, approximately 550 metres. A special transformer is used with a step-down ratio of about 1 to 3, and its secondary is joined by a screened lead to the aerial terminal of the broadcast set.

The set to use with this converter can be either a superheterodyne or a straight set, but in the case of the last mentioned it is necessary that it include at least one RF stage. This proviso does not apply to superheterodyne receivers.

In order to render the converter independent so that it does not rely on the broadcast set for its operating voltages a separate power pack is provided. Taking HT and LT from the main receiver gives no control over the operation conditions of the short-wave frequency-changer, since the available voltage is rarely the same in any two sets, whereas with its own power unit the correct voltages can be used.

It would be advisable to draw attention to the two resistances, R8 and R9, shunted across the oscillator coils L8 and L9 respectively. These are the coils for ranges two and three respectively, and their purpose is to equalise the oscillator output on all three ranges.



Only the tuning condensers and the output transformer are mounted on the top of the chassis.

A feature of interest in regard to the converter is that the coils and switching are contained in a separate screening box, but the coil units form an integral part of the chassis, though it can be removed by disconnecting the external wires without disturbing any other part of the converter.

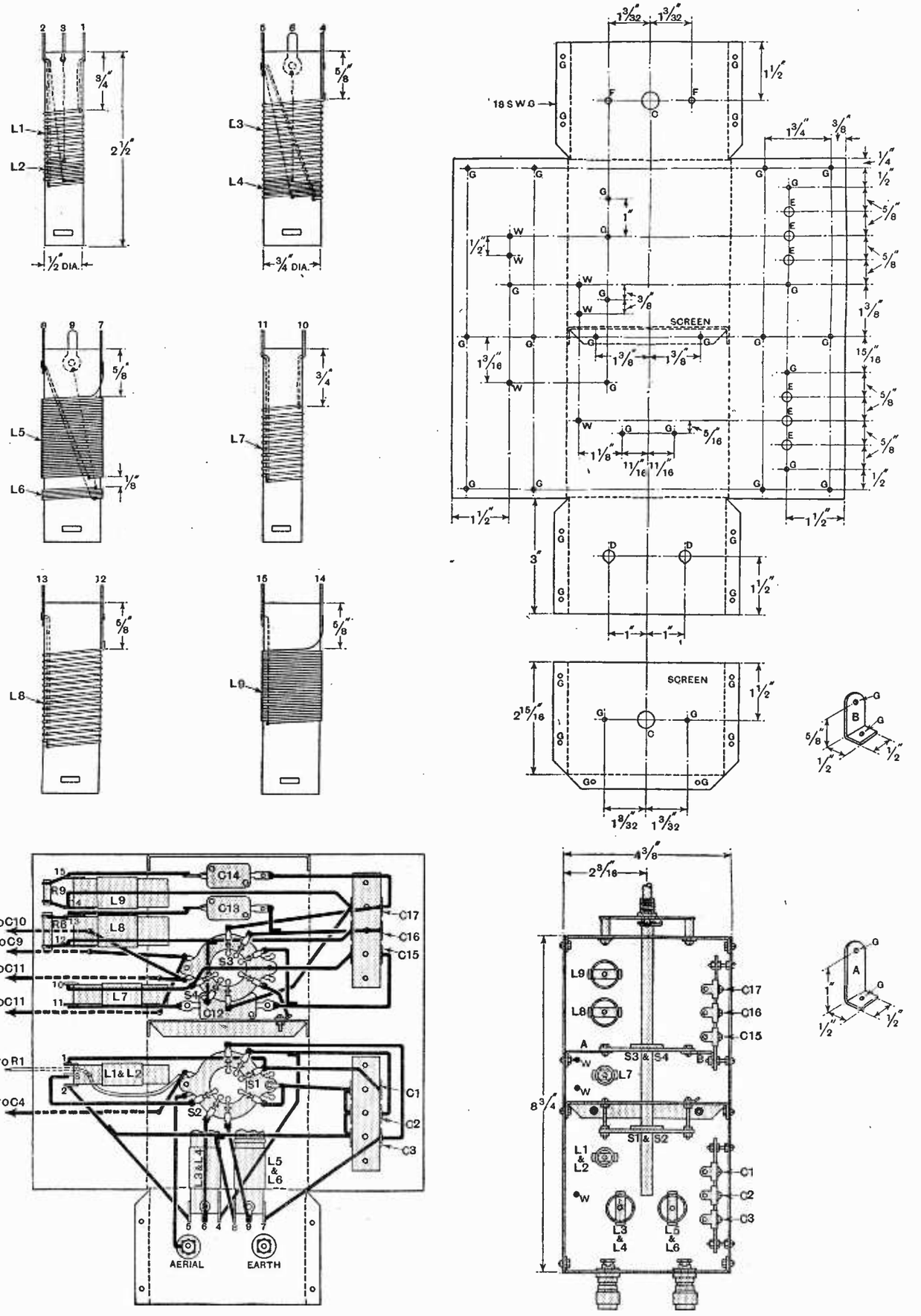
The reason for adopting this form of construction is that it enables the complete coil unit to be constructed apart from the set, and if desired it could be purchased as a complete unit, wired and tested and ready for assembling in the converter. The British Television Supplies, Ltd., have intimated that they are prepared to supply the coil unit as designed, though full constructional details are given for the benefit of those readers who would prefer to make it.

Simplifying Adjustment

It has been found possible to reduce the number of adjustments needed in the initial test stage by dispensing with variable series tracking condensers in the oscillator circuits and fitting fixed condensers. C12 of 0.01 mfd. for range 1 can be a standard type with a tolerance of ± 15 per cent., but for C13 and C14, each of 0.001 mfd., condensers with tolerances not exceeding ±5 per cent. must be used. Only the parallel padders in the oscillator and signal circuits, and there is one for each coil, will require adjusting, but this will not be found at all difficult, since the values chosen are such that if the layout and coil construction are strictly followed no difficulty will be encountered in the initial adjusting of the circuits. However, this matter will be discussed in detail later in the operating notes.

The drawing of the coil unit, together with the winding data contained in the table, provide all the essentials details for building this part of the converter, and as they are self-explanatory a written description seems hardly necessary.

There is, however, one useful piece of advice that can be passed on, and this relates to the construction of the coil box. Originally this was cut from one piece of aluminium, with the sides and ends bent



Dimensional drawing of the coil box, with the layout of the components and the wiring details. Sizes of the holes are as follows :— C= $\frac{7}{16}$ in. dia. ; D= $\frac{5}{16}$ in. dia. ; E= $\frac{1}{4}$ in. dia. ; F= $\frac{5}{32}$ in. dia. ; G= $\frac{1}{8}$ in. dia., and W are the holes to pass connecting wires. Constructional details of the coils are also included.

AC Short-Wave Converter—

up and the edges turned over for bolting together.

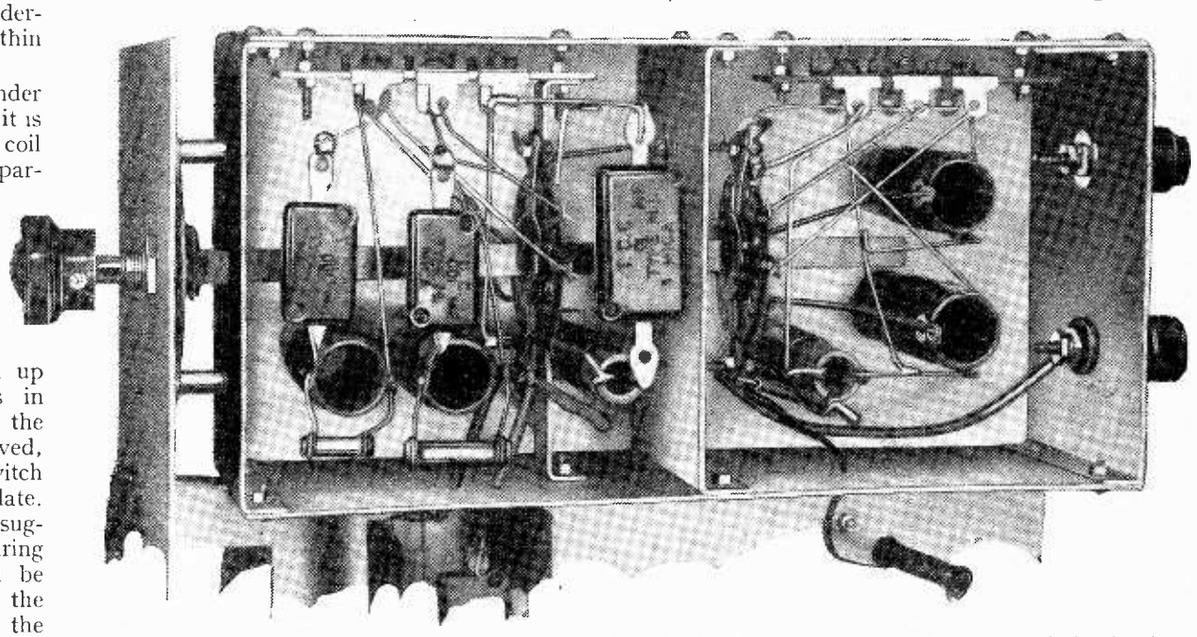
Though ample space was provided in each compartment it subsequently transpired that some of the connections, especially those at the bottom of the switches, were a little awkward to reach unless one had a soldering iron with a long thin bit.

In order to render them more accessible it is suggested that the coil box be made with separate end pieces and only the bottom and the sides be made in one piece.

The switches can then be assembled and lined up with the end-pieces in place, after which the latter can be removed, together with the switch rod and the locator plate.

By adopting this suggestion the interior wiring of the coil box will be much simplified, as the lower contacts of the switches become accessible from each end even though a soldering iron with a large and broad bit be used.

In the concluding part of the article the assembly of the converter and power pack will be described.



The coils and switching are contained in a separate unit which is bolted to, but actually forms part of, the chassis.

LIST OF PARTS.

Certain components of other makes but of similar characteristics may be used as alternatives to those given in the following list.

2 Variable condensers, 100 mmfds. **Eddystone 900 C4, C11**
2 Flexible couplers **Eddystone 1009**
1 Condenser drive, two-ratio **Eddystone 1070**
2 Stand-off insulators **Eddystone 1019**
1 Valve holder, 7-pin, without terminals **Clix Chassis Mounting S.W. Type V5**
1 Group board, 5-way **Bulgin C31**
Condensers:
3 0.1 mfd., tubular **T.C.C. 250 C5, C6, C8**
2 0.01 mfd., mica **T.C.C. "M" C10, C12**
1 0.0001 mfd. mica **T.C.C. "M" C9**
2 0.001 mfd., mica, tolerance ± 5 per cent. **T.C.C. "M" C13, C14**
Resistances:
1 50 ohms, ½ watt **Erie R1**
1 25,000 ohms, ½ watt **Claude Lyons R8**
1 30,000 ohms, ½ watt **Claude Lyons R9**
1 50,000 ohms, ½ watt **Claude Lyons R6**
1 400 ohms, 1 watt **Claude Lyons R5**
1 10,000 ohms, 1 watt **Claude Lyons R4**
1 70,000 ohms, 1 watt **Claude Lyons R7**
1 10,000 ohms, 2 watts **Claude Lyons R3**
1 15,000 ohms, 3 watts **Claude Lyons R2**
1 Trimming condenser, single type, 500 mmfds. max. **Hunts 3276TD C7**
1 Connector, four-way **Bryce Light Pattern**
1 Plug-top valve connector **Belling-Lee 1175**
2 Switches, 2-pole 3-way with earthing plate and tag **B.T.S.-B123FET S1/S2, S3/S4**
1 Switch rod and locator, 7in. long **B.T.S.**
2 Multiple strip condensers, 3-way, 30 mmfds. **Bulgin SW101 C1, C2, C3, C15, C16, C17**
2 Coil formers, ½in. dia. × 2½in. long, threaded 12 tpi. **B.T.S.**
2 Coil formers, ¾in. dia. × 2½in. long, threaded 14 tpi **B.T.S.**
2 Coil formers, ¾in. dia. × 2½in. long, plain **B.T.S.**
1 Coil former, 1in. dia. × 2in. long, plain **B.T.S.**
2 Terminals, ebonite shrouded **Belling-Lee "B"**
1 Aluminium coil screen, 2 × 2 × 3in. **Goltone R9/328**
1 Battery cable, 4-way **Bulgin BC2**
1 Plug, 4-pin **Bulgin P9**
1 Length screened sleeving, 2 mm. **Goltone R39/281**
Miscellaneous: **Peto-Scott**
3 lengths systoflex; small quantity Nos. 18 and 20 enamel wire, Nos. 20 and 34 D.S.C. wire, Nos. 16 and 18 tinned copper wire, Aluminium for coil unit, chassis, partitions, valve bracket, condenser support and panel. Small ebonite bracket for condenser, 6BA studding, etc. Screws: 24 ¼in. No. 6 R/hd., 12 ½in. No. 6 R/hd., 8 1in. No. 6 R/hd., all with nuts and washers; 2 6BA with 8 nuts and washers.
Valve: 1 AC/TH1 **Mazda**

POWER PACK.

1 Mains transformer: 250-0-250 volts, 60 mA., 4 volts, 2.5 amps., centre tapped, 4 volts, 2/3 amps. **All Power PT/AP**
1 Smoothing Choke, 50 henries, 25 mA **Bulgin LF17S**
1 Condenser, dry electrolytic, 8 mfds., 500 volts peak **Polar-N.S.F. C18**
1 Condenser, dry electrolytic, 4 mfds., 500 volts peak **Polar-N.S.F. C19**
2 Valve holders, 5-pin, chassis type **Bulgin VH13**
Miscellaneous: **Peto-Scott**
3 lengths systoflex; small quantity Nos. 16 and 20 tinned copper wire, aluminium for chassis, etc. Screws: 22 ¼in. No. 6 R/hd., 6 ½in. No. 4 R/hd., all with nuts and washers.
Valve: 1 UU4 **Mazda**

COIL WINDING DATA.

Coil No.	Description.	Former dia.	Turns.	Wire.	Winding.
L1	Range 1 signal circuit ...	½ in.	11½	No. 18 SWG EN	Turns spaced 12 tpi.
L2	Aerial coil ...	—	3	No. 34 SWG DSC	Interwound with L1 on earth end of former.
L3	Range 2 signal circuit ...	¾ in.	16	No. 20 SWG EN	Turns spaced 14 tpi.
L4	Aerial coil ...	—	3	No. 34 SWG DSC	Interwound with L3 on earth end of former.
L5	Range 3 signal circuit ...	¾ in.	28	No. 20 SWG DSC	Turns close wound.
L6	Aerial coil ...	—	6	No. 34 SWG DSC	Turns close wound on earth end of former; spaced ⅛ in. from L5.
L7	Range 1 oscillator circuit...	½ in.	11½	No. 18 SWG EN	Turns spaced 12 tpi.
L8	Range 2 oscillator circuit...	¾ in.	15½	No. 20 SWG EN	Turns spaced 14 tpi.
L9	Range 3 oscillator circuit...	¾ in.	25½	No. 20 SWG DSC	Turns close wound.

The coil formers can be Paxolin or bakelised tubes of diameters stated with walls $\frac{1}{16}$ in. thick, and each is 2½ ins. long. Slots are cut in the sides at the earth end of each coil as shown in the drawings and small pieces of ¼ in. wide strip brass $\frac{1}{16}$ in. thick are inserted. These are drilled and tapped 6 BA to take the fixing screws.

Unconsidered Trifles

UNEXPLORED BY-WAYS ON THE SHORT WAVEBANDS

By

J. GODCHAUX ABRAHAMS

IN view of the daily increasing number of short-wave broadcasts which the listener may now pick up from distant stations overseas, I am of opinion that we are rather too prone to neglect the transmissions which can be more easily received daily from points nearer home, namely, the European continent. Much less frequent mention is made of these signals, yet they are those which the purchaser of a so-called "all-wave" or three- or four-band receiver is more likely to tune in at the outset. By all means let him try for the more distant stations, but if he desires certainties during his apprenticeship he will do well to go all-out for the more powerful broadcasts at his disposal—e.g., those emanating from the nearer European centres.

It is the logging of these Continentals—a comparatively easy task—which will facilitate a search for more distant, and in most instances weaker, signals. Whether a condenser dial is marked in degrees, wavelengths, kilocycles, or stations, or combines two or more of these features matters little providing an accurate reading of the pointer can be obtained for the purpose of recording channels. It is essential that the exact point on the scale should be carefully noted if the same station is to be found again at a later date. Personally, for exact logging, I prefer a scale minutely divided into degrees, as where stations are marked, however small the type may be compatible with legibility, the separation of channels is so slight that one may well find two or three programmes within the space occupied by one station name alone.

Overlapping Wavebands

Another point of importance, and one less understood by the beginner, is that of the overlap existing in the individual bands. The total range covered by receivers of different makes varies slightly, but where two short wavebands are incorporated the ranges are roughly from 13-33 metres (23—9 Mc/s) and from 30-82 metres (10—3.7 Mc/s). This overlap will be found very useful, as experience will show that in some instances it will be possible to secure better reception of transmissions made on wavelengths between, say, 30-33 m. at the bottom of the 30-82 m. range than at the top of the 13-33 m. section. As it happens, this is a bracket which comprises a very large number of broadcasts and one over which specially slow and careful tuning is likely to provide very pleasant results. You will come across many carrier waves, and every one of these is worth a short examination, especially in the later hours of the evening when many of the European medium-wave stations close down and there is less likelihood of a signal proving to be a mere harmonic of a more or less near-by transmission.

THE author gives many useful hints for newcomers to short-wave listening, and also describes a number of lesser-known but, nevertheless, interesting transmissions, giving lists of wavelengths on which they are conducted.

It must be borne in mind that searching for stations on the short wavebands differs from the practice commonly adopted by users of receivers solely capable of tuning in broadcasts on the medium and long wavebands. In the latter case almost every portion of the dial reveals broadcasts in view of the fact that the bands selected are those which contain the frequencies allotted to radiotelephony transmitters. On the other hand, the range covering, say, 13-82 metres includes a large number of channels almost exclusively occupied by morse (telegraphy) or commercial telephony transmitters whose frequencies, for obvious reasons, may not be used by stations devoting themselves to wireless entertainment. On this account, if the beginner is ignorant of the channels allotted to broadcast telephony, he may waste considerable time in endeavouring to find that class of programme. With but few exceptions broadcasting stations will be found on channels comprised within the following limits:—

11.28-11.72	m.	(26,600-25,600 kc/s).
13.92-13.99	m.	(21,550-21,450 kc/s).
16.85-16.90	m.	(17,800-17,750 kc/s).
19.54-19.87	m.	(15,350-15,100 kc/s).
25.21-25.64	m.	(11,900-11,700 kc/s).
31.25-31.58	m.	(9,600- 9,500 kc/s).
48.78-50.	m.	(6,150- 6,000 kc/s).

Unfortunately, however, there exists a certain number of transmitters which must be classed as exceptions; incidentally, many of the new South American and West Indian short-wave transmitters are working on channels falling in the 44.93-48.78 m. (6,675-6,150 kc/s) band.

The time question is an important factor; by time is implied the hour of the day or night at which to listen to signals on different sections of the waveband. Many transmitters utilise a number of channels which are best suited for transmissions destined to countries overseas at the hour most convenient to listeners. Taking it broadly, during April and May, from about 11.0 a.m. to 6 or 7 p.m., searches should be made for broadcasts on the 16- and 19-metre bands. Transmissions on the 25- and 31-metre bands may be picked up at good strength from 1 p.m., and often held until the early morning hours. From 6 p.m. or 8 p.m. the 49-metre band comes into its own and may be successfully scoured until 7 a.m. the next morning or even later.

Relayed Transmissions

The identification of a transmitter is not always an easy matter. Note that I mention *transmitter*, and not *transmission*, as, in most instances, in view of the frequent interval signals and announcements, it is not difficult to trace the origin of a broadcast. But the transmission may be on a channel which does not tally with any usually associated with the city from which the programme emanates. The explanation is, generally, that the entertainment is being relayed by a commercial telephony station for re-broadcast in a foreign country. This may present some trouble in identifying the actual transmitter, although there may arise no doubt whatsoever as to the nationality of the actual broadcast. A short list of the prin-

Unconsidered Trifles

cipal stations which carry out this work will prove useful.

PRINCIPAL RE-BROADCAST STATIONS

GERMANY.—ZEESEN, DZG, 19.53 m. (13,360 kc/s); **DZH,** 20.75 m. (14,460 kc/s); **DZE,** 24.73 m. (12,130 kc/s); **DJP,** 25.31 m. (11.855 kc/s); **DJO,** 25.43 m. (11,795 kc/s); **DZB,** 29.87 m. (10,042 kc/s); **DZA,** 31.01 m. (9,675 kc/s); and **DZM,** 49.35 m. (6,079 kc/s).

SWITZERLAND.— PRANGINS, HBF, 15.83 m. (18,950 kc/s); **HBJ,** 20.64 m. (14,535 kc/s); **HBL,** 31.27 m. (9,595 kc/s); and **HBO,** 24.94 m. (12,030 kc/s).

UNITED STATES. — ROCKY POINT (N.Y.), WQE, 15.86 m. (18,920 kc/s); **WQB,** 16.72 m. (17,940 kc/s); **WLL,** 16.74 m. (17,900 kc/s); **WQV,** 20.27 m. (14,800 kc/s); **WEB,** 20.31 m. (14,770 kc/s); **WQP,** 21.58 m. (13,900 kc/s); **WEA,** 28.28 m. (10,610 kc/s); **WQW,** 28.30 m. (10,600 kc/s); **WCG,** 28.9 m. (10,380 kc/s); **WEL,** 33.52 m. (8,590 kc/s); and **WEZ,** 37.15 m. (8,075 kc/s). **LAWRENCEVILLE (N.J.), WKF,** 15.61 m. (10,220 kc/s); **WLA,** 16.36 m. (18,340 kc/s); **WMN,** 20.56 m. (14,590 kc/s); **WMF,** 20.73 m. (14,470 kc/s); **WMA,** 22.4 m. (13,390 kc/s); **WON,** 30.4 m. (9,870 kc/s); and **WOF,** 30.77 m. (9,750 kc/s).

Few commercial broadcast receivers are built to receive the transmissions on the 5 m. (60 Mc/s), 10 m. (30 Mc/s), and 160 m. (1.8 Mc/s) bands used by amateur experimental transmitters, but in the course of an evening's condenser twiddling the listener is bound to pick up calls and hear exchanges of conversation on channels used by them in the 20 m. (14 Mc/s), 40 m. (7 Mc/s), and 80 m. (3.5 Mc/s) amateur bands.

Wavelengths and frequencies allowed to these experimenters are given hereunder, and in order to facilitate searching a few details are added in respect to the channels granted or prohibited by a few of the more active European countries to their national "fans." A special article would have to be devoted to the translation of the radio jargon which is heard when these signals are tuned in, as many of the terms, although perfectly clear to those in the know, must undoubtedly puzzle the casual listener.

AMATEUR TRANSMITTING BANDS (approximately):—

5-5.357 m. (60,000-56,000 kc/s).
10-10.71 m. (30,000-28,000 kc/s).
20.83-21.43 m. (14,400-14,000 kc/s).
41.10-42.86 m. (7,300-7,000 kc/s).
75-85.71 m. (4,000-3,500 kc/s).

In Germany the 5 m. and 160 m. bands may not be used, and the 80 m. section is limited to 83.28 m.-85.66 m. (3,600-3,500 kc/s). British amateurs will be found using channels comprised in the following bands: 5.0-5.34 m. (59,995-56,005 kc/s); 10.02-10.72 m. (29,995-28,050 kc/s); 20.84-21.4 m. (14,395-14,005 kc/s); 41.10-42.8 m. (7,295-7,005 kc/s); 80.38-85.5 m. (3,730-3,505 kc/s); 150.30-174.30 m. (1,995-1,720 kc/s). In Switzerland the 160-metre band is prohibited, and the 80 m. band extends from 81.03-85.66 m. (3,700-3,500 kc/s). In Austria licences are granted for channels between 83.28 m.-85.66 m. (3,600-3,500 kc/s), but not for 160 m. In Denmark the channels most used are 152.2 m. (1,970 kc/s), 163.8 m. (1,830 k/cs) and 173.3 m. (1,730 kc/s), 80 m. (as in Germany); also from 41.13-42.77 m. (7,290-7,010 kc/s); 20.85-21.40 m. (14,380-14,020 kc/s); 10.01-10.7 m. (29,970-28,030 kc/s); 5.05-5.34 m. (59,900-56,100 kc/s). Finnish amateurs do not work on the 160 m., but on all other bands, and, finally, in the U.S.A. the 10 m., 20 m., 80 m., and 160 m. bands are allowed for telephony but not the 40-metre band.

Ship to Shore Traffic

In the same way, radio-telephony from ships at sea—in most instances from the more important liners—will crop up occasionally. Transmissions of this description are usually carried out on channels comprised between 16.85-18.27 m. (17,800-16,420 kc/s); 22.50-24.30 m. (13,335-12,345 kc/s); 33.93-36.59 m. (8.842-8,200 kc/s); 67.87-73.17 m. (4,420-4,100 kc/s). The different frequencies, as in the case of land or fixed transmitters, are used according to the time of day and, in addition, the choice of the channel is influenced by the ship's position at the time communication with either her home or a foreign port is to be established. If, on the journey outwards, the French transatlantic liner *Normandie* (FNSK), as an example, tries to get into touch with New York in the morning hours either 13.6 m. (22,060 kc/s) or 17 m. (17,650 kc/s) would be the wavelength selected for the purpose. Later, in the afternoon, 22.71 m. (13,210 kc/s) would be used, and after dusk, 33.98 m. (8,830 kc/s). When relatively near her destination messages would be sent out on 68.03 m. (4,410 kc/s). On the other hand, when desiring to communicate with a French station slightly different channels would be adopted, namely, 13.61 m. (22.040 kc/s); 17.02 m. (17.630 kc/s) during early daylight hours; 22.74 m. (13,190 kc/s) if afternoon; 34.05 m. (8,810 kc/s) after sunset and 68.34 m. (4,390 kc/s) when at no great distance from the coasts of Europe.

There is no secret in the channels used by liners or land stations for the public telephony services, but it should be remembered that these, as all transmissions which are not of the broadcasting type, must be deemed of a private nature and, in consequence, according to the terms of the Post Office listening licence, may not be revealed to a third party or, in any other way, communicated. Whilst on the subject of shipping it may be of interest to note that DOAI, *Europa*, DOAH, *Bremen*, DHJZ, *Hamburg*, and DHEY, *Deutschland*, as representatives of the German transatlantic ferries, can frequently be heard operating on 18 m. (16,665 kc/s); 23.81 m. (12,600 kc/s); 24.34 m. (12.325 kc/s); 26.93 m. (11.140 kc/s); 35.42 m. (8.470 kc/s); and 74.07 m. (4,050 kc/s). ICEJ, *Rex*, IBLI, *Conte de Savoia*, IBGI, *Conte Verde*, and IBEJ, *Conte Rosso* of the Italian mercantile fleet work with IAC, Coltano (near Pisa, Italy) on such channels as 17.01 m. (17.640 kc/s); 17.31 m. (17,333 kc/s); 22.99 m. (13.050 kc/s); 33.98 m. (8,830 kc/s); 34.61 m. (8,667 kc/s); 35.14 m. (8,538 kc/s); 68.97 m. (4,350 kc/s) and 71.82 m. (4,177 kc/s). From Coltano (Italy) clear speech will often be tuned in on one of the following frequencies: 16.95 m. (17,699 kc/s); 23.45 m. (12,795 kc/s); 35.80 m. (8,380 kc/s); 45.11 m. (6,65 kc/s) and 68.88 m. (4,355 kc/s). Germany, on the other hand, keeps in touch with her vessels through DAF, Norddeich, of which the busiest channels are: 17.38 m. (17,265 kc/s); 22.90 m. (13,100 kc/s); 34.23 m. (8,765 kc/s) and 68.18 m. (4,440 kc/s). France, on the other hand, works radio-telephony through Paris TSF and St. Nazaire. Transmissions should be sought on 17.78 m. (16,870 kc/s); 23.22 m. (12,920 kc/s); 23.61 m. (12,705 kc/s); 23.87 m. (12,570 kc/s) 35.46 m. (8,460 kc/s) and others.

The field of exploration for the short-wave listener is a vast one, and gives him a radius of action far surpassing that vouchsafed to the man who searches for distant stations merely on the medium and long wavebands.

Club News

Leeds Radio Society

Headquarters: Y.C.C.A., Cookridge Street, Leeds, 2.
Hon. Sec.: Mr. J. Kavanagh, 63, Dawlish Avenue, Leeds, 9.

The most popular of the Society's recent activities proved to be the visits to the North Regional transmitter, the Leeds studios and the Kirkstall Power Station. Mr. Gautby, A.M.I.R.E. (G6GA) has been giving a very interesting series of lectures.

Exeter and District Wireless Society

Headquarters: Y.W.C.A., 3, Dix's Field, Southernhay, Exeter.
Hon. Sec.: Mr. W. J. Ching, 9, Sivell Place, Heavitree, Exeter.

Dr. C. Wroth aroused considerable interest by his lantern lecture on the high frequencies used by the medical profession. Dr. Wroth was assisted by Mr. Pemberton of the Royal Devon and Exeter Hospital in demonstrating how radium is detected and recovered when lost in hospital dressings.

There was a very good attendance of members at the lecture on "Electricity as applied to Agriculture," given by Mr. L. W. Cornish, of the Exeter City Electricity Undertaking. On April 12th, Mr. R. C. Lawes will give a talk on short and ultra-short waves.

Croydon Radio Society

Headquarters: St. Peter's Hall, Ledbury Road, S. Croydon.
Meetings: Tuesdays at 8 p.m.
Hon. Pub. Sec.: Mr. E. L. Cumbers, 14, Campden Road, South Croydon.

At the annual general meeting a discussion took place on future programmes and it was decided to include a proportion of musical talks. Members asked for more short-wave lectures and demonstrations. The final meeting of the session will be held on April 13, when Mr. H. G. Salter will give a gramophone recital.

Cardiff and District Short-wave Club

Hon. Sec.: Mr. H. H. Phillips, 132, Clare Road, Cardiff.

At the last meeting of the club, Mr. R. T. Matthews, G8AM, gave a talk on CO/PA transmitters, followed by a demonstration. This talk was one of a series for the amateur transmitter. At the next meeting on April 15th, Mr. H. H. Phillips, 2BQB, will give a talk and demonstration of interest to the receiving members of the society. Subsequent meetings have been arranged for April 29th, and May 13th and 27th.

Television Reception

NOTES ON THE DESIGN OF MODERN RECEIVING EQUIPMENT

IN this article some notes are given on the design of receiving apparatus for television, and the question of time-bases receives particular attention. The material is derived from the work of the well-known German pioneer, Manfred von Ardenne.

IN considering television equipment it is not sufficient merely to discuss the receiver proper, for the associated apparatus is just as important. Every part, from the aerial to the cathode-ray tube, must be correctly designed if the complete apparatus is to function properly.

A dipole aerial is usually adopted and connected to the receiver by a feeder, and the same aerial is employed for reception of both the sound and the vision transmissions. Since a resonant aerial of this type has selective properties its damping, either natural or artificial, must be high enough to enable the sidebands of the vision transmission to be passed. The transformation ratio between field-strength (V/m.) and input voltage is about 0.5-2.0.

According to measurements made by Scholz the field-strength decreases with distance from the transmitter approximately according to a square law, while Holmes and Turner find that at 7 metres with an aerial power of 1 kW. field-strengths of under 1 mV/m. are obtained at distances of 10-15 km. This is with an aerial height of 100 m. and for transmissions over a city. This order of field-strength leads to a receiver input of about 1 mV.

The total noise level is made up of the sum of the external and internal noise. The former is generally caused by electrical apparatus and car ignition systems, while the latter is made up in about equal parts by thermal agitation and shot effect. For a band-width of 4 Mc/s and an input circuit impedance of 1,000 ohms, the internal noise level is of the order of 0.03 mV. Consequently, a signal input of 1 mV. must be provided if 3 per cent. interference modulation is considered tolerable.

The vision receiver is usually a superheterodyne, and for the avoidance of interference the intermediate frequency must not be lower than the highest modulation frequency. The frequency generally lies between 8 Mc/s and 20 Mc/s.

Since the frequency-changer introduces about three times as much noise as an amplifier, it is preceded by an RF stage. In order that the noise level shall be governed by this stage, its amplification must be greater than 3 times. Tuning is better carried out by means of variable inductances than by the more usual variable condensers, since higher amplification can be secured with the greater L/C ratio. The circuits must be correctly damped by suitable resistances.

The IF Amplifier Couplings

In the IF amplifier it is possible to secure stage gains of 5-10 times with modern valves even when modulation frequencies as high as 2 Mc/s must be catered for. With single sideband working the stage gain can be doubled, but it has not yet been proved that such good picture definition is obtainable with this system. The following types of intervalve coupling are used in IF amplifiers:—

(*a*) Resistance-capacity with series inductance. The upper frequency limit of response is about twice that obtained without the inductance. This type of coupling is not used in commercial receivers, but is very important in vision-frequency amplification.

(*b*) Tuned anode coupling. With this system the coupling inductance is tuned by the stray capacities. The circuits may all be tuned to the same frequency or some may be tuned towards the edges of the IF band. More steeply sloping sides to the resonance curve are then obtainable. This system is used in some commercial receivers.

(*c*) Band-filter coupling. This type of coupling is the most widely used, and generally with capacity coupling of the tuned circuits.

The cathode-ray tube generally used requires some 10-20 volts input for modulation, but in projection types it may be as high as 40 volts. Owing to the low impedance of the couplings necessary to obtain the required band-width, it is quite difficult to secure output voltages of this order, and there is little uniformity in design. Rectification is sometimes carried out in the CR tube itself, but this is not advisable on account of the inefficient operating conditions.

Full-wave detection immediately before the CR tube demands a large output stage, and this is then the last IF valve. The detector can, of course, be followed by a VF stage which makes an efficient output stage. If the DC component is to be retained to control the average picture brightness, however, the amplifier must be direct-coupled.

Distortion in television naturally has a different effect than in sound reception, but is due to the same causes. Frequency distortion causes blurred outlines when it consists of a cut-off of the upper modulation frequencies, but uneven reproduction of large surfaces when it is in the form of a lack of low frequencies. Phase distortion causes "plastic"—a false appearance of relief — while very bad phase distortion gives multiple contours. Amplitude distortion leads to the absence of half-tones.

Frequency and phase distortion are usually closely inter-related, and are unimportant if the drop in response at the edges of the band is of the order of 5-10 per cent.

In order to obtain uniform amplitudes of sync pulses—that is, pulses which are affected neither by the picture content nor by the noise level—the small component lying between "black level" and "noise level" must be selected. Several amplitude filters are available. The von Ardenne system embodies a screen-grid valve operated so that its characteristic shows two sharp bends. The valve is biased slightly beyond anode current cut-

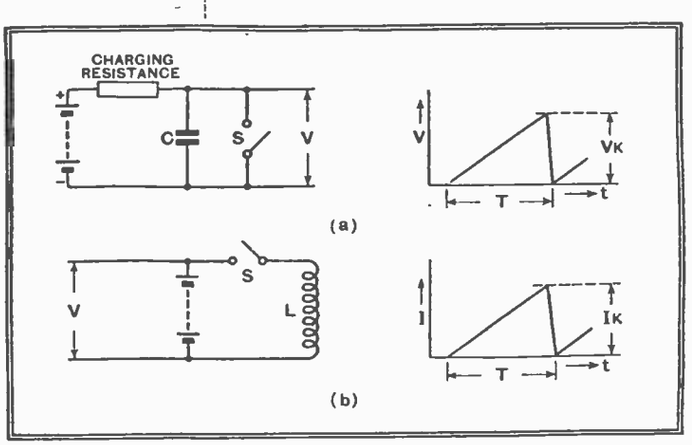


Fig. 1.—The basic circuit for producing a voltage of saw-tooth waveform is shown at (a) and that for generating a current at (b).

Television Reception—

off and operated with an IF input. The Messner filter is operated by the detector output. A valve with a similar characteristic is used, but is biased just beyond the upper bend in its curve. Sometimes a combination of these two methods is adopted and in other cases a diode is employed after the detector.

It is very important that a good amplitude filter be employed, for extreme regularity of sync pulses is required for good operation of the time-base. When using self-running time-bases it is sufficient if the amplitudes of successive sync pulses are maintained within some ±2-5 per cent., but with externally controlled systems the accuracy must be as high as ±0.5 per cent.

The necessary voltages or currents for deflecting the cathode-ray beam in accordance with the requirements of scanning are produced by time bases. When electrostatic deflection is adopted a voltage of saw-tooth wave form is required, but with electromagnetic deflection a current of the same wave form is needed.

The fundamental time-base circuit is shown in Fig. 1 (a). A condenser C is charged with a constant current so that the voltage V across the condenser increases linearly with time. When it reaches a predetermined value, which is less than that of the charging source, the condenser is rapidly discharged through a device such as a gas-discharge valve. This is shown in Fig. 1 by the switch S. The discharge time is only about 5 per cent. of the charging time, consequently the discharge current is much larger than the charging current.

With magnetic deflection the current through the coil L (Fig. 1 (b)) corresponds to the voltage across the condenser C in the circuit for electrostatic deflection. In order to obtain a current increasing linearly with time it is necessary that the voltage V of the source be kept constant by a glow-discharge stabiliser. Before the current through L reaches the limiting value determined by the circuit resistance it is interrupted by a circuit-breaking device S. This interrupter can be a low-resistance valve which can be blocked suddenly by the synchroning pulse.

Time-Base Circuits

The usefulness of this circuit is limited at high frequencies by the inevitable self-capacity of the coil L, because a tuned circuit is formed which is kicked into self-oscillation at its natural frequency by the periodical breaking of the circuit. This effect can be greatly reduced, however, by connecting a diode in parallel with the coil in the manner suggested by Urtel-Andrien. The inductance must be so chosen that the half-cycle of the natural oscillation is less than the fly-back time.

Although the deflecting voltage or current is produced in most time bases by the relatively slow charge of a condenser and the fly-back by its rapid discharge, it must be remembered that the conditions can be reversed. In many cases, merely by a rearrangement of the circuit, the deflecting voltage can be produced by the slow discharge of a condenser and the fly-back by its being rapidly charged.

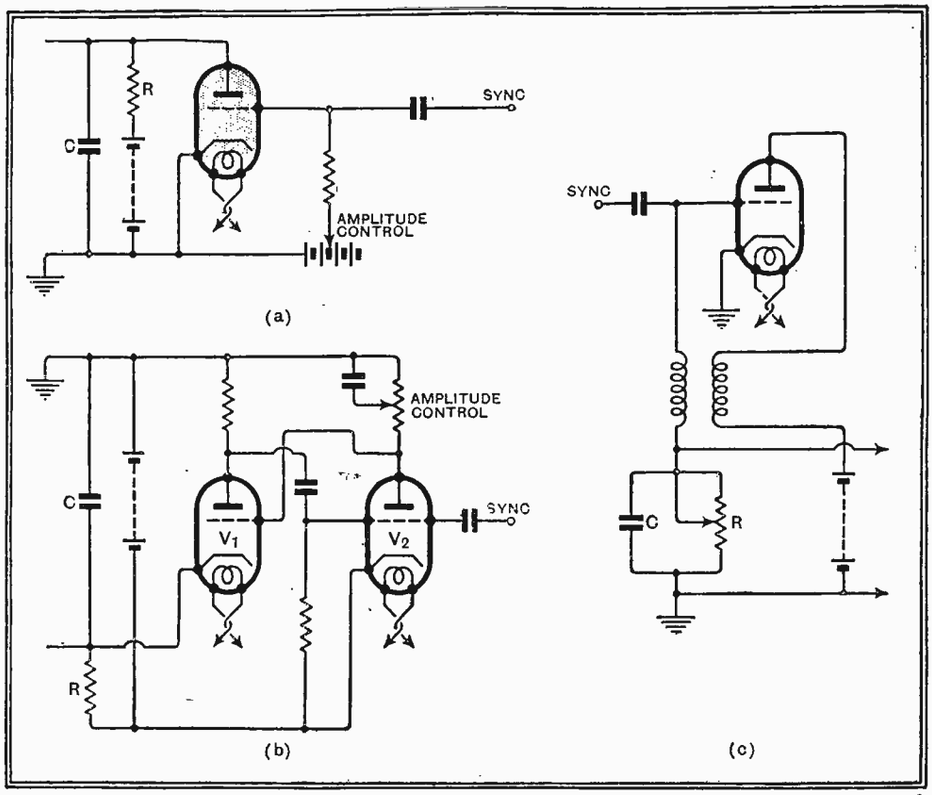


Fig. 2.—The fundamental time-base circuit using a gas-filled triode is shown at (a) while an alternative arrangement embodying two hard valves appears in (b). A single hard valve circuit is given in (c).

When charging is adopted for the deflecting stroke it is important that the voltage shall rise linearly with time. This can be achieved to a close degree by using a saturated diode or a screen-grid valve as a charging resistance. When the voltage source is very high, however, it is possible to use an ordinary resistance and still obtain sufficient linearity. The amount of distortion in such voltages is most conveniently measured by the ratio of the velocities of the spot on the tube at the start and at the end of its path. The highest permissible value for this ratio is 1.1, and this means that when an ordinary resistance is used in the charging circuit the voltage across the condenser must be only some 7-9 per cent. of the voltage of the source.

Two general types of time-base are found —the self-running and the externally maintained. The former is usually adopted, and there are many varieties of this type. One of the most widely used is shown in Fig. 2 (a); the valve is a gas-filled triode and is initially non-conductive. The condenser C charges through the resistance R and when the potential reaches a certain value the valve strikes and rapidly discharges the condenser; it then again becomes non-conductive and the cycle is repeated.

The second time-base (Fig. 2 (b)) employs only hard valves, but two are used instead of one. Here again the condenser C is charged through R; when the voltage rises to a certain figure V1 becomes conductive and starts to draw current. This causes its anode potential to fall and a negative pulse to be communicated to the grid of V2, the anode voltage of which consequently rises. This in turn makes the grid of V1 move positively, with the result that the current taken by this valve is increased. The net result is a rapid discharge of the condenser. When the condenser is discharged the series of operations is reversed and V1 becomes non-conductive, so that the condenser C again starts to charge.

An important circuit using only one hard valve is shown in Fig. 2 (c). The time-base condenser and resistance C and R are in the grid circuit of a low-μ triode, the grid and anode circuits of which are coupled together by the coils, so that it is really an oscillator. In operation the valve oscillates and draws a heavy grid current which charges the condenser C, and hence the grid potential becomes negative. When operating correctly the valve becomes biased so heavily that it stops oscillating; the condenser then discharges through R until the grid potential falls sufficiently to permit the valve to start oscillating again.

It will be observed that in this case it is the slow discharge of the condenser which provides the steady sweep for the tube, and the rapid charge which provides the fly-back. The fly-back time depends on the resonance frequency of the oscillator coils. In many cases it is necessary to follow this circuit by a special amplifier in order to correct for the exponential

Television Reception—

change of voltage across the condenser C.

With the second class of time-base—the externally controlled type—the functioning of the time-base is entirely dependent upon the synchronising signals. It does not work at all in the absence of such pulses. The circuit adopted is identical with that of Fig. 2 (a) save that a hard valve is used instead of the gas-filled triode. The condenser C is charged through R in the usual manner and is discharged through the valve when a synchronising pulse makes the grid positive. The advantage of this arrangement is that there are no critical adjustments to make. The disadvantage is that it is necessary to have an exceptionally good amplitude-filter, for extremely regular synchronising pulses are required.

When electrostatic deflection is employed a balanced output is necessary from the time-base. The most usual method of obtaining such an output is through the use of a resistance-coupled push-pull amplifier. In some cases, however, it has proved possible to employ a push-pull transformer for feeding the deflecting plates.

Very careful design of the transformer is necessary, however, for the saw-tooth wave form which it must handle necessitates a response characteristic free from frequency and phase distortion over quite a wide band of frequencies. When the fly-back time is about 5 per cent. of the charging time, the transformer must have a flat characteristic from the fundamental time-base frequency to at least ten times this value.

Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

Horn-Loaded MC Speakers

AS an enthusiastic devotee of high quality reproduction of sound I beg to respond to the letter by Mr. Barden included in the issue of *The Wireless World* dated March 19th.

The doubt immediately assailed me on reading this gentleman's letter whether he had ever heard Mr. Voigt's domestic speaker.

Although formulæ are naturally essential for the practical working of any science, I think there is no doubt that the ear is the ultimate critic of reproduction. As far as my experience goes, the only flat baffle that did not introduce some sort of coloration, especially in the bass, was a brick wall, and for a considerable time I thought this was to be the final position of my speaker, as it provided, of course, practically an infinite area.

Having heard, however, a good deal of discussion about the horn loading of domestic loud speakers, I decided to go to a Voigt demonstration—I might say, with no little intention of "picking flies." My surprise and admiration may be imagined when I found that the glove was very definitely on the other hand, and, as a result, I came away a thorough convert. The bass reproduced by the speaker, which appears to be Mr. Barden's chief item of attack, was far more real than any baffle speaker I have heard, and, moreover, did not contain any disagreeable resonance.

The suggestion made by Mr. Barden of attaching the speaker to a flat baffle placed at right angles to a wall at the point where the baffle meets the floor would, admittedly, give a larger baffle area, but in so doing would project the high-frequency ray where it was least required.

The Voigt h.c. corner-horn which I now use gives a very even distribution of the top, complete absence of the effect that the sound is radiating from a definite spot, and although there is no bass chamber, a 50-cycle note (direct from mains via transformer to speech coil) differs very little from that produced by the same speaker set in the wall. The speaker, incidentally, is a Hartley-Turner twin cone, which, I think, everyone will agree, goes well below 50 cycles.

Finally, then, in view of this, added to the increased efficiency and improved psychological effect, I would like to offer my humble opinion that, with all respects to Mr. Barden, horn loading is definitely superior to that provided by flat baffles. I have found, moreover, that this is not only my view, but that of nearly all the critical quality enthusiasts with whom I have come in contact.

This opinion is entirely independent, and the writer has no connection with either of the firms mentioned.

Walsall. A. A. COTTERELL.

Service

I HAVE read with interest the comments of your contributor "Diallist," in the issue of March 19th, on the question of service.

The Editor's interpolation regarding the suggested fixed fee of 3s. 6d. for testing a set and locating a fault seemed particularly apt.

I have no doubt that retailers may find it a satisfactory solution of their service worries to be able to quote a fixed nominal charge to their customers. This low figure may be used as a sales-aid, and may often at a later date prevent the alienation of the customer's goodwill. In this case service is being used as a subsidiary to the primary business of set retailing. Where repairs are executed by those who are solely engaged in repair work and who give a guaranteed job this figure is inadequate.

I feel, however, that the extension of this practice to pure radio servicing is strongly to be deprecated as it inevitably results in small faults being over-charged and vice versa. Surely it is not reasonable to make the same labour charge for a set needing a new resistor and for a set needing the mains transformer rewound and a new condenser bank fitting.

Where an estimate is desired this should be given in full detail, showing the new parts required and the parts that need repairing or adjusting. The invoice should give full details of work done, together with the respective charges for labour and parts. The practice of returning all parts removed is very desirable and satisfies the customer.

The views expressed by Mr. Fairbairn in his letter published in your issue of March 19th coincide with my own, and I believe that implicit honesty with efficient and guaranteed work form the basis of satisfactory service.

C. A. HEMMERDINGER,
Partner, Holiday and Hemmerdinger.
Manchester, 3.

Recording

I HAVE read the various articles on sound recording in the recent special issue of *The Wireless World* with particular interest, and am sending you a recording made by me on a Simplat disc, which I should be glad if you would try over. The disc was cut with a Simplat cutter, using a sharp-pointed sapphire stylus.*

As one with some years' practical experience in disc recording and amplifier design, I am surprised to notice the complete lack of all data relating to microphones suitable for recording purposes.

In my experience the microphone is a most, if not *the* most, important part of the whole equipment, and one's troubles only really begin when recording from microphone. Radio recording is comparatively simple. The curves given in Mr. Leever's article appear to be based on a pure input to the recording amplifier, a state of affairs seldom, if ever, met with when using standard-type microphones. This, then, would surely tend to alter very much the overall characteristics of the system as shown in Fig. 3 of that article. Generally speaking, a carbon microphone is not suitable for recording, more particularly if using a disc coated with a gelatine compound, as the background hiss may be in excess of that of the disc itself, always assuming the latter to be properly cut. Of other microphones tried, the velocity type seems to come out best, but, personally (although I must admit those tried have been of foreign manufacture), they leave much to be desired when used in a small studio, and have many disadvantages. I have found by trial that the ideal microphone for the home recordist is the Rothermel-Brush Piezo-Electric Type D.104. This is a diaphragm-type model, and has an admitted peak round about 4,000 cycles, which almost coincides with that shown in the diagram referred to above, giving an accentuated peak at this frequency. The curve would thus appear to be misleading. It is most important when using this microphone to design carefully the associated amplifier in such a way as to balance out this peak; otherwise, the resulting recordings will be shrill and hard. My recordings, judged aurally, would appear to show that I have succeeded in doing this.

I should be exceedingly interested to learn the views of other readers with experience.

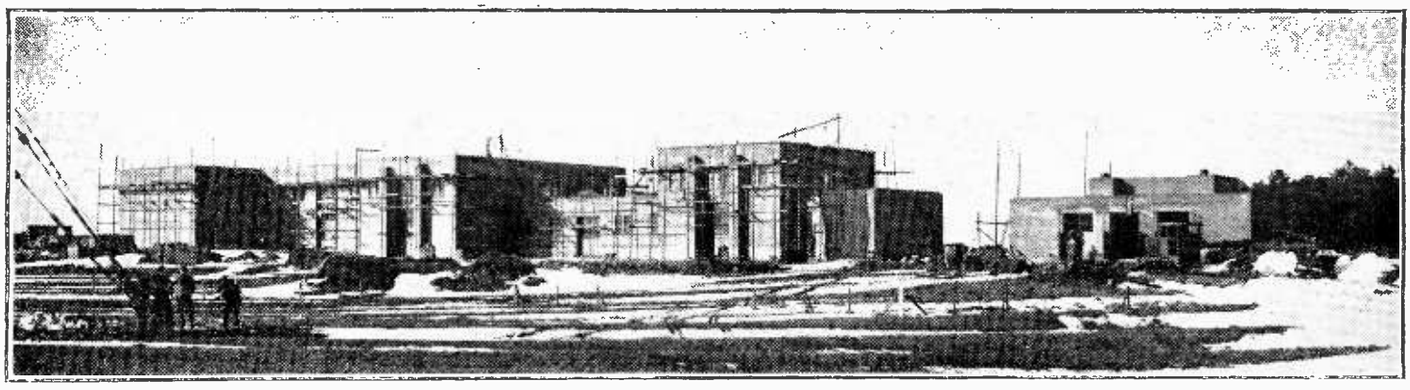
E. I. HOWLETT.

North Harrow.

"Volume Expansion"—A Correction

IN Fig. 2 of Mr. Laurence Snell's letter, published in our issue of March 26th, a condenser should be interposed between the anode of V1 and the output circuit. The purpose of this condenser (which may have a capacity of 0.1 mfd. upwards) is to prevent the application of a DC potential to R and VR.

* The record is a very good example with very low surface noise.—Ed.



IN THE MAKING. Progress continues to be made with the erection of the North-east Regional Station buildings at Stagshaw, near Newcastle.

BROADCAST BREVITIES

NEWS FROM PORTLAND PLACE

Coronation Television

THE Coronation procession will be televised from Apsley Gate, Hyde Park Corner.

Although H.M. Office of Works has not seen fit to permit more than one television camera point, it is understood that the B.B.C. will make the most of the available opportunity to give as comprehensive a view of the procession as possible. To this end telephoto as well as ordinary lenses will be employed to provide close-ups of the Royal Coach and other highlights.

Cable or Radio Link ?

It has not yet been decided whether to use the co-axial cable for the Coronation relay or to rely on the ultra-short wave link with Alexandra Palace. Probably an attempt will be made to have both systems available . . . just in case.

Within the next few days work will begin on the erection of a receiving aerial above the existing sound and vision arrays at the television transmitter.

Fanfare Beneath the Dome

IF rich acoustic effects can add splendour to a musical occasion, there will be a grand climax to the "Service in Preparation for the Coronation," to be broadcast at 8 p.m. on Sunday, May 9th. The service itself will be held in the Concert Hall at Broadcasting House, but the final hymn, the National Anthem and a Solemn Fanfare will be broadcast from under the dome of St. Paul's Cathedral. Here will be assembled members of the Coronation Choir, together with delegate singers from the Dominions, Scotland, Wales, Ireland and London.

"The Royal Anointing"

The Archbishop of Canterbury will give the Address, while the Invocation and Hallowing will be said by the Rev. F. A. Iremonger, M.A., Chaplain to the King and B.B.C. Director of Religion. To make the service as widely representative as possible, it has been arranged that Thanksgivings shall be said by the Rev. M. E. Aubrey, M.A., Moderator of the Federal Council of Evangelical Free Churches, and Prayers by the Right Rev. Professor Daniel Lamont, D.D., Moderator of the Church of Scotland.

Very old texts will be used in the service, including "The Royal Anointing"—a greeting addressed by the Bishop of Lincoln to Henry III in A.D. 1246. "The King's Prayer," which will also be said, dates from the year 1382.

Three Hours of Coronation Dance Music

LONDON and the provinces are to be "tapped" for dance music on Coronation Night. Nearly three hours of rhythm will be radiated, beginning at 10.15 p.m., when Henry Hall and his boys strike up at Maida Vale. Thence we shall be transported to Belfast, and afterwards, with intervals at Maida Vale, we shall "visit" Blackpool, Birmingham, Swansea or Cardiff, and Torquay. Stations close down at 1 a.m.

Coronation Numbers

Dance bands broadcasting during Coronation Week include those of Roy Fox, Joe Loss, Billy Cotton, Ambrose (from the Royal Albert Hall) and Jack Payne (from Grosvenor House).

And every band will be broadcasting a special "Coronation" number.

Manchester Linked with Glasgow

EVERY quarter the B.B.C. Engineers issue to Departments concerned a special map of the British Isles showing the "S.B." lines linking the various stations. As time goes on the network grows more complicated.

The April map, just issued, shows a new direct link between Manchester and Glasgow, with provision for two-way simultaneous working. Glasgow, in fact, can now enjoy Gracie Fields in her native county while Manchester revels in bagpipe music. For six and a half hours each day the engineers also have the use of a Post Office telephone line over this circuit for check purposes.

The Strongest Link

The biggest number of lines are between London and Daventry, which can simultaneously exchange three programmes each way. There are also numerous telephone lines permanently available for engineers' use.

Stagshaw : The Latest

SKILLED labour is again skilfully labouring at Stagshaw, where work on the North-East Regional was recently held up on a little question regarding the contents of pay envelopes. No one doubts now that the station really will be working by the autumn.

Architecturally, the station follows Regional practice; in fact, it is only in the use of a single mast aerial that it differs radically from its prototype at Brookmans Park. Hats should be lifted to Captain Peter Eckersley, the B.B.C.'s first Chief Engineer and originator of the Regional scheme.

Hopeless Dawns

ABOUT two hundred scripts —musical plays, sketches and lyrics — are submitted weekly to the B.B.C.'s Light Entertainment Department. Of this huge output only about one quarter per cent. is found suitable for broadcasting.

In other words, 99¾ per cent. of would-be radio writers live bitter lives.

Topicality Wins

How to change all this is indicated by Max Kester and Edwin Collier in a sprightly little book, "Writing for the B.B.C." Sketches, preferably humorous, are in big demand, provided they do not play for more than fifteen minutes. The most popular run to three minutes. Topicality is the quickest means of securing acceptance, provided you are first with the idea, but it has to be remembered that every new topic of importance is seized upon by all the humorists in the land. Towards the end of 1934, as a case in point, Belisha Beacons sprang into being, and immediately the Light Entertainment Department was deluged with Belisha jokes and sketches. One in four hundred was accepted.

Do's and Don'ts

The authors plead with writers not to attempt to put scripts into technical broadcasting form. The B.B.C. experts will gladly do this work if the basic idea is good.

The book closes with the pathetic plea that writers should read over their material before submitting it. If they all did so, fewer scripts would be submitted.

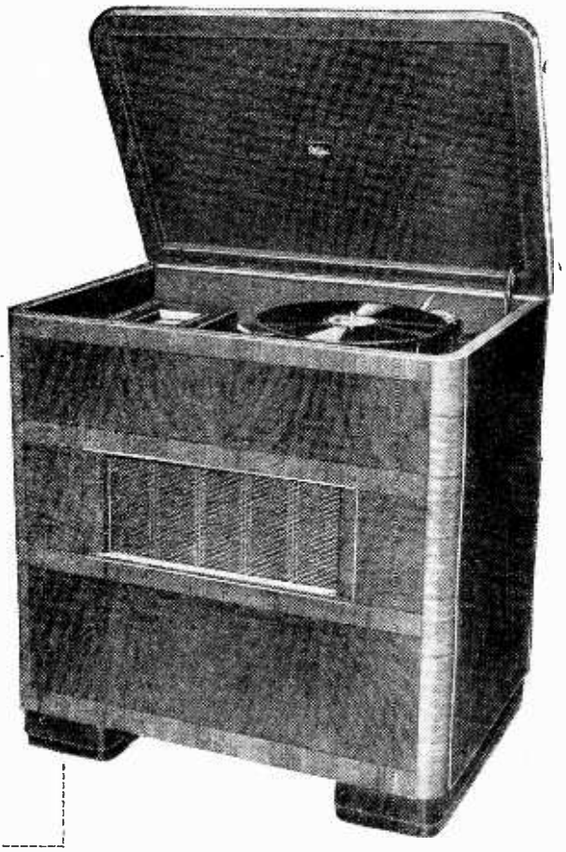
Televising Television

TELEVISION will shortly be televised. The idea is not so crazy as it sounds, for the intention is to take viewers on a screen tour of the B.B.C. wing at Alexandra Palace. The camera will first be taken to the vision transmitting hall; then by easy stages the sound transmitter, dressing-rooms, make-up department and wardrobe will come into the picture. By way of a finale the camera will move slowly along the main corridor till the studio is reached just in time to televise the televising of a variety show. If another camera then began to televise the televising of the televising . . . the idea is too disturbing.

Marconiphone

MODEL 395

An All-wave AC/DC Radiogramophone with Record-changer

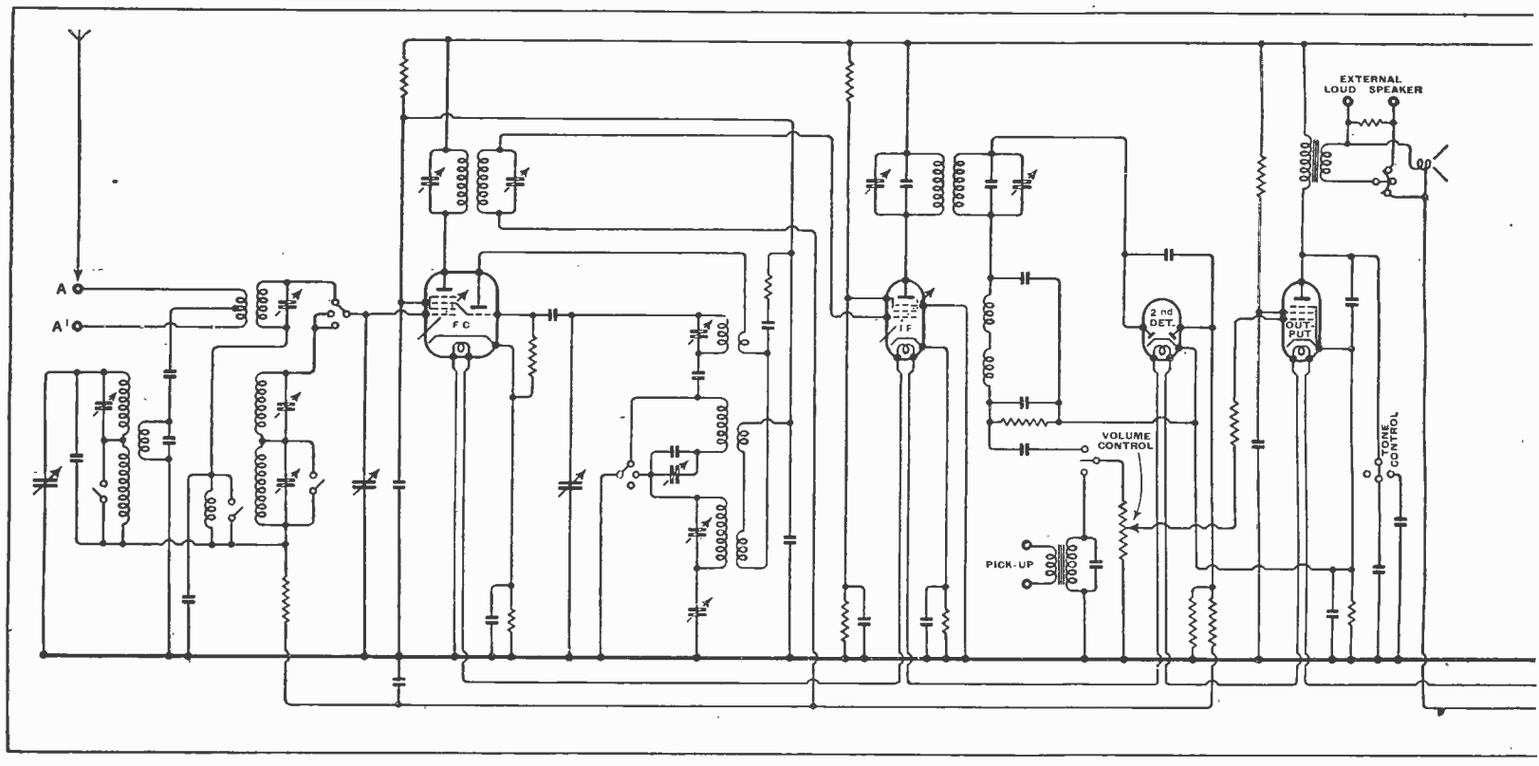


FEATURES.—***Type.***—*Radiogramophone with record-changer incorporating three-waveband superheterodyne chassis.* ***Waveranges.***—*(1) 16.5-50 metres. (2) 200-580 metres. (3) 750-2,000 metres.* ***Circuit.***—*Triode-hexode frequency-changer—var.mu pentode IF amplifier—double-diode second detector—pentode output valve. Half-wave valve rectifier. Barretter current regulator.* ***Controls.***—*(1) Tuning. (2) Combined tone and volume. (3) Wave-range. (4) Radiogram. switch. (5) Mains on-off switch.* ***Price.***—*33 guineas.* ***Makers.***—*The Marconiphone Co., Ltd., 210/212, Tottenham Court Road, London, W.1.*

THE listener who is not on AC mains or who may be contemplating a move to a district where his supply will be of a different nature has a fairly wide choice among table model receivers, but hitherto he has not been too well catered for if his requirement is a full-sized radiogramophone.

The Marconiphone Model 395 should go far to solve his difficulty, for it is a solidly constructed instrument and of impressive appearance. The up-to-date radio chassis includes a short-wave band and the gramophone equipment includes an automatic record-changer. As far as the radio chassis is concerned this is self-adjusting for direct or alternating current supplies between 200 and 250 volts and 25-60 cycles, but an adjustment is necessary to the motor regulating resistance before the instrument is put into operation.

The aerial circuit is suitable for normal single-wire elevated aerials or special aerials of the anti-interference type, and comprises a single tuned circuit on the short-wave band and a band-pass filter with "mixed" coupling on the medium and long waves. A triode-hexode frequency changer is the first valve in the circuit and its output is amplified by a single pentode IF amplifier. This is followed by a double-diode second detector which also supplies delayed AVC to the first two stages in the set. The output from the second detector is very thoroughly filtered and passed through resistance coupling without amplification to the high-slope pentode output valve. A transformer is associated with the gramophone pick-up and serves the dual purpose of completely isolating it from the chassis and giving some voltage step-up to take the place of intermediate amplification before the output stage. There is a three-stage tone control consisting of condensers shunted across the output circuit and a switch is provided which enables any desired combination of the internal and external loud speakers to be obtained. Damage to the output pentode is guarded against by a ballasting resistance across the external loud speaker terminals, which prevents the volts



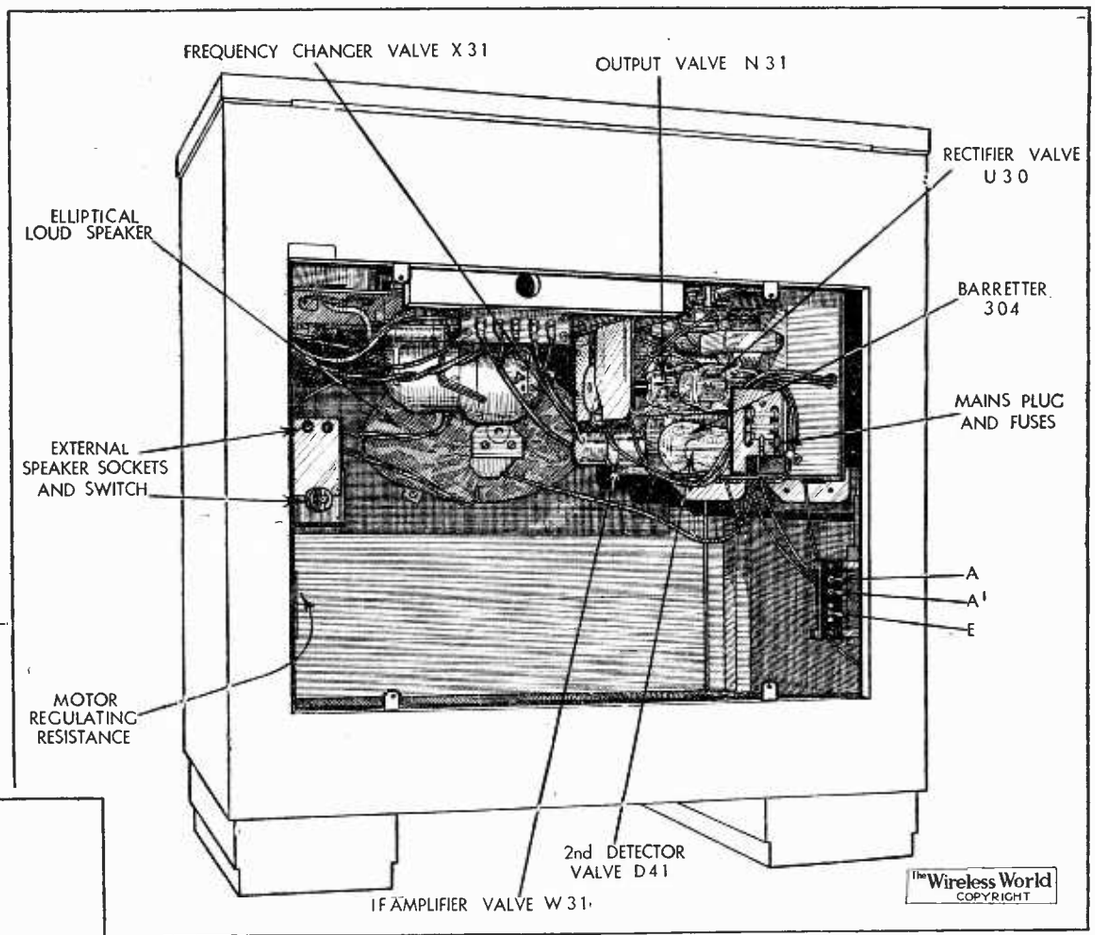
developed in the anode circuit from rising unduly should the switch be put into this position when no external loud speaker is connected.

The HT supply is derived through a U30 rectifier with the elements connected in parallel, and a barretter lamp is connected in series with the filaments to hold the heater current constant. Both the mains and the connections to the gramophone motor carry HF filtering chokes and each mains lead is supplied with separate fuses and switch contacts.

A high over-all magnification is not to be expected in a circuit of this type, but it is nevertheless quite adequate, and has this advantage, that the loud speaker is never overloaded. The balance of volume as between radio and gramophone is well kept, and, while ample power in keeping with the size of the set is obtained, it is virtually impossible to produce overload distortion in either case.

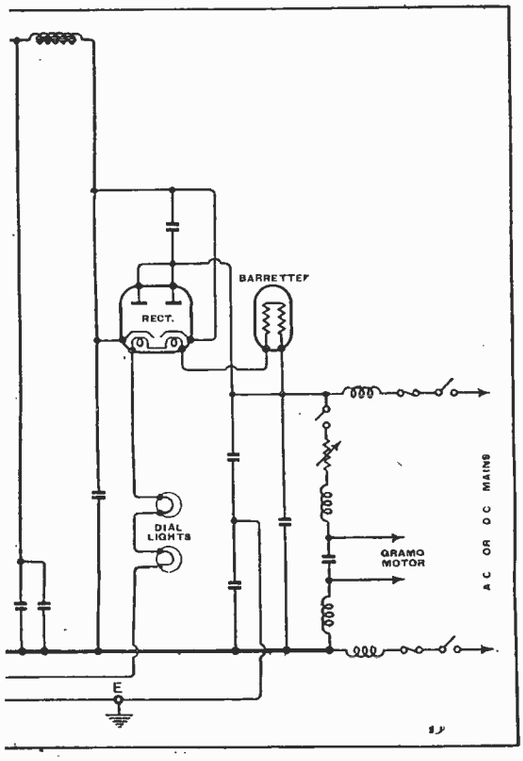
The elliptical loud speaker has an excellent bass response and gives wide angle distribution of the high tones, which are present in just the right proportion. Needle scratch is hardly noticeable, and yet the full high-note range can be used except under conditions of unusually bad interference on the short-wave range.

Although the over-all magnification is not more than is necessary, no reduction has been made in the amplification of the earlier stages in the set upon which the sensitivity and range depend, and the receiver gives an excellent account of itself in bringing in distant stations both on the normal broadcast bands and on the short waves. W2XAD and W3XAL were received at a comfortable strength and there was a generous choice of Continental broadcast programmes during the switch is rather unconventional and is operated by a lever working through a slot in the panel. Separate rotary switches are provided for changing from radio to gramophone and for switching the set on and off. The tone control is combined with the volume control and is matched by a similar concentric pair of knobs giving fast and slow movement to the tuning dial. A particularly lucid tuning scale has been provided in which the three straight scales run parallel on a translucent white illuminated background. The scales are over 8in. in length and



Rear view of the Model 395 with back panel removed. Note the three-position loud speaker switch and the accessible placing of the fuses.

No amplification is provided between the second detector and output stages, but the sensitivity is good and the over-all magnification is sufficient to give the full power output on all worth-while stations.



hours of daylight on medium and long waves.

No second-channel whistles of any serious consequence are to be recorded and the selectivity enabled clear reception of stations spaced by more than one channel from the local stations to be obtained when using the set at a distance of 15 miles from Brookmans Park. The strength of the Deutschlandsender was excellent, but full use had to be made of the tone control to bring the sideband interference from Droitwich and Radio Paris within reasonable bounds.

All the controls are situated on the left-hand side of the motor board under the lid of the cabinet. The wave-range are calibrated with station names on the medium and long waves.

With the motor resistance adjusted according to the instruction book the power appeared to be just sufficient to prevent slowing of the turntable during loud passages, and it was noticed that the turntable speed was to some extent dependent upon the setting of the regulating resistance as well as upon the external governor control on the top panel. In changing from one supply to another, therefore, the motor speed should be checked and corrected, if necessary. The chassis is mounted against the left-hand side panel of the cabinet which can be removed for inspection of the under side of the chassis. The mains plug is devised so that the back panel cannot be removed without disconnecting the supply and the fuses are accessibly placed adjacent to the mains plug. In sets of this type it is to be expected that more

Marconiphone Model 395—
external heat is developed than with pure AC receivers and it is gratifying to note that every possible precaution by means of deflectors, etc., has been taken to ensure that this shall not interfere with the future reliability of the instrument.

To sum up, the Model 395 provides all that one can reasonably wish from the point of view of entertainment either from radio or records with an economical circuit specification, which has this great advantage, that it provides a set which is extremely docile to handle and is virtually incapable of producing distorted results.

RANDOM RADIATIONS

By "DIALLIST"

A Spate of Sets

SINCE the beginning of this year over one hundred and twenty new receiving set models have made their appearance on the market! Only a year or two ago all the new sets came along at the time of the Exhibition or just afterwards, and from Christmas until August novelties in receiving sets were almost as rare as water in the Sahara. The present policy of manufacturers is in many ways a good one. People are ceasing to think that they must wait till the Radio Show before replacing their old sets, and from this it follows that employment in the radio industry is becoming less of a seasonal affair. But I'm not quite sure that we aren't overdoing it a bit in the way of new types. A hundred and twenty in the first three months of the year is a pretty useful number—and it's not at all unlikely that there'll be a good few more between now and the Coronation. The vast majority of the sets that have so far seen the light this year are variations on the old theme of how to get rather more than you really ought to get out of three valves; but I note with joy that some bigger sets are amongst them.

News Out of Spain

SOMETIMES when you've been indulging in a little knob-twiddling in the medium and short wave bands and have been listening to copious news out of Spain from both Franco and Government stations it's rather disappointing to hear the B.B.C. report in its news bulletins that there is little or nothing to tell of happenings in that country. Myself, I find Spanish news direct from Spain of great interest. Not the smallest of its interest is to make a list of the victories, captures, advances and so on claimed by one side and then see how many of these are categorically denied by the other. The B.B.C. must be able to tap these news bulletins by way of Tatsfield. I suggest that they give us occasional samples of the way in which both sides are defeated and both victorious in the same battle. If the B.B.C. won't do so, the owner of a wireless set worthy of the name can always tune in Moscow and Rome and derive no little diversion from their commentaries in English on the Spanish news. I can assure you it's well worth while!

Impropaganda

ONE of the most amusing ways of wiling (I am not dropping an "h"; I maintain that the word is wiling and not whiling), of *wiling* away an hour with the wireless set is to tune in stations in some of the rather more deadly earnest countries whilst they are giving their talks and news in English. Whatever command their announcers may have of our queer language, it becomes almost instantly obvious that those who write what they have to read have very little familiarity with our still queerer mentality. Most of us are only faintly interested in politics—foreign politics, anyhow. You can't listen long to one of these propaganda talks without feeling pretty sure that it can cut absolutely no ice with British listeners. Hence, though your blood may occasionally display a tendency to boil at some of the things that are said, there is no need to get hot under the collar. The impropaganda talks are mostly too comic for anyone to take them seriously, unless he is totally bereft of a sense of humour. I, for one, am glad that we have adopted a policy of not answering back.

Les Mots Justes

IF you listened, as no doubt you did, to Professor Appleton's recent talk on Sunspots, you must have been struck by the peculiar aptness of one of his similes. "As the sunspots increase," he said, "there is a greater tendency for the sun to send out both bursts of ultra-violet light and swarms of flying atoms. When these reach the higher atmosphere *the reflecting properties of the layers are impaired. It is like breathing on a looking-glass.* I can't imagine any words that could have given the man in the street a clearer idea of the effects produced by the Heaviside and Appleton Layers on long-distance wireless reception and of the influence that outbreaks of sunspots have on them. A good many years ago H. G. Wells wrote that no department of human learning had more vital messages to give to humanity than science, but from sheer inarticulateness no department was less able to convey them. Men like Appleton, Bragg and Jeans have taken up that challenge and we are fortunate indeed in having them to put difficult things into such simple but vivid words that all who read or listen may understand.

America Predicts

Speaking of sunspots reminds me that the astronomers of the Mount Wilson Observatory in California, who make rather a speciality of solar work, predict that we are shortly to witness one of the biggest outbursts of sunspot activity that there has been for a century or more. Though there's still about a couple of years before the maximum is due we have already had some pretty useful manifestations; twice in recent months there have been sunspots easily visible to the naked eye, or, rather, the eye protected by a screen of smoked glass. If something still bigger and still more spectacular is to be expected we can be fairly sure that there will be some weird radio happenings. As it is, we have had some remarkable instances of short-wave and ultra short-wave reception over vast distances. No one can say what further wonders are in store as we approach the maximum period, reach it and begin to leave it behind us.

An Extra Valve ?

I'M wondering what improvements we shall see in this year's medium-priced sets, by which I mean those within the £12 limit. It's likely that there'll be many much cheaper sets incorporating simple three-valve superhet layouts; there will also be a fair sprinkling of sets selling at £20 and upwards. But the £12 receiver is sure to remain popular, for that is the kind of price that people have got used to paying. Some of these will no doubt contain signal-frequency stages. Every year production costs are lowered by the adoption of more and more scientific methods of manufacture. In 1937 it may therefore be possible to throw in an extra valve at the old price. If it is used for signal-frequency amplification it will mean greater sensitiveness as well as a reduction of "images" and self-generated whistles. But it may, of course, be employed for other ends. Some designers may plump for its use for ATC purposes; others may feel that the growing demand for better quality justifies its use on the low-frequency side of medium-priced sets.

Sets for All Purses

The fact that there are at least three different uses of an extra valve to improve the performances of what has become virtually the standard superhet in this country which jump to the eye gives one to think a bit. It means that any such set could become an altogether better thing if it had *three* extra valves; if, in other words, the superhet in general use contained six valves in addition to the rectifier instead of the now almost traditional three. Probably it would be impossible to market such a receiver, even with modern mass-production methods, at a price of £12 or so; but in view of its really superior performances couldn't the public be educated up to regarding a set at about £15-£18 as the normal medium-priced receiver? I think it could. We'd then have this very satisfactory position. For the man with a short purse who wants a reasonably good set there'd be the receiver at about £9, capable of bringing in home stations and a good many foreigners on the long, medium and short waves with acceptable quality; a far higher standard would be reached by the set priced at about twice as much, and for those who want the best there'd be the receiver with a dozen valves or more, costing from £25 to £40.

Making It Easy

IN the old days of wireless, when the operator of a receiving set had to possess a certain amount of skill, we had a vast array of knobs and switches on the panel and quite simple circuits within. It's almost axiomatic that the more you simplify your visible and tangible controls the more you must complicate the unseen "works" of a wireless set. So long as the average operator was skilled there was no need to make sets foolproof; but now that the great majority of sets are handled by folk who neither know nor want to know anything at all about what happens when you do this or that with a knob it is of paramount importance that in every possible way the correct tuning and the best quality of reproduction should be attained automatically. If manufacturers will realise these things *and stress them*, they shouldn't have much difficulty in showing the man in the street that the set that sells at a pound or two more is worth every penny of its extra cost. Will they do so? I hope that they will.

UNBIASED By FREE GRID

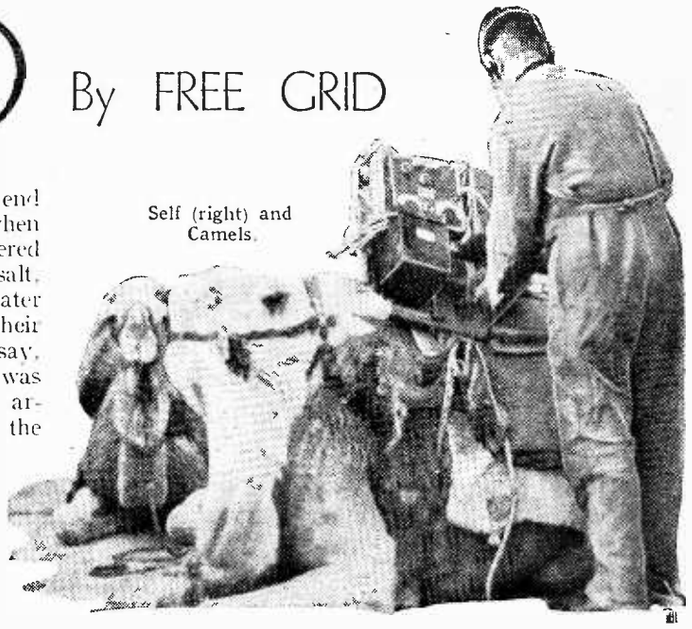
War-time Recollections

I SEE in my daily paper that the great *caravanserai* which cross the Sahara desert are now fully equipped with wireless so that they can keep in touch with civilisation during their journeyings. Reading about this has taken my mind back nearly twenty years when during the war I and some fellow scientists, at the special request of the Government, undertook the pioneer work of fitting the ships of the desert with wireless.

It was during 1917 when the German submarine campaign was at its highest, more especially in the Mediterranean, which was a veritable lions' den. In order to circumvent the enemy, the Government arranged that all ships bound for the Near-Eastern theatre of war should discharge their cargoes on the west coast of Morocco, to be transported from there to Egypt across the great Sahara and Libyan deserts by means of camels. Unfortunately, a great deal of loss and confusion were caused by the fact that the ships' officers who were put in charge of the camels were totally lacking in experience in the matter of desert navigation, with the result that frequently convoys of camels were unexpectedly turning up in Sierra Leone or Cape Town instead of Alexandria. Naturally this tended to dislocate the plans of the Allied High Command and added materially to the undue prolongation of the war.

Eventually it occurred to somebody at the Admiralty that if each camel were fitted with a complete wireless installation it would enable them to keep in touch with each other and with the various "land" stations on the north coast of Africa. I and my fellow scientists were immediately despatched to Egypt to commence the necessary experimental work and quickly had the first few camels fitted with suitable sets. Incidentally, I have dug out an old photograph which I reproduce herewith showing myself (stern view) adjusting one of the sets.

We were troubled at first by the lack of a suitable earth, the desert being notoriously dry and therefore entirely unsuitable. By a tremendous stroke of luck, however, one of the members of my staff recollected learning at school that camels carried water in their humps, and we at once got the Royal Army Veterinary Corps to operate on the animals and insert silver plates inside the humps in order to make good contact with the water. Even so, however, results were exceedingly poor, and we could not think what could be the cause of the trouble. We felt that we were on the right track, however, for after all if an ordinary sea-going ship uses water very successfully as an "earth" why should it not be equally suitable for a ship of the desert?



Self (right) and Camels.

We were at our wits' end to know what to do when somebody remembered that sea water is salt, whereas it is fresh water camels store in their humps. Needless to say, this little difficulty was soon remedied by arranging to provide the camels with salt water at all the filling stations—or oases, to use the old-fashioned name—in the desert. Immediately this was done we got really snorting results, and were just about to fit the entire fleet of camels with sets when we received a telegram to say that the war was over and ordering us to return home immediately.

To be strictly truthful, it was in 1922 that we received the telegram. We had been astonished in the midst of our labours to find among the many tourists who came out from Cairo to gaze at us and our "shipyard," several parties of Germans whom we very promptly made prisoners-of-war. It was in reply to our despatch reporting this that we received the telegram. The Admiralty department concerned had apparently forgotten all about us, although it must be placed to the credit of the Government's watertight departmental system that our salaries and supplies had continued to arrive regularly.

Per Scientiam Ad Astra

I AM one who never believes in taking anything for granted, and I am always chary of accepting other people's statements until I have proved their truth or otherwise by scientific experiment. Consequently, when I read the other day a statement by "Diallist" to the effect that the resistance of the human body was astonishingly low after a hot bath, I determined not to accept it as true without experimental verification. Indeed, I may say that my whole soul rose in revolt at the statement, which was manifestly untrue.

Experimental work in my bathroom.

The way I argued it out was this. Under normal conditions the pores of our skin are clogged with—pardon me, ladies—the natural exudations consequent upon the exercise of our daily functions, or, to put it in less scientific language, perspiration. These exudations are largely composed of *sodium bisomethingorother*, or, in other words, are salty.

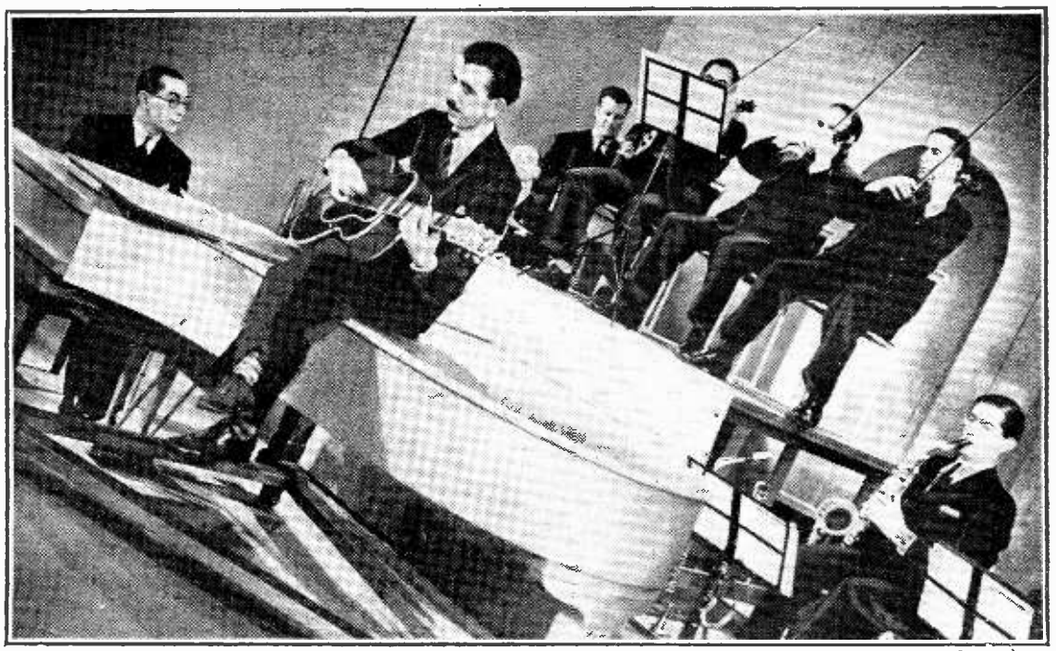
Now saline liquids are, as every schoolboy knows, very good conductors of electricity, far better than ordinary fresh water; it follows, therefore, that, in the normal state, the contact resistance of our bodies is extremely good, so that if we become connected in an electric circuit we receive a severe shock. The effect of a bath—even a cold one—is to cleanse our pores of these salty exudations, and to substitute fresh water, with the result that the contact resistance of our bodies rises considerably. In the case of a *hot* bath the cleansing effect, as everybody knows, is much greater, and therefore it follows logically that the contact resistance of the body is proportionately higher. Bathing, should therefore be regarded, not as a danger, but as a precautionary measure to be taken by all who dabble with high voltages.

These elementary physiological facts form, I think, a convincing argument against the veracity of "Diallist's" rash statement; but, as I have previously remarked, I never accept anything without experimental proof, and so I am proposing to carry out an elaborate series of tests in my bathroom. Should it so happen, therefore, that my usual contribution does not appear in next week's issue of *The Wireless World* you will know that "Diallist's" statement was correct after all.

Listeners' Guide f

Outstanding Br

TO hear the Prime Minister broadcast twice in four days is an unusual experience for listeners. This will, however, occur during the next week, the first occasion being on Tuesday, when he will speak at the dinner given in his honour at Grosvenor House, Park Lane, by the Federation of British Industries. His speech will be broadcast in the National programme at 9.20. On Friday, April 16th, he will be the first speaker in the new series of important broadcast talks on "The Responsibilities of Empire." In this series he will be followed by many famous statesmen within the Empire, some of whom will be members of Coronation delegations from India and the Dominions.



SAVOY MEMORIES is the title of a reminiscent programme of twenty-five years of dance music to be given on Tuesday at 8.10 (Nat.) by Carroll Gibbons and the Savoy Hotel Orpheans. He is here seen with some of the Orpheans during a recent television broadcast. Among those we shall hear in this programme are Debroy Somers, Billy Mayerl and Rex Palmer.

A.B.C.

A NEW variety feature entitled "The B.B.C. Presents the A.B.C." will succeed "In Town To-night" as from this Saturday. It has been devised by Alan Keith, the promising young writer, who as an actor is already well known to listeners for his radio performances. On twenty-six successive Saturday evenings, except for Coronation week, one for each letter of the alphabet, the feature will deal with people and things whose names begin with the appropriate letter. Thus the first programme will be introduced by a celebrity whose surname initial is A. The programmes will not necessarily consist solely of talks and interviews. Outside broadcasts may be introduced, and telephone calls will enable well-known people in Europe to take part. The feature will be broadcast at 7.30 (Nat.), produced by A. W. Hanson, who has been responsible for "In Town To-night" since its inception in October, 1933.

"THE FIRST DAYS OF STEAM"

THE Atlantic was crossed under power for the first time nearly a hundred years ago—in April, 1838. Addressing the British Association on steam navigation a month or two previously, Dr. Lardner was voicing popular opinion when he remarked, "As to the project of making a voyage under steam from Liverpool to New York, one might as well talk of a voyage from Liverpool to the moon." The first steamship to set out for New York was the paddle vessel *Sirius*. Built of wood, she carried ninety-four passengers, took nineteen days to make the passage, and had a gross tonnage of 703.

"The First Days of Steam" programme on Sunday at 9.5 (Nat.) will be an imaginary account of that historic voyage compiled from the actual ship's log by Alexander Bone, the well-known nautical writer.

Details of this week's Television programmes will be found an p. 361.

FIRE WALKING

AN unusual type of O.B. comes to Regional listeners today (Friday). At Carshalton, Surrey, the University of London Council for Psychical Investigation is to see a demonstration of fire walking by Ahmed Hussain. Although this seems much more fitted for a television O.B. than a "sound" broadcast, it should be none the less interesting for those who are able to listen in the early afternoon. For a quarter of an hour from 1 o'clock, listeners will be told of the preparations being made in readiness for the walk, then at 2.50 they are to hear a commentary on the walk itself.

SWING

ADMIRERS of the hotter forms of jazz will no doubt welcome the B.B.C.'s decision to give a regular place in the quarter's programmes to "live" swing music. Weekly broadcasts will be given alternately from London and abroad. Last week Duncan White and his orchestra opened the series. On Wednesday at 7 (Nat.) Willy Lewis and his Negro Band will be heard from Paris. Other famous Continental bands to be heard include Kai Ewans from Stockholm, the Ramblers from Holland, and the Quintette du Hot Club de France.

PIANOFORTE

RAWICZ and Landauer, the well-known pianists, will give a recital for two pianos on Sunday at 4 (Reg.). Their programme will include an arrangement of Tchaikovsky's "Nutcracker Suite."

The Sunday Orchestral Concert which will be broadcast this week at 9.5 (Reg.) will be conducted by Sir Henry J. Wood. The programme includes William Walton's Sinfonia Concertante for piano and orchestra, the soloist being Clifford Curzon.

On Tuesday, Franz Reizenstein will give a recital at 6 (Reg.), during which he will play his own suite for pianoforte. This will be the first broadcast performance.

Solomon will give a recital with Antonio Brosa in the National programme at 10.20 on Thursday.

SPORTS

FROM 2.30 until 3.15 on Saturday, National listeners will be given a commentary on the play in the final stages of the match at the Queen's Club, West Kensington, between D. S. Melford (Gt. Britain) and N. Setzler (U.S.A.), for the World's Open Racquets Championship. Later in the afternoon the Public Schools Sports at the White City Stadium and the Empire Trophy Motor Race at Donington Park will provide commentaries. At 4 and 4.50 the switch will be put over to

r the Week

asts at Home and Abroad

the White City, where H. M. Abrahams will be waiting to tell listeners of the progress of events. At 4.25 and 5.5 Donington Park will be switched in to allow F. J. Findon and Graham Walker to give commentaries on the Empire Trophy Race of the British Racing Car Drivers' Club.

The heavyweight boxing match between Tommy Farr and Max Baer at Harringay Arena will be described by Howard Marshall for Regional listeners at 9.30 on Thursday.

BLENHEIM PALACE ORGAN

ON Thursday, at 8, Regional listeners are to hear a Midland programme which is the first of a resumed series entitled "Midland Organs and Organists." The Duke of Marlborough has consented to a recital being broadcast on the organ at Blenheim Palace, Woodstock. A description of the organ will also be included. This, it is hoped, will be given by the Duke himself.

The organ, one of the finest instruments in the country, was installed in the Long Library at Blenheim Palace in 1891. Engraved over the console is the following inscription, written by the eighth Duke of Marlborough: "In memory of happy days, and as a tribute to this glorious home, we leave thy voice to speak within these walls when ours are still." G. D. Cunningham, City of Birmingham organist, who has played several times at Blenheim, will give the recital.

CITY OF BIRMINGHAM ORGANIST. G. D. Cunningham, who will give the recital from Blenheim Palace on Thursday. He will also conduct the City of Birmingham Choir and Orchestra in Part 1 of Bach's Mass in B minor at the Town Hall on Saturday. (7.30, Reg.)

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NAPOLEONIC

ANTHONY ELLIS'S second radio play on the subject of Napoleon comes into this week's programmes; the title is "His Father's Sword." The first play was "Brumaire," which was broadcast in 1935. The story is a brief account in dramatic form of Bonaparte's wooing of Josephine de Beauharnais, widow of the Vicomte Alexandre de Beauharnais, at one time Commander of the Revolutionary Army of the Rhine, but later executed as an aristocrat and a traitor against the Republic.

It is an imaginative reconstruction of the episode, and in writing it Anthony Ellis has availed himself of the dramatist's licence and selected those incidents which best accentuate the story, accepting as authentic material of doubtful historical exactitude.

As a very small boy Anthony Ellis listened to his Dutch grandmother's personal memories of the "Little Corporal." The old lady retained vivid memories of the days when the French troops were billeted on her father's farm. The play will be broadcast on Tuesday at 7.30 (Reg.) and Thursday at 9.20 (Nat.).

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OPERA

THOUGH first produced in 1890, Tchaikovsky's wonderfully vivid Russian tragic opera, "The Queen of Spades," otherwise known as "Pique Dame," only reached London in 1915. Pushkin's story describes a degenerate phase in the Russia of Catherine the Great. Acts I and II of this opera will be relayed from the Municipal Theatre, Berne, by Beromünster at 7 tonight (Friday). Statkowski's "Marya" comes from Warsaw at 7.5 on the same day. Statkowski won the first prize at the International Opera Competition held in London in 1903.

Sunday's performance of Stravinsky's "L'Histoire du Soldat" from Radio-Paris at 3 will interest those who love the ultra-modern. Strictly speaking, it is not an opera, but according to the standard works of reference, a "story told, acted and danced."

Tuesday brings something new from the 120-kW Rennes station. It is excerpts from Darius Milhaud's Opéra-Bouffe, "Esther de Carpentras." Milhaud is still a novelty to most of us, despite the recent B.B.C. performance of his "Christopher Columbus." At the present time he seems to be at the height of his powers, for almost every other week sees some new work of his produced on the French stage. The present broadcast will be preceded by Saint-Saëns' one-act "La Princesse Jaune," at 7.30. Produced in 1872, this was an utter failure, but has since won its way.

THE AUDITOR.

HIGHLIGHTS OF THE WEEK.

FRIDAY, APRIL 9th.

Nat., 7.30, Al Collins and his dance orchestra. 9.30, I Was There; Scott's last expedition.
Reg., 6 Recital, Laelia Finneberg (soprano) and Gordon Walker (flute). 8.45, B.B.C. Orchestra (E), conductor Glav Kielland.
Abroad.
Beromünster, 7, Acts I and II of Tchaikovsky's "The Queen of Spades."

SATURDAY, April 10th.

Nat., 7.30, A.B.C.: An alphabetical miscellany. 8, Music Hall. 9.20, London is not England—Manchester programme.
Reg., 6, The Fol-de-Rols. 9, B.B.C. Theatre Orchestra.
Abroad.
Stuttgart, 7.10, Variety: Part I—an evening with Robert Stolz Part II—popular music.

SUNDAY, APRIL 11th.

Nat., 7.15, Violin recital, Isolde Menges. 9.5, The First Days of Steam, a feature programme. ¶B.B.C. Theatre Orchestra and Dmitri Smirnoff (tenor).
Reg., 4, Rawicz and Landauer; two pianos. 9.5, Sunday Orchestral Concert.
Abroad.
Frankfurt, 7, "In Grandfather's Days"—visit to a dance of 1890 with a German and an American reporter.

MONDAY, APRIL 12th.

Nat., 6.40, From the London Theatre. ¶The Music Shop—14. 7.45, The Adventures of Mr. Penny.—2.
Reg., 8, Songs You Might Never Have Heard—VII. 9, B.B.C. Theatre Orchestra and Alfredo Tomasini.
Abroad.
Radio-Romania, 8, European Concert of Lithuanian music.

TUESDAY, APRIL 13th.

Nat., 8.10, Savoy Memories. 9.20, The Rt. Hon. Stanley Baldwin.

Tuesday, April 13th—(*continued*)

Reg., 6, Pianoforte recital; Franz Reizenstein. 7.30, "His Father's Sword." ¶The Lass of Richmond Hill; the true story behind the old song.
Abroad.
Strasbourg, 7.30, Mozart concert by the orchestra of the Mozarteum Salzburg.

WEDNESDAY, APRIL 14th.

Nat., 7, Willy Lewis and his orchestra, from Paris. 7.45, and 9, The Symphony Orchestra at the Town Hall, Leeds
Reg., 8.30, B.B.C. Singers (B). 9.20, Callender's Senior Band.
Abroad.
Radio-Paris, 7.5, Verdi's "Rigoletto" from the Grand Théâtre, Bordeaux.

THURSDAY APRIL 15th.

Nat., 7.40, Star Gazing; Edith Day. 9.20, "His Father's Sword." ¶Recital: Antonio Brosa and Solomon.
Reg., 7.40, "The King's Pardon," short story. 8, Midland Organs and Organists. 9.30, Commentary on Farr-Baer fight.
Abroad.
Radio Toulouse, 9.35, Excerpts from "Véronique" (Messager).

BEBE DANIELS and her husband, Ben Lyon, before the H.M.V. recording microphone. They appear with Billy Bennett, Tessie O'Shea and Teddy Brown in this week's Music Hall. (Sat. 8, Nat.).

About Push-Pull

THE BASIC SYSTEM EXPLAINED

By "CATHODE RAY"

THIS is going to be very simple. Readers who, like me, are looking around for clear definitions of all the alphabetical barnacles that have grown around the original Push-Pull will not find them here. I think I know my "ABC," so long as it goes no further than that, but the other day I saw some reference to Class "D," and that leaves me one behind again.

No; for the benefit of any who would be unable at a moment's notice to give five reasons for preferring push-pull this is just going to be a simple account of the ordinary common variety, or, if one must be alphabetical, Class "A"; with perhaps an occasional reference to Class "B" thrown in.

First, briefly, what push-pull *is*. When it was invented, 22 years ago, valves were not very good. The characteristic curves were so short that they could effectively amplify only the positive half-waves of signal (Fig. 1 (a)). That is the same

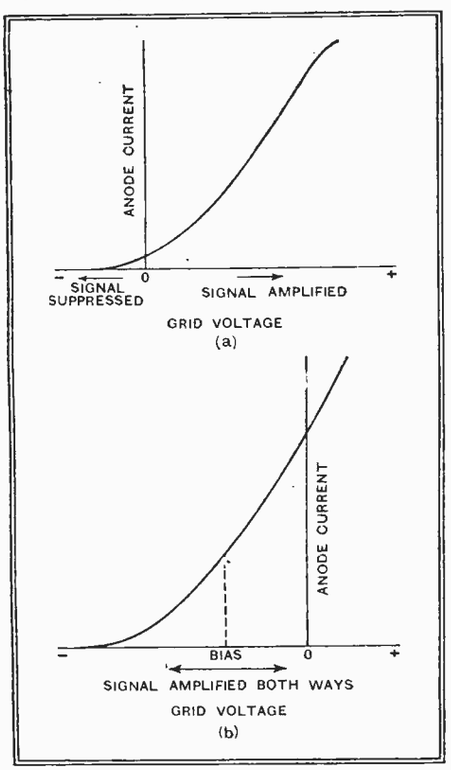
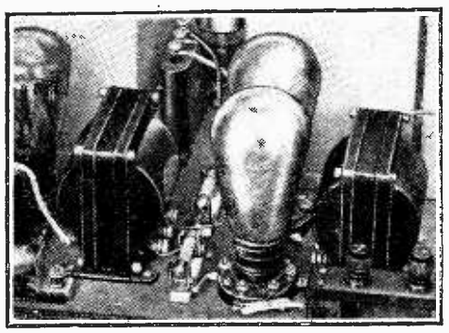


Fig. 1.—(a) Typical characteristic curve of very ancient valve (also of modern Class "B" valve). The negative half of the signal applied to the grid produces negligible effect, even if no negative bias is used. (b) Curve of typical power valve. When biased negatively there is still room for amplifying both halves of the wave, the positive slightly more than the negative, however.

thing as saying they worked as "anode bend" rectifiers. In the early days of radio nobody worried very much if an



amplifier left out one half of the signal so long as it made a good loud noise with the other half. But at the date mentioned the idea of distortion and how to avoid it was beginning to occupy men's minds. If only the positive half-waves are amplified, distortion is very bad.

Now *negative* is simply positive reversed, so if another valve is connected "upside down" in the circuit then what is negative to the first valve, and therefore ignored by it, is positive to the second, and therefore amplified. So one valve deals with all the originally positive halves and the other with all the halves originally negative but reversed to look positive; and by putting the amplified products together again in the right order the result is a complete undistorted amplified wave.

Fig. 2 shows the basic circuit. At the date in question grid bias was not used, for valves then were near the "lower bend" even with no bias; with it, they would have been silenced altogether. Suppose, then, that only the upper valve is working. The output consists of positive halves only. Now if the lower valve is put in, at every moment when the upper valve receives a negative signal, and is therefore idle, the other (being connected to the input transformer the opposite way round) is getting a positive signal, which it is amplifying. The contributions from the two valves are put together again by the output transformer. It is like a couple of men who can push but not pull, sawing a log with a two-handled saw, sitting one each side and making themselves responsible for alternate strokes of the saw, instead of one man (or two men) sitting one side and having to do both pushing and pulling. ("Which, I suppose" you say "is why the *former* arrangement is called push-pull!" Well, as a matter of fact, it should strictly be called "push-*push*." But see on.)

As valves improved and became able to amplify both halves of a signal wave at once (Fig. 1 (b)), this system was abandoned; to be revived later for another reason, under the name of Class "B."

But although the development of power valves capable of handling the whole of a signal without serious distortion semed to make this type of circuit superfluous, actually it did not, as there were still several good reasons for continuing to use it. In fact, it is more popular at the present day than ever before.

Firstly, although a modern valve can amplify the whole wave, it never does it perfectly. At this stage we must distinguish between triodes and pentodes. Because the triode gradually becomes less effective as the grid voltage is made more negative, the negative halves are never

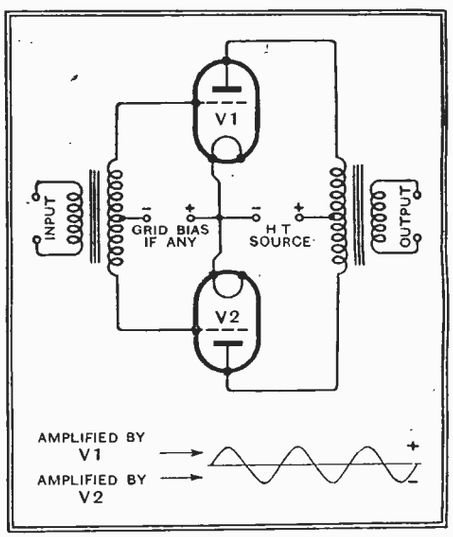


Fig. 2.—Basic push-pull circuit. One cannot definitely tell from the diagram what "Class" it is.

quite so full-grown as the positive (remember that what are called positive grid voltages are so relative to the negative grid bias; the grid, with the present system of working, is never driven actually more positive than the cathode). The lopsided wave thus produced is equivalent to an undistorted wave plus an added wave of double the frequency; in other words, a second harmonic. A triode valve causes second-harmonic distortion. The pentode, as usually adjusted, does not unbalance the wave in this way but it introduces a sort of S-shaped twist—a third harmonic.

From what has gone before, it should be clear that the lopsidedness due to triode amplification can be put right by using two valves as in Fig. 2. Both valves are now working all the time, like two men each alternately pushing and pulling a saw. But if each man is a little weaker in the pulling, it is an advantage to have this compensated by the strong push of his mate, which can be done if they take

About Push-Pull—

opposite positions. This, then, can legitimately be described as push-*pull* although the circuit is identical with push-*push*. The circuit itself is often loosely called the push-pull circuit, however used.

This balancing out of distortion means that two valves in push-pull give double the output of a single valve with less distortion, or more than double output with the same distortion. So far as triodes are concerned, this is a reason why push-pull is preferable to the same two valves in parallel, or one valve double the size. As the most serious part of pentode distortion is already equally balanced, this argument does not hold good for pentodes.

The reason just given is the usual answer to the question about the object of using push-pull. There are others.

Avoiding Magnetic Saturation

When a large output power is wanted, the design of the output transformer gets very difficult. If a single power valve is used, or several in parallel, there is a large steady current from the HT supply flowing through the primary winding from end to end. It magnetises the iron core so strongly that unless it is very massive indeed it is magnetically saturated—loses most of its virtue for the purpose. Then, when the valve is working to give a large output, this current alternately falls nearly to zero and rises to nearly double normal. Unless the iron core is very generously proportioned, the saturation effect tends to cut the above-normal peak as compared with the below-normal. In other words, harmonic distortion again.

But by connecting in push-pull (and assuming each valve draws its proper half share of current) then half of the current flows one way round the primary coil, and the other half the other way, completely neutralising the magnetisation. The core can therefore be made quite small even for a large feed current. Moreover, the magnetisation due to the signal starts from zero instead of from a strongly magnetised level, so there is less risk of the peaks being distorted.

The output transformer is one of the most expensive items in a good amplifier, and the saving on this alone due to push-pull may more than pay for the second valve! Another costly item, if the power is very large, is the smoothing choke, and for the same reason. Push-pull doesn't enable the heavy feed current—"polarising" current—to be split into opposing camps, but it does help in another way. A push-pull stage can tolerate very sketchy smoothing—it has even been worked with no smoothing choke at all—because any ripple that is left over from the smoothing condenser sends currents through the valves in such a way that they cancel out so far as any effect on the output transformer secondary is concerned. Hum from other causes—grid bias or heaters—also tends to balance out. It is true that the earlier stages in the amplifier still need adequately smoothed HT, but as the current to be dealt with is relatively small a cheap resistor or tiny choke may do all that is required.

Even in this part of the circuit push-pull is helpful. If it is not used, the working of the output stage causes large signal currents to circulate through the HT supply, and, owing to the considerable smoothing impedance required there, these currents cause corresponding fluctuations of voltage that are passed on via the HT feed to the earlier stages. Thorough decoupling is then needed to prevent trouble. But with push-pull the signal current in the HT supply is practically nil, and these precautions may be greatly relaxed.

There are other advantages for special purposes. Line telephone amplifiers use push-pull so that the system is balanced with respect to earth, and, therefore, less liable to cause "cross-talk" (interaction between lines, which may ultimately result in other sorts of cross talk).

Television receivers use it for the deflector voltages applied to the scanning plates of the cathode-ray tube. Although the power involved is quite small, single valves are undesirable because they would cause the average voltage at that part of the tube to vary, which would have the effect of defocusing the spot of light. Push-pull makes one plate negative while the one opposite is positive, so keeping the average steady.

Ultra-high-frequency oscillators are often connected in push-pull, because a balanced system is more likely to work well when unbalanced stray capacities have such vital influence as in ultra-short-wave work.

I mentioned that the original purpose of a balanced circuit, used as push-*push* or Class "B," has long since disappeared; and what I have been describing is true push-pull or Class "A." The reasons for the revival of Class "B" are too complex to dismiss in a sentence, so perhaps they will do for the next time.

The Radio Industry

PHILCO receivers will in future be distributed throughout London and the Home Counties by Philco Southern Distributors, Ltd.; this firm is transferring its headquarters from Redhill to London.

The five Lockheed Electra aircraft recently purchased by British Airways have been equipped by Standard Telephones and Cables with Lorenz Blind Approach Receiving equipment. The complementary Lorenz ground apparatus has been installed at Gatwick and Croydon airports.

Radiometers, Ltd., of Eagle House, Jermyn Street, London, S.W.1, informs us that a new Data Book for use with the Universal Valve Tester will shortly be available. The book, which will be in loose-leaf form, is to cost 2s. 6d., and the contents will be arranged for speedy reference.

A central receiver feeding ten separate loud speakers has been installed at the Savoy Hotel by Ismay Distributors. The basic unit is a Halcyon Model A581 chassis, which feeds a 20-watt amplifier.

R.C.A. Photophone, Ltd., have recently installed high-fidelity sound reproducing equipment at Radio Luxembourg.

The Television Receiver

VI.—THE OUTPUT STAGE

By W. T. COCKING

IN dealing with the output stage of a sound receiver we are accustomed to think in terms of power, for the loud speaker which it feeds is a power-operated device. The cathode-ray tube adopted for television, however, is voltage-operated, and requires power no more than an ordinary valve which is functioning with adequate negative grid bias. Since the tube needs an input of something like 30 volts p-p only, it would at first appear that the output stage of a television receiver would not offer any particular difficulties.

The input voltage required by the tube must be developed across a coupling impedance, however, and we have seen in the earlier articles in this series that because of the enormous range of frequencies involved this impedance must be of low value. It follows that an appreciable amount of power is required in order to develop the necessary voltage across a low impedance. Although the tube itself does not require a power input, as does a loud speaker, the voltage for operating it cannot be produced without the expenditure of power in the coupling.

If we feed the CR tube directly from the detector in the manner described in Part V, then for a tube input of 30 volts p-p the detector input must be about 15 volts RMS for a voltage-doubler detector, 30 volts RMS for a single diode, and 60 volts RMS for a push-pull detector. This input voltage must be developed across the intervalve coupling by the last RF or IF valve, and quite a large amount of power is involved.

For a moderate degree of sideband cutting with a single tuned circuit the coupling impedance at resonance should be no more than 1,000 ohms when a band-width of 4 Mc/s is required. Since power is equal to E^2/R, we find that the power output should be 0.225, 0.9, and 3.6 watts for the three detectors enumerated above. Actually, of course, a single tuned circuit is an unsuitable coupling for either the voltage-doubler or the push-pull detectors since each requires a transformer which is really the equivalent of a band-pass filter. This type of coupling is also more suitable for the single diode, since it permits the attainment of a higher load impedance on the valve for a given frequency response.

The power required, however, does not seem excessive in view of the amounts to which we are accustomed in sound reproduction, but when we examine the case in detail it will be seen to be quite difficult to obtain it. An output-type pentode will give an output of some 2.5-3.5 watts with moderate distortion, but only when it has a load impedance of some 5,000-10,000 ohms, according to the exact valve used. In television IF circuits, however, we cannot employ a load of more than about 2,500 ohms at most, and even that only under the most favourable circumstances.

THE considerations affecting the design of the output stage of a television receiver are discussed in this article. Particular attention is paid to the case when this valve is also the last IF amplifier

Suppose we find a valve which will give 3 watts into a load of 5,000 ohms, what voltage are we likely to get in a load of 2,500 ohms? When a pentode is used with a low-impedance load the output voltage across the load is roughly proportional to the load impedance. Three watts in a 5,000-ohm load means a voltage of 122.5 volts across it, so that if we use a 2,500-ohm load we cannot expect to obtain more than 60 volts across it. It is only in the most favourable circumstances that we can use such a high load, however, and if we can employ only 1,000 ohms we can develop only about 25 volts across it.

An exact solution can be obtained by the usual graphical process from the valve curves, but it must never be forgotten that it is not always easy to apply the full voltage to the detector. There is always some loss of voltage in the diode load resistance by-pass condenser, and this is appreciable with low intermediate frequencies. Accurate calculation is consequently difficult, and computation should not be relied on, but should be checked by measurement.

Various arrangements have been tried by the writer, and among them the following give a useful guide to the results obtainable. In every case the last IF valve was an N43 pentode.

(1) Single diode detector in receiver for single-sideband operation at an IF of 4.5 Mc/s. Series-resistance type coupling to detector. Max. undistorted output = 20 v. p-p.

(2) Voltage-doubler detector in single-sideband receiver at 3.5 Mc/s. Transformer coupling to detector. Max. undistorted output = 30 v. p-p.

(3) Single diode detector in receiver for double-sideband operation at 10.0 Mc/s. Transformer coupling to detector. Max. undistorted output = 30 v. p-p.

(4) Voltage-doubler in receiver for double-sideband operation at 8.0 Mc/s. Transformer coupling to detector. Max. undistorted output = 60 v. p-p.

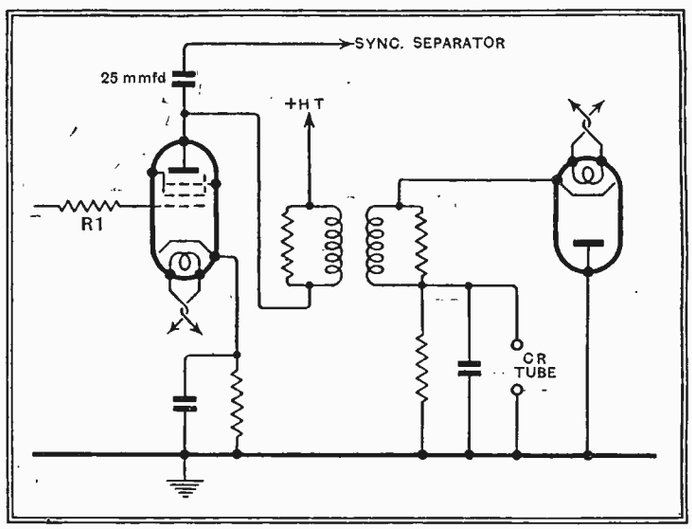


Fig. 16.—At high intermediate frequencies sufficient output can be obtained with a single diode detector and an N43-type pentode for the last IF valve.

With the N43 valve it is possible to secure a 30-volt p-p detector output from a single diode provided that transformer coupling is adopted and that the intermediate frequency is not lower than 8.0 Mc/s. If the frequency must be lower than this, then it will be necessary in most circumstances to use a voltage-doubler detector.

The N43 can be successfully employed as an IF valve provided that the frequency is not too high; the writer has used it successfully at 10.0 Mc/s in the circuit of Fig. 16. The grid-stopper R1 of 50 ohms is necessary to prevent parasitic oscillation. The coupling transformer is tuned by the stray capacities, and each winding must be experimentally adjusted for resonance at the intermediate frequency. The coupling must be tightened sufficiently to enable the required band-width to be obtained, and the resistances then chosen to smooth out the peaks in the response. As

The Television Receiver—

a guide to those interested, it may be said that for 10.0 Mc/s the writer has used coils wound end to end on a 0.75in. diameter former, the gap between primary and secondary being about 1/32nd inch. The secondary needed 38 turns of No. 32 DSC and the primary 20 turns only, the difference being occasioned by the difference in

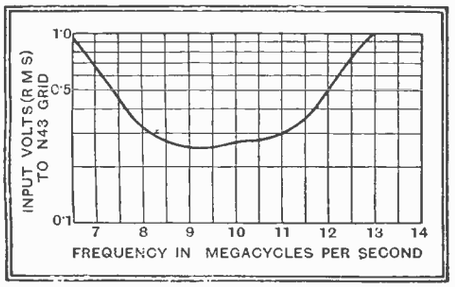


Fig. 17.—The frequency-response curve of the transformer coupling used in the last stage.

the stray capacities. Incidentally, the primary capacity is rather heavy on account of the N43 and also because of the sync separator.[1] With a primary shunt resistance of 3,500 ohms and a secondary shunt of 10,000 ohms, the resonance curve of Fig. 17 was obtained. The curve was taken with an unmodulated input to the N43 grid and for a constant rectified voltage across the diode load resistance of 3 volts. At 10.0 Mc/s the N43 input was 0.27 volt RMS, so that the ratio of detector output/N43 input is $3/0.27 = 11.1$; this figure is also the effective ratio between the detector peak-to-peak output and the N43 RMS input on 100 per cent. modulation, so that it represents the effective gain of the last IF valve taking into account the AC/DC conversion efficiency of the detector. For a 30 v. p-p output, therefore, the N43 must have an input of 2.7 v. RMS.

The N43 has a very low grid-anode capacity—for an output-type pentode. Actually, it is about 0.3 $\mu\mu$F, and is very high for operation at radio frequency. Owing to the low efficiency of the circuits, however, it is quite possible to use it at 10.0 Mc/s (30 metres), but even so there is considerable feed-back through the capacity, and it is not easy to design the coupling of the penultimate stage by calculation. In the writer's opinion, the valve would probably become unusable at much higher frequencies unless neutralisation of the grid-anode capacity were adopted. It would almost certainly be impossible to use it in a straight set at 45.0 Mc/s.

Because of this, one is usually forced to adopt VF amplification if a high operating frequency is used. Actually, a vision frequency output stage is in any case more economical so far as the output stage itself is concerned. In the first place, the bandwidth is halved, with the result that the load impedance is doubled and the power output halved; and, secondly, the detector losses come before instead of after the power stage, so that the power output is still further reduced. Instead of a power output of 0.2-3.0 watts being needed, it can be as small as 0.032 watt (30 v. p-p across 3,500 ohms), and it is just possible to obtain this from an RF pentode.

The use of VF amplification has certain disadvantages, as pointed out in Part II, but its superiority in the matter of power output may lead us to reconsider the advisability of including it. Should we for any reason decide to adopt a high intermediate frequency we shall be practically forced to use it.

[1] *The Wireless World*, January 22nd, 1937.

Television Programmes

Transmission times are from 3-4 and 9-10 daily.

Vision 45 Mc/s. Sound 41.5 Mc/s.

FRIDAY, APRIL 9th.

3, Chief Os-Ke-Non-Ton in North American Red Indian songs. **3.10,** Friends from the Zoo. **3.25,** Gaumont-British News. **3.35,** Scenes from a new cabaret now running in the West End.

9, Beatrix Lehmann and Ernest Milton in scenes from Shakespeare's "Richard III." **9.10,** Repetition of 3.10 programme. **9.25,** British Movietonews. **9.35,** Repetition of 3.35 programme.

SATURDAY, APRIL 10th.

3, Living History—the use of models in teaching history. **3.20,** John Carr's Jacquard Puppets. **3.35,** British Movietonews. **3.45,** "Thomas and Sally or The Sailor's Return"—dramatic pastoral composed by Dr. Arne.

9, Repetition of 3.20 programme. **9.15,** "Queue for Song," a little show. **9.35,** Gaumont-British News. **9.45,** Repetition of 3.45 programme.

MONDAY, APRIL 12th.

3, Fashions for cruising—parade of clothes for sea travel. **3.15,** British Movietonews. **3.25,** Cabaret Cruise.

9, Repetition of 3 programme. **9.15,** Gaumont-British News. **9.25,** Repetition of 3.25 programme.

TUESDAY, APRIL 13th.

3, Vienna Boys' Choir. **3.5,** The World of Women. **3.20,** Gaumont-British News. **3.30,** Henry Hall and the B.B.C. Dance Orchestra.

9, Repetition of 3 and 3.5 programmes. **9.20,** British Movietonews. **9.30,** Dorset Garden; a miniature restoration revue.

WEDNESDAY, APRIL 14th.

3, Snooker; exhibition of play by Horace Lindrum and Willie Smith. **3.10,** Preview of Daffodil Show. **3.20,** British Movietonews. **3.30,** Forty-fifth Picture Page.

9, Music Makers, Alfredo Tomasini. **9.10,** Repetition of 3.10 programme. **9.20,** Gaumont-British News. **9.30,** Forty-sixth Picture Page.

THURSDAY, APRIL 15th.

3, Comedy Act. **3.5,** Masks through the Ages—II. **3.20,** Gaumont-British News. **3.30,** "Ad Lib."; a revue by Herbert Farjeon.

9, Henry Hall and the B.B.C. Dance Orchestra. **9.30,** British Movietonews. **9.40,** Repetition of 3.5 programme. **9.55,** Comedy Act.

Current Topics

EVENTS OF THE WEEK IN BRIEF REVIEW

Norwegian Concession to Tourists

FOREIGN tourists who take wireless receivers with them to Norway are to be exempt from the necessity of obtaining a Norwegian listener's licence provided that their stay does not exceed eight weeks. This ruling applies to any type of wireless set irrespective of whether it be carried in a car, a yacht, or in any other manner.

Mountaineers' S O S.

THE possession of a trans-receiver has been the means of saving the lives of certain members of a scientific expedition engaged in exploratory work in the Andes. Some members of the party became separated from the main body during a blinding snowstorm at an altitude of over 6,000 ft. A call for help was picked up at the base and a relief party immediately set out. The lost explorers were eventually located and rescued.

Well-known Wireless Personality Dead

BY the death of Brigadier-General Sir Capel Holden on March 30th, at the age of 81, wireless loses one of its oldest enthusiasts. Sir Capel Holden, who was Director of Mechanical Transport during the War, always took a great interest in wireless matters, and in 1927 became President of the Radio Society of Great Britain.

Pirate Transmitter Baffles German Police

APPARENTLY the German authorities are not so good at tracking down illegal wireless transmitters as is the British G.P.O. For some time past the resources of the German radio detectives have been directed to the unearthing of a transmitter accused of broadcasting subversive propaganda. The Government direction-finders appear to differ as to the location of the station, not only from day to day but almost from hour to hour. It would appear, therefore, that either the station is a mobile one or that there are a number of them, each working according to a pre-arranged time-table.

The International Musical Festival

SEVERAL sessions of the annual Music Festival organised by the International Society of Modern Music, which will be held in Paris this year, are to be broadcast by all French stations. The Festival will be held from June 20th to the 27th during the International Exhibition.

Coronation Ceremonies and Recording

ALTHOUGH anybody is at liberty to relay to the public any ceremony or musical programme broadcast by the B.B.C. in connection with the Coronation, they must not record them except by permission of the Earl Marshal. The Performing Right Society has waived all fees for the relaying of copyright music broadcast during the festivities.

French Licence Figures

IN France crystal-set owners do not pay so much for their licences as valve-set users. For crystal sets 15 francs per annum is demanded. There are 67,369 of these licences in use. Valve-set users make up by far the greater part of French listeners, there being no fewer than 3,642,944 of these out of a total of 3,759,690. These pay 50 francs each. Receivers used for free public listening contribute the sum of 100 francs per licence, while, if a charge is made for listening, 200 francs is payable.

Station Migrating

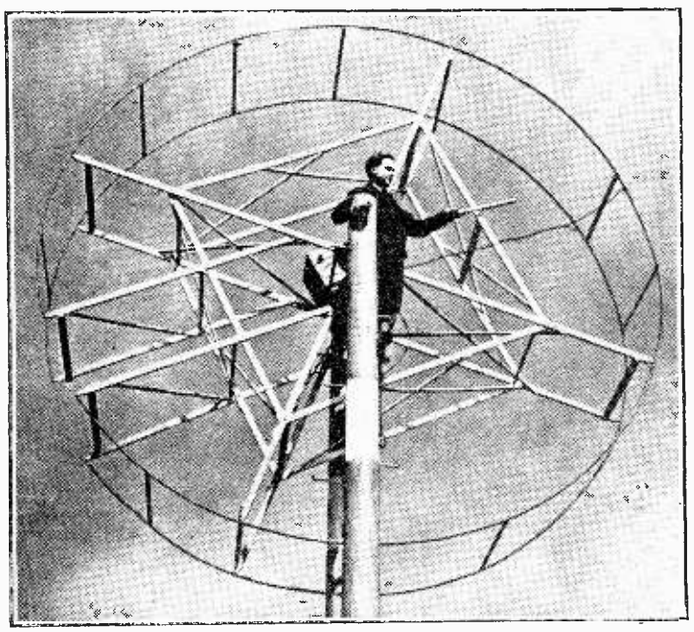
A WIRELESS station with a mast nearly 500ft. high is being built at Argenteuil by the French N.B.C. (Compagnie Nationale de Radiodiffusion). This will be the new transmitter for the Radio-Cité station. The studios will remain in Paris.

A Trip to Paris

REMARKABLE enterprise is being shown by the Southall Radio Society, who are arranging a special trip to the French Radio Show. The party is not restricted to members of the Society, and other wireless enthusiasts will be gladly welcomed. The cost will be about £2 per head, and no passports will be required. It is proposed that the party should leave on Friday evening (May 21st) and return on the following Sunday. Those interested should get into touch immediately with Mr. S. Gould, 3A, Argyle Road, West Ealing, London, W.13, who will be glad to furnish full particulars of the exhibition and travelling arrangements.

Paris Exhibition News

IT has been decided that the S.P.I.R. (Syndicat Professionnel des Industries Radio-Electriques) and the C.S.I.R. (Chambre Syndicale de L'Industrie Radio-Electrique) will have a collective stand in the International Exhibition in the Grand-Palais des Champs-Elysées. The S.P.I.R. is to have its own Spring show from May 14th to the 30th in the Palais du Neó-Parnasse in the Boulevard Raspail, while the C.S.I.R. will exhibit in the Foire de Paris during May. There will be no official Salon in September this year.



DIRECTIONAL LOOP. This 20ft. aerial, installed at the Grand Central Air Terminal, Glendale, California, is part of a new long-range transmitting station serving the whole of the American trans-continental aircraft route.

Manchester Anticipates Trouble

IT has been announced that before very long trolley buses will replace trams in Manchester. This has caused a certain amount of uneasiness among listeners, who have heard reports of very severe interference in other districts in which trolley buses have made their appearance.

The Manchester City Transport manager has, however, intimated that all buses will be fitted with suitable suppressors in order to prevent any trouble of this nature.

Sound Effects on Sale

A NEW company is said to have been formed in America to record every possible type of sound effect likely to be required by the producers of broadcast plays. Over forty records containing 120 different sound effects have already been made, and these will be offered to the various broadcasting authorities throughout the world.

Mecca Calling

CONSIDERABLE difficulties were encountered in the building of the broadcasting station which has just been completed in the Holy City of Islam. Since the station stands on holy ground, to which unbelievers are not admitted, only Moslem engineers could be permitted to erect the station. Four natives were therefore sent to London to study radio engineering. All the material for the station had to be taken to Mecca on camels owing to the absence of railway facilities. The station will be used chiefly for broadcasting the prayers and ordinances of the Prophet and disseminating his teaching. It will also be employed for the spreading of Arabian culture generally.

U.I.R. Meeting

AT the Berlin meeting of the International Broadcasting Union four new members were admitted, namely, the Broadcasting Services of Bulgaria, Canada and India, and the U.S.A. National Association of Broadcasters. The questions discussed included wavelengths, acoustic problems and television. In addition, the schedule of International European concerts for the season 1937-1938 was fixed.

Association for French Broadcasting Employees

THE personnel belonging to the artistic, literary and news sections of the State Broadcasting Service have formed themselves into an association and have applied for affiliation to the French T.U.C. (Confédération Générale du Travail).

The Manufacturer's Guarantee

WHAT IT MEANS

By "ALTER EGO"

BIOLOGISTS say that the uni-cell lives for ever. This simple form of life has little in it to go wrong. At the other end of the scale is man, a highly complex organised organism, the failure of *any one* of whose parts might stop his working. At his birth he is plunged into the world without a guarantee, but his stay here below in working order and condition does not bear comparison with a uni-cell.

A wireless receiver, radiogramophone, or television set is a complex man-made article for which the purchaser pays good, hard cash, and for that reason alone, it seems, should be better than anything that Nature produces.

For about ten guineas upwards a wireless receiver can be purchased all complete and ready for working, definitely with knobs on, and sometimes handles. But the manufacturer, unlike Nature, knowing that it *is* a complex article, actually gives a guarantee with the instrument. To some this guarantee represents the assurance of the manufacturer that nothing will go wrong with his receiver within a certain time, and that inference is the first mistake so widely made by members of the general public, and is the root cause of so much dissatisfaction to-day.

The word "guarantee" has been so abused and twisted about that it has been misinterpreted when applied to wireless apparatus. It means "to be responsible for." The wireless manufacturer gives documentary assurance that if anything goes wrong with the instrument within a stated time he will put it right for nothing, provided that it is brought to him. He does not guarantee that the set *will* not break down. Nobody can do that.

In every instrument there are valves, resistances, condensers, loud speakers, transformers, switches and other things which may or may not be made by reputable sub-contractors or specialists, and in spite of all precautions any one of these may break down, causing defective working or a complete stoppage. These proprietary units are tested by the men who made them, and when they are delivered to the instrument manufacturer they are tested and examined, as a rule, before passing to his stores. On withdrawal from the stores they are usually tested before going out to a manufacturing line, and when the chassis of the instrument is being tuned up—i.e., lined or tracked against standard signal generators—the components are functioning under working conditions. After being encased in a cabinet or other housing the general procedure is to give the instruments a reception test and lastly a life test.

In spite of all these precautions, no manufacturer can see the *insides* of all the component parts he uses. He cannot tell you, for example, that the insulation of the windings of a mains transformer is perfect. There *might* be a flaw somewhere in the goods he is using which have so rigorously been tested by the men who made them and by his own staff.

In short, there is no method known to science or industry by which it is possible to forecast the life of any component tested and used in a wireless receiver short of invoking the aid of psychic mediums, and then I cannot see how they could help. Surely a medium can only see what is going to *happen*, and how could it happen if the component destined to cause the breakdown is changed before the issue of the wireless receiver.

Having regard to these indisputable facts a manufacturer would be a fool to take on such a profound responsibility as to state categorically: "This receiver *will* not break down for three months."

The manufacturer's guarantee on a complex article like a wireless instrument, therefore, is not an assurance that it *will* not go wrong, but that if it *does* go wrong he will put it right free of charge during the stated period.

Once the correct interpretation of the word "guarantee" is gripped, it does a great deal to smooth the way to understand the rest.

The Electrical Encyclopedia. Edited by S. G. B. Stubbs. Waverley Book Co., Ltd., London. Price 70s. (four volumes).

THE second edition of an exceedingly comprehensive work first published two years ago. The material is arranged in alphabetical order and articles by authorities cover every branch of electrical engineering. The new edition brings the articles up to date where necessary, and new matter has been added. In addition to the four volumes there is supplied with them a pocket-book of electrical tables and useful data contained in 64 pages.

The "Express" Division Reckoner. Pp. 120. Published by Gall and Inglis, 12, Newington Road, Edinburgh, 9. Price 2s. 6d.

THIS book is the converse of the ordinary ready-reckoner insomuch that it divides instead of multiplying, the cost of a unit being quickly ascertainable from the total cost. It is particularly useful in working out the value of each instalment when a wireless receiver is being bought or sold by the hire-purchase system.

Fame. Edited by Terry Ramsey. Pp. 278; numerous illustrations. Published by Quigley Publications, New York.

A BOOK devoted, among other things, to statistics concerning the popularity of artistes in the various branches of the entertainment world. The data concerning broadcasting artistes—confined to those appearing at American stations—is compiled from the votes of more than 400 radio editors in the U.S.A. and Canada.

Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

LONG- AND SHORT-WAVE AERIALS

AN aerial is arranged so that it can be used either for short-wave working or for receiving ordinary medium- or long-wave programmes. The down-lead consists of three strips of copper, which are separated by insulators inserted at intervals along their length and are closely wound inside a common flexible cover. The strips are connected either (a) to a dipole aerial or (b) to a second wire arranged at right-angles to the dipole and acting as an earthed T or L aerial, the two alternative modes of connection being controlled by a switch. The whole arrangement is such that the impedance of the down-lead is low, and no coupling-transformer is necessary at the aerial end.

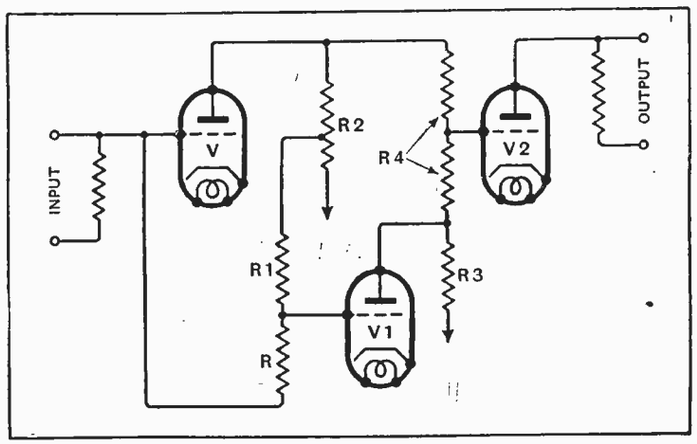
Marconi's Wireless Telegraph Co., Ltd., and N. M. Rust. Application date June 8th, 1935. No. 458084.

oooo

PREVENTING VALVE DISTORTION

ONE effect of valve-curvature is the production of undesired harmonics, whilst another is the inter-modulation of any currents of different frequency that may be present.

The Figure shows a circuit in which non-linear distortion is prevented by a method of feeding back components from the output to the input in a compensating sense. A potentiometer R, R1, the upper part of which is in the grid-cathode circuit, whilst the lower part is on the anode-cathode circuit. The screening grid is adjustably biased from a tapping on



Method of obtaining distortionless amplification.

R2 is provided between the output from the amplifier V and its grid, and a tapping is taken from a point between R and R1 (which remains at a practically constant potential when no distortion is present) to the grid of an auxiliary valve V1. The result is that if any distortion components are present in the resistance R2 they are compensated, so far as their effect on the subsequent amplifier V2 is concerned, by corresponding fluctuations produced in the output resistance R3 of the valve V1. The amplification factor of the valve V1 is twice that of the valve V, and the two anode circuits are connected together through a high resistance R4 having a mid-point tapping to the grid of the valve V2.

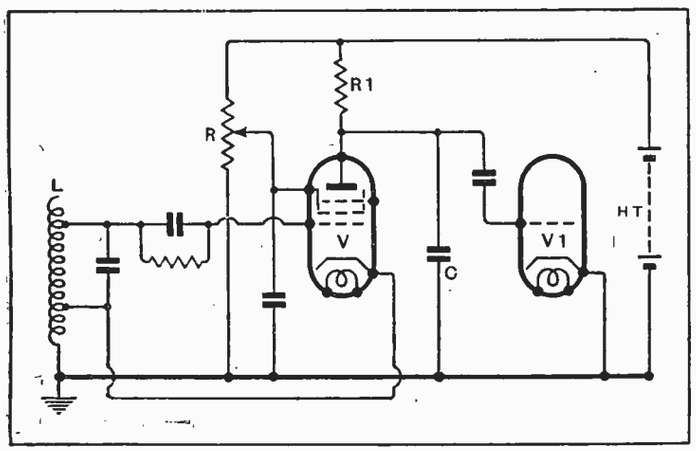
Marconi's Wireless Telegraph Co., Ltd., and G. M. Wright. Application date June 21st, 1935. No. 458449.

oooo

REACTION CIRCUITS

THE grid and anode of an amplifier or detector valve V (which may be a pentode), are back-coupled through the coil L, a resistance R shunting the HT supply. The anode of the valve is earthed through a condenser C, which, though having a high impedance for the rectified signals, forms a short-circuit for the carrier frequency, thus keeping the latter out of the anode resistance R1 and away from the succeeding amplifier V1. Reaction control, which is effected through the sliding contact on the resistance R, is stated to be particularly smooth and convenient.

Baird Television, Ltd. and L. R. Merdler. Application date June 18th, 1935. No. 458133.



Detector circuit giving smooth control of regeneration.

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TELEVISION RECEIVERS

TO protect the bulb of a cathode-ray receiver, it is mounted immediately behind a concave "window" of unbreakable glass, or a grill of open-mesh thin wire. The use of a concave surface is found to minimise the effect of any light reflected back from external objects. This is an advantage, since the light intensity of the received picture is generally small.

The "window" may be hinged to the cabinet, and, when opened, automatically cuts off the high-tension supply so that the circuits are made "dead." The same safety device is automatically brought into operation if the window is accidentally broken.

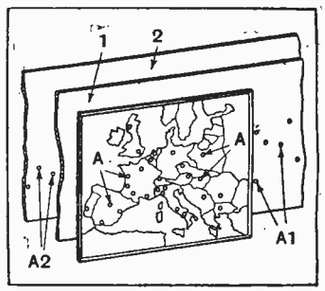
Marconi's Wireless Telegraph Co., Ltd., and A. A. Linsell. Application date May 24th, 1935. No. 457274.

oooo

STATION INDICATORS

THE object is to indicate, on a map associated with the tuning dial, the geographical situation of the station to which the set is, for the time being, tuned. As shown, a map of Europe is mounted in a window on the cabinet and is provided with a series of small holes, A, to show the location of transmitters in various countries.

Behind the map are two sliding panels 1, 2, both of which are controlled by the tuning-knob in such a way that whilst one panel moves to the right, the other moves to the left. Each panel is pierced with holes marked A1, A2, respectively. The arrangement is



Details of tuning dial with stations arranged geographically on a map.

such that when the set is tuned, say, to the programme from Rome, a hole A1 in the panel 1 coincides with a hole A2 in the panel 2, and both come into alignment with the particular hole A which represents the position of Rome on the map. When this occurs, the light from a lamp located behind both of the panels appears through the holes, to indicate the position of the station received.

Fabrica Italiana Magneti Marelli. Convention date (Italy) February 6th, 1935. No. 458059.

oooo

SCANNING SYSTEMS

WHEN magnetic deflecting-coils are used to control the scanning movements of the electron beam inside a cathode-ray tube, their inductance tends to slow-up the "flyback" movement of the beam. In order to prevent this, both coils are shunted by a gas-filled valve.

Since the "flyback" stroke is more rapid than the working stroke, the voltage induced across the coils acquires a value sufficiently high to discharge the gas-filled valve. The coils are therefore short-circuited during each of the "flyback" periods.

Marconi's Wireless Telegraph Co., Ltd., and G. B. Banks. Application date June 8th, 1935. No. 457929.

oooo

AMPLIFYING CIRCUITS

IT is found that when a valve amplifier or photo-electric cell works on to a load which has a negative-resistance characteristic, the resulting "load-line" shows a more favourable performance. In the case of a photo-electric cell, for instance, a greater change of cell-current is produced for a given change in illumination.

Accordingly an "electron-multiplier" of the type having two electron-emitting surfaces, between which the stream passes and repasses to produce secondary emission, is used as the load impedance of an amplifier valve or P-E cell, and, because of its negative resistance characteristic, gives a performance higher than is usually obtained. In addition it is stated to reduce the well-known Miller effect.

Baird Television Ltd. and J. C. Wilson. Application date April, 1936. No. 457886.

The Wireless World

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CONTENTS

EDITORIAL COMMENT

Empire Broadcasting

A Progressive Policy

IT will be recollected that the Broadcasting Committee presided over by Lord Ullswater which, in 1936, presented its Report and Recommendations on the future conduct of broadcasting, especially recommended that the Empire Broadcasting Service should be authorised in the new B.B.C. Charter and that additional funds required for its development should be provided by the Corporation from its increased share of licence receipts.

This recommendation for the fuller recognition of the Empire Broadcasting Service and its value is already bearing fruit. The B.B.C., with the co-operation of the Marconi Company and Standard Telephones and Cables, have designed the most powerful group of short-wave transmitters in Europe, and these are now nearing completion.

Sir Noel Ashbridge, Chief Engineer of the B.B.C., made public a few days ago some details regarding these new developments and an account of them appears elsewhere in the pages of this issue. These developments are particularly gratifying to us because in them we see the fulfilment of those objects which we had in view when years ago, in spite of opposition, we urged that an Empire Broadcasting Service on short waves should be established.

Now that so much has been done towards improving the service at the transmitting end, it is time to express the hope that the authorities in the Dominions and Colonies will be prepared to take the initiative to improve reception conditions at their end. Reception with individual short-wave receivers will, no doubt, always remain the most popular arrangement, but there is also scope for much more to be done in the way of establishing reception centres on lines similar to the B.B.C. station at Tatsfield, in order that the Empire transmissions may be received under conditions as ideal as possible, and the output from these receivers fed to local transmitters and so received on standard sets. Such an arrangement is by no means new; it was adopted in connection with the Dutch short-wave transmitter set up for broadcasting to the Dutch East Indies a good many years ago, and since that time there is a wealth of experience with such arrangements to draw upon, particularly in connection with the B.B.C. receiving centre at Tatsfield. The establishment of such centres in the Dominions and the Colonies need, therefore, no longer be regarded as experimental and uncertain in results.

The use of a local relay system to be fed from a receiving centre may also commend itself in many instances, more particularly where the population is fairly concentrated.

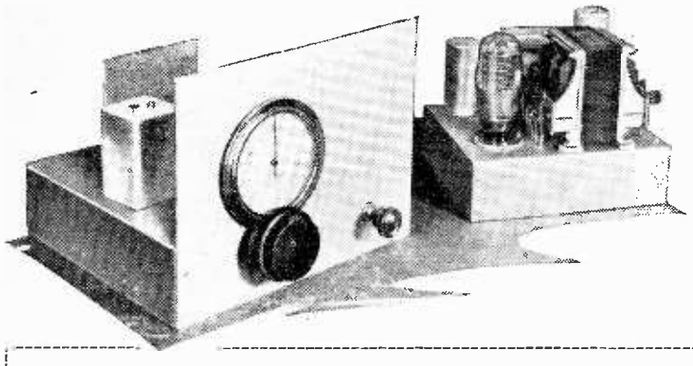
In the House

Answers to Wireless Questions

REPLIES were given in the House of Commons last week to two questions of special interest to our readers.

The Assistant Postmaster-General stated that a Bill to give effect to the recommendations of the Committee on Electrical Interference was under consideration, although no hope could be held out that it would be introduced this session.

Replying to another question, the Assistant P.M.G. said that additional revenue for the B.B.C. from the licence receipts would come from the Treasury if at any time they were satisfied that the income of the B.B.C. was insufficient for their services, including Television and Empire Broadcasting.



AC Short-Wave

Constructional Details, Preliminary Adjustments, and Operating Notes

By H. B. DENT

THIS converter, which is AC operated and has a separate power unit, can be used with any type of broadcast receiver. Last week the construction of the coil box was dealt with, and in this instalment the complete assembly, adjustment, and operation are described.

BEFORE giving attention to the assembly of the converter there is a small detail in connection with the coil unit that may require a few words of explanation. In order to limit the oscillator output on Range 2 and Range 3 parallel resistances are joined across the circuit. These are marked R8 and R9 respectively. In the theoretical circuit diagram they are shown joined across the trimmer condensers C16 and C17 respectively.

In the original model the resistances were the small half-watt type, and it was found more convenient to join them to the two connecting tags on the coil formers. Though not, therefore, absolutely in accordance with the theoretical circuit they, nevertheless, serve the same purpose, as for merely damping the circuit it is quite immaterial whether they shunt the coil only or the whole circuit.

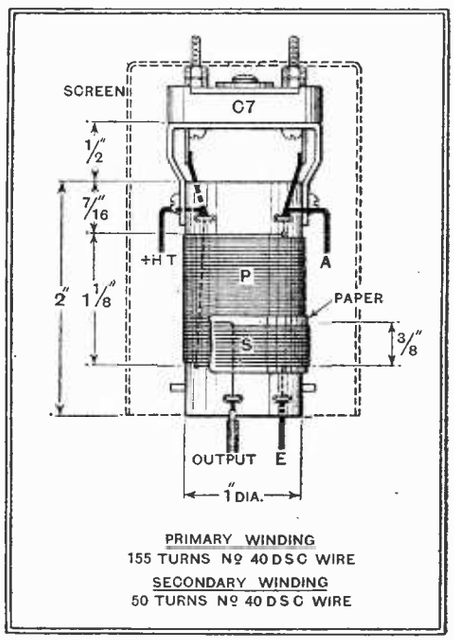
Should longer resistances than those used be fitted it may be found more convenient in wiring to connect them from one tag on the coil formers to the parallel trimming condensers C16 and C17 on the opposite side of the compartment.

In regard to the construction of the converter the first procedure is to make up or to assemble the chassis from parts that can be obtained cut and bent to size.

The chassis is a little unorthodox as the coil box, though a separate unit, actually forms an integral part of it, being bolted to one side and serving also to position the front panel. When this is finished the two condensers C4 and C11 can be mounted, the former on a metal bracket measuring 4in. × 4in. and the latter on an insulated one consisting of a piece of ebonite or Paxolin to which has been fitted a piece of angle brass.

This insulated bracket and the metal one below the chassis that carries the valve-holder must be assembled together, as the same fixing screws are used for both. With the condensers in position the dial can be assembled on the front panel and the whole correctly lined up. Next mount the group board carrying the resistances R4, R5 and R7, and condensers C6 and C8 so that it stands far enough away from the chassis to clear the driving disc on the dial. Short lengths of 6BA screwed rod are used for this.

At this stage it would be advisable to uncouple the dial and condensers, leaving the latter in position, and remove the front panel, as by doing so the pins on the valve-holder become much more accessible for wiring.



Constructional details of the IF transformer are given above, and on the right is shown the finished unit with the screening can removed.

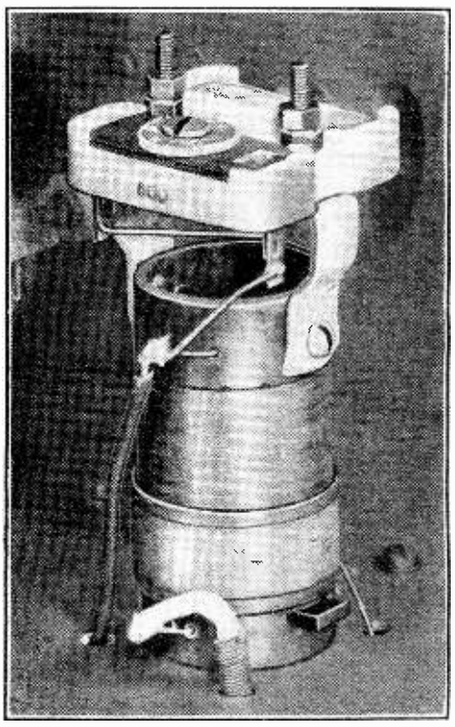
For the time being the output transformer can be omitted unless it has already been made or acquired, in which case it can be assembled on the chassis. Its construction will be dealt with later.

As will be seen from the drawings and the illustrations, the wiring of the converter is quite a simple matter and does not require much explanation save in connection with the filament of the valve. Only one lead is taken from the heater pins to the terminal block at the back, as the other pin of the valve is joined direct to the chassis.

In cases where the heater wiring is carried out in the more orthodox manner it is usually necessary in short-wave apparatus to join a condenser from each filament pin to the earth line, to prevent modulation hum. By adopting the scheme used in the present case these condensers become unnecessary, and since their capacity must be at least 0.1 mfd. the saving of these two components is worth while.

It must be remembered, however, that should an existing power pack be employed, and there is no objection to this course provided it gives the required voltages, then the centre tap on the filament winding must be disconnected from the earth line or one half of the heater winding will be short-circuited.

In order to obtain the best possible results from the frequency-changer it was decided to tune the anode circuit of the valve to the intermediate frequency and feed the IF output from a step-down



secondary winding through a screened lead to the aerial terminal of the broadcast set. The step-down ratio adopted is approximately 3 to 1.

Constructional details of this trans-

Converter

(Concluded from last week's issue)

THREE-RANGE UNIT COVERING 12.5 TO 62.5 METRES

former are given in the drawings. It consists of a 2in. long former 1in. in diameter, and it is wound with No. 40 SWG DSC wire. The primary winding is 1⅛in. long, and about 155 turns can be accommodated in this length. A thin coating of shellac can be applied, and when dry three or four layers of stout gummed paper ½in. wide are wound over the earth, or lower, end. The secondary is wound on this paper strip, and consists of 50 turns of No. 40 SWG DSC wire, and it should occupy ⅜in. in length.

At the start the winding is laid lengthwise along the former with the free end towards the bottom end, and a piece of the gummed paper, about ½in. square, is used to secure it. The winding is then commenced from the top end, and wound over the stuck-on paper. At the finish a second piece of paper can be used to secure the end. If the coil is then given a thin coat of shellac, the turns will be securely fixed when the coil is dry.

The primary winding of this coil is tuned by a Hunt's mica trimming condenser of 0.0005 mfd., and, with about three-quarters of the total capacity, will tune to 550 kc/s, approximately 550 metres, which is the IF chosen for the converter.

Intermediate Frequency

There are several reasons that have influenced the choice of this particular frequency. If the IF is too low—i.e., 150 kc/s (2,000 metres)—pulling between the signal circuit and the oscillator is inclined to be troublesome, and if too high —i.e., 1,500 kc/s (200 metres)—there is a risk of the harmonics generated in the oscillator of the broadcast set, assuming a superhet. is employed, beating with the short-wave oscillator and producing what appears to be unmodulated carrier waves at various tuning positions of the short-wave unit. The actual frequency adopted is a compromise between these two extremes. It means, of course, that the broadcast set has to be tuned to the top end of the medium-wave band.

When the assembly has been completed and the power pack built, the actual construction of which will not be discussed since it is quite straightforward, the wiring should be carefully checked, and if everything be found in order the valves can be fitted and the final adjustments made.

It is advisable to examine the ganged condensers and couplers to make sure that both are being driven by the dial, and that when the pointer is at 100 on the scale the moving vanes of both condensers are fully in mesh with the fixed vanes.

If the initial test be made in the evening it would be advisable to start with range three, for which the waveband switch is turned to the third position in a clockwise direction. This range should tune from 36.6 metres (8.2 Mc/s) to 62.5 metres (4.8 Mc/s), and the adjustments are effected on the two trimmers C3 and C17, signal and oscillator circuits respectively. C17 will require to have very nearly the full capacity available, so that this trimmer is screwed up fully and then slackened off about one-quarter of a turn. The signal circuit trimmer C3 will require only a very little capacity.

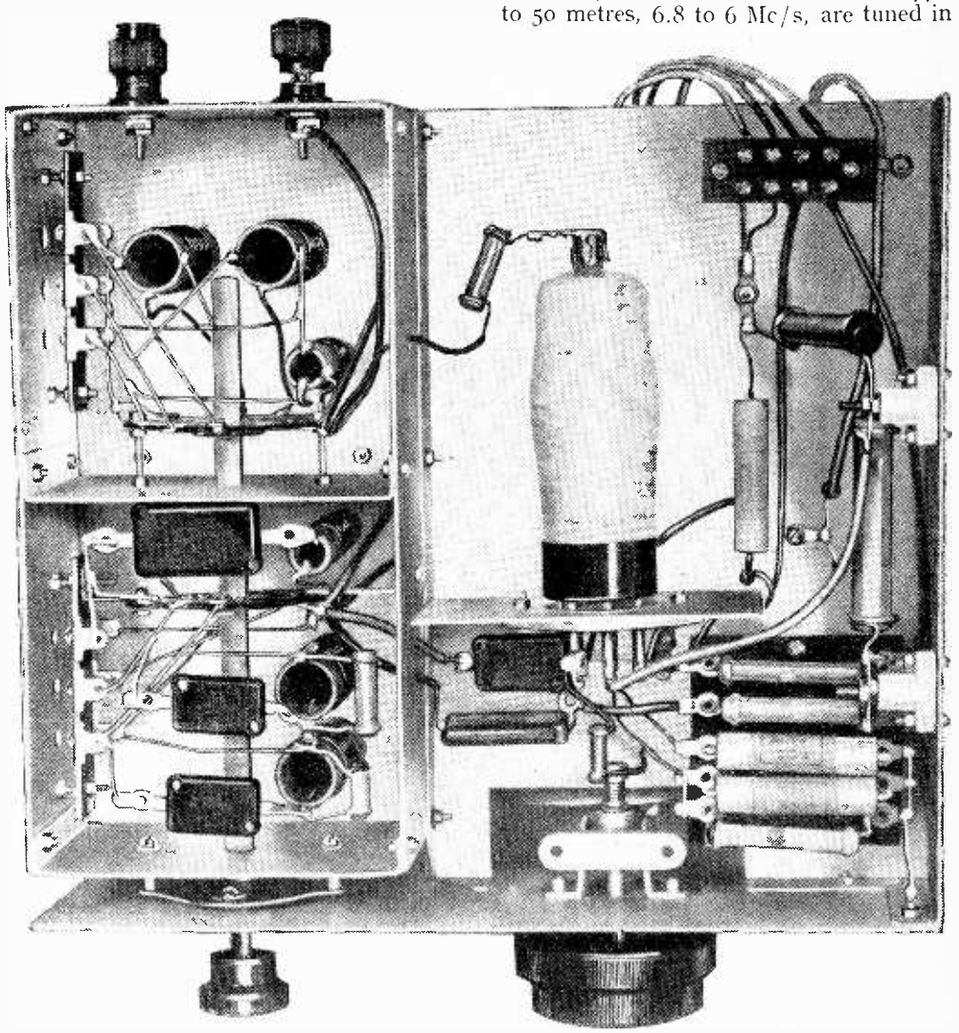
Initial adjustment of C3 should be made with the pointer at about 15 on the scale, and the condenser is adjusted by its screw to give the best sensitivity, which in the absence of a signal can be judged by the background. An approximate setting only need be found at this stage, since the oscillator trimmer C17 has still to be adjusted for the correct coverage.

Possibly the best point to take on this range as a key position is 50 metres (6 Mc/s), where the Moscow station RNE is usually found operating. The actual wavelength of Moscow is 49.99 metres (6.001 Mc/s), and it is a good strong signal.

This should tune in on the converter at 48.1 on the scale, and C17 and C3 can be adjusted in turn to give the strongest signals.

The short-wave broadcast stations in the 6 Mc/s band which extends from 44.1 to 50 metres, 6.8 to 6 Mc/s, are tuned in on this range between 31 and 48 on the scale. Just outside this band on the lower wavelength, or higher frequency, side will be found the 7 Mc/s amateur band, 41.12 to 42.83 metres, and the centre of this band falls at about 20 on the scale.

Range 2 is required to give a coverage of 22 to 37 metres, 13.65 to 8.12 Mc/s, and is usually the best range for short-wave signals during the afternoon and early evening. It takes in the 11 Mc/s and 9 Mc/s broadcast bands. A good key station is Zeesen DJN on 31.45 metres, 9.54 Mc/s, and adjustments should be made on the oscillator and signal circuit trimmers C16 and C2 respectively to bring in this station at 56.4 on the scale. The



The frequency-changer valve and most of the components are accommodated below the chassis. This view shows also the interior of the coil box.

A blue print combining all the constructional drawings is available from the Publishers, Dorset House, Stamford Street, London, S.E.1. Price 1s. 6d. each post free.

AC Short-Wave Converter—

25-metre stations will then be found centre about 24 on the scale.

The most productive range of the three during the daytime will, however, be range one, which tunes from 12.5 to 23 metres, 24 Mc/s to 13 Mc/s. In it are the 13-, 16- and 19-metre broadcast bands and the 21-metre amateur band. American stations can generally be received in daylight in all three of the broadcast bands. W8XK on 13.93 metres, 21.54 Mc/s, should tune in at 17.5; W3XAL 16.87 metres, 12.78 Mc/s, is found at 40.5, and W2XAD, 19.57 metres, 15.33 Mc/s, at 61.4 on the scale. These three make useful key stations for the adjustments, which on this range are made by the trimmers C15 and C1 in the oscillator and signal circuits respectively.

Another useful key point is Zeesen DJE, at times a very strong signal on 16.89 metres, 17.76 Mc/s, just above W3XAL, and it should tune in at 40.6 on the dial.

The amateur band which covers 20.83 to 21.43 metres, 14.395 to 14.005 Mc/s, should be centred at 77 on the scale.

Though precautions have been taken to render the handling of the converter as easy as possible without the elaboration of band-spread tuning, the frequency coverage of each range is so wide, despite the comparatively small tuning condensers fitted, that those who have not had much previous experience with short-wave sets must be prepared to exercise patience in tuning. Very slow rotation of the dial is essential to avoid passing over stations, and the slow-motion drive should be used on all occasions other than when changing from one to another of the broadcast bands and the intervening wavelengths are not to be explored.

Owing to the very high selectivity of many broadcast receivers a strong short-wave signal may cause the receiver to emit a loud howl when the volume control is turned up.

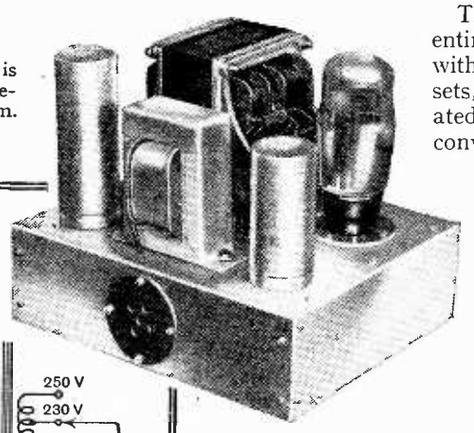
This microphony howl, as it is sometimes called, is due partly to the oscillator drifting and partly to acoustic feed-back to the vanes of the short-wave oscillator condenser.

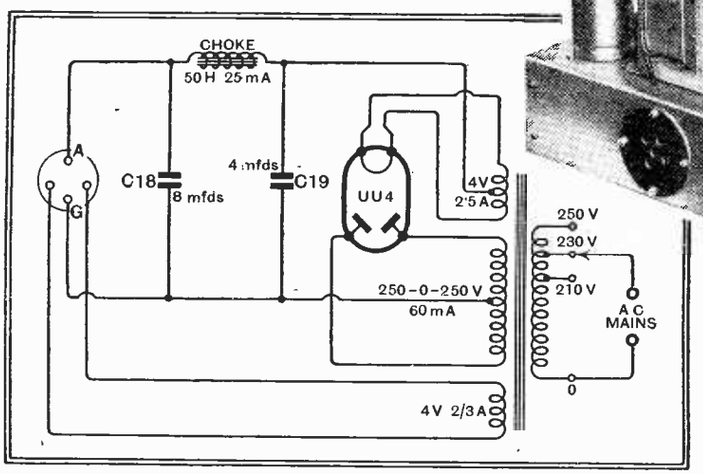
Though it cannot be entirely eliminated with very selective sets, it can be ameliorated by mounting the converter on sponge rubber and enclosing it in a cabinet. Alternatively standing the cabinet of the converter on a sheet of sponge rubber will usually serve the same purpose.

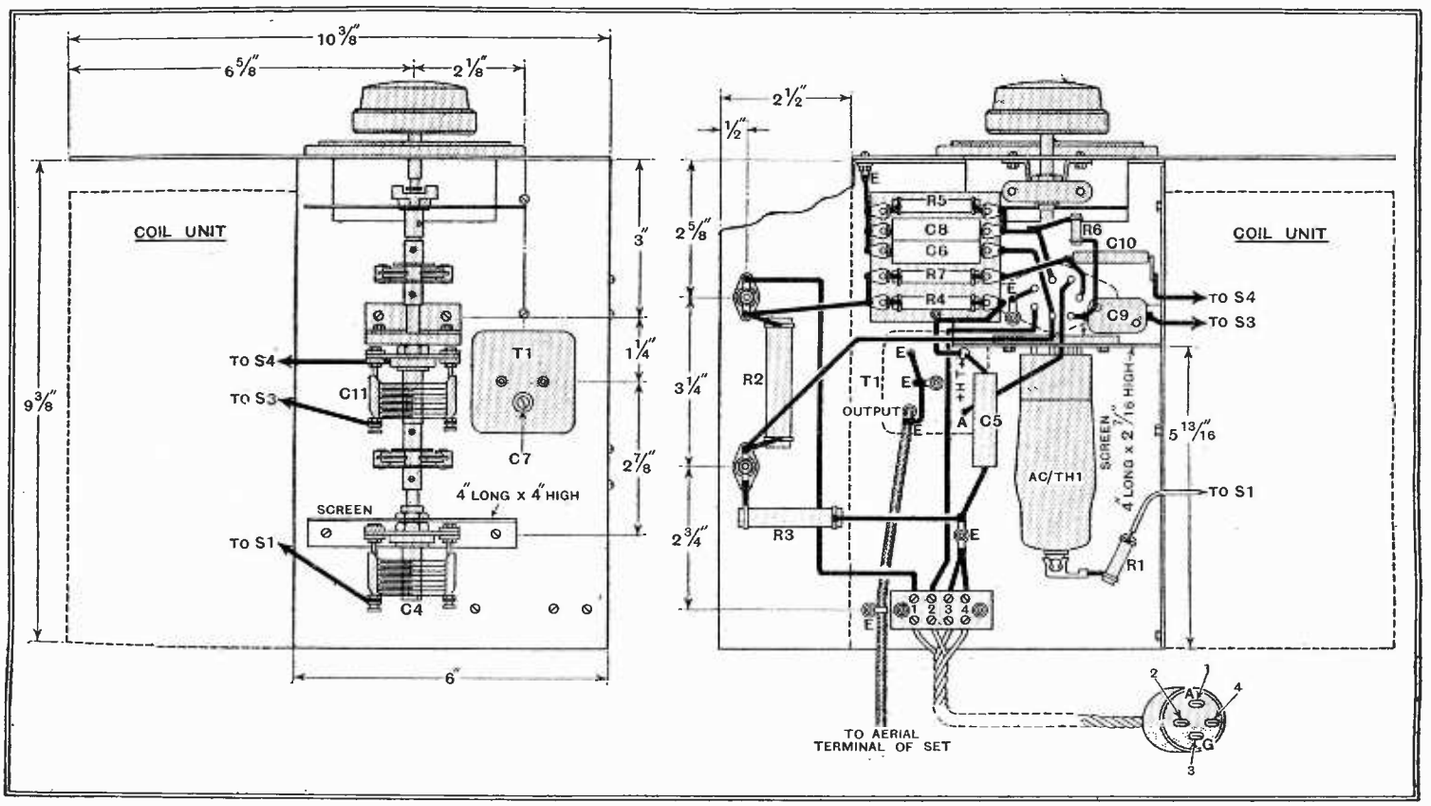
When it is used with a set having a variable selectivity control howling is rarely encountered if the set is adjusted to have a comparatively wide band response in the IF amplifier. There will be occasions, however, when the IF amplifier will have to be adjusted to a high degree of selectivity to avoid interference from adjacent channels, since the short-wave bands are fairly crowded and there are many powerful stations now in operation.

At some early period during the tests and for preference as soon as the first signal is tuned in, the trimmer on the IF transformer T1 should be adjusted for maximum signal strength. The adjust-

The small power pack is shown on the right and below is the circuit diagram.







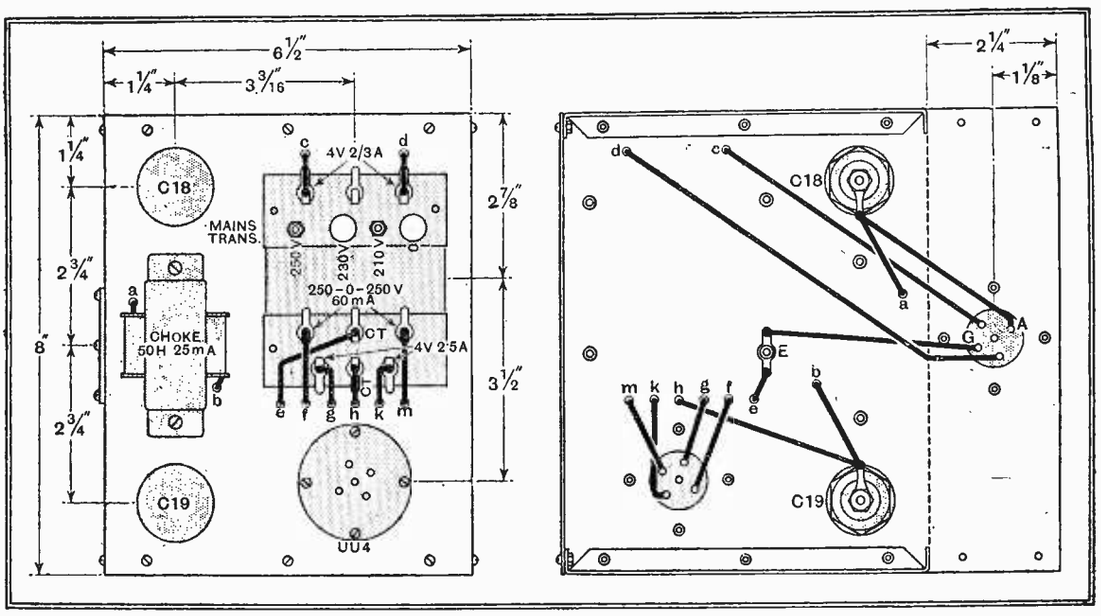
Lay-out of the components for the converter and the wiring plan. Details of the coil box are omitted as these were given in a separate drawing last week.

AC Short-Wave Converter—

ment is not critical, but an optimum setting will be found without any difficulty.

The tuning control on the broadcast set can always be used for fine tuning, but the receiver should not be mistuned much each side of 550 kc/s or the dial readings on the converter for stations that have been identified will not hold good.

When the converter is mounted in a cabinet ventilation holes must be provided. Some of these should be arranged to ventilate the underside of the chassis where the valve and screen-feed potentiometer are housed, and a few large holes in the base below this part of the chassis are desirable.



Dimensional drawings, wiring plan and layout of the components for the power pack.

Interference on a Quantitative Basis

The Characteristics and Performance of Apparatus for the Measurement of Radio Interference. (British Standard Specification No. 727-1937). Pp. 28, with 3 diagrams. The British Standards Institution, 28, Victoria Street. Price 2s., by post 2s. 2d.

BY way of excuse for delays in taking strong measures to abate the interference nuisance, it has been urged that quantitative standards for the maximum permissible field strength of interference, etc., must first be formulated and agreed. This view has not met with universal agreement. *The Wireless World*, for example, has urged that the blessed word "reasonable" should be invoked, and has pointed out that legal actions to restrain audible "nuisances" were successfully prosecuted hundreds of years before the introduction of scientific means for measuring sound intensity.

Be this as it may, the introduction of a generally accepted standard for assessing the efficacy of anti-interference devices, and of measuring interference-producing voltages and fields, will be generally welcomed as likely to pave the way for a happier and more equitable state of affairs than that at present existing. British Standard Specification No. 727-1937 has been prepared by committees on which the Post Office, B.B.C., I.E.E., R.M.A., and many other influential bodies were represented, and as it "embodies the relevant agreed recommendations of the C.I.S.P.R. [Comité International Spécial des Perturbations Radiophoniques] as to the nature, essential characteristics and performance of an instrument for the measurement of interference," it should help greatly towards international agreement on matters relating to machine-made interference with broadcast reception.

The specification deals with such technical details as the wave-ranges on which measurements are to be carried out, as well as the audio-frequency range, and lays down rules for such features as input impedance of the measuring equipment and the characteristics of its output indicating device. Methods of carrying out the actual measurements on various types of appliance are given.

The greater part of the booklet is taken up with a detailed description of portable measuring apparatus complying with the specification; the instrument embodies a superheterodyne unit with a triode-hexode frequency-changer and three 110-kc/s IF stages followed by a diode-triode, of which the triode section serves as a DC amplifier, the indicating meter being connected in its anode circuit.

H. F. S.

Television Programmes

Transmission times are from 3-4 and 9-10 daily.

Vision. 45 Mc/s. Sound 41·5 Mc/s.

FRIDAY, APRIL 16th.

3, Fredrika (mezzo-soprano). **3.10,** John Mansbridge will describe and demonstrate portrait painting. **3.20,** British Movietonews. **3.30,** Theatre Parade.

9, Musical interlude. **9.10,** Repetition of 3.10 programme. **9.25,** Gaumont-British News. **9.35,** Snooker; exhibition of play by Horace Lindrum and Willie Smith. **9.45,** Starlight: Steve Geray and Magda Kun.

SATURDAY, APRIL 17th.

3, O.B. of railway locomotives from the Alexandra Palace station. **3.20,** Coronation Ware; samples of Coronation pottery, past and present. **3.35,** Gaumont-British News. **3.45,** Tommy Handley and Company in "The Disorderly Room."

9, Reginald Purdell (comedian). **9.10,** Repetition of 3.20 programme. **9.20,** British Movietonews. **9.30,** "Ad. lib"; a revue by Herbert Farjeon.

MONDAY, APRIL 19th.

3, Margaret Morris Dancers. **3.15,** Coronation tree planting. **3.30,** "Briny"; a memory and a foretaste of sea-side shows, with Hastings Mann's "After Dinner Company" from the Pier Casino, Shanklin.

9, Repetition of 3 programme. **9.15,** British Movietonews. **9.30,** Repetition of 3.30 programme.

TUESDAY, APRIL 20th.

3, Demonstration of Fire Walking by Ahmed Hussain in the grounds of Alexandra Palace. **3.25,** British Movietonews. **3.35,** "April Showers"; comedy in one act. **3.50,** Starlight.

9, Personalities—1. **9.10,** Repetition of 3.35 programme. **9.25,** Gaumont-British News. **9.35,** Café Bar: a cabaret show.

WEDNESDAY, APRIL 21st.

3, Victor Hotchkiss and his marionettes. **3.10,** Cartoons: Nicolas Bentley. **3.20,** Gaumont-British News. **3.30,** Forty-Seventh Picture Page.

9, Musical Act. **9.10,** Repetition of 3.10 programme. **9.20,** British Movietonews. **9.30,** Forty-Eighth Picture Page.

THURSDAY, APRIL 22nd.

3, Anona Winn; songs. **3.10,** Architecture.—2 **3.25,** British Movietonews. **3.35,** Play.

9, Music Makers: Alfredo Campoli. **9.10,** Repetition of 3.10 programme. **9.25,** Gaumont-British News. **9.35,** Cabaret.

The Radio Industry

THE current issue of the *Bulgin Monthly Bulletin* contains information on newly introduced components (small high-voltage condensers and high-voltage insulators), further information on the Bulgin vibratory HT generator, and an article on automatic grid bias. A scheme has been formulated whereby Bulgin interference-suppressing devices may be purchased on a three-day trial and approval plan.

La Société Française Radio Electrique has sent us an attractively produced booklet describing the recently inaugurated radio-telephonic link between France and the U.S.A.

Film Industries advise us that as a result of the increase in price of material there will be a 10 per cent increase as from May 1st in the prices apearing in current lists.

Philco announces the introduction of two new all-wave superhets for AC mains. Eight valves are used and a coverage of from 150 kc/s to 18.2 Mc/s is provided in four steps.

Dubilier resistances and condensers are now being supplied on cards; the various ranges include capacity and resistances values in greatest demand for replacement and other purposes. Components in cartons will still be supplied.

The Future of Television

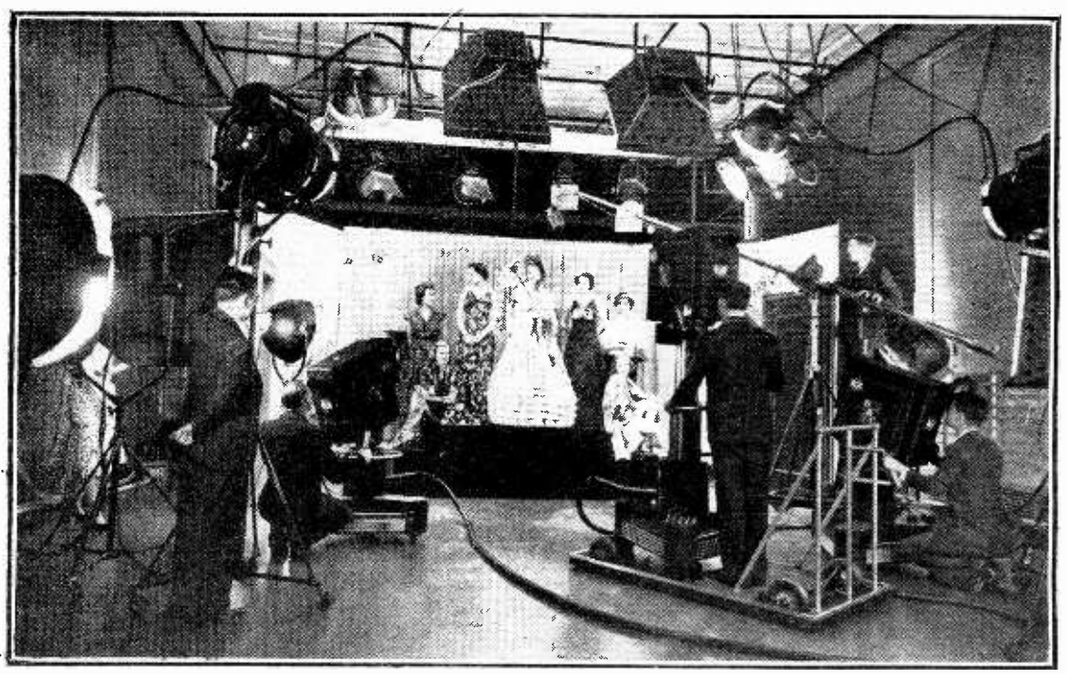
WHY A NEW TECHNIQUE OF PRESENTATION MUST BE DEVELOPED

By R. W. HALLOWS

IT was, I believe, G. K. Chesterton who wrote in the early days of broadcasting: "We have invented a wondrous method of talking to the ends of the earth, but seem to have no messages worth the sending." Very much the same might be said of television to-day: we have achieved a means of sending images through the ether, but at present we don't appear to have many worth-while images to send. In a word, now that we have television after so many years of waiting we don't yet quite know what to do with it.

Something of the kind often happens when important inventions reach fruition, even if their development has been watched eagerly and expectantly. Unless there is an obvious and immediate application to warlike or commercial purposes a considerable amount of time may be required to discover their real scope and to evolve a suitable technique for them.

Again, the ties of old associations are difficult to break. For years the designers of railway passenger vehicles could not forget the coach and the brougham; the motor car was for a long time just a horseless carriage; the wireless receiver of 1922 with its horn loud speaker was distinctly reminiscent of the gramophone of the period, and the broadcast items that it reproduced were largely the kind of "turns" of which wax records were then made; the cinematograph in its early days showed mainly films that were first cousins to the moving and dissolving comic slides of the magic lantern.



AMERICAN PROGRESS. Inside the television studio in the R.C.A. Building in New York, where the N.B.C. are carrying out extensive experimental work.

To-day television is finding it difficult to break away from the shackles of talking-film methods. It is, perhaps, rather natural that television transmissions nowadays should be so much on talkie lines. In both cases you have a method whereby moving images can be projected on to a screen whilst their accompanying sounds are reproduced by a loud speaker. But when you come to examine them in detail it becomes quite clear that moving-picture technique, though much may be learnt from it, is not suitable *en bloc* for television.

If we can determine exactly how the scope of television differs from that of the "talkies" we shall be well on the way to discovering the lines on which the technique of the former can best be planned.

Film sources are almost unlimited: a single programme may take you from the Sahara to Alaska, from Cornwall to the Society Islands. For direct projection television is at present tied down to a radius of about 1,000ft. from the nearest tapping point of a co-axial cable connected to the transmitting station.

On the other hand, television projects its images instantly, whilst events recorded by the cine camera cannot appear on the screen until some time after they have happened.

Scenes involving considerable numbers of people or big areas are suitable for the large screen of the cinematograph, but not for the present small one of television.

Films are not made without many "retakes," and before they assume their final form much cutting and editing must be done. No such things are possible in television; there can be only one "take" and no subsequent revision.

Last, but perhaps most important of all, an enormous amount of money may be spent on a single film in the hope that millions of people will pay to see it in the world's picture houses. The television producer has to keep within the limits of a fixed and not very large expenditure. His limitations are even narrower than those of the theatrical producer, who can count on a week's run with the worst of plays.

It would seem that anything like an all-day television programme is entirely out of the question for some time to come. Apart from the matter of expense, there is neither sufficient staff nor sufficient accommodation available for the immense amount of rehearsals that would be needed. But does anyone want more or less continuous "vision" entertainment morning, noon, and night? I don't think so. What I would suggest is: (1) That the "sound" transmitters at the Alexandra Palace[1] and at other high-definition stations as they come into action should give genuine high-fidelity radiation of the local regional programme at all times when there is no television broadcast; (2) that there should be, say, three fixed television hours each day devoted to set programmes; (3) that there should be brief "news flashes" at intervals.

Let us see how these proposals would work out. The adoption of the first would enable the owner of a television set to use its "sound" portion at all times for obtaining reproduction of the highest quality of the regional programme; he would not feel such reluctance as he may now about spending a good deal of money on apparatus that can be used only for an hour or

[1] Or the B.B.C.'s ultra-short-wave plant at Broadcasting House.

The Future of Television—

two each day. The second and third suggestions, were they put into practice, would provide ample opportunities for using the "vision" side of the receiver.

And what are we to do with the fixed television hours? First, I feel that the films which are shown should not be such as one can see rather better at any picture theatre. The standard news reels come under this head, but we might probably except "trailers" of outstanding films. If there are to be news reels they should be specially made each day; but I would rather see news dealt with mainly by the "flashes," to which I shall come in a moment when we discuss the third suggestion.

Since retakes are impossible, and there are great difficulties about arranging the number of rehearsals that are necessary to ensure clockwork precision, one wonders whether television will not tend to grow up outside the studio rather than in it. Many of the "sound" outside broadcasts, for instance, could be made into excellent fare for viewers if televised either directly or by the indirect film method. So far, no theatre or music-hall has been wired for television transmissions. Could it be arranged that all of the more important ones were available, scenes from plays or turns from variety bills would be most acceptable.

In time, I imagine, not only the theatres and the variety houses, but also sports grounds and buildings such as the Albert Hall, the Queen's Hall, Olympia, Earl's Court, the Agricultural Hall, to mention but a few that come to mind, will be adapted for television transmissions, and then there will be no dearth of programme material.

Some studio work there is bound to be, but I feel that in this matter normal "sound" broadcasting and television will rapidly become closer and closer partners instead of remaining the more or less separate entities that they now are. All important speakers, debaters, solo artists, entertainers, concert parties, and so on, are bound to be televised as a matter of course in the near future, their words or music being also transmitted, just as they are at present, from regional and national stations for the benefit of those who cannot look in.

Such a close partnership is, after all, the natural line of development; it is also the economical line for the evolution of programmes suitable for both sound and vision transmission, or sound alone, means a great saving in expense and the possibility of providing television as a regular thing with material of the highest class, which might otherwise be beyond its means, save on rare occasions.

Lastly, there is the question of news flashes. Here there must be no conflict of interests with the newspapers, which are far too valuable a national asset for us to allow them to suffer by encroachments on their established rights. Nothing of the kind need occur. What I have in mind is that one or more of the mobile television units should be on duty at most times, the work being twofold. At any time the announcer might break into the ultra-short-wave "sound" programme to tell us to stand by for a brief television transmission of some item of interest. News flashes of this kind, which might be given quite frequently, would serve as *hors d'œuvre* rather than solid fare, and should do anything but injure the newspapers. The second duty of the television vans would be to prepare films, which might well be sent out as a visual accompaniment to the "sound" news bulletins.

Well, there are some ideas for the ways in which television may be developed. If they do nothing else, they will at least provide a basis for argument and discussion. There is just one more thing that I should like to add: Whatever else happens, those responsible must not succumb to the temptation (there are signs of it already) to make television programmes too instructional. Entertainment must be their main object all the time.

In Next Week's Issue

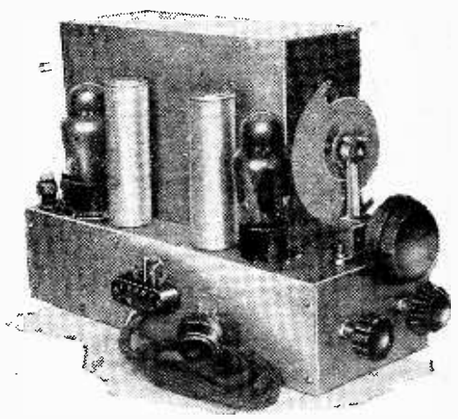
Ultra-short-wave Quality Receiver

Three-Valve Straight Set Designed to Work with "The Wireless World" Quality Amplifier

TRANSMISSION on ultra-short wavelengths is generally carried out at higher quality than is feasible on the normal broadcast band, for the lack of congestion in this region makes it possible to transmit the highest modulation frequencies. A very high standard of reproduction thus becomes possible without difficulties from the interference, such as sideband splash and heterodyne whistles, which is all too common on the medium waveband.

At the present time the only regular transmission on the ultra-short waveband is the Alexandra Palace sound accompaniment to television, but it is anticipated that the B.B.C. transmitter on Broadcasting House will commence relaying one of the London programmes ere long. There is no doubt that when this occurs all who are within its range and are suitably equipped will prefer to use it in preference to the medium-wave station on account of the superior quality obtained.

The Ultra-short-wave Quality Receiver is a three-valve straight set which is intended for use with the Push-pull Quality Amplifier, the PA Amplifier, or the amplifier of the Pre-tuned Quality Receiver. A single RF stage is included with a grid detector and a phase-reversing stage. The set is extremely simple to construct and handle, and, although it is not really intended for such purposes, its sensitivity is sufficient to enable reception of American amateur stations on the 10-metre band when conditions are favourable.



LIST OF PARTS.

2 Variable condensers, 40 mmfds. **"Apex Economy" Webb's Radio** 14, Soho St., W.1.

1 Variable condenser, 15 mmfds. **"Apex Economy" Webb's Radio**

1 Dial, dual ratio **Eddystone 1070**

Condensers:

2 0.01 mfd., mica	**T.C.C. "M"**
1 0.0001 mfd., mica	**T.C.C. "M"**
2 0.0005 mfd., mica	**T.C.C. "M"**
1 50 mfds., 12 volts, electrolytic	**T.C.C. "FT"**
2 8 mfds., 460 volts peak, electrolytic	**T.C.C. 802**

Resistances:

1 100 ohms, ½ watt	**Dubilier F½**
1 500 ohms, ½ watt	**Dubilier F½**
1 2,000 ohms, ½ watt	**Dubilier F½**
1 10,000 ohms, ½ watt	**Dubilier F½**
3 25,000 ohms, ½ watt	**Dubilier F½**
1 50,000 ohms, ½ watt	**Dubilier F½**
1 75,000 ohms, ½ watt	**Dubilier F½**
1 100,000 ohms, ½ watt	**Dubilier F½**
1 2 megohms, ½ watt	**Dubilier F½**
1 100,000 ohms, 2 watts	**Dubilier F2**

1 Potentiometer, 10,000 ohms, wire-wound **Haynes Radio**

1 Trimmer **Bulgin SW95**

2 Coils (constructional details will be given)

3 Extension control outfits **Eddystone 1008**

1 Valve holder, 5-pin (without terminals) **Clix Chassis Mounting Standard Type VI**

1 Valve holder, 5-pin (without terminals) **Clix Chassis Mounting SW Type V5**

1 Valve holder, 7-pin (without terminals) **Clix Chassis Mounting SW Type V5**

1 Socket strip **Clix "C"**

2 Terminals, ebonite shrouded, output +, – **Belling-Lee "B"**

1 Group board, 10-way **Bulgin C32**

1 Plug top valve connector **Belling-Lee 1175**

1 Connector, 5-way **Bryce**

1 Cable, 5-way, with twin 70/36 leads and 5-pin plug **Goltone**

Chassis: (Dimensions will be given)

Miscellaneous: **Peto-Scott**
2 Lengths Systoflex, 1 oz. No. 18 tinned copper wire, aluminium for brackets, etc. Screws: 48 6BA ¼in. R/hd.; 2 4BA ¾in. R/hd.; 2 6BA 1in. R/hd., all with nuts and washers.

Valves:

1 TSP4, metallised	**Mullard**
2 MH4, plain	**Osram**

UNBIASED

By FREE GRID

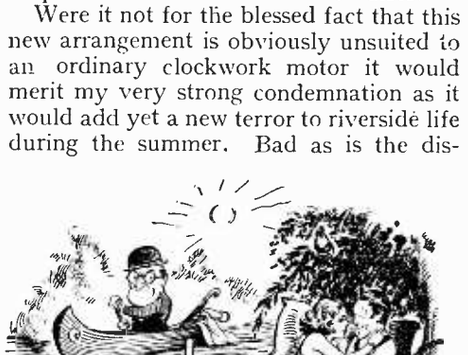
A Medical Veto

TO those readers who might be looking forward to the result of my projected bathroom experiments to which I referred last week, I regret that I shall have to be a disappointment, but I have been deterred by my medical adviser, for reasons not unconnected with part of my early life spent out East, from doing what I proposed, and so the experiments are—for the moment, at any rate—off. My medical readers and others who have lived out East will, perhaps, guess the unfortunate reason.

Concerning Radiograms

I AM very pleased to see that a radio-gramophone has been introduced which makes use of the sound-on-film principle of recording. Its advantages are obvious, for apart from the fact that a continuous programme of one hour's duration can be enjoyed without changing the record, there is a pleasing absence of bulk and weight in the reels of film. An hour's worth of entertainment can easily be slipped into the jacket pocket whereas I needn't remind you of the impossibility of doing this with the conventional disc-type records. You may argue, of course, that sensible people don't want to shove records in their jacket pockets, but I am merely using this homely analogy to emphasise the fact that with the new system you can store as much entertainment in a small cupboard as would need a couple of pantechnicons in the case of discs.

Were it not for the blessed fact that this new arrangement is obviously unsuited to an ordinary clockwork motor it would merit my very strong condemnation as it would add yet a new terror to riverside life during the summer. Bad as is the disturbing noise of portable gramophones under present conditions, they would be infinitely worse were it not for the fact that the bulk and weight of records prevents river hogs from taking too many of them as an accompaniment to their back-water philanderings.



". . . their back-water philanderings"

There are one or two obvious disadvantages, however, such as the fact that if the fancy takes you to listen to something in the middle of the reel you are going to have the very deuce of a time to find it. I know what I am talking about in this matter as I have had the same sort of experience with long amateur ciné films and have eventually found a solution by carefully marking the titles of the various scenes contained in the reel at the points where they commence along its diameter.

To use this method, however, the projector or radiogram must naturally be provided with a quick wind both forwards and backwards, but this is quite easily arranged for. In any case this type of radio-gramophone could, if necessary, be supplied with small reels of individual musical items of the same playing time as ordinary discs. Since a lot of people who buy these new machines will undoubtedly already possess a goodly collection of ordinary discs, it is, I think, a mistake not to have built into the machine a separate turntable and pick-up of the ordinary type, or at least a couple of pick-up terminals for an ordinary playing desk.

Talking of playing desks reminds me of another thing, and that is that it wouldn't be at all a bad idea if special playing desks were made available for use with these film records so that they could be used with our existing sets. Probably there would be a greater sale for these than for complete sets, as the average man who already has a good set naturally feels loth to scrap it for the sake of getting a special type of gramophone, no matter how good the latter may be. The necessary small pre-amplifier and its miniature power-pack could easily be built into the playing desk.

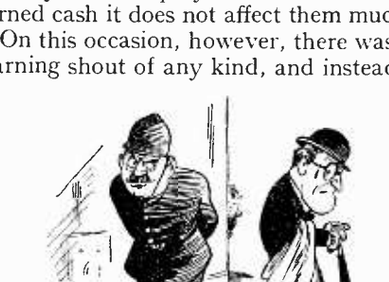
To What Base Uses

I SUPPOSE that most of you, like myself, although not given over entirely to the evils of betting and gambling, indulge in an occasional flutter in the cases of races of world-wide renown such as the Derby and the Grand National. It is a thoroughly bad habit, of course, from a moral point of view, although curiously enough I very often feel better in health as a result of it, since the necessity of existing on extremely short commons for a week or two after it gives the digestive organs a badly needed rest.

This year, however, I am not feeling in my usual good health after my post-Grand National fast, since, owing to a most extraordinary circumstance, I was deprived of it. I had strolled out on the day of the race to see my customary commission agent on the street corner and was just about to hand over my betting slip with the name of a horse written thereon when, without a word of warning, he suddenly took to his heels and bolted.

Now I have frequently had this experience before, but the bolting of the bookie's tout has invariably been preceded by a warning shout from one of his copper-spotters farther along the street. Those of you who study the police court reports as well as the racing news will remember that these unfortunate (?) touts frequently get hauled before the Bench for obstructing the police by warning their lord and master of the approach of Nemesis. Their fines are usually heavy, but since they are paid by their employers out of *our* hard-earned cash it does not affect them much.

On this occasion, however, there was no warning shout of any kind, and instead of the customary sight of a couple of breathless policemen coming round the corner at the double to nab their prey there was merely one minion of the law furtively plodding his way along the street and looking at every citizen with the codfish eye of suspicion. I was frankly puzzled and proceeded to make my way to a street in another district where I knew that the firm with which I usually transacted my business had another kerb-side branch.



The codfish eye of suspicion.

It so happened that I spotted one of the bookie's touts whom I knew well by sight and almost simultaneously I saw an outsize in policemen. To my amazement the scout took no notice of him whatever and I was just about to shout a warning myself when, far down the street, I saw the rapidly retreating figure of the bookmaker who had, in some mysterious way, received word of the law's approach.

The final result was that I was unable to get "on" this year. I should probably have forgotten all about the incident had I not chanced to mention it to a friend who had recently graduated with first-class honours from the Police College at Hendon. He was at once interested, and set himself to work keeping observation at certain well-known bookmakers' pitches in the suburbs. The result of this was that although lacking any evidence of an offence against the betting laws, he arrested a commission agent and a brace of well-known touts on a charge of loitering with intent to commit a felony, a charge which proved perfectly well founded when the prisoners were searched at the station and a complete ultra-short wave trans-receiving equipment was found.

Current Topics

Another 100 kW Station

THE Rome station has been making several tests with increased power, and will, it is hoped, soon be transmitting regularly on 100 kW.

News from Poland

WITH a view to increasing the number of listeners, the Polish authorities have decided to raise the power of Warsaw to 150 kW and to build a number of new high-powered stations. In addition, a "People's Receiver" is to be made available. Poland has about 600,000 listeners.

More Power for Graz

COMPLAINTS have been made by the inhabitants of Eastern Austria of poor reception from Vienna owing to the fact that the aerial is directional towards the West. To remedy this, the power of the Graz station, which acts as relay to Vienna, has been raised to 15 kW. and its aerial heightened.

Tunis Station Opened

AN unfortunate technical hitch marred the opening ceremony of the rebuilt Tunis station. When the station was switched on in the presence of the Bey of Tunis and many important officials including the French Resident - General, nothing happened, and it was some time before the engineers could locate the trouble.

NEWS OF THE WEEK IN BRIEF REVIEW

International Broadcasting

BETWEEN 1924 and 1929 there were only seventeen instances in which European programmes were relayed by American stations, or vice versa. In 1930, however, the number jumped to 103. Last year it was 678.

New Police-trap Device

THE new R.C.A. car-speed detector, which was recently demonstrated, uses photo-electric cells. The instrument contains two cells a foot apart into which two parallel beams of light shine from a lighting unit on the other side of the road. Immediately the car has broken the second beam its speed is automatically registered by the machine.

The Tower of Stentor

THE leading feature of the great World's Fair to be held in New York in 1939 will be a stone obelisk 700ft. high from which will protrude giant loud speakers enabling announcements to be heard in any part of the grounds. The "stunt" nature of this idea is said to be the cause of its being adopted in place of the more conventional arrangement of having several loud speakers in different parts of the Fair.

THE MAN IN THE STREET is interested in Television. A receiver chassis in a well-known window in Kingsway (London) attracts a crowd.

N.B.C. Stations

THE total number of broadcasting stations operated by the National Broadcasting Company of America now amounts to 133, of which fifteen function on short waves.

Car Radio News

CERTAIN car manufacturers in the U.S.A. are insisting that when dealers fit car radio to their products before selling them, only one particular make of set shall be used. This is causing considerable dissatisfaction.

A recent attempt to make car radio illegal in Idaho was heavily defeated in the State Congress.

Electrification to Popularise Listening

THREE hundred and fifty villages scattered throughout Hungary are to have an electricity supply. The Government has been largely influenced in its decision to carry out this project by the decline in broadcast listening which has taken place in remote country districts owing to battery charging difficulties. During the past year the number of listeners in Hungary has declined by over 24,000.

Glider Radio

SOME interesting experiments in the use of 5-metre trans-receivers were recently carried out under the auspices of the Radio Section of the Murphy Radio Sports Club. Successful two-way communication was established between a glider in flight and a ground station using one wavelength and the "switch-over" system. It is hoped to experiment soon with a duplex system employing two separate wavelengths. The apparatus used embodied a battery double pentode, one of the latter, in the case of the transmitter, acting as an oscillator and the other as a modulator. When receiving, the oscillator functions as a super-regenerative detector, and the modulator as an LF amplifier.

I.E.E. Lectures

THIS evening (April 16th), Mr. J. B. Kramer will deliver a lecture entitled "The Photocell and Its Application in Industry." This will be followed by a discussion.

Havana Radio Congress

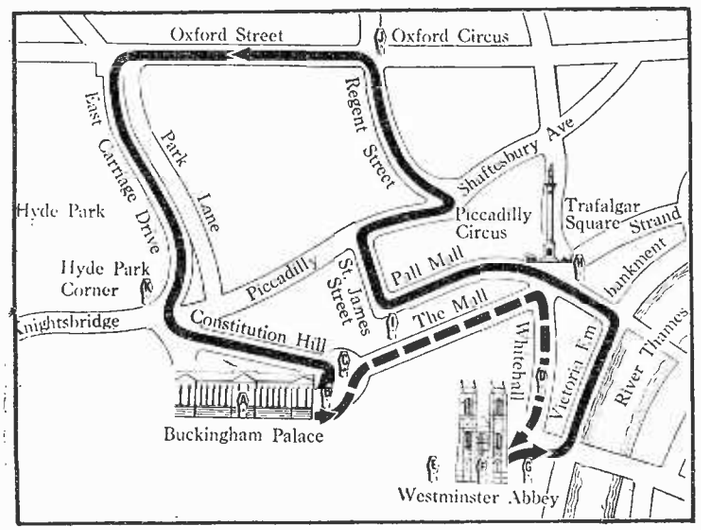
AN important radio meeting is taking place in the Cuban capital, at which Canada, the U.S.A., and all the many republics of Latin America are represented. No questions concerning programme policy are on the agenda, the discussions being confined to technical matters.

Communal Receivers

A SCHEME is being prepared by the Egyptian Minister of Education whereby communal wireless receivers will be established in each village for disseminating instructional talks to the peasants. The average villager in the Land of the Nile is far too poor to afford a good radio set of his own. The scheme will cost about £130,000.

Town and Country

ONLY 44 per cent. of the receivers sold in Canadian rural districts last year were of the all-wave type. In urban areas, however, the proportion was 78 per cent. This is said to be partly due to the fact that in the towns AC mains are almost universal, although the conservatism of country dwellers is thought to be the principal cause of it.



CORONATION PREPARATIONS. This map of the procession route, which has been compiled by the N.B.C. of America, shows lettered microphone positions at which commentators will be stationed. These microphones will, of course, be placed in position by the B.B.C. and will therefore also be used for the B.B.C. broadcasts. According to the N.B.C. details, microphones will be placed as follows: Two inside and four outside Buckingham Palace; two at Constitution Hill and the Mall; two at the Cenotaph; two outside and thirty-three inside Westminster Abbey; two inside the Abbey Annexe; one in Trafalgar Square; one at St. James's Palace; one in Oxford Circus, and one at Hyde Park Corner.

Listeners' Guide for the

All times given in these pages for programmes from Sunday onwards are British Summer Time, which comes into operation at 2 a.m. on April 18th.

BROADCASTS of opera will be a regular feature in the programmes during the coming season at the Royal Opera House, Covent Garden, which opens on Monday. There will be a greater proportion than usual of French and Italian opera, and a feature of the season will be a visit of the entire Opéra and Opéra Comique Companies from Paris. On the opening night Verdi's "Othello" will be broadcast in its entirety, Acts I and II being relayed Regionally at 8 and 8.50 respectively, and Acts III and IV Nationally at 9.50 and 10.40. On Wednesday, Regional listeners will be able to tune in to the second act of Donizetti's "Don Pasquale" at 9.20. Each broadcast from the Royal Opera House will be preceded by a five-minute introduction.

IN THE FOYER of the Royal Opera House, Covent Garden, on the opening night of the 1935 Jubilee season. The Coronation season, which opens on Monday with "Othello," will provide many opera broadcasts.

EMPIRE PROBLEMS

AN important new series of ten talks, entitled "The Responsibilities of Empire," will be opened this week by the Prime Minister. He will be heard Nationally at 9.20 to-night (Friday). The second speaker in the series will be Lord Snell, the Socialist peer, who was recently re-elected for the fourth successive year as Chairman of the London County Council. His contribution will be made on Wednesday at 9.30 (Nat.).

All the speakers chosen for this series are distinguished men whose views reflect experience and mature thought on the problems common to the peoples of the great British Empire. They will speak of the responsibilities of the Empire both to itself and to the world at large.

UNDER THE HAMMER

A SALE at Sotheby's provides an unusual Regional broadcast on Monday, when art treasures removed from 148, Piccadilly, including valuable Dutch paintings, will be auctioned. These treasures were the property of the late Lord Rothschild, and are now being sold by Mr. Victor Rothschild, who is giving up the nineteenth-century London mansion.

It is hoped that the Dutch landscapes included in the collection will come under the hammer between 1 and 1.45, and the B.B.C. is arranging to have an expert on the spot at this time. He will have the assistance of Messrs. Sotheby's secretary to point out the famous dealers of world repute who will be present at this the first important sale of the season. Listeners must not expect a boisterous broadcast, as the auctioneer's voice alone is heard during the sale, while bids are made by the raising of a hand or the nod of a head. Only when records are reached is the calm disturbed.

RATCLIFF HIGHWAY

IN commemoration of what was once one of the most notorious streets in London, a programme, "The Ratcliff Highway," to be broadcast to-night (Friday) at 8.15 (Nat.), has been devised by Thomas Burke. He is author of many books dealing with life in the poorer districts of the Metropolis, and is well known for his "Limehouse Nights" and "The London Spy." The famous, or infamous, highway is now prosaically known as St. George Street, Stepney, and is soon to undergo demolition. In its heyday the street saw scenes of noisy gaiety and drunken debauchery. Back in the 'sixties, when a ship arrived in London river the seamen made automatically for Ratcliff Highway, which contained, in a distance of about 90 yards, some thirty-five public houses. Profitable sidelines, such as dope-peddling and organised "shanghai-ing," flourished quite openly.

INDOOR BISLEY

THE O.B. department is arranging a novel broadcast of what is popularly called "The Indoor Bisley." This is a small-bore rifle championship to be shot at Alexandra Palace on Saturday. The teams entered consist of three marksmen. Six pottery discs about the size of a halfpenny form the target at about 40 yards range. The first team to break the six discs wins the heat, and the final is shot for in the same manner. The teams open rapid fire at a blast on a whistle. Captain E. H. Robinson in his commentary at 5.45 (Nat.) will cover the quarter finals, the semi-finals, and the finals.

THREE WOMEN

THREE separate sketches have been arranged to form one programme by M. H. Allen, each sketch being an adaptation by her of a short story by Katherine Mansfield. They are three studies of women, and the characterisation provides clear-cut and arresting contrasts. The first, "Ma Parker," is concerned with a charwoman who, whilst washing up, soliloquises about her squalid existence and unhappy domestic affairs. Next comes "Pictures," the story of Miss Moss, an ageing and unsuccessful soprano who tries to break into the film world. Finally, "The Lady's Maid," a brilliantly revealing monologue.

These poignant life stories in miniature were first heard separately in the "Miscellany" programmes broadcast in 1932-33. The principal parts were then taken by Margaret Yarde, Vivienne Chatterton, and Gladys Young respectively, who will repeat their

Week

Outstanding Broadcasts at Home and Abroad

memorable performances on Sunday at 7.15 (Nat.).

MUSIC

PAUL WITTGENSTEIN, the one-armed pianist, will play the Ravel Pianoforte Concerto for left hand alone at 7.50 (Reg.) to-night (Friday). This Concerto received its first performance in England at a Promenade Concert in 1932. It is characteristic of the scintillating and brilliant piano style of Ravel, who composed it specially for this pianist. Wittgenstein has made a speciality of arranging music for pianoforte for the left hand alone, and many leading composers have written works specially for him. A feature of this programme, which is to be conducted by Clarence Raybould, will be a performance of Glazounov's ballet, "The Seasons," which includes the famous Bacchanale immortalised by Pavlova and Mordkin in the early days of Russian ballet.

The last Sunday orchestral concert of the season will take place this week at 6.30 (Reg.). Sir Adrian Boult will conduct, and the programme, an all-British one, will consist of Elgar's Violin Concerto, with Jean Pougnet as soloist, John Ireland's "London" Overture, and Holst's ballet music, "The Perfect Fool."

SECOND HOUSE

THE first of the new Saturday night Variety programmes "Second House" will be presented by Archie Campbell this week in the National programme at 8. Carl Brisson, who shortly undertakes a tour of provincial music halls, will be heard in several specially-written new numbers. In the same programme listeners will hear Kimberley and Page, Walsh and Barker, Fred Gwyn, Gypsy Nina, and Brookins and Van. Davy Burnaby will be host, and Charles Shadwell will conduct the Variety Orchestra.

This will be the first of the Variety programmes to alternate with "Music Hall," which, during the summer, becomes a fortnightly show.

MUSIC FROM THE MOVIES

LOUIS LEVY and his Symphony are giving their next broadcast in the present "Music from the Movies" series on Wednesday at 7.10 (Nat.). Louis Levy made a great name for himself while conducting various cinema orchestras, and eventually he was appointed studio musical director for Gaumont-British productions. During 1936 he introduced to broadcasting "Louis Levy and his Symphony" in this now popular series.

OPERA

LISTENERS who are interested in modern opera will be glad of the opportunity of hearing "Blue Beard's Castle," a one-act opera by the famous Hungarian modernist composer, Béla Bartók, which will be broadcast from the Royal Hungarian Opera House, Budapest, on Saturday, and relayed Regionally at 8. This is a work of grim and enigmatic character, full of atmosphere and dramatic interest.

Produced in Berlin in 1816, "Undine" is one of the dozen or so operas of that most eccentric and versatile of composers and *littérateurs*, E. T. A. Hoffmann, of whom Carlyle said that he wasted on wild living gifts which might have seasoned the nectar of the gods. Recordings of this opera will be broadcast from Cologne at 9.30 to-night (Friday).

Saturday's opera performance from Milan at 8 is "Liolà," the work of a much-appreciated contemporary Italian composer, Mulè, the Director of Palermo Conservatoire. He has written some half a dozen operas, as well as incidental music to the Greek tragedies produced at the Greek Theatre, Syracuse.

Excerpts from the simple pastoral opera, "Le Devin du Village" (The Village Soothsayer), comes from Luxembourg at 9 on Tuesday. Both the words and music of this opera are the work of the philosophical writer, Jean Jacques Rousseau. It was produced at Fontainebleu in 1752, after which followed four hundred performances at the Opéra, Paris.

THE MARSEILLAISE

FROM Brussels II on Tuesday at 8 comes a programme entitled "The Anniversary of the Marseillaise." The French revolutionary hymn was first heard on April 25th, 1792. The programme will include many works which embrace the French National Anthem, among them being Tchaikovsky's 1812 Overture.

CATHEDRAL CONCERT

A FESTIVAL of Church Music is being held in Norway, the crowning event of which is a representative concert in the ancient cathedral of Trondheim. The programme, which will be radiated by the Norwegian stations on Tuesday at 8.30, consists of works by contemporary Norwegian composers.

WALSH AND BARKER, the American duettists, who will be heard in "Second House," the variety show which takes the place of the usual Saturday "Music Hall."

ENGINEERS' ORCHESTRA

ON Saturday at 7.55, the Finnish long-wave station, Lahti, will be radiating a concert given by the Polyteknikernas Orchester. The members of this orchestra, which enjoys immense popularity, are drawn from the engineering staff of the Finnish Polytechnic.

THE AUDITOR.

Details of this week's Television programmes will be found on p. 369

HIGHLIGHTS OF THE WEEK

FRIDAY, APRIL 16th.

Nat., 7.15, The Wireless Puppets. 8.15, Ratcliff Highway 9.20, The Prime Minister.
Reg., 6, Worthing Municipal Orchestra. 9, Star gazing; Edith Day.
Abroad.
Kalundborg, 9, Opera and operetta music.

SATURDAY, APRIL 17th.

Nat., 7.30, B.B.C. Presents the A.B.C.—B. 8, Second House; a radio variety. 9.35, More Macabre: Uncanny stories.
Reg., 6, The Wireless Puppets. 8, Relay from the Royal Hungarian Opera House, Budapest. 9, Peter Yorke and his Orchestra.
Abroad.
Leipzig, 7, "Elektra"; one-act opera (Richard Strauss).

SUNDAY, APRIL 18th.

Nat., 6.15, I Knew a Man. 7.15 "Three Women." 9.5, "Ghosts of London."
Reg., 5, The Richard Crean Orchestra. ¶Sunday Orchestral Concert. 9.5, Recital for two pianos; Heinz and Robert Scholz.
Abroad.
Frankfurt, 8, Gala Concert of scenes from opera.

MONDAY, APRIL 19th.

Nat., 7, "Monday at Seven." 8, Talk; Towards National Health—2. 9.50 and 10.40, Acts III and IV of "Othello," from Covent Garden.
Reg., 6.40, Anona Winn and her Winners. 8 and 8.50, Acts I and II of "Othello." ¶Hermann Löhr's music—Reginald Foort at the Theatre organ.
Abroad.
Lille PTT, 8.30, Symphony concert from Paris.

TUESDAY, APRIL 20th.

Nat., 6.25, The Empire Orchestra. 8, "The Second Round" (Sapper).
Reg., 6, The B.B.C. Military Band and Arthur Cranmer. ¶Recital of Syncopated Music, by Ruby Duncan. 9, "The Quaker Girl."
Abroad.
Breslau, 8.10, Spanish Folk Songs.

WEDNESDAY, APRIL 21st.

Nat., 7.10, Music from the Movies. 9.30, Lord Snell. 9.45, The Ceremony of the Keys.
Reg., 6, "The Second Round" (Sapper). 7.45, Variety from the Palace Theatre, Plymouth. ¶Act II of Don Pasquale from Covent Garden.
Abroad.
Berlin, 9, Hans Pfitzner Concert, composer conducting.

THURSDAY, APRIL 22nd.

Nat., 6.40, Eddie Carroll and his music. 7.40, "The Quaker Girl." ¶Talk—"Words Fail Me."
Reg., 7.30, "Aerbut and Gaertie," Birmingham dialect sketch. 7.40, Midland Parliament—Modern Advertising and Industry. 9.5, Jack Payne and his band.
Abroad.
Rome, 9, "Lucia di Lammermoor" (Donizetti) from the Royal Opera.

The Television Receiver

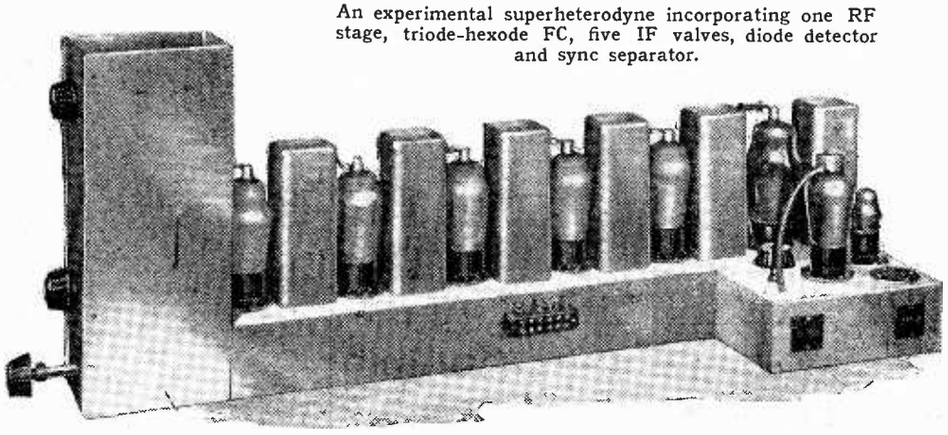
VII.—THE SIGNAL-NOISE RATIO AND SUPERHETERODYNE

THE problems of signal-noise ratio and interference are treated in this article and it is shown that the superheterodyne needs careful design if it is to be as good as the straight set in the matter of background. The straight set also has the advantage of being free from certain special forms of interference.

By W. T. COCKING

SO far little has been said about the relative advantages of the straight set and the superheterodyne. It has been pointed out that the latter is preferable from the points of view of obtaining high gain with stability and of checking the design by measurement, for the higher the frequency at which amplification is obtained the more difficult it is to avoid instability and to make accurate measurements. While these points are in favour of the superheterodyne, they are not alone sufficient to make us choose it in preference to the straight set, for they are by no means insuperable and they are actually the only drawbacks to the straight set.

Examination of the question in detail may show the superheterodyne to have more serious failings, and if this should happen to be the case we should naturally choose the straight set. In this connection we shall do well to bear in mind that the data on intervalve couplings given in earlier articles in this series applies with equal force to both types of receiver. The only exception is the coupling with series resistance described in Part IV, but this is not of much use even in superheterodynes unless the intermediate frequency is below some 5.0 Mc/s.



An experimental superheterodyne incorporating one RF stage, triode-hexode FC, five IF valves, diode detector and sync separator.

There is first of all the question of the signal-noise ratio. It may seem rather absurd to speak of noise in the case of television reception, but the meaning of the term is well understood, and it is difficult to find a better one to describe the voltage fluctuations in tuned circuits and valves which can cause a background of hiss in sound reception and a dirty background in vision reception.

If we assume a band-width of 4.0 Mc/s and a tuned circuit impedance of 1,000 ohms, the noise voltage due to thermal agitation in the conductor of the first tuned circuit is likely to be about 8 μV. on the grid of the first valve. The valve noise cannot be so accurately calculated, but for the same band-width and for a valve having $g=6.0$ mA/V. and a current of 20 mA., the equivalent noise on the grid is likely to be about 26 μV. The total voltage is thus $\sqrt{8^2+26^2}=27.2$ μV. We can, therefore, say that the circuit noise will be negligible in comparison with the valve noise, and this is a normal result in short-wave receivers owing to the low impedance of the circuits.

Now in the case of a frequency-changer the current consumption is lower, some 4.7 mA. only, but the conversion conductance is also lower, about 0.64 mA/V. The equivalent noise voltage on the grid is thus some 118 μV. A frequency-changer consequently introduces about 4.5 times as much noise as an amplifier. If the superheterodyne is not to be inferior to the straight set in the matter of the signal-noise ratio, therefore, the frequency-changer must be preceded by an RF amplifier of sufficient gain for the ratio to be determined by the first amplifier valve. If we call the RF gain A, and the noise voltage on the amplifier grid V_1, then the noise applied to the frequency-changer is AV_1. With this must be combined the frequency-changer noise V_2, and the total noise will be $V_T=\sqrt{V_2^2+A^2V_1^2}$; inserting the values given above, $V_T=\sqrt{13{,}900+676\,A^2}$. We can say that the frequency-changer noise will be negligible if it increases the total noise by 5 per cent. only, or $V_T=1.05V_1A$. Inserting values, we find that $A=14.2$. Therefore, the RF amplifier should give a gain of not less than 14 times if the optimum signal-noise ratio is to be secured.

A gain of this order is rather high for a single stage if the requisite band-width is to be maintained. As long as the RF stage gain exceeds about 4.5 times, however, its use will improve the signal-noise ratio, but will not be equal to the straight set unless it reaches 14 times. Actually, a superheterodyne having an RF gain of 14.2 will have the same signal-noise ratio as a straight set of equal sensitivity and with a stage gain of 3.3 times; the latter figure can easily be exceeded.

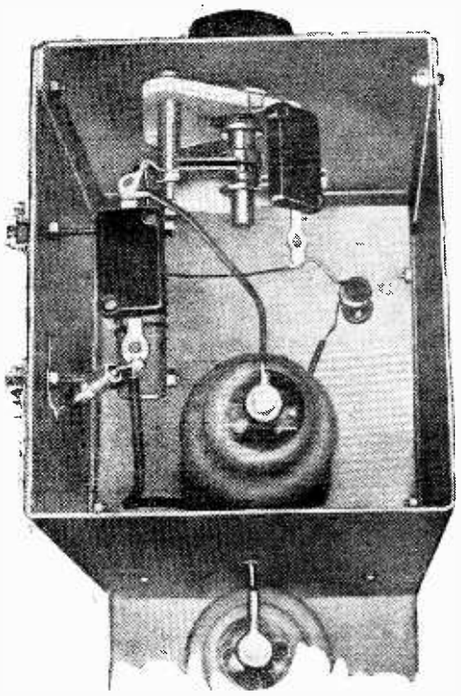
It is somewhat difficult to determine the lowest signal-noise ratio tolerable, but it is probably about 30-1. Assuming this figure, the weakest signal which will give us a tolerable picture with the best receiver is $30\times26=780$ μV., and with a superheterodyne having no RF stage about 3,500 μV. These figures agree well with practical experience.

Maximum Useable Gain

Confining our future remarks to the case of the straight set or the superheterodyne with an RF amplifier, we can calculate the maximum gain necessary to provide full output on the minimum tolerable input of 780 μV. About 30 volts p-p output is needed, and since the detector efficiency factor of input (RMS volts)/output (p-p volts) is generally about unity, the gain is $30/0.00078=38{,}500$ times. To be on the safe side, we should allow a gain of 40,000-50,000 times. On this question of signal-noise ratio there is nothing to choose between the straight set and the superheterodyne, provided that the latter is properly designed.

The Television Receiver—

Let us now consider the matter of those special forms of interference to which the superheterodyne only is subject. These follow the ordinary laws to which we are accustomed in sound receivers, but the matter is somewhat complicated by the enormous band-width of the vision amplifier. In what follows it will be assumed that the band-width is 4.0 Mc/s.



The RF stage can be seen in the screening box with the frequency-changer just outside.

Second-channel interference is the type which first comes to mind. If the oscillator is set at a frequency higher than the signal, such interference can only come from stations operating with frequencies equal to that of the wanted signal plus twice the intermediate frequency plus or minus one-half the band-width of the amplifier. If the intermediate frequency is 10.0 Mc/s, only stations between 63 Mc/s and 67 Mc/s can cause interference. There are probably few or no stations in this band, so that second-channel interference is unlikely to be important, and in practice it is not.

The next possibility of trouble occurs when the frequency difference between two stations of equal strength lies within the band transmitted by the IF amplifier. The only stations which can cause this trouble are the sound and vision transmitters, and their frequency difference is 3.5 Mc/s. To avoid the possibility of interference of this nature, the intermediate frequency should not lie between 1.5 Mc/s and 5.5 Mc/s.

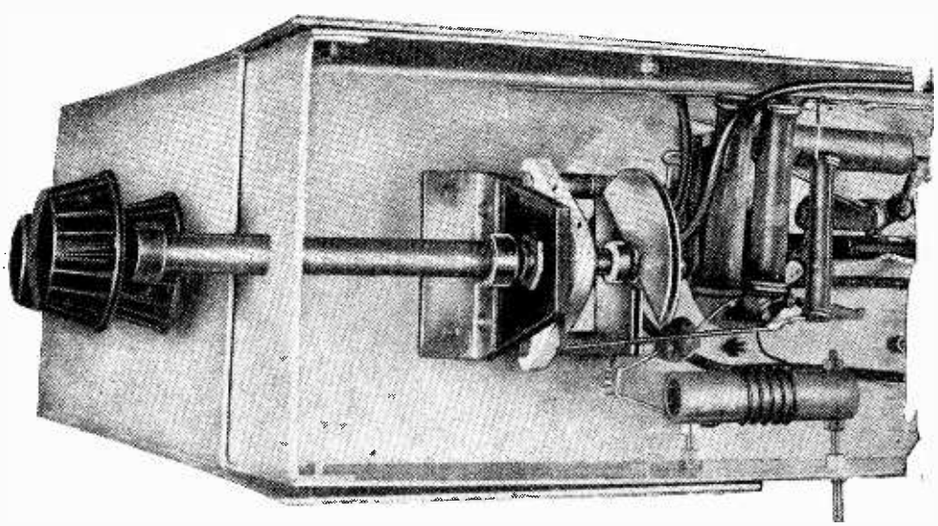
The second harmonic of the beat between the stations is 7.0 Mc/s, and if present at any appreciable intensity would prohibit the use of an intermediate frequency between 5.0 Mc/s and 9.0 Mc/s. The third harmonic is 10.5 Mc/s, and would prohibit frequencies between 8.5 Mc/s and 12.5 Mc/s.

In practice this form of interference is by no means serious. It is probably wise to avoid the use of a frequency near the fundamental difference frequency, but it seems possible to ignore the possibility of interference through the harmonics. Nevertheless, if frequencies of this order are chosen, it is wise to make the midband frequency of the IF amplifier equal to the mid-frequency between two harmonics. In this way any interference will be of high frequency and will be less noticeable. One would choose, therefore, intermediate frequencies of $(3.5+7.0)/2 = 5.25$ Mc/s, or, better, $(7.0+10.5)/2 = 8.75$ Mc/s.

IF Harmonic Interference

The next type of interference to consider is that produced in the receiver by the feed-back of harmonics of the IF output to the input. If the intermediate frequency is f_i and the band-width $2n$, the output frequencies are $m(f_i \pm n)$ where m is the order of the harmonic. Suppose we make $f_i = 8.75$ Mc/s. and $n = 2.0$ Mc/s, the output frequencies are for the fundamental ($m=1$) 6.75 – 10.75 Mc/s, for the second harmonic 13.5 – 21.5 Mc/s, for the third harmonic 20.25 – 32.25 Mc/s, for the fourth harmonic 27 – 43 Mc/s, for the fifth harmonic 33.75 – 53.75 Mc/s, for the sixth 40.5 – 64.5 Mc/s, for the seventh 47.25 – 75.25 Mc/s. Both the fifth and sixth harmonics will cause interference if the feed-back is sufficient.

It is possible to avoid this type of interference by choosing an intermediate frequency such that the signal frequency lies between the first and second or second and third harmonic bands of frequencies. This means a lower limit to the intermediate frequency of about 20.0 Mc/s, however, and if one has to use such a frequency there would seem little advantage over the straight set.



An under view of the chassis showing the oscillator components.

In the writer's experience these forms of interference are by no means theoretical possibilities, but occur in practice to a serious degree. He has used amplifiers at frequencies ranging from 2.5 Mc/s to 10.0 Mc/s, and in all the same interference problems existed to a greater or lesser degree. The results generally found are that as the oscillator tuning is varied so that the intermediate frequency passes through the range of frequencies with which the amplifier will deal, points of interference alternating with points of clear reception are found. The term clear reception is relative, for in some cases there is no point at which complete freedom from interference can be obtained. The interference at the worst points, of which there are usually two or three, takes the form of mottled background to the picture which is not unlike watered silk in appearance. At the comparatively clear points interference is more often in the form of parallel dark lines across the picture. Their number and width, and the angle which they make with the vertical, are dependent upon the precise frequencies involved and change with the tuning.

It is generally possible to find one tuning point at which interference is negligible, but, unfortunately, this is not always the best tuning point for maximum efficiency nor for the best picture. It sometimes happens that at an interference-free point there is severe phase-distortion, with the result that the picture appears in relief.

It is, of course, quite possible to prevent this interference from occurring by preventing the feed-back. This is not as easy as it sounds, however, for an extraordinarily high degree of circuit isolation is necessary. Actually, more screening is needed between the input and output circuits to prevent harmonic interference in a superheterodyne than to avoid instability in a straight set. It will thus be seen that one of the two disadvantages of the straight set, the need for careful screening, is also present in the superheterodyne.

If a television receiver had to be capable of receiving a number of stations like a broadcast set, we should probably be forced to use the superheterodyne on account of the large number of tuned circuits which would otherwise have to be

The Television Receiver—

ganged. We have only a single station, however, so that the straight set can be just as much pre-tuned as an IF amplifier. When we also take into account the fact that it is easier to obtain the optimum signal-noise ratio than in a superheterodyne, it is clear that the straight set is likely to be the more satisfactory of the two. This is especially the case when initial adjustments have to be made with a test oscillator of doubtful accuracy or even on the signals themselves, for the precise adjustment of circuits to dodge some of the interference points is then much more difficult.

Straight Set *v.* Superheterodyne

After considerable experience with the superheterodyne, the writer has been driven to the opinion that for television reception the straight set is simpler and that for a given amount of apparatus and limited skill of adjustment it gives a better performance. This statement carries greater weight when it is remembered that he commenced work on television receivers with a bias in favour of the superhet.

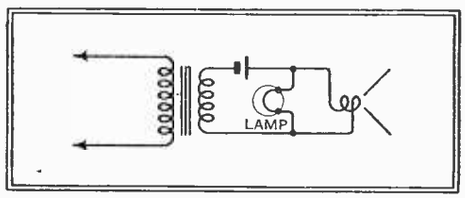
In the earlier articles in this series particular stress has been laid upon this type of receiver for the reason that most people will feel as the writer did at first that the difficulties of the straight set are too great. By discussing the questions fully in this way, a better understanding of the characteristics of each system is obtained, and most of the data is directly applicable to the straight set.

Contrast Expansion

Further Notes on the Simple Lamp Method

By GERALD SAYERS

AS pointed out in *The Wireless World* of December 18th, 1936, one of the difficulties of utilising the simple lamp method of volume expansion is that of the inefficiency of a filament which most of the time is not working anywhere near its rated wattage. If the lamp or lamps can be arranged to remain at a good glowing temperature the degree of control will approximate more closely to the desirable square law. Obviously the way is to superpose a constant direct current; in the simplest case, as illustrated, a cell or

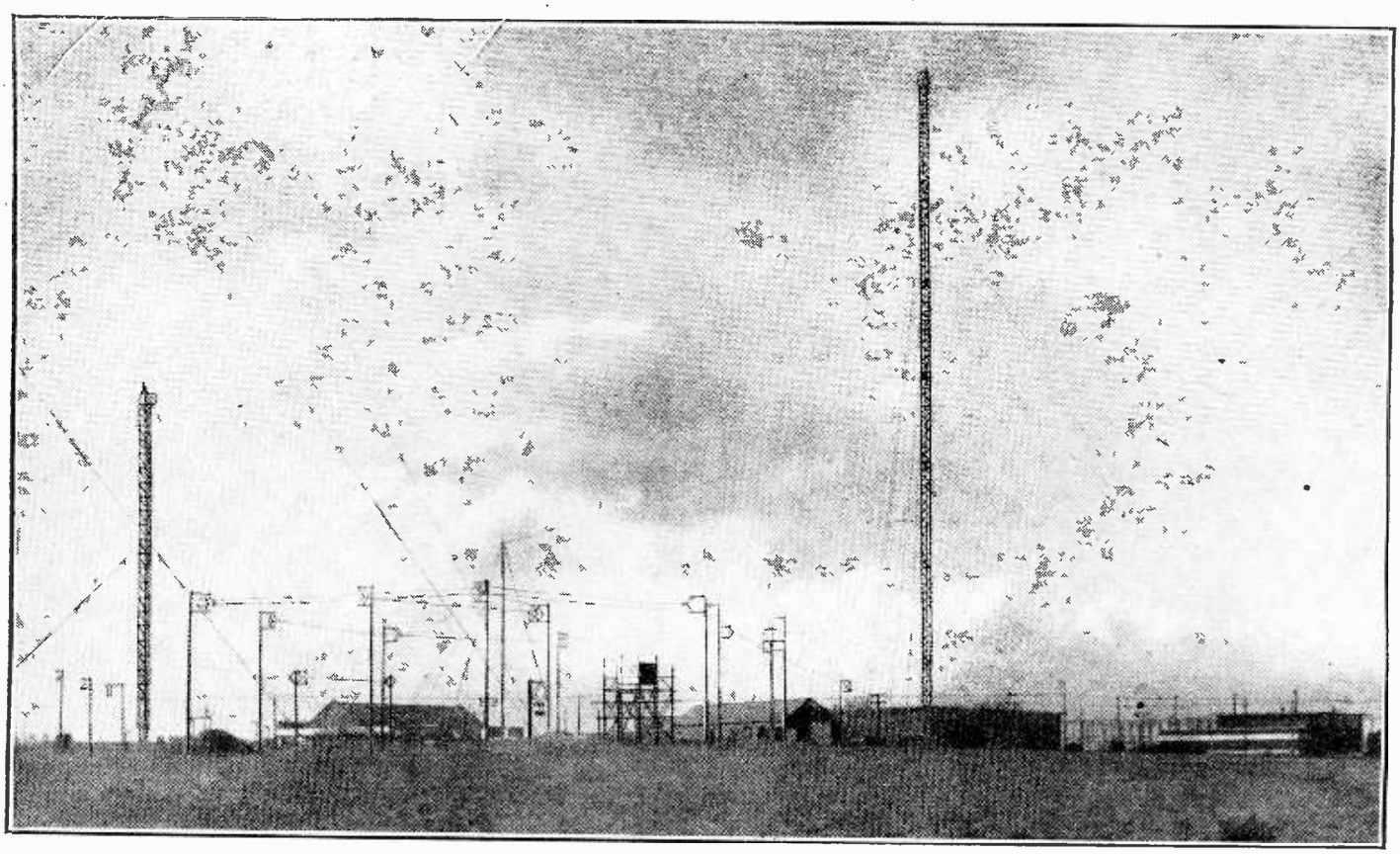


Showing the addition of a cell for supplying "polarising" current to a control lamp.

battery can be inserted to achieve this. An accumulator is not recommended for initial experiments as the available current might cause damage in case of accident.

Usually the normal current is insufficient to hold the speech coil seriously out of alignment, but in any case a trial reversal of polarity might secure the better result. In a final arrangement it may be possible to balance out direct current through the speaker, and any bridge circuit containing lamps or resistances can be developed on similar lines. Alternatively with a mains-supplied amplifier demanding a relatively large current—and such an amplifier is necessary for successful contrast expansion—the insertion of a potentiometer in the negative lead may supply the current for lighting the lamps and thus the adjustment for optimum conditions may be easily effected; such an expedient makes the selection of suitable lamps considerably easier because the no-load resistance can be set to the desired value, and it would seem that less signal power is wasted than in continually warming up a cold filament. It is safe to say that most lamps will stand transient values up to twice their rated wattages.

Contrast expansion can most certainly have the subjective effect of reducing background noise, although at present probably at the sacrifice of some low-level sounds. When operated at the output end, as in a lamp arrangement, the set noise also can be subdued, and this advantage offsets to some extent the large power wastage. With true contrast compression low-level signals should be brought up at the transmitter well above the total noise level, thus allowing attenuation to their relative values without loss.



EMPIRE BROADCASTING. A *Wireless World* photograph of part of the site on which stand the new B.B.C. Empire transmitters. Two of the new 50-kW plants are already testing, and it is hoped that these two will be in use by the time of the Coronation. There will, however, be no official opening as time does not permit, but the transmitters will be put into regular service when tests are completed.

Broadcast Brevities

NEWS FROM PORTLAND PLACE

The New Empire Station

SIR NOEL ASHBRIDGE, Chief Engineer of the B.B.C., displayed a tinge of justifiable pride at his Press conference last week when he drew aside the veil which has enveloped the Empire broadcasting station during the past few months.

Work on Europe's most powerful group of short-wave transmitters is now nearing completion, though progress has been slow because entirely new apparatus has had to be constructed to cope with the designs of the B.B.C. Research Department in co-operation with the Marconi Company and Standard Telephones and Cables.

Thirteen Masts

The original Daventry site now accommodates three transmitters of 50 kilowatts each, and there is provision for another; in addition, the old 10-kilowatt plant is being maintained. When the station is ready it will look like a miniature Rugby, for there will be thirteen masts in all. The four old masts remain *in situ*; the nine newcomers will vary in height from 80ft. to 325ft.

Actually, there will be 23 aerial systems capable of transmitting in 12 different directions; most of these will have reflector systems. It will be possible to connect any aerial to any transmitter, and there will be six miles of feeder wire.

Seventy-five Kilowatts?

Thus Daventry resumes its status as a "world beater" which it forfeited when Germany entered the short-wave field. Zeesen employs 40-kilowatt transmitters; Daventry, although rated at 50 kilowatts, is expected to reach 75 or even more, though this may not be achieved for several months.

Yardstick of Reception

Sir Noel demonstrated an interesting gramophone record illustrating the B.B.C.'s standards of reception. Signals from prominent short-wave stations all over the world had been classified according to strength and clarity, but the difficulty had been to give a clear idea of the relative standards to the picked observers in the Empire. Someone hit upon the happy idea of setting out representative examples on this gramophone record, which has been sent to nearly 100 reliable listeners.

For the last three years special log charts have been sent to interested listeners, and since this service was instituted more than 20,000 completed logs have been returned to the B.B.C.

Foreign Languages Soon?

It is hoped to have practically the whole of the Empire station in working order in time for the Coronation. For the first few months, at any rate, only the English language will be used, though the B.B.C., in consultation with the Foreign Office, is now seriously considering whether a polyglot service would make the station of more vital importance to the interests of the Empire.

The B.B.C. in the Abbey

ALTHOUGH the orchestra for the Coronation Service in the Abbey numbers only 59, no fewer than 31 of these will be B.B.C. players, among them being Mr. Bernard Reillie, leader of the Variety Orchestra. This is believed to be the first time that a variety orchestra has been represented in the Abbey.

Two Conductors

Another innovation will be the employment of two conductors. It is expected that Sir Adrian Boult will assist Dr. Ernest Bullock, the Abbey organist, by reflecting his baton beats, to those parts of the orchestra which cannot see them direct. Dr. Bullock is, of course, chief conductor, but he will be concentrating on the choral side.

All-Sunday Rehearsal

The B.B.C. Symphony Orchestra will be represented in the Abbey, and there will also be players from the Empire Orchestra and the Military Band.

The Coronation Orchestra will spend the whole of Sunday, May 2, rehearsing at the Maida Vale studios, making history as the first orchestra to graduate from a former skating rink to Westminster Abbey.

Coronation Commentators

COMMENTARIES on the Coronation procession and on the general scenes are to be broadcast by Harman Grisewood (precincts of Buckingham Palace), John Snagge (Green Park, overlooking Buckingham Palace, Harold Abrahams (Whitehall, near the Cenotaph), George Blake (outside Middlesex Guildhall, facing Westminster Abbey), Michael Standing (in the Abbey annexe), and Howard Marshall (in the Triforium). During the Service the B.B.C. Director of Religion, Rev. F. A. Iremonger, stationed alongside Howard Marshall, will add some comments on the Service.

The Nerve Centre

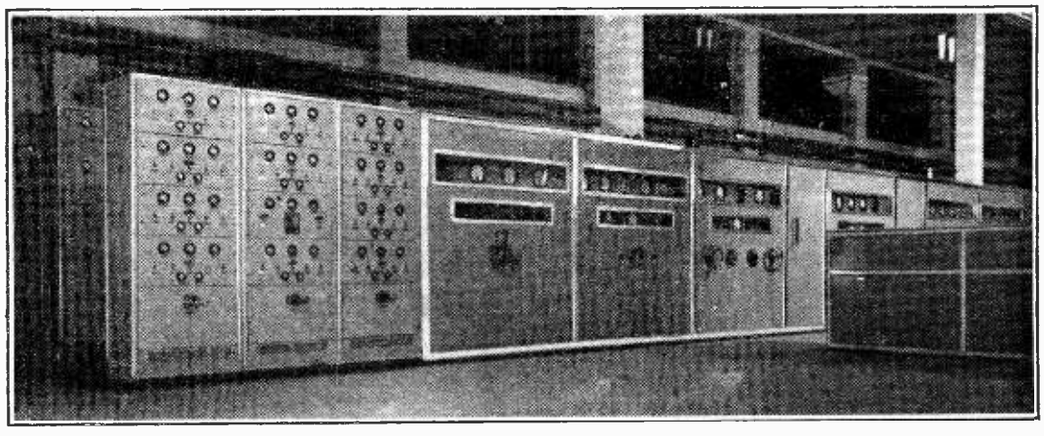
Thirty-eight microphones will be utilised in various parts of the Abbey. The control room, on the south-west side of the nave, will have concentrated upon it all the microphones along the processional route, as well as those in the Abbey. A fancy figure might be given of the miles of wiring required for what our American friends would call the great "hook-up." But any estimate in advance is bound to be unreliable, seeing that many technical changes are certain to be made during the week prior to Coronation Day. Between five and ten miles of wiring may be required.

Toscanini at the B.B.C.

THE greatest musical event of the year in broadcasting will be the appearance of Arturo Toscanini at six concerts during May and June, all to be given in the Queen's Hall, and each function having a Coronation flavour. It is doubtful if the B.B.C. would have been successful in securing Toscanini's services had it not been for the Royal event, which next month will draw tens of thousands to London from all parts of the world; as, although the first concert is not taking place until May 26th, many distinguished visitors will still be here at that time, and a considerable proportion of them who are musical enthusiasts will be staying on especially to attend.

Dates to be Noted

At the first concert, works by Busoni, Ravel and Beethoven will be played, and the concert will wind up with Brahms' First Symphony. The second concert, on May 28th, opens with Elgar's Introduction and Allegro for Strings, and includes the first performance in England of Tommasini's "Il Carnevale di Venezia." On June 2nd the Sixth Symphony of Beethoven will be given, and his Third Symphony (Eroica) is included in the programme for June 4th. The remaining two concerts are on June 14th and 16th, the latter being an all-Wagner programme.



HIGH-POWERED TRANSMITTER for Empire Service. One of the three new transmitters showing (left) the crystal oscillator and frequency doubling stage; (centre) the intermediate amplifying and output stages; and (right) the modulator unit. All three transmitters are housed in one large new building which can be seen on the extreme right of the photograph on the opposite page.

Televising Fire-walking

A TRENCH is to be dug in Alexandra Park for a fire-walking demonstration before the television camera on Tuesday next, April 20th, by Ahmed Hussain, whose prowess was recently the subject of a running commentary in sound broadcasting. Viewers will see Ahmed discard shoes and socks before essaying what many people regard as one of the most prodigious feats of mental concentration yet devised.

SHORT-WAVE STATIONS OF

(Stations with an Aerial Power of 20 kW. and above are shown in heavy type)

Station.	Call Sign.	kc/s.	Tuning Positions.	Metres.	kW.
Sourabaya (Dutch East Indies)	YDB7	1,530	.....	196.08	0.07
Soekaboeni (Dutch East Indies)	YDA4	1,550	.....	193.55	0.02
Malang (Dutch East Indies) ...	YDB6	1,570	.....	191.08	0.1
Batavia (Dutch East Indies) ...	YDD3	1,585	.....	189.27	0.05
Solo (Dutch East Indies) ...	YDB5	1,595	.....	188.09	0.02
U.S.A. Police	—	1,596	.....	180.45	—
Tjepoe (Dutch East Indies) ...	YDB4	1,615	.....	185.76	0.02
Buitenzorg (Dutch East Indies)...	YDA3	1,640	.....	182.93	0.02
Tjokjakarta (Dutch East Indies)	YDB3	1,660	.....	180.72	0.1
U.S.A. Police	—	1,666	.....	180.07	—
U.S.A. Police	—	1,674	.....	179.21	—
U.S.A. Police	—	1,706	.....	175.73	—
U.S.A. Police	—	1,712	.....	175.23	—
U.S.A. Amateurs	—	1,715–2,000	.....	175.00–150.00	—
British Amateurs	—	1,730–1,985	.....	173.40–151.10	—
Liepaja (Latvia)	—	1,734	.....	173.00	0.1
Small craft, including Yachts, Trawlers, Lifeboats and Lifeships	—	1,837.10	.....	163.30	—
U.S.A. Police	—	2,000–2,100	.....	150.00–142.85	—
British Police	—	2,054.79	.....	146.00	—
Tjokjakarta (Dutch East Indies)	YDE5	2,350	.....	127.66	0.02
Batavia (Dutch East Indies) ...	YDA2	2,385	.....	125.78	0.15
Bandoeng (Dutch East Indies)...	—	2,500	.....	120.00	0.07
Semarang (Dutch East Indies) ...	YDE3	2,710	.....	110.70	0.01
U.S.A. Police	—	2,750–2,850	.....	109.09–105.26	—
Cheribon (Dutch East Indies) ...	YDA6	2,870	.....	104.53	0.01
Tandjonk Priok (Dutch E. Indies)	YDA	3,040	.....	98.68	10
Pekalongan (Dutch East Indies)	YDA	3,270	.....	91.74	0.01
U.S.A. Amateurs	—	3,500–4,000	.....	85.70–75.00	—
Aircraft of all types	—	4,000–17,647.05	.....	75.00–17.00	—
Aircraft Land Stations	—	4,000–18,750.00	.....	75.00–16.00	—
Khabarovsk (U.S.S.R.)	**RW15**	4,273	.....	70.20	20
Solo (Dutch East Indies) ...	YDE2	4,810	.....	63.37	0.1
San Cristobal (Venezuela) ...	YV2RA	5,710	.....	52.54	0.2
Lima (Peru)	OAX4D	5,780	.....	51.90	—
Caracas (Venezuela)	YV5RC	5,800	.....	51.72	1
San Jose de Costa Rica (Costa Rica)	TIGPH	5,822	.....	51.35	—
Maracaibo (Venezuela)	YV1RB	5,850	.....	51.28	—
San Pedro de Macoris (Dominica)	HI1J	5,857	.....	51.22	0.04
Tegucigalpa (Honduras)... ...	HRN	5,875	.....	51.06	—
Quito (Ecuador)	HCK	5,885	.....	50.98	0.3
Barquisimeto (Venezuela) ...	YV3RA	5,895	.....	50.89	0.2
Port au Prince (Haiti)	HH2S	5,920	.....	50.68	0.1
Guatemala City (Guatemala) ...	TG2X	5,940	.....	50.51	—
Bogota (Colombia)	HJN	5,950	.....	50.42	1
Vatican City (Vatican State) ...	HVJ	5,976	.....	50.20	15
Bucaramanga (Colombia) ...	HJ2ABD	5,988	.....	50.10	1
Georgetown (British Guiana) ...	VP3MR	6,005	.....	49.96	—
Montreal (Canada)	CFCX	6,005	.....	49.96	6
Colon (Panama)	HP5K	6,005	.....	49.96	—
Havana (Cuba)	COCO	6,008	.....	49.93	0.3
Prague (Podebrady) (Czechoslovakia)	**OLR**	6,010	.....	49.92	34
Bogota (Colombia)	HJ3ABH	6,012	.....	49.90	1
Santiago de los Caballeros (Dominica)	HI3U	6,017	.....	49.86	0.02
Zeesen (Germany)	**DJC**	6,020	.....	49.83	50
Prague (Podebrady) (Czechoslovakia)	**OLR2B**	6,030	.....	49.75	34
Moscow (U.S.S.R.)	**RNE**	6,030	.....	49.75	20
Panama (Panama)	HP5B	6,032	.....	49.74	0.1
Tandjonk Priok (Dutch E. Indies)	YDA	6,040	.....	49.67	10
Boston (U.S.A.)	W1XAL	6,040	.....	49.67	10
Barranquilla (Colombia) ...	HJ1ABG	6,042	.....	49.65	1
Daventry (Great Britain) ...	GSA	6,050	.....	49.59	15
Bogota (Colombia)	HJ3ABD	6,055	.....	49.55	1
Skamlebaek (Denmark)	OXY	6,060	.....	49.50	0.5
Philadelphia (U.S.A.)	W3XAU	6,060	.....	49.50	1
Cincinnati (U.S.A.)	W8XAL	6,060	.....	49.50	10
Bogota (Colombia)	HJ3ABF	6,069	.....	49.43	1
Maracaibo (Venezuela)	YV1RV	6,079	.....	49.35	0.15
Zeesen (Germany)	**DJM**	6,079	.....	49.35	50
Penang (Malaya)	ZHJ	6,080	.....	49.34	0.05
Colon (Panama)	HP5F	6,080	.....	49.34	0.2
Chicago (U.S.A.)	W9XAA	6,080	.....	49.34	0.5
Nairobi (Kenya)	VQ7LO	6,082	.....	49.33	0.5
Rome (Italy)	**I2RO**	6,085	.....	49.30	25
Cali (Colombia)	HJ5ABD	6,087	.....	49.28	1
Toronto (Canada)	CRCX	6,090	.....	49.26	1
Johannesburg (South Africa) ...	ZTJ	6,097	.....	49.20	5
Medellin (Colombia)	HJ4ABE	6,099	.....	49.19	1
Chicago (U.S.A.)	W9XF	6,100	.....	49.18	10
Bound Brook (U.S.A.)	**W3XAL**	6,100	.....	49.18	35
Belgrade (Yugoslavia)	—	6,100	.....	49.18	0.3
Manizales (Colombia)	HJ4ABD	6,107	.....	49.12	1
Daventry (Great Britain) ...	GSL	6,110	.....	49.10	15
Calcutta (India)	VUC	6,110	.....	49.10	0.5
Prague (Podebrady) (Czechoslovakia)	**OLR**	6,115	.....	49.06	34
Wayne (U.S.A.)	W2XE	6,120	.....	49.02	1
Bogota (Colombia)	HJ3ABX	6,122	.....	49.00	1
Montevideo (Uruguay)	CXA4	6,125	.....	48.98	—
Havana (Cuba)	COCD	6,127	.....	48.96	0.15
Halifax (Canada)...	CJHX	6,130	.....	48.94	0.5
Georgetown (British Guiana) ...	VP3BG	6.130	.....	48.94	—
Pittsburgh (U.S.A.)	**W8XK**	6,140	.....	48.86	40
Pereira (Colombia)	HJ4ABU	6,147	.....	48.80	1
Winnipeg (Canada)	CJRO	6,150	.....	48.78	2
Santiago (Dominica)	HI5N	6,150	.....	48.78	0.1
Caracas (Venezuela)	YV5RD	6,158	.....	48.72	0.2
Santiago de los Caballeros (Dominica)	HI1A	6,185	.....	48.50	0.05
Trujillo City (Dominica) ...	HI8Q	6,200	.....	48.39	0.02
La Ceiba (Honduras)	HRV	6,235	.....	48.12	—
Trujillo City (Dominica) ...	HIN	6,245	.....	48.04	—
Lima (Peru)	OAX4G	6,258	.....	47.94	—
Sanctus Spiritus (Cuba) ...	COHB	6,280	.....	47.77	—
Trujillo City (Dominica) ...	HIG	6,280	.....	47.77	0.05
Maracaibo (Venezuela)	YV4RD	6,298	.....	47.63	0.1
Trujillo City (Dominica) ...	HIZ	6,307	.....	47.57	0.1
Trujillo City (Dominica) ...	HIX	6,335	.....	47.36	1
Caracas (Venezuela)	YV5RB	6,377	.....	47.04	0.30
Caracas (Venezuela)	YV5RH	6,400	.....	46.87	0.25
San Jose de Costa Rica (Costa Rica)	TIPG	6,410	.....	46.80	1
Puerto Plata (Dominica) ...	HI1S	6,420	.....	46.73	0.02
Trujillo City (Dominica) ...	HI4V	6,478	.....	46.31	0.02
Trujillo City (Dominica) ...	HIL	6,500	.....	46.15	0.02
Valencia (Venezuela)	YV6RV	6,518	.....	46.03	0.30
Bolivar City (Venezuela) ...	YV6RB	6,546	.....	45.83	—
San Jose de Costa Rica (Costa Rica)	TIRCC	6,552	.....	45.79	—
Riobamba (Ecuador)	—	6,630	.....	45.25	2
Trujillo City (Dominica) ...	HIT	6,630	.....	45.25	0.1
Lima (Peru)	OAX7A	6,650	.....	45.11	—
San Jose de Costa Rica (Costa Rica)	TIEP	6,690	.....	44.84	—
Moscow (U.S.S.R.)	RTV	6,725	.....	44.61	15
U.S.A. Amateurs	—	7,000–7,300	.....	42.90–41.10	—

THE WORLD

Arranged in Order of Frequency and Wavelength

Station.	Call Sign.	kc/s.	Tuning Positions.	Metres.	kW.
Mexico (Mexico)	**XECR**	7,390	.....	40.60	20
Moscow (U.S.S.R.)	**RKI**	7,520	.....	39.89	25
Prangins (Radio Nations) (Switzerland)	**HBP**	7,797	.....	38.48	20
Moscow (Koupavna) (U.S.S.R.) .	RCC	7,800	.....	38.46	15
Rabat (Morocco)	CNR	8,035	.....	37.33	10
Camaguey (Cuba)	CO9JQ	8,665	.....	34.62	0.1
Quito (Ecuador)	HCJB	8,935	.....	33.58	0.15
Budapest (Hungary)	HAT4	9,130	.....	32.86	6
Havana (Cuba)	COCH	9,435	.....	31.80	0.15
Rio de Janeiro (Brazil)	PRF5	9,500	.....	31.58	12
Cartagena (Colombia)	HJ1ABE	9,500	.....	31.58	1
Buenaventura (Colombia) ...	HJU	9,510	.....	31.55	1
Daventry (Great Britain) ...	GSB	9,510	.....	31.55	15
Melbourne (Australia)	VK3ME	9,510	.....	31.55	1.5
Hong Kong (China)	2BW3	9,525	.....	31.49	2.6
Jeloy (Norway)	LKJ	9,525	.....	31.49	1.5
Schenectady (U.S.A.)	**W2XAF**	9,530	.....	31.48	40
Tokio (Japan)	**JZI**	9,535	.....	31.46	50
Zeesen (Germany)	**DJN**	9,540	.....	31.45	50
Prague (Podebrady) (Czechoslovakia)	**OLR3A**	9,550	.....	31.41	34
Barranquilla (Colombia) ...	HJ1ABB	9,558	.....	31.23	1
Cucuta (Colombia)	HJ2ABC	9,558	.....	31.23	1
Zeesen (Germany)	**DJA**	9,560	.....	31.38	50
Bombay (India)	VUB	9,565	.....	31.36	4.5
Millis (U.S.A.)	W1XK	9,570	.....	31.35	10
Lyndhurst (Australia)	VK3LR	9,580	.....	31.32	1
Daventry (Great Britain) ...	GSC	9,580	.....	31.32	15
Sydney (Australia)	**VK2ME**	9,590	.....	31.28	20
Philadelphia (U.S.A.)	W3XAU	9,590	.....	31.28	1
Huizen (Holland)	PCJ	9,590	.....	31.28	12
Prangins (Radio Nations) (Switzerland)	**HBL**	9,595	.....	31.27	20
Moscow (U.S.S.R.)	**RAN**	9,600	.....	31.25	20
Santiago de Chile (Chile) ...	CB960	9,603	.....	31.24	0.1
Panama (Panama)	HP5J	9,605	.....	31.23	0.2
Cartagena (Colombia)	HJ1ABP	9,616	.....	31.20	1
Rome (Italy)	**I2RO3**	9,635	.....	31.12	25
Port au Prince (Haiti)	HH3W	9,645	.....	31.10	0.1
Lisbon (Portugal)	CT1AA	9,650	.....	31.09	—
Sourabaya (Dutch East Indies)...	YDB1	9,657	.....	31.07	1
Buenos Aires (Argentina) ...	LRX	9,660	.....	31.06	5
Havana (Cuba)	COCQ	9,740	.....	30.80	—
Madrid (Spain)	EAQ	9,860	.....	30.43	10
Lisbon (Portugal)	CSW	9,940	.....	30.18	—
Bandoeng (Dutch East Indies)...	PMN	10,260	.....	29.24	1.5
Ruysselede (Belgium)	ORK	10,330	.....	29.04	11
Buenos Aires (Argentina) ...	LSX	10,350	.....	28.99	12
Teneriffe (Spain)	EAJ43	10,365	.....	29.94	4
Tokio (Japan)	**JVN**	10,660	.....	28.14	20
Bandoeng (Dutch East Indies)...	PLP	11,000	.....	27.27	1.5
Moscow (U.S.S.R.)	**RIA**	11,705	.....	25.63	20
Stockholm (Sweden)	SM5SX	11,705	.....	25.63	—
Paris (Radio-Colonial) (France)...	TPA4	11,715	.....	25.61	12
Winnipeg (Canada)	CJRX	11,720	.....	25.60	2
Huizen (Holland)	**PH1**	11,730	.....	25.57	20
Daventry (Great Britain) ...	GSD	11,750	.....	25.53	15
Prague (Podebrady) (Czechoslovakia)	**OLR4B**	11,760	.....	25.51	34
Zeesen (Germany)	**DJD**	11,770	.....	25.49	50
Vienna (Austria)	OER2	11,780	.....	25.47	1.5
Boston (U.S.A.)	W1XAL	11,790	.....	25.45	10
Zeesen (Germany)	**DJO**	11,795	.....	25.43	50
Tokio (Japan)	**JZJ**	11,800	.....	25.42	50
Rome (Italy)	**I2RO4**	11,810	.....	25.40	25
Daventry (Great Britain) ...	GSN	11,820	.....	25.38	15
Wayne (U.S.A.)	W2XE	11,830	.....	25.36	1
Chicago (U.S.A.)	W9XAA	11,830	.....	25.36	5

Station.	Call Sign.	kc/s.	Tuning Positions.	Metres.	kW.
Prague (Podebrady) (Czechoslovakia)	**OLR4A**	11,840	.....	25.34	34
Zeesen (Germany)	**DJP**	11,855	.....	25.31	50
Daventry (Great Britain) ...	GSE	11,860	.....	25.29	15
Sourabaya (Dutch East Indies)...	YDB1	11,860	.....	25.29	1
Pittsburgh (U.S.A.)	**W8XK**	11,870	.....	25.27	40
Prague (Podebrady) (Czechoslovakia)	**OLR**	11,875	.....	25.26	34
Paris (Radio Colonial) (France)...	TPA3	11,885	.....	25.24	12
Reykjavik (Iceland)	TFJ	12,235	.....	24.52	7
Moscow (U.S.S.R.)	**RNE**	12,060	.....	24.88	20
Rabat (Morocco)	CNR	12,830	.....	23.39	10
Warsaw (Poland)	**SPW**	13,635	.....	22.00	20
U.S.A. Amateurs	—	14,000–14,400	.....	21.43–20.83	—
British Amateurs	—	14,030–14,370	.....	21.38–20.88	—
Moscow (U.S.S.R.)	RTV	14,580	.....	20.58	15
Sofia (Bulgaria)	LZA	14,900	.....	20.13	7
Moscow (U.S.S.R.)	**RK1**	15,040	.....	19.95	25
Zeesen (Germany)	**DJL**	15,110	.....	19.85	50
Vatican City (Vatican State) ...	HVJ	15,120	.....	19.84	10
Daventry (Great Britain) ...	GSF	15,140	.....	19.82	10
Bandoeng (Dutch East Indies)...	YDC	15,151	.....	19.80	3
Tokio (Japan)	**JZK**	15,160	.....	19.79	50
Batavia (Dutch East Indies) ...	—	15,150	.....	19.80	3
Daventry (Great Britain) ...	GSO	15,180	.....	19.76	10
Hong Kong (China)	ZBW4	15,190	.....	19.75	2.6
Zeesen (Germany)	**DJB**	15,200	.....	19.74	50
Pittsburgh (U.S.A.)	**W8XK**	15,210	.....	19.72	40
Huizen (Holland)	PCJ	15,220	.....	19.71	12
Prague (Podebrady) (Czechoslovakia)	**OLR**	15,230	.....	19.70	34
Paris (Radio Colonial) (France)...	TPA2	15,240	.....	19.69	10
Boston (U.S.A.)	W1AL	15,250	.....	19.67	10
Daventry (Great Britain) ...	GSI	15,260	.....	19.66	10
Wayne (U.S.A.)	W2XE	15,270	.....	19.64	1
Zeesen (Germany)	**DJQ**	15,280	.....	19.63	50
Buenos Aires (Argentina) ...	LRU	15,290	.....	19.62	5
Daventry (Great Britain) ...	GSP	15,310	.....	19.60	10
Prague (Podebrady) (Czechoslovakia)	**OLR**	15,320	.....	19.58	34
Schenectady (U.S.A.)	**W2XAD**	15,330	.....	19.57	40
Zeesen (Germany)	**DJR**	15,340	.....	19.56	50
Budapest (Hungary)	HAS3	15,370	.....	19.51	6
Zeesen (Germany)	**DJE**	17,760	.....	16.89	50
Wayne (U.S.A.)	W2XE	17,760	.....	16.89	1
Huizen (Holland)	**PHI**	17,770	.....	16.88	20
Bound Brook (U.S.A.)	**W3XAL**	17,780	.....	16.87	35
Daventry (Great Britain) ...	GSG	17,790	.....	16.86	10
Bandoeng (Dutch East Indies)...	**PMC**	18,145	.....	16.53	60
Prangins (Radio Nations) (Switzerland)	**HBH**	18,480	.....	16.25	20
Bangkok (Siam)	**HS8PJ**	19,020	.....	15.77	20
Bandoeng (Dutch East Indies)...	**PMA**	19,345	.....	15.51	60
Zeesen (Germany)	**DJS**	21,450	.....	13.97	20
Prague (Podebrady) (Czechoslovakia)	**OLR**	21,450	.....	13.97	34
Daventry (Great Britain) ...	GSH	21,470	.....	13.97	10
Wayne (U.S.A.)	W2XE	21,520	.....	13.94	1
Daventry (Great Britain) ...	GSJ	21,530	.....	13.93	10
Pittsburgh (U.S.A.)	**W8XK**	21,540	.....	13.93	40
British Amateurs	—	28,050–29,950	.....	10.70–10.02	—
U.S.A. Police	—	30,000–42,000	.....	10.00–7.14	—
Alexandra Palace, Sound ...	—	41,500	.....	7.23	3
Alexandra Palace, Vision ...	—	45,000	.....	6.67	17
British Amateurs	—	56,070–59,930	.....	5.35–5.00	—

On the Short Waves

NOTES FROM A LISTENER'S LOG

CONDITIONS have remained generally good during the past fortnight, and reached a peak on Wednesday, April 7th, when W9XAZ on 26.4 Mc/s was excellent at times at 10 p.m.!

There was, however, a fade-out of 28 Mc/s signals due, apparently, to low ionisation levels between March 29th and April 5th, and in spite of considerable visible sunspot activity the limiting frequency for transatlantic communication was not appreciably higher than 23 Mc/s, with the peak around 19 Mc/s. This is, of course, still much higher than during the corresponding period last year, and at the moment of writing reception on 21 Mc/s (14 m.) is excellent from New York until well after midnight, checking on the performance of the commercial telegraph transmitters WIA and WQA. The Buenos Aires transmitter LSE on about 20 Mc/s has also been a very good signal in the late evening recently.

All this points to poor afternoon and early evening reception on 15 Mc/s or lower (20 metres or higher) during the coming summer from the U.S. and elsewhere, and it would appear that the new high-power transmitter which W2XE hopes to bring into use this month will be able to give a good account of itself this summer on 21.52 Mc/s.

It will also be very instructive to watch the performance of W3XAL on 17.78 Mc/s, especially if the European aerial is to be used at all extensively, since the summer ionisation level of the F or bending layer is said to be almost entirely a function of its temperature, there always being an excess of ionisation agent (i.e., ultra-violet light). The expansion of the upper region in summer, therefore, sets a definite limit to the highest workable frequency, since the electron producing material (per cubic centimetre) is reduced.

The peak of maximum ionisation will probably occur in the sunspot minimum years during the equinoctial periods, i.e., optimum condition of sunlight against temperature, but during the sunspot maximum years, when the ionisation is less dependent on sunlight, the maximum will probably occur during midwinter, i.e., sunspot activity as the ionising agent coupled with minimum temperature, which means, of course, the greatest concentration of material (oxygen) per unit volume.

Best Summer Frequency

It is obvious that observations made on the limiting upper frequencies during the next two or three years can yield data of absorbing interest since, if it is true that the F region is always ionised to "saturation" in summer, then the upper limiting frequency for summer afternoon transmission will be the same in 1937-8 as in 1933-4—but the limiting frequency for winter afternoon transmission this year seems to have been very much higher than it was during 1933-4.

In any case next winter will definitely see a boom in ultra-high frequency reception and an increase in the number of stations using the 26 Mc/s (11 m.) broadcasting band.

Now to review the conditions during the past week: On Sunday, March 28th, 28 Mc/s signals from the States were fair at 4.20 p.m., W1COO and W3EMM being amongst the best 'phone stations. A little later, at 5.10 p.m., YR5AA, a 28 Mc/s 'phone station at Bucharest, Romania, suddenly began putting in a R9+ signal into London and remained so for a considerable period, providing the best 10-metre reception of the afternoon.

At 8 p.m. W2XAD was strong, but obviously still improving, and finally became excellent by 9.40 p.m., at which time W3XAL was also excellent on 17.78 Mc/s, with quick fading at times.

The Spanish transmitter EAG2 (EDZ) was an enormous signal on 9.48 Mc/s approx., but badly overmodulated at 8 p.m., whilst EAG on 9.8 Mc/s was much poorer than its "sister" transmitter.

The 19 Mc/s Siamese transmitter at Bangkok was quite fair at 2 p.m. on Monday, March 29th, and a really first-class signal at 11 p.m. was CSW Lisbon on its 10 Mc/s channel, W1XK on 9.57 Mc/s was excellent, too, at this time, and the 11 p.m. news was taken from this station.

Reception was again good on Tuesday, and W2XAD was giving a fine performance on the "Mailbag" programme until midnight.

On Thursday, April 1st, W8XK was exceptionally good on 11.87 Mc/s at 12.30 a.m., but apart from this little was heard.

A unique "broadcast" from W2XAD/W3XAL was intercepted at 7 p.m. on Friday when both these transmitters were heard calling Berlin in German; this is the first time these transmitters have been heard on a point-to-point service since the old two-way tests between W2XAD and G5SW in 1926-27.

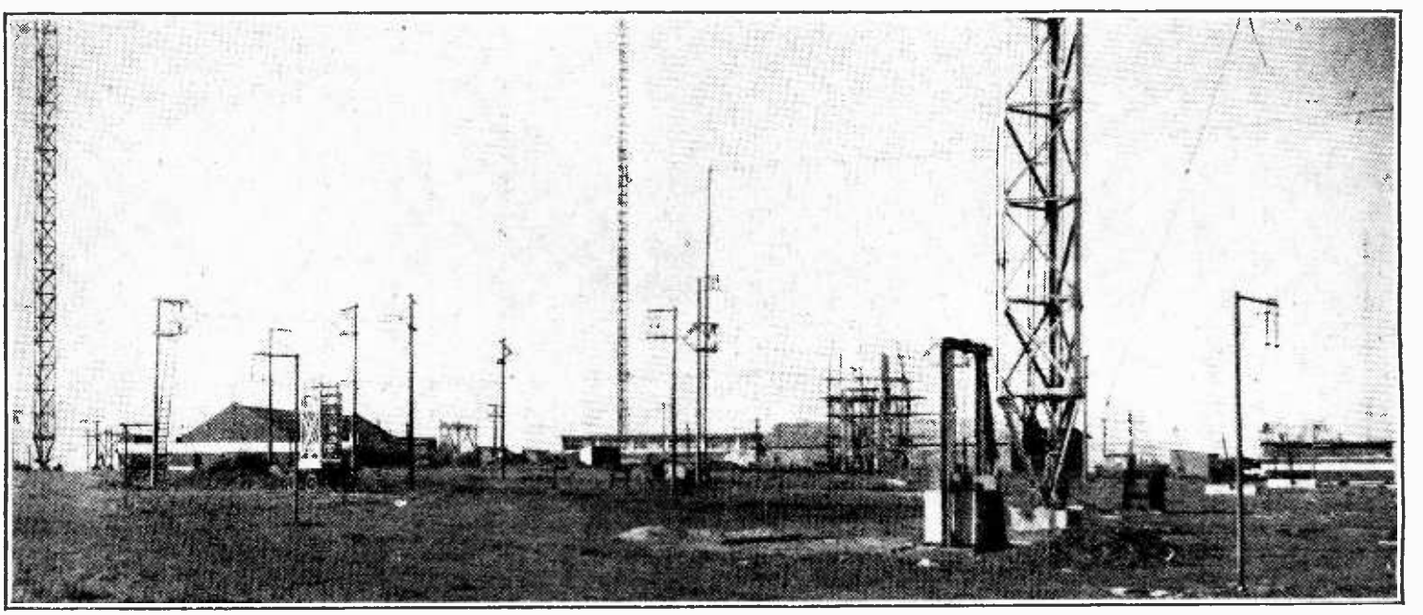
The Boston transmitter W1XAL was observed to be working on 15.25 Mc/s at 3 p.m. on Sunday, April 4th, a bad heterodyne (about 200 c/s or less) resulting between this station and the U.S.S.R. telephone transmitter RIM, Tashkent.

Fair results on Sunday were also obtained from YDC Batavia, Java, on 15.15 Mc/s at 11 p.m.

As mentioned at the beginning of these notes reception conditions became excellent again by April 6th, and in particular W2XAD as usual was outstanding.

Perhaps the most interesting signals heard were those of the new high-power Daventry transmitter's testing on GSG 17.79 Mc/s and GSO 15.18 Mc/s at about midnight.

ETHACOMBER.



ACTIVITY is portrayed by this *Wireless World* close-up photograph of some of the feeders which run from the Empire Station's twenty-three aerial arrays. The station will be quite self-contained, as in an emergency two diesel engines can be brought into operation to supply enough power for the running of at least two of the transmitters.

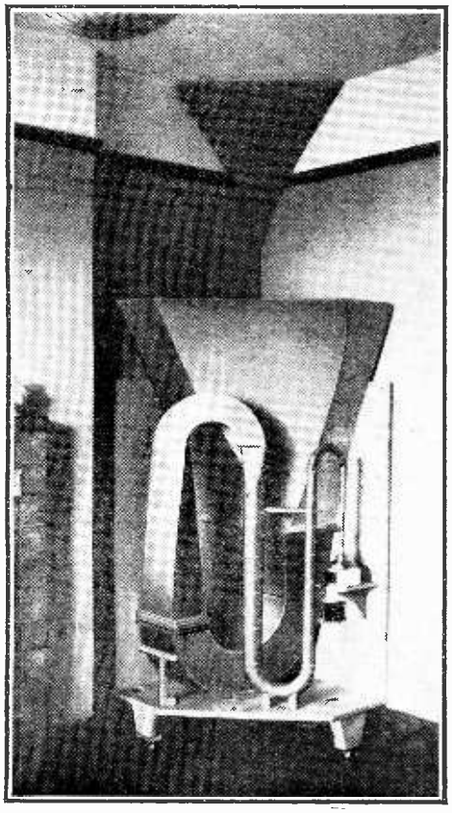
Letters to the Editor

The Editor does not hold himself responsible for the opinions of his correspondents

Horn-loaded MC Speakers

THE last two paragraphs of Mr. Voigt's letter on the subject of horn-loaded moving-coil loud speakers interested me considerably. It occurred to me when studying an advertisement of Voigt Patents, Ltd., just over two years ago, that if the two walls and ceiling at the corner of a room were used as a flare a horn with a quite low cut-off frequency could be built within a floor space that was tolerable in a small room.

I decided to build a horn experimentally on these lines, and found that the rate of expansion could be low enough to give a cut-off frequency of 37 cycles. The floor



Mr. Maggs' experimental corner horn.

space occupied is a quarter of an octagon whose centre is at the corner of the room, and the mid-points of whose sides are 29in. from the corner. The actual mouth of the horn is about three feet from the ceiling, which gives about the correct expansion towards the virtual mouth. Organ pedal notes down to about 40 cycles are audible, and at 48 cycles the output is strong, due to a resonance.

It is difficult to say how far the small room is responsible for the resonances that do exist, but I think it has a considerable influence, since, as far as the lower frequencies are concerned at any rate, the horn has in effect a closed mouth.

The upper cut-off frequency occurs at about 1,400 cycles, and the remainder of the frequency band up to about 9,000 cycles is handled by a small horn mounted in the mouth of the large one.

I see no reason why a horn baffle for a moving-coil speaker of normal type could not equally well be designed to utilise the one-eighth sphere formed by the walls and ceiling as a flare. It is questionable, however, whether the reproduction would be so satisfying as that of a true-to-type horn and unit.

I enclose a photograph of the horn without its enclosing screen. I have since removed the triangular piece in the top corner and find the reproduction suffers little.

Rugby. A. H. MAGGS.

I HAVE refrained from writing to you till this week in order to see if Mr. Voigt would cover in his reply an aspect of reproduction which I think is of great importance. I refer to transient response.

In spite of attempts at education, the public still assumes that a straight-line frequency response is the only ideal of a speaker. Although I am sure Mr. Barden knows better, he is helping to foster this viewpoint when he states that a speaker cannot be termed "high fidelity" unless it reproduces down to 40 c/s. Incidentally, I should like to ask why he doesn't mention the higher audio-frequencies, and state that high fidelity also embraces frequencies up to 20,000 c/s—a frequency which is quite audible—since, in the opinion of many enthusiasts, frequencies above 5,000 c/s are more important than those below 100 c/s, assuming no interference.

But even more important than frequency response (within reason, of course) is the response to transients.

To reproduce them does not necessarily require an unreasonable high-note response, though this is a common fallacy (Fourier's analysis is only applicable for wave shapes which are constant, do not bend back and are repeating, and cannot be used for a wave shape which is probably the one and only), and the goodness of a baffle speaker in this direction seems largely to be a matter of hit and miss. I know of a seven-year-old speaker of famous make which, in spite of a large and heavy diaphragm and deficient top, is greatly preferable to listen to than any of the modern wide-frequency examples yet heard just because of its comparatively better transient response.

Now, Mr. Voigt has not mentioned any of this in detail, probably because he was keeping to the subject matter of Mr. Barden's letter, but it is a very real advantage of the horn type that owing to the lighter weight of the moving parts and to the heavier damping it can respond to transients with little distortion.

J. K. TODD.

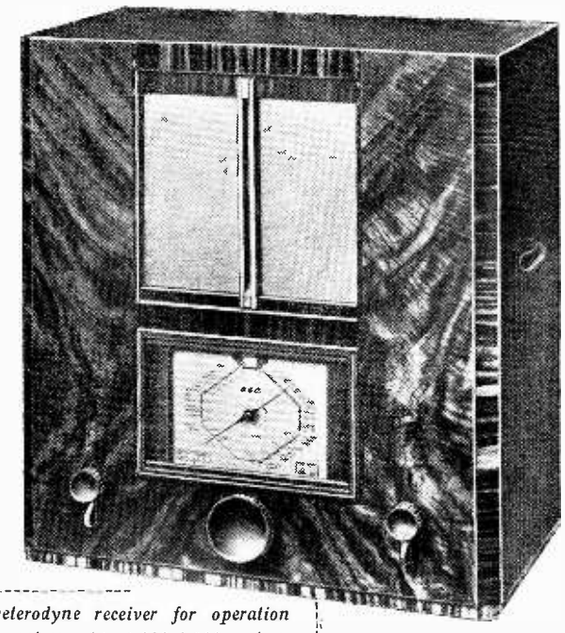
Polegate, Sussex.

"Hard Valve Time Bases"

The author of the article under this title which appeared in our issue of April 2nd, asks us to point out that the time base illustrated in Fig. 2 should have been acknowledged to Appleton, Watson-Watt and Herd.

G.E.C. AC TRANSPORTABLE 5

A Superheterodyne Operating Without Aerial or Earth Connections



THE transportable type of receiver brings wireless into line with most other domestic electrical appliances which can be plugged into the nearest mains point and put into use without further ado. It can be conveniently carried from room to room, and its appeal is primarily to those for whom the erection of an aerial, if not actually impracticable, presents a responsibility from which they would gladly be relieved.

To obtain a performance comparable with that of the ordinary receiver working from an outdoor aerial the design of the circuit requires care. It goes without saying that a stage of RF amplification is necessary to compensate for the reduced pick-up of the comparatively small frame aerial, and the high magnification of the circuit as a whole raises its own special problems, principally those of achieving stability in a receiver which will be operated without an earth connection.

FEATURES.—***Type.***—*Self-contained superheterodyne receiver for operation from AC mains.* ***Waveranges.***—*(1) 200-550 metres. (2) 1,000-2,000 metres.* ***Circuit.***—*Var.-mu pentode RF amplifier—triode-hexode frequency-changer—var.-mu pentode IF amplifier—double-diode second detector—pentode output valve. Full-wave valve rectifier.* ***Controls.***—*(1) Tuning. (2) Combined volume control, muting and mains on-off switch. (3) Combined waverange switch and tone control.* ***Price.***—*16 guineas.* ***Makers.***—*General Electric Co., Ltd., Magnet House, Kingsway, London W.C.2.*

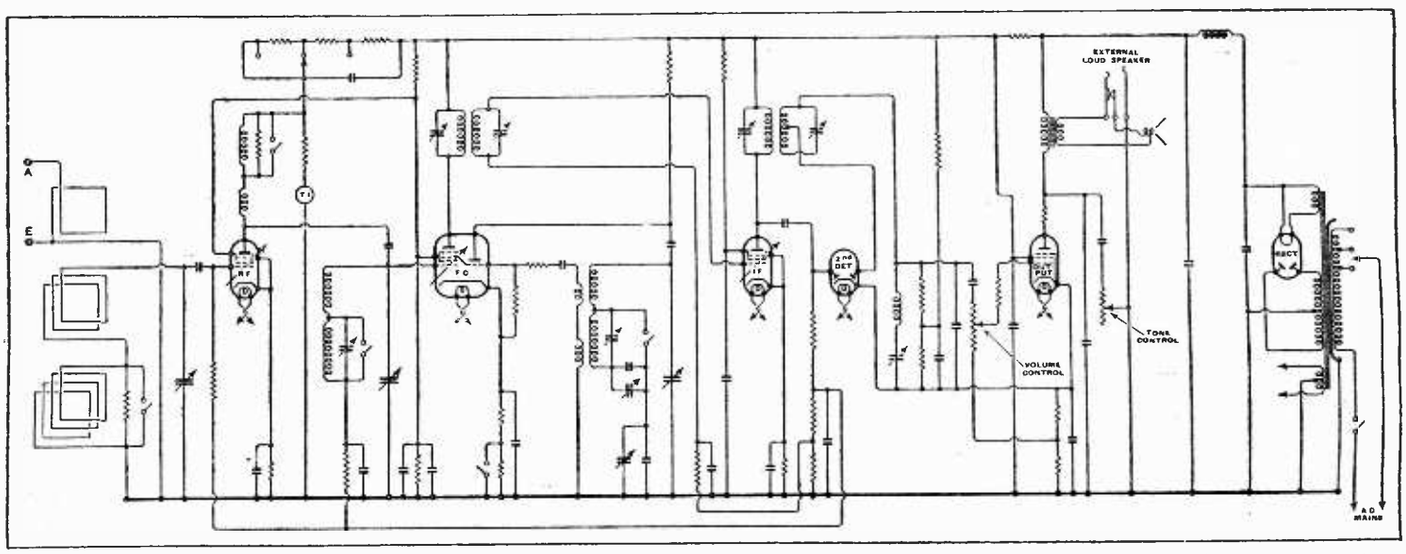
It will be seen from the circuit diagram that the valve used to amplify the incoming signal before passing it to the frequency-changer is a variable-mu RF pentode. Tuned grid coupling follows this stage, and the impedance of the anode choke is varied to give the best operating conditions on each of the two broadcast wavebands. Stabilising resistances are used both in this circuit and in the long-wave section of the frame. It is possible to use the set with an outdoor aerial, and the coupling consists of a few turns adjacent to the main frame aerial windings.

A neon-type tuning indicator is connected across the anode circuit of the RF amplifier, and an adjustment is provided by a resistance with three alternative tappings controlled by a plug at the back of the chassis.

The frequency-changer is a triode-hexode, and two degrees of sensitivity or "muting" are provided by varying the standing bias of this stage. The single stage of IF amplification makes use of a variable-mu pentode valve and is controlled by an AVC voltage which is less than that applied to the two preceding stages. No amplification is provided between the double-diode second detector and the high-slope pentode output valve, but the sensitivity of the receiver is such that an ample input voltage to the grid of the final stage is at all times available.

There is a continuously variable tone control across the output circuit, and as the loud speaker is of the permanent magnet type a smoothing choke has been provided. The power supply circuit follows conventional practice, and the mains transformer incorporates an electrostatic shield between primary and secondary windings.

The set is mounted on a turntable so that the best use can be made of the directional properties of the frame. Because of the effective automatic volume control the apparent signal strength of incoming stations is not appreciably affected by the orientation of the set, but the proportion of background noise can be considerably reduced by directing the frame aerial to the angle which gives maximum pick-up. As is only to be expected, a set of this type is rather more susceptible to stray magnetic fields from lift machinery, etc., but here again the directional properties of the frame can be



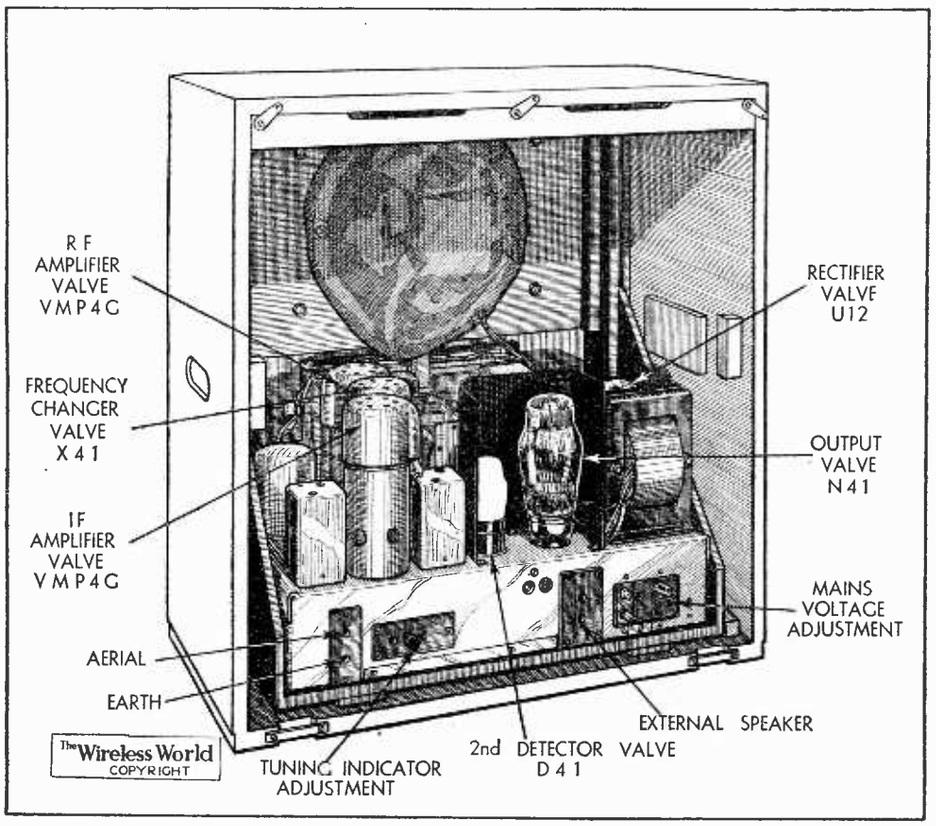
Complete circuit diagram. Although designed primarily for operation with the self-contained frame aerials, an external aerial and earth may be connected if desired.

G.E.C. AC Transportable 5—

put to useful purpose in reducing interference.

In most buildings there is a certain amount of metal work—water pipes, lighting conduits, etc.—which is a potential form of screening, and it is well worth while to experiment with alternative positions for the receiver in order to avoid possible blind spots.

Tested at first under the worst possible conditions in a steel-framed building, the set was nevertheless capable of providing a choice of at least eight foreign programmes on the medium waveband during the hours of daylight. Under conditions which would be closer approximation to those obtaining in a normal brick building, however, no fewer than twenty-five Continental stations were logged, and background noise was far less troublesome, particularly on the long-wave band.



Loud speaker, frame aerial and chassis are mounted on a subsidiary framework which can be withdrawn from the cabinet as a unit.

Selectivity above the average

Selectivity was appreciably better than that which we have been accustomed to expect from the more popular makes of four- or five-valve superheterodynes designed for use on an outdoor aerial. In Central London the Brookmans Park stations were both completely lost when the tuning was shifted more than 12 kc/s on either side of the normal settings, so that considerably less than one 9-kilocycle channel was lost on account of the modulation spread of these stations.

Because of this high degree of selectivity rather more care is necessary in tuning stations accurately if accentuation of high audio frequencies is to be avoided. For this reason a tuning indicator with a somewhat more precise indication would have been welcomed. Provided the necessary care is taken in tuning, the set gives excellent quality of reproduction, and at exact resonance the full range of tone can be usefully employed. There is a welcome freedom from valve-generated harmonic distortion, and the reproduction is characterised by brightness and clarity as well as a quite useful low-frequency response.

There is provision for an extension loud speaker, though not for a gramophone pick-up. A special plug is provided which when first inserted enables both loud speakers to be operated, but when pushed fully home disconnects the internal loud speaker, leaving only the external speaker in operation. The receiver chassis complete with frame aerial and loud speaker can be withdrawn from the cabinet a complete unit. There is a mains voltage adjustment by means of which the standard model can be adapted for AC mains between 190-250 volts and 40-100 cycles. A special model is also available for mains voltages between 110 and 130 as well as between 210 and 230 volts, with the same latitude in the matter of frequency as that specified for the standard model. The cabinet, which is similar in appearance to that of the other table models in the G.E.C. range, is 19in. in height, with a width of 18in. and a depth of 11in. The total weight of the set is 42 lbs. and its current consumption approximately 70 watts.

Random Radiations

By "DIALLIST"

Good Work

IT'S good to hear that the British Standards Institution is shortly to issue a special "Radio Interference Mark" for attachment to electrical apparatus of all kinds. Apparatus bearing this mark is guaranteed to be either non-radiating or to radiate so feebly that it does not reach the level at which officially recognised interference is caused. I hope that the existence of this mark will be given plenty of publicity and that the public will soon learn that it is in its own interests not to buy electrical appliances which do not bear it. My only regret is that agreement on what constitutes interference was not reached years ago and the mark issued then. As it is, thousands upon thousands of householders and others have bought apparatus that does radiate and radiate badly—in most instances without any idea that it could cause interference with radio reception. And one can't help blaming manufacturers who have marketed such things, well knowing the trouble that they were capable of causing.

Television Contour Maps

CONGRATULATIONS to the B.B.C. for having published in their 1937 Annual the first field-strength contour maps for 7.75 metre signals from the Alexandra Palace.[1] The work must have needed a great deal of skill, time and trouble, and the heartiest of pats on the back is due to those responsible. My only criticism is that though the maps contain the names of scores of towns and villages there are no dots to mark the precise positions of these. The maps cover the country within a radius of 25 to 30 miles of the Alexandra Palace. They well repay close examination, for this discloses several points of interest. Field strength, for instance, is particularly good towards the south-east of the transmitter. Here the 0.5 millivolt-per-metre line extends to well beyond 30 miles for a roof-height aerial in the district to the east of Rochester. In the south there are some striking "islands" of specially good field strength round Sutton, Tatsfield and Kingsdown. Two conclusions must be drawn from the contour maps. The first is that the erection of a high television aerial is a good investment; the second, that the service area of A.P. is proved to be larger and to have a shape more nearly approaching a circle than was originally anticipated.

Figuring it Out

THERE are some rather queer things about the wireless licence figures when you come to look into them. According to the B.B.C.'s calculations, for instance, the percentage of licences to households for the whole of the London Regional service area is 71, but for the London County Area itself, where at first blush you might expect the highest figure, it is only 57, as against 98 (I find that hard to believe!) for Hertfordshire and 87 for both Kent and Surrey. The explanation is probably that the London County Area, though its households are estimated to number 1,270,758, contains a very considerable number of poor people who cannot afford even the cheapest kind of wireless set. It is rather interesting to note that the highest percentage of licences is most likely to occur in the county in which a Regional transmitter is situated. Hertford, already mentioned, is the county of Brookmans Park; Warwickshire heads the list in the Midland Region with 85 per cent.; Yorkshire that of the North Region with 70 per cent.; Antrim that of Northern Ireland with 52 per cent. Stirlingshire with 69 per cent. is just beaten by Edinburgh's 71. In the West, Washford Cross is in Somerset, but both South Gloucester, with 74 per cent., and Devon, with 72, beat the "parent" county's 61. The most surprising case is that of Anglesea, which can raise only 19 per cent., despite its giving a home to Penmon, against Caernarvon's 80 per cent.

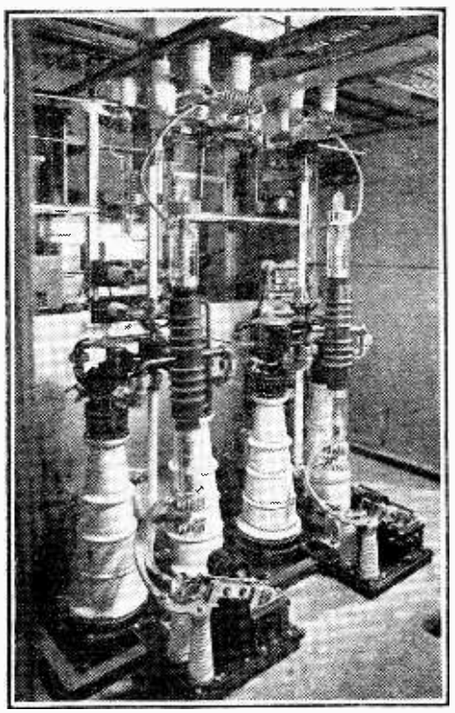
[1] A reproduction of one of the maps appears in our review of the B.B.C. Annual on p. 387.—ED.

Which Regions "Pay?"

The licence totals for the seven regions show enormous differences, as is only to be expected considering their varying density of population. Most of them definitely pay their way; some barely do so, and one, at any rate, falls a good bit short. To the best of my ciphering ability I make the round figures for the Region's contributions to the B.B.C.'s £2,509,750 from licence fees last year:—

London	£924,500
North	738,000
Midland	359,000
Scotland	203,000
West	152,750
Wales	102,000
N. Ireland	30,500
	£2,509,750

From this it seems that as Northern Ireland has its 100-kilowatt station at Lisnagarvey the Welsh demand for a high-powered Regional station of their very own is fully justified. At present the use of the West Regional for partly English and partly Welsh programmes is unsatisfactory, but all will be well when the new station near Start Point gets going and West Regional becomes definitely Welsh Regional.



FINAL STAGE of the modulator unit of one of the new 50-kW Empire transmitters. The mechanical water interlocks, which prevent the power being switched on to the valves until the cooling water is flowing, are clearly visible. The engineers, in arranging for an average modulation of from 45 to 50 per cent. have slightly sacrificed quality of transmission for the sake of power, which is perhaps more important when dealing with long-distance short-wave transmissions.

Financing Television

THERE'S some talk of an increase in the cost of the receiving licence to 12s. 6d. in order to meet the cost of television during the next few years. But one need not be a prophet to predict that the licence will stay put at its present ten bob. Raising it by half a crown would be about as unpopular a move as the Chancellor of the Exchequer could make; many people can only just manage the present amount—ten shillings all at once is a big bit out of a smallish weekly wage—and the average listener might resent being called upon to pay extra for the development of something that is likely to be outside his reach for some time to come. But the money for television has to be found somehow; there can't be cheap television receivers until sales are big enough to make mass-production possible, and sales can't reach these dimensions unless and until the greater part of the population is brought within television service areas.

What's to be Done?

Roughly speaking, there ought to be about a million pounds available at once for the B.B.C. to be able to get on properly with the job of giving the country television. That sum certainly can't come out of the Corporation's revenue or out of its reserves. Part of it might be borrowed, but that should be avoided if possible. The only satisfactory solution seems to be to adopt the recommendation of the Ullswater Committee that the 25 per cent. of the licence fees that does not now go to the B.B.C. should be regarded as potentially available for their use when urgently required. There's no doubt that the need *is* urgent now, and that 25 per cent. represents just about the necessary £1,000,000. Given that amount to play with, the B.B.C. could have a Regional scheme for television in being before the end of next year.

Heart Records

STILL another application of the wireless valve—and this time of the gramophone record as well—to the art of healing was described recently in that rather

grimly named medico's paper, *The Lancet*. The phonostethoscope is an apparatus for reproducing on the loud speaker the sounds made by a patient's heart. It has taken some time to evolve, since parasitic noises from other sources presented a knotty problem. However, that has been solved and the apparatus is now proving completely successful. One of its uses is to allow either the physician or a class of students to hear the heart noises enormously amplified by direct transmission from the patient. But they can also be recorded on the familiar wax disc with, if desired, superimposed comments by a demonstrator. The usefulness of a series of such records to the medical student is obvious. It is now also possible for a heart specialist to take a record of the patient's heart sounds when he first sees him and to file it away for comparison with the results of subsequent tests.

Fluorescent Screens

Fig. 1 used in the above article in the issue of April 2nd was reproduced from the paper of Levy and West, referred to in the article.

The B.B.C.'s Annual Survey

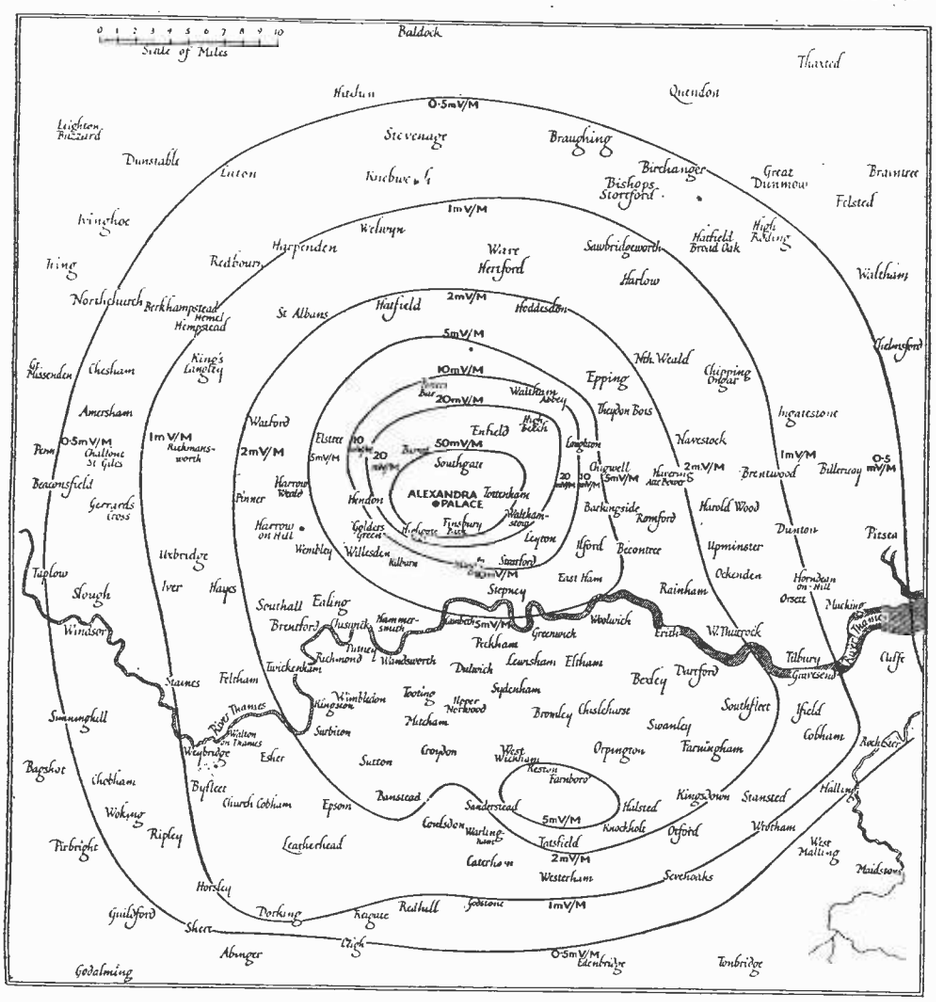
B.B.C. Annual, 1937. Pp. 176, with 103 illustrations. The British Broadcasting Corporation, Broadcasting House, London, W.1. Price 2s. 6d.; by post 3s.

IT would be legitimate to summarise the contents of this book as "all about British broadcasting"; as a make-weight there is quite a lengthy section on the various aspects of Empire broadcasting as well. Though first and foremost a survey of the past year's work, the Annual is also a reference book on things of the present that can be depended on to provide an answer to any reasonable question likely to be asked on the B.B.C.'s activities. A useful reminder of various transmission times is given.

Organisation, finance, engineering, public and foreign relations are all dealt with, and, naturally enough, a large part of the book is devoted to matter relating to programmes. In the technical section there is a particularly interesting article on studio design in which the new type of hall, in which one end is acoustically "live" and the other "dead," is described at length. The maps showing measured field strength of the London television station, though relating to the sound transmitter, would tend to prove that the consistent range is limited to some 25 miles (allowing a minimum field strength of about 1 millivolt per metre).

Illustration and make-up is of a high standard, and the 1937 Annual is a remarkably good half-a-crown's worth to anyone who takes any serious interest in broadcasting.

H. F. S.



One of the television field-strength maps reproduced (on a slightly reduced scale) from the B.B.C. Annual, 1937. The contours have been corrected to show estimated field strength at roof level (10 to 15 metres above ground).

Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

"PROSPECTING" BY WIRELESS

THE location of an invisible conductor, such as a buried mass of metal, or an aeroplane flying in fog, is ascertained by observing the disposition of the nodes and loops of a standing-wave system, which is created between it and a short-wave transmitter by the outgoing and reflected radiation.

The transmitted short-wave beam is modulated by a longer wave, and advantage is taken of the fact that whilst the beam as a whole can be sharply concentrated in any desired direction, and is reflected as though it were not modulated, yet the standing-waves set up by the modulating frequencies can be more conveniently used for making the desired measurements.

Telefunken Ges. fur drahtlose Telegraphie m.b.h. Convention date (Germany) May 18th, 1935. No. 457737.

o o o o

MUTING CIRCUITS

INTERSTATION "noise" is suppressed by means of a gas-filled discharge tube, which is connected in the low-frequency part of a wireless set and acts as an attenuating device. As shown in the simplified diagram, the low-frequency output from the detector valve D passes through a condenser C to the amplifier V1. The DC component is, however, passed through a resistance R, and the voltage developed is applied, in part, as an AVC bias to the high-frequency amplifier V. It is also applied in part to control the impedance of a valve VC in series with the attenuator discharge tube T.

In the absence of any signal, the impedance of the valve VC is low and the voltage-drop across the discharge tube T is sufficient to ionise the contained gas. This acts as a shunt across the input of the amplifier V1 and thus meeting the loud speaker. Directly a worth-while signal is tuned in, the bias applied to the grid of the valve VC raises the impedance of that valve, so that the discharge tube T de-ionises and leaves the received signals free to pass through the LF amplifiers to the loud speaker in the ordinary way.

Standard Telephones & Cables, Ltd. (assignees of H.M.W.E. Reichle and G. N. Thayer). Convention date (U.S.A.) June 19th, 1935. No. 458235.

o o o o

CATHODE-RAY TUBES

A HIGH-SPEED cathode-ray tube, particularly suitable for measuring "transients," is constructed entirely of metal and porcelain, without glass, this favouring the production of a more intense beam of electrons.

In such tubes it is found that the electron stream contains a proportion of atomic particles, called "retrograde rays," which gain or lose electric charges as they pass through the gas, and so tend to "fog" the screen or photographic film on which the record is made, because they are not effectively controlled by the magnetic or electrostatic fields applied to the deflecting electrodes.

According to the invention the axis of the discharge path is slightly inclined to the main axis of the tube, so that any "heavy" or "neutral" particles of the kind in question are "trapped" by an apertured diaphragm and are thus prevented from reaching the sensitised screen or recording film.

R. V. Whelpton and Metropolitan Vickers Electrical Co., Ltd. Application date June 24th, 1935. No. 458270.

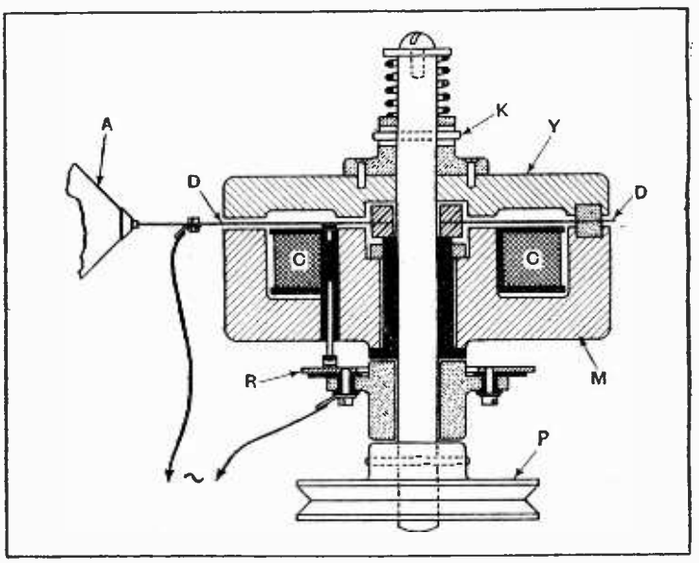
o o o o

LOUD SPEAKERS

A LOUD-SPEAKER movement of high acoustic capacity consists of a pot-magnet M which is constantly rotated through a pulley P from a motor (not shown). The speech-coils C are carried inside the magnet, which is fitted with a yoke Y, also driven from the pulley-shaft through a pin K. A thin magnetic disc D is fitted between the magnet M and yoke Y, so that the applied signal currents create a frictional torque on the disc which is, in turn, communicated to the diaphragm A of the loud speaker.

Speech currents are fed to the coils C through a contact ring R on which a brush connected to the coil lightly rests. The other terminal of the input is taken to the disc D, as shown, this being also fitted with a sliding contact. The arrangement allows the inertia of the oscillating parts of the movement to be kept extremely small. Also, since the mechanical force exerted on the diaphragm is derived from a pure pressure between frictional surfaces, the disc D can be made very thin and light.

H. Vogt. Convention dates (Germany) November 3rd, 1934, and October 1st, 1935. No. 458287.



Details of the loud speaker described in Patent No. 458287.

o o o o

TELEVISION

WHEN a cinema film is being televised, abrupt changes of scene may occur, which are not followed "smoothly" on the fluorescent screen of the receiver, owing to what is called "after-glow." The same may happen when the transmission of an out-of-doors event is followed by a scene from a comparatively dimly lit interior.

To remedy this, provision is made to deliberately reduce the intensity of the picture signals immediately preceding any abrupt change from a high-light to a low-light background. For instance, in the case of a film a certain number of the frames preceding the change-over are rendered opaque. In the case of the direct transmission of an outdoor scene a suitable shutter or filter is interposed, to lessen the value of the light falling on the photo-electric cell.

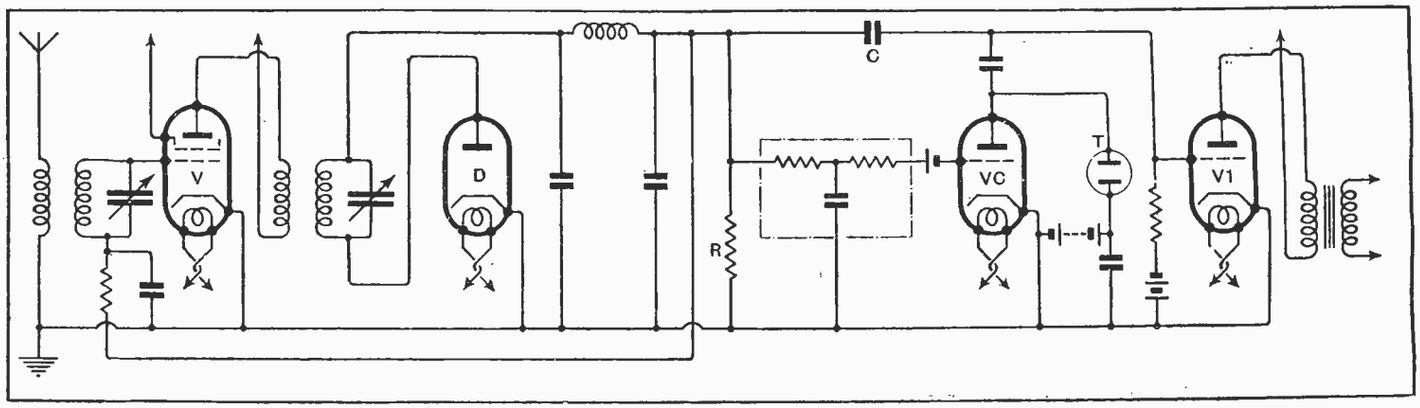
Scophony, Ltd., J. D. Baynes, and G. Wikkenhauser. Application date September 27th, 1935. No. 458382.

o o o o

AIRCRAFT WIRELESS

THE trailing aerial used in an aeroplane is released or wound in by a remote-control device acting through a clutch. The latter is arranged between the winding crank and the reel, so that a single flexible shaft serves either to wind up the aerial, or to let it out, according to the direction in which the crank handle of the remote control device is turned.

Romeylowerk Ges. fur drahtlose Telegraphie. Convention date (Germany) June 5th, 1935. No. 458018.



Simplified circuit of system for suppression of inter-station noise.

The Wireless World

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27th Year of Publication

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CONTENTS

EDITORIAL COMMENT

Electrical Interference

Disappointing Delay

IT is a matter of considerable disappointment to learn that the Postmaster-General holds out no hope that the Bill to give effect to the Recommendations of the Committee on Electrical Interference can be introduced during the present session of Parliament. Every additional delay which occurs aggravates the situation, because the distribution of domestic and other electrical plant which interferes with broadcast reception is going on at a tremendous rate.

Some of the larger electrical firms are, we are glad to know, taking some steps, in anticipation of legal control, to make the apparatus which they market interference-free on a voluntary basis. It seems unfair, however, that these conscientious firms should be put to an additional manufacturing cost, however small, whilst other firms competing with them are content to sit back and do nothing until legislation compels them to act.

We have also to take into account the position with regard to electrical equipment imported from abroad which, in the absence of controlling regulations, may be the cause of a large amount of the electrical disturbances irritating the listener.

Now that we are aware that legislation, although delayed, is as good as certain to go through, we feel it is time that the purchaser of apparatus, whether for domestic or other uses, should satisfy himself that the equipment is interference-free. If he does not do so, he will no doubt find, in a matter of some months' time, that he has to make arrangements to fit suppressing devices to the apparatus at his own cost, and when once apparatus has been installed it becomes a more costly matter to suppress the interference than if the manufacturer does it at the time of supplying. The purchaser would probably find that even though some additional charge was made when the apparatus was installed, it would prove worth while to have it done then rather than later on.

Once the apparatus has been sold, it is the user who will become liable, so that we feel the time has certainly arrived when every purchaser of electrical equipment should be made conscious of this obligation which will soon devolve upon him.

The Co-Axial Cable

Importance to Television

LAST week Colonel Angwin, Deputy Engineer-in-Chief of the Post Office, gave a technical description of the much-discussed new co-axial cable, the most spectacular telephone development of recent years, at a meeting of the Institution of Electrical Engineers.

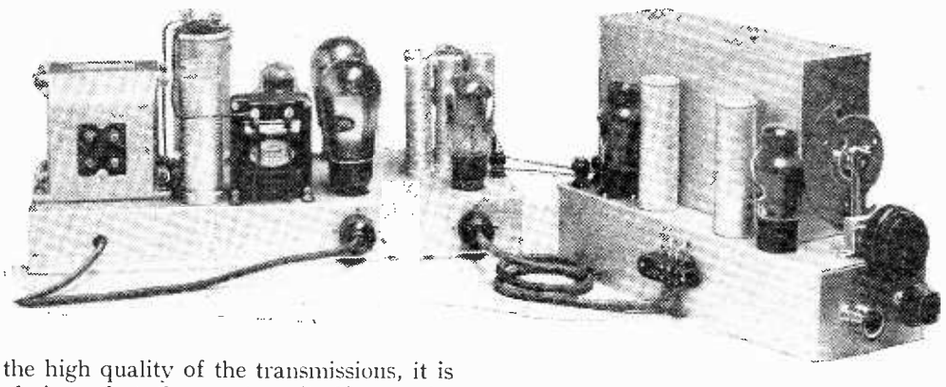
This cable has been designed primarily for telephone requirements of the Post Office by Standard Telephones & Cables, Ltd., but it is in its application to television that it interests our readers. The cable is already laid between London and Birmingham, extending from thence to Manchester and on to Newcastle. Additional routes are being arranged.

The cable provides at present the only alternative to short-wave wireless links for carrying television. It should now be possible to erect television transmitters at Birmingham and elsewhere and feed the transmitters from London studios.

The cost to the B.B.C. of the use of the cable has not yet been disclosed, but it seems certain that it will not be more than the expenditure involved if the B.B.C. had to establish local studios and programmes for each television transmitter erected.

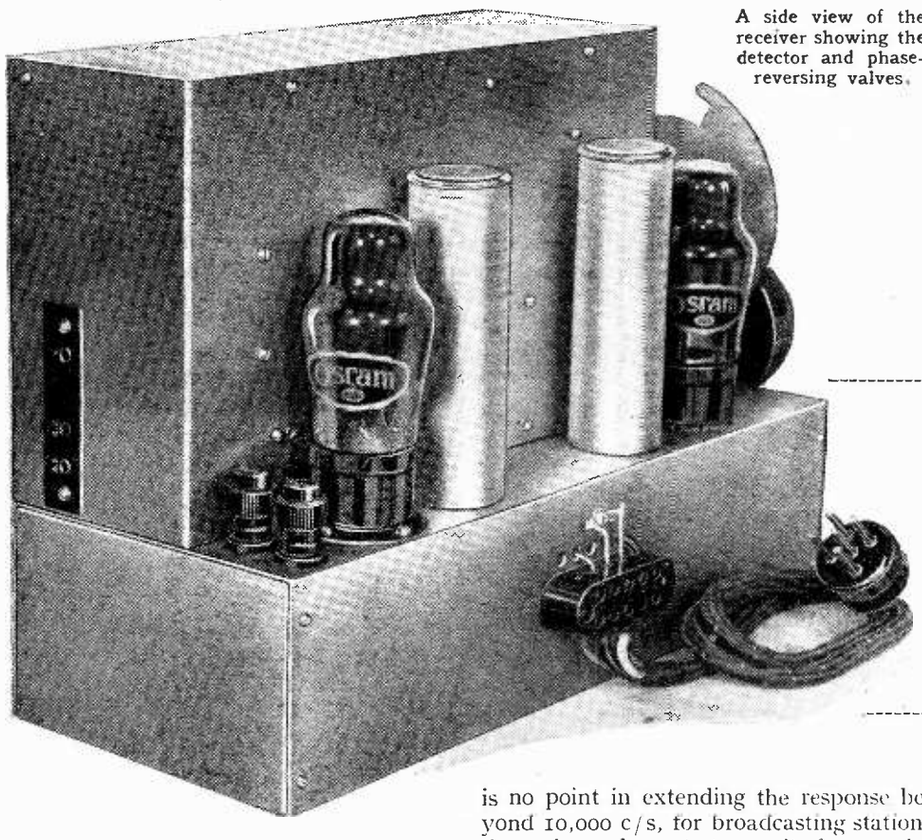
Ultra-Short-Wave Quality

A STRAIGHT SET FOR THE PUSH-PULL QUALITY AMPLIFIER



IT is possible to obtain a much higher standard of quality of reproduction on the ultra-short waveband than on the ordinary broadcast band because the higher musical frequencies can be transmitted without causing interference with neighbouring stations. Frequencies well above 15,000 c/s are transmitted by stations such as the Alexandra Palace sound transmitter, and a considerable improvement in the reproduction is noticeable, especially in the case of transient sounds.

At the time of writing there is a project for the programme of one of the London stations to be relayed on the ultra-short waveband, and when this takes place London listeners will have an opportunity of obtaining extraordinarily good quality.



A side view of the receiver showing the detector and phase-reversing valves.

When such transmissions eventuate it seems probable that those who have the necessary receiving equipment will not willingly return to the medium-wave stations.

Now, if full advantage is to be taken of the high quality of the transmissions, it is obvious that the receiver itself must be suitable. It is, of course, quite possible to receive such stations on an ordinary broadcast receiver with the addition of an ultra-short-wave converter. In few cases, however, will the quality then be an improvement over that obtained on the medium waveband, and it may be considerably poorer! Even the best broadcast receivers are likely to attenuate frequencies above 10,000 c/s considerably, and the majority start to cut-off at a much lower frequency. On this waveband there is no point in extending the response beyond 10,000 c/s, for broadcasting stations themselves do not transmit frequencies much higher than this; moreover, it is only at short distances from a station that this degree of response can be tolerated on account of interference.

Furthermore, with an ultra-short-wave converter it is extremely difficult to prevent howling, because any feed-back causes the oscillator frequency to vary. The ordinary broadcast set is much too selective to permit good reception to be obtained below 10 metres with a converter of simple type.

The wise course, therefore, is to build a special receiver, and the choice lies between superheterodyne and straight set. A superheterodyne is entirely satisfactory if designed especially for the job. It must not be too selective, and it should have a high intermediate frequency. Experience shows that a frequency of about 5.0 Mc/s is satisfactory. High sensitivity is readily obtained with such a receiver, but in general we do not need this, for in the reception of weak signals we shall find interference from car ignition systems. As we are out only for high-quality reproduction we shall do better to use a set of only moderate sensitivity, for it will be appreciably cheaper.

We thus come to the straight set, and experience shows that a single RF stage with a reacting detector will give a very satisfactory performance indeed. Such a receiver is easy to construct and handle, and is reliable in performance for it does not suffer from tuning drift.

GOOD reception on wavelengths below 10 metres can be obtained with quite simple apparatus, and the receiver described in this article is designed primarily for use with the Push-Pull Quality Amplifier. An extremely high standard of reproduction is obtainable and the apparatus is easy to handle.

The Ultra-Short-Wave Quality Receiver is designed for use with the Push-Pull Quality Amplifier,[1] the PA Amplifier,[2] or

[1] *The Wireless World*, May 11th and 18th, 1934. (A reprint is available at 7d. post free).
[2] *The Wireless World*, April 3rd and 10th, 1936.

Receiver

the amplifier of the Pre-tuned Quality Receiver,[3] and its circuit diagram appears in Fig. 1. An RF pentode is used as the amplifier and a type having a high mutual conductance, no less than 6.0 mA/v, has been selected. Valves have a low input impedance at very high frequencies on account of the electron-transit time,[4] and the grid is consequently tapped down the first tuned circuit, L2 C1.

The Tuning System

A tuned-anode coupling between the RF and detector valves is used, and the coil is centre-tapped for the HT connection, thus reducing the damping of the valves and enabling reaction to be obtained very simply. The reaction circuit is, in fact, analogous to that of a Hartley oscillator, and since it dispenses with a separate reaction coil it simplifies the coil construction.

The use of tapped coils in this way not only reduces the valve damping on the tuned circuits, but also reduces their minimum capacities and so allows a wide tuning range to be obtained with a small condenser. The tuning condensers C1 and C5 are of 40 $\mu\mu$F. capacity only and yet a tuning range of over 7-12 metres is obtained. A trimmer C2 is fitted to the aerial circuit to permit the circuits being reasonably well matched.

Since the RF valve requires the same voltage for the screen as for the anode, it becomes possible to use common decoupling for these circuits, and this is provided by the 500-ohm resistance R4 and the 0.0005 μF. condenser C4. The cathode is earthed through the 0.01 μF. condenser C3, and the minimum bias for the valve is obtained by means of the 100-ohm resistance R1. For volume control purposes the bias can be increased by means of the potentiometer R2.

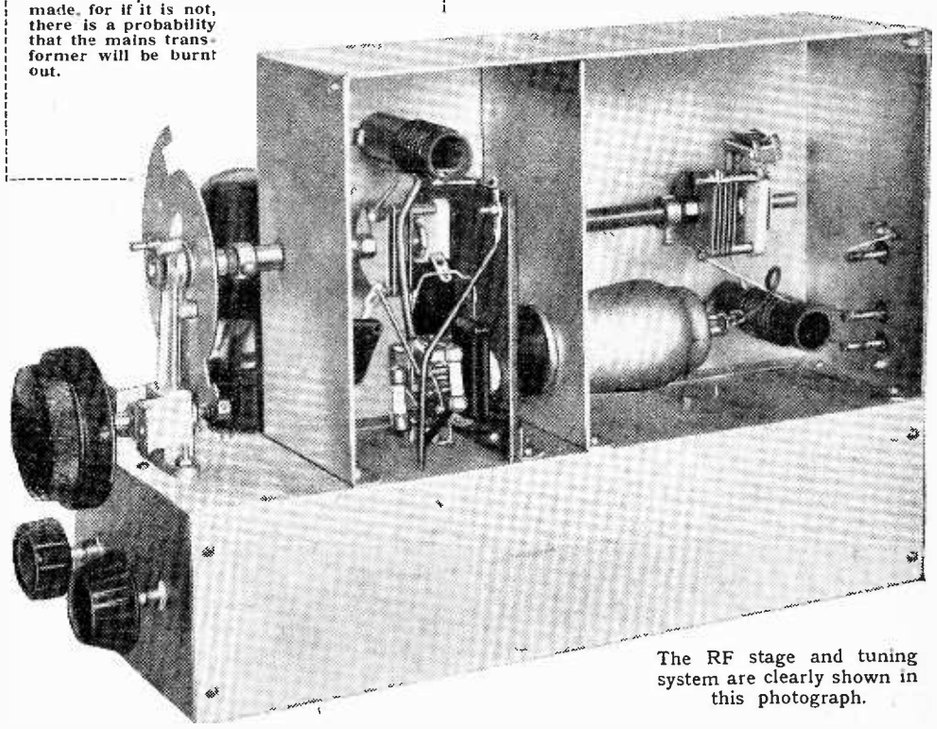
A triode detector is used, and the grid leak and condenser R5 and C7 have values which enable them to deal with high modulation frequencies. In the anode circuit, a resistance R6 of 10,000

WARNING!

BEFORE using this receiver the centre-tap on the heater secondary of the mains transformer in the amplifier *must* be disconnected from the chassis.

In the Push-Pull Quality Amplifier, this is CT on the 4 volt 7·8 Amp. winding. In the PA Amplifier it is CT on the 4 volt 9 Amp. winding, and in the amplifier of the Pre-tuned Quality Receiver it is CT on the 4 volt 10 Amp. winding.

It is imperative that this alteration be made, for if it is not, there is a probability that the mains transformer will be burnt out.



The RF stage and tuning system are clearly shown in this photograph.

[3] *The Wireless World*, Sept. 25th and Oct. 2nd, 1936.

[4] "Grid Loss at Ultra-High Frequencies," (Scroggie), *The Wireless World*, Oct. 23rd, 1936.

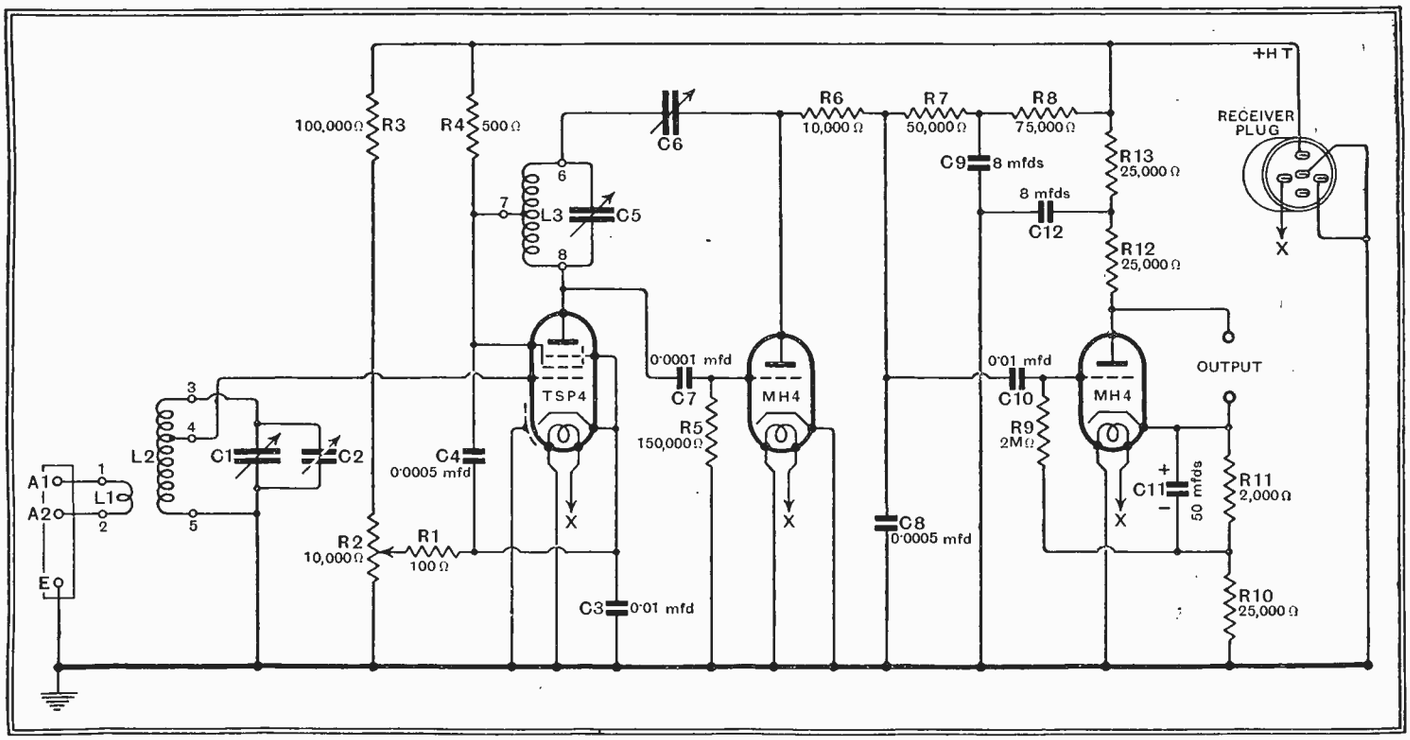


Fig. 1.—In this complete circuit it will be seen that an RF stage is used with a grid detector and that this combination is followed by a phase-splitting valve.

Ultra-short-wave Quality Receiver—

ohms is used instead of an RF choke, since it permits a more even response over a wide band, and reaction is controlled by the 15 $\mu\mu$F. condenser C6.

After this point, the circuit is conventional in that resistance coupling is used to the phase-splitting valve which operates with equal cathode and anode resistances R10 and R12.

One point in connection with the circuit will be noticed, and this is a departure from normal practice. One side of each valve heater is earthed directly instead of the centre-tap on the mains transformer. Past experience has shown that a large amount of interstage coupling occurs on heater wiring. The usual remedy is to connect condensers from heater to earth, but this is not only expensive but is only a partial cure. With the heaters earthed directly it has been found that feed-back in this circuit is almost completely eliminated; in fact, it has been found easy to stabilise high-gain amplifiers which proved unhandleable with the normal connections.

Contrary to what one might expect, this direct earthing does not introduce mains hum. Because of this system of earthing, however, it is important to make sure that the mains transformer in the amplifier has the centre-tap of the appropriate secondary winding disconnected. If the centre-tap is not disconnected from the chassis, one-half of the winding will be short-circuited and the mains transformer will burn out unless the primary fuses blow and protect it.

Construction and Operation

The construction of the receiver is quite straightforward and calls for comment only in regard to one point. This is in connection with the couplings of the variable condensers and dial. The standard coupling units have a length of 4in., but the one used for coupling the two condensers must be cut to 2in. and the one linking the dial to the first condenser to 1¾in. After cutting, it is necessary to drill a fresh hole in the tube for the set-screw. A dipole aerial resonant to the station which is most frequently required is recommended, but very good results are obtainable with an ordinary outdoor aerial. The latter should be joined to A1 and A2 connected to earth.

The variable condensers should, of course, be linked so that they run in step and at a low wavelength, and C2 adjusted for maximum sensitivity while keeping the set just off the oscillation point by backing off reaction as the circuits come into tune. In most cases this adjustment is readily carried out even if no signal can be found, for there is usually sufficient background of ignition noise when the receiver is working all out.

Even with strong signals it will often be necessary to use some degree of reaction for the valve damping on the tuned circuits is heavy. In some cases, moreover, it will be found desirable to use re-

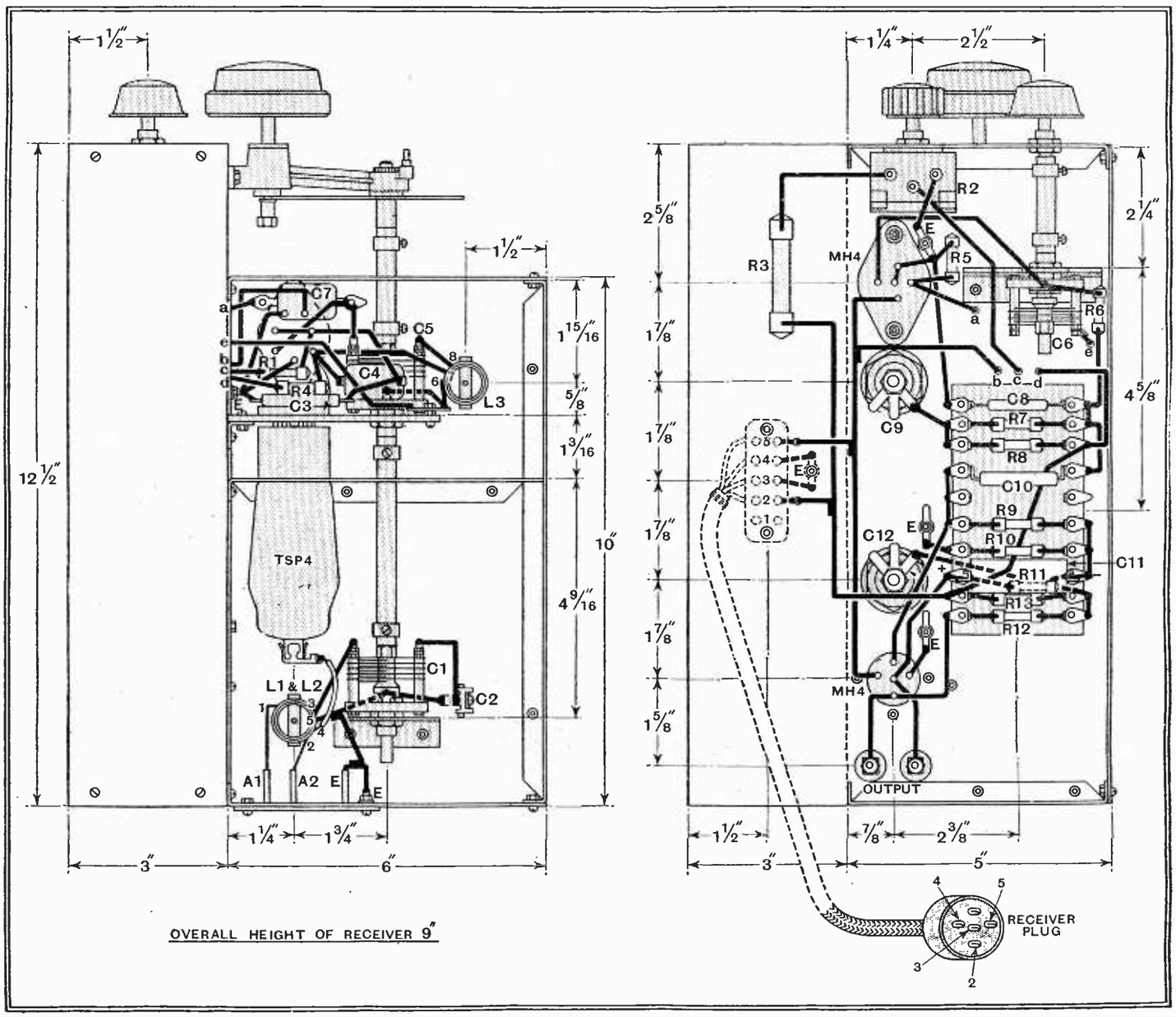


Fig. 2.—Complete constructional and wiring details are given in these drawings.

Ultra-Short-Wave Quality Receiver—

action to increase selectivity. When listening to the sound accompaniment to television, for instance, it is usually necessary to use reaction to sharpen the tuning in order to avoid interference from the vision signal. The sound may then be undesirably strong, and so it is reduced appropriately by the volume control.

Under normal conditions it is to be anticipated that good reception of the Alexandra Palace will be secured up to at least twenty-five miles when a dipole aerial is used. In many cases, of course, reception will be possible at greater distances,

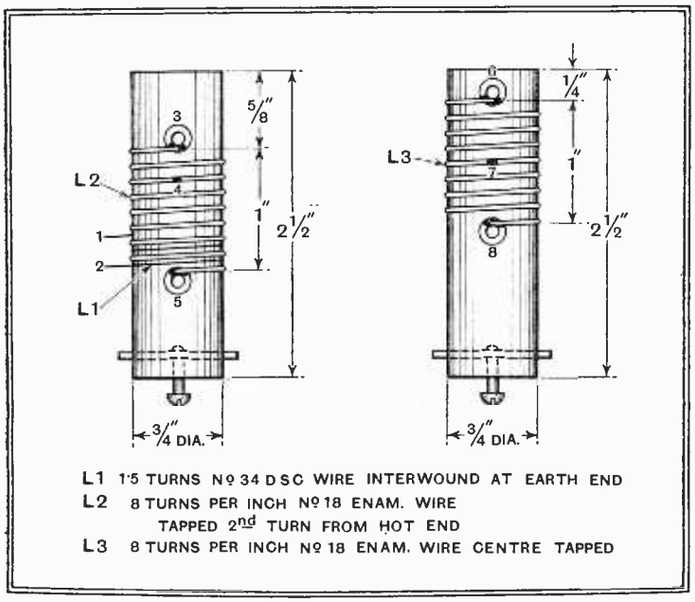
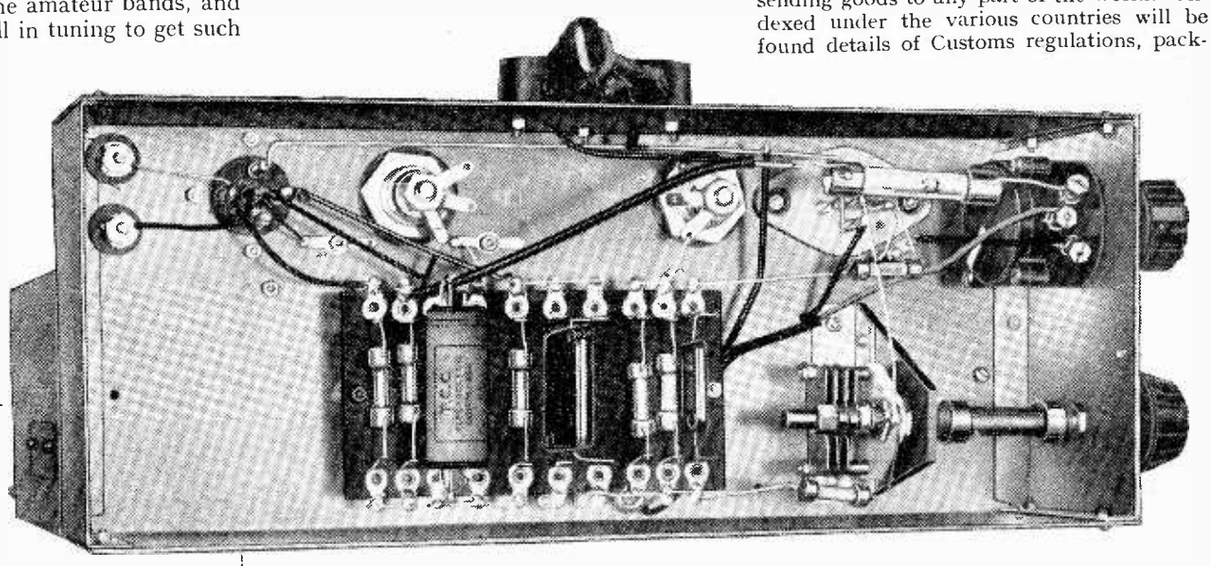


Fig. 3.—The construction of the coils is clearly shown in this illustration.

and this is undoubtedly the case with signals of longer wavelength.

On the 10-metre amateur band, for instance, American amateurs have been heard working telephony when conditions have been suitable. The receiver, however, is not really intended for such long-distance reception, for it is not selective enough for use in the amateur bands, and it requires some skill in tuning to get such signals.

For the purpose for which it has been designed, however, tests have shown it to be eminently satisfactory, and it forms an ideal sound receiver for television.



An underview of the receiver showing the wiring.

LIST OF PARTS.

Certain components of other makes but of similar characteristics may be used as alternatives to those given in the following list.

2 Variable condensers, 40 mmfds., **C1, C5** **"Apex Economy" Webb's Radio** 14, Soho St., W.1.

1 Variable condenser, 15 mmfds., **C6** **"Apex Economy" Webb's Radio**

1 Dial, dual ratio **Eddystone 1070**

Condensers:

2 0.01 mfd., mica, **C3, C10** **T.C.C. "M"**
1 0.0001 mfd., mica, **C7** **T.C.C. "M"**
2 0.0005 mfd., mica, **C4, C8** **T.C.C. "M"**
1 50 mfds., 12 volts, electrolytic, **C11** **T.C.C. "FT"**
2 8 mfds., 460 volts peak, electrolytic, **C9, C12** **T.C.C. 802**

Resistances:

1 100 ohms, ½ watt, **R1** **Dubilier F½**
1 500 ohms, ½ watt, **R4** **Dubilier F½**
1 2,000 ohms, ½ watt, **R11** **Dubilier F½**
1 10,000 ohms, ½ watt, **R6** **Dubilier F½**
3 25,000 ohms, ½ watt, **R10, R12, R13** **Dubilier F½**
1 50,000 ohms, ½ watt, **R7** **Dubilier F½**
1 75,000 ohms, ½ watt, **R8** **Dubilier F½**
1 150,000 ohms, ½ watt, **R5** **Dubilier F½**
1 2 megohms, ½ watt, **R9** **Dubilier F½**
1 100,000 ohms, 2 watts, **R3** **Dubilier F2**

1 Potentiometer, 10,000 ohms, wire-wound, **R2** **Haynes Radio**

1 Trimmer, C2 **Bulgin SW95**

2 Coils (for constructional details see sketch)

3 Extension control outfits **Eddystone 1008**

1 Valve holder, 5-pin (without terminals) **Clix Chassis Mounting Standard Type V1**

1 Valve holder, 5-pin (without terminals) **Clix Chassis Mounting SW Type V5**

1 Valve holder, 7-pin (without terminals) **Clix Chassis Mounting SW Type V5**

1 Socket strip **Clix "C"**

2 Terminals, ebonite shrouded, output +, — **Belling-Lee "B"**

1 Group board, 10-way **Bulgin C32**

1 Plug top valve connector **Belling-Lee 1175**

1 Connector, 5-way **Bryce**

1 Cable, 5-way, with twin 70/36 leads and 5-pin plug **Goltone**

Chassis:

Miscellaneous: **Peto-Scott**

2 Lengths Systoflex, 1 oz. No. 18 tinned copper wire, aluminium for brackets, etc. Screws: 48 6BA ¼in. R/hd.; 2 4BA ¾in. R/hd.; 2 6BA 1in. R/hd., all with nuts and washers.

Valves:

1 TSP4, metallised **Mullard**
2 MH4, plain **Osram**

NEW BOOKS

Motoring Made Easy. Sixth edition, by R. F. Broad and the Technical staff of *The Autocar*. Pp. 133, with numerous illustrations. Published by Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1. Price 2s. 6d.

THIS book, which is as invaluable to the experienced driver as it is indispensable to the novice, has been improved and amended where necessary. The chapter on "Law and the Motorist" has been brought completely up to date.

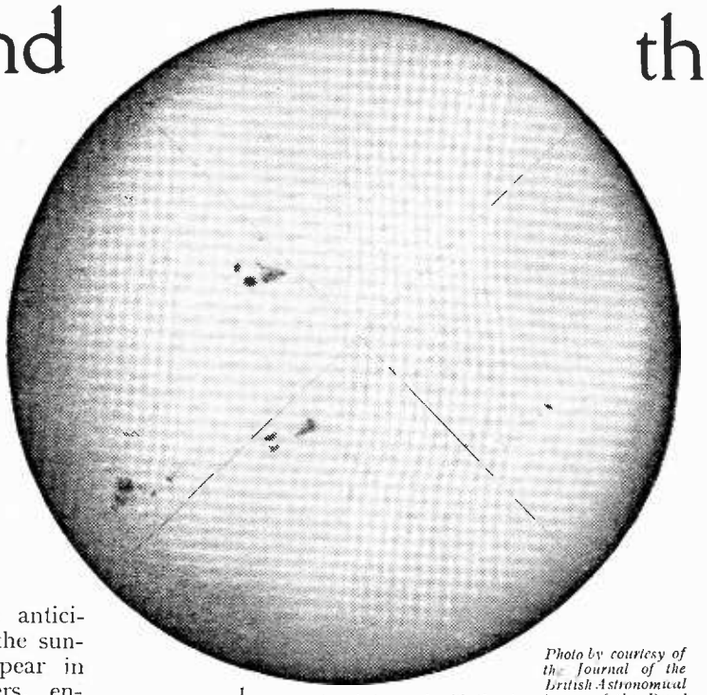
The International Mercantile Diary and Year-book, 1937. Published by Syren and Shipping, Ltd., 44-46, Leadenhall Street, London, E.C.3. Price (including quarterly copy of The Merchant Shipper) 10s. 6d.

THIS year-book, which is now in its 21st annual edition, contains everything which the exporter might wish to know about sending goods to any part of the world. Indexed under the various countries will be found details of Customs regulations, packing and marking of goods, currency values and a host of similar information which varies so much in different parts of the world.

There are, in addition, forty pages of calendars, weights and measures and other useful formulæ, and also, of course, the diary portion which shows a week at an opening. The information in the year-book is brought up to date every quarter by The Merchant Shipper, which is posted free of charge to all subscribers.

Sunspots and the

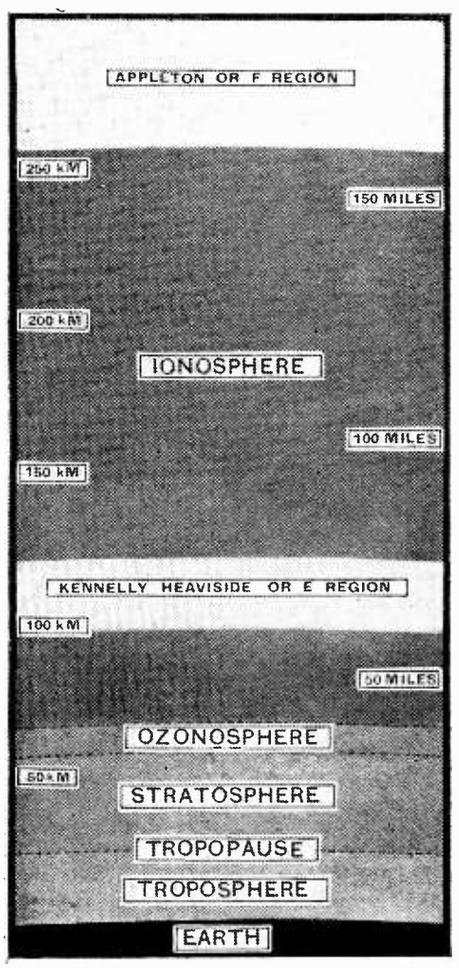
IN this article a non-technical description is given of the effect of solar activity on propagation of the short waves as revealed by sunspots. It is a matter of considerable importance to radio engineers since it influences the selection of radio frequencies for transmission to different parts of the world at various times of the day



A recent photograph of the sun taken at the Greenwich Observatory showing various groups of spots.

Photo by courtesy of the Journal of the British Astronomical Association and with the permission of the Royal Observatory, Greenwich.

THE approaching maximum sunspot period seems likely to be one of exceptional intensity, and the increasing solar activity is already having a marked effect on radio propagation phenomena, particularly in regard to the frequencies above about 3 Mc/s. Solar activity moves in an eleven-year cycle, and the last maximum was reached in 1927-28, while a minimum period occurred during 1933, so that we will be due for another peak of activity in 1938-39, and, as we are now in a far better position than we were in 1928 to take full cognisance of the effects produced upon short-wave propagation, some interesting developments may be anticipated. Already, as the sunspots continue to appear in ever-increasing numbers, engineers engaged in short-wave transmission are finding it necessary to make considerable modifications to the frequencies they employ to reach particular points on the earth's surface, and, when they have correctly interpreted the sunspot effect, some surprisingly good results have been obtained.



The various strata in the atmosphere with their relative heights and dimensions are shown in this illustration.

How Solar Radiation affects the Ionosphere

What then is the precise effect of solar activity on short-wave reception, and how is this effect brought about? It must be admitted, in reply to this question, that the work of correlating day-to-day short-wave reception conditions with sunspot activity is an exasperating business, and no exact accord between the two has in fact been achieved. Of course, the solar cycle does not take the form of a smooth curve, the sunspots appearing sometimes singly and sometimes in large groups in an erratic manner, but with ever-increasing frequency as the maximum approaches Some general effects have been fairly well established, however, and to understand them we must briefly consider the mechanism of short-wave propagation in the ionosphere.

There exist at least two well-defined layers in the ionosphere, the upper, or F layer, at a height of about 180 miles above the earth, and the lower, or E layer, at a height of about 60 miles. Because of the pronounced diurnal variations in both the layers, it is evident that the sun is the main factor in their production. And, since they enclose the whole earth, as it were, in a shell, it would appear that they are caused by some solar agent which is not deflected by the earth's magnetic field. It is thought that there are two of these agents, namely, ultra-violet light, and neutral corpuscles which have been ejected from the sun, and both play their part in the production of the two layers.

As the F layer is the one which is subjected to the greatest amount of solar radiation, the density of the free electrons in it is higher than that in the E layer, and because of the low gas pressure existing at this height the rate of recombination of the electrons and positive ions is comparatively low. Whilst the density of free electrons in the E layer is lower, the recombination rate is much higher owing to the higher gas pressure at this height. Thus we see that when the sun's action has been removed from the layers the degree of ionisation will fall rapidly in the E layer and comparatively slowly in the F.

Radio waves above about 3 Mc/s in frequency are propagated by means of refraction or "bending" in the F layer, the amount of bending depending, among other things, on the frequency used and the density of free electrons in the layer. Some other effects also occur, but we need not consider these here, merely remembering that the amount of bending is proportional to the density of free electrons, and inversely proportional to the square of the frequency of the wave. But before reaching the F layer the wave must pass through the E. Here the density of free electrons is not normally sufficient to cause enough refraction to return the wave, but in its passage through the layer the wave becomes attenuated to a degree depending on the free electron density and on the frequency.

Effect of Sunspots

Thus we see that for any particular frequency there are two separate conditions which can cause poor reception: (*a*) inadequate bending in the F layer, due to a

Short-Wave Listener

too low ionisation level there; and (*b*) excessive attenuation of the wave, due to a too high level of ionisation in the E layer.

On days when there is a large number of sunspots radiation of the ionising agents from the sun increases. These occasions become more frequent and the effect increases in intensity as the sunspot cycle proceeds towards its maximum, and consequent upon this the levels of ionisation in both layers become higher. According to Professor Appleton they are at present 300 per cent. higher in the F layer and 50 per cent. higher in the E, than in the minimum period.

For short-wave propagation over a daylight path the optimum frequency is shifted towards the higher frequency end of the spectrum. Notice that "the band of frequencies for good reception" is not entirely controlled by the F layer ionisation level, but to a great degree by that of the E layer, which is largely responsible for the attenuation of the wave. In other words, while there is an upper limiting frequency for adequate bending in the F layer, the lower limiting frequency is that for which the attenuation in the E layer becomes excessive.

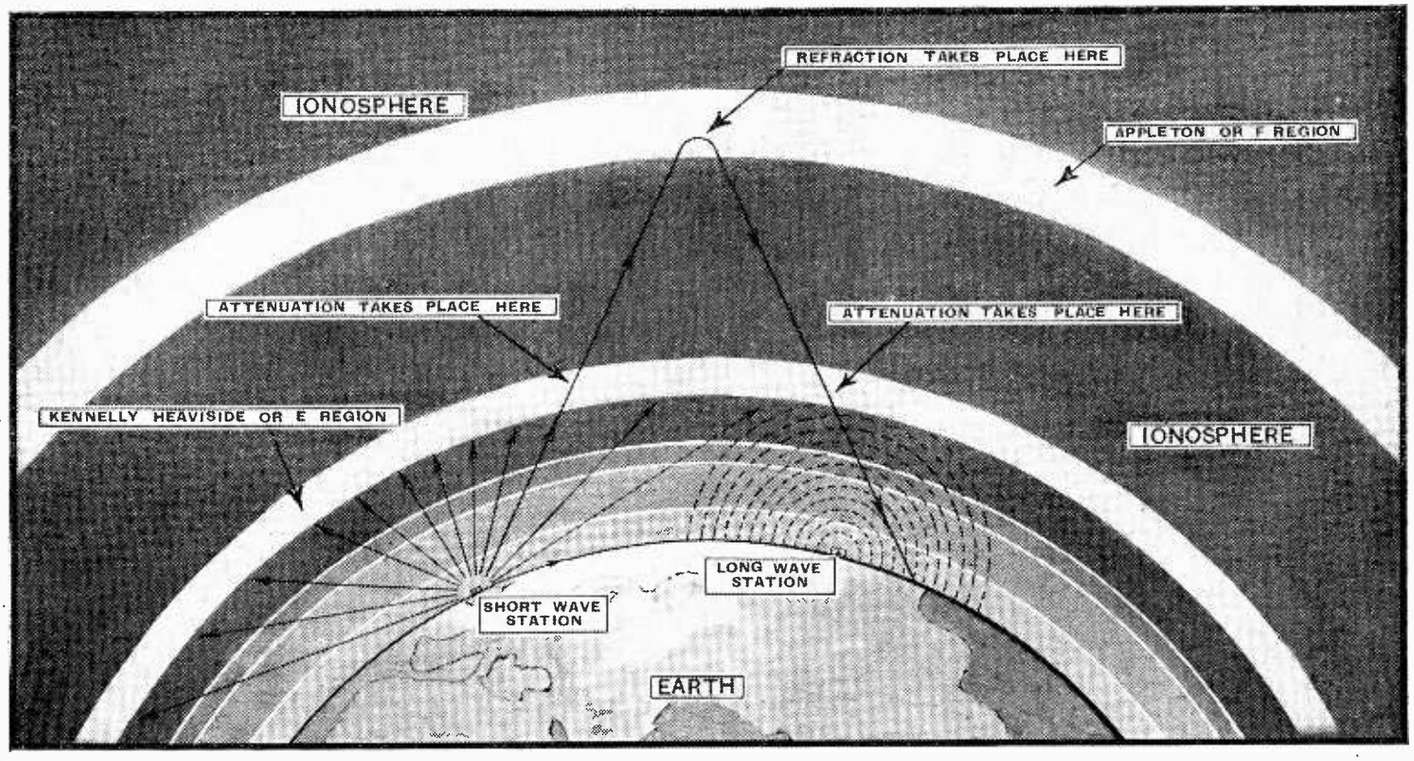
To see an example of the effect of solar activity on a daylight transmission path, one has only to note the frequencies now being employed in the B.B.C. Empire Service. To secure good propagation over a very long daylight path during sunspot minimum years a frequency in the region of 15.14 Mc/s was suitable. But to serve the same part of the world at the present time the B.B.C. uses a frequency of 21.47 Mc/s, since the former frequency, while being adequately bent in the F layer, would suffer such severe attenuation in the E layer that it would not provide the best signal possible for the area in question. There are signs, in fact, that higher frequencies still may be necessary before the maximum is reached, as it is evident that on days of exceptionally high solar activity even this high frequency is suffering heavy attenuation.

Dark Transmission Paths

Somewhat different sunspot effects occur when the transmission path passes into the night hemisphere. Short-wave listeners will often have noticed that on certain evenings, long after darkness has set in, while the stations transmitting on the normal night-time frequencies commence to come in, those which remain on the higher frequencies still continue to be well received. In other words, the frequency band for good reception is considerably broadened, and the effect may last up to midnight, at the mid point of the path. It is as though the earth at some point on the transmission path were still being illuminated by the sun's rays, and the effect is, indeed, due to a solar cause. It may be assumed that the sun is in a state of high activity, and during the day this has led to a high degree of ionisation in both layers. After dark the ionisation level in the E layer rapidly falls, owing to recombination of the electrons and positive ions. Thus its attenuating effect upon the lower frequencies is decreased, and they reach the F layer, undergo refraction, and return to the earth without excessive loss of energy. Owing to the much lower gas pressure in the F layer, the rate of recombination is much lower there, and the abnormally high residual ionisation permits of adequate bending of the higher frequencies, which also continue to be well received. It is thought that the F layer recombination process may be further retarded after dark by bombardment of the outer ionosphere by streams of charged corpuscles ejected by the sun. These are concentrated towards the poles by the action of the earth's magnetic field, so that the effect is most noticeable on transmission paths in the night hemisphere which pass near to polar regions. As the *optimum* frequency is that which suffers least attenuation while being adequately bent, it follows that it is shifted up, as was the case in daylight, for it must be remembered that attenuation occurs in the F layer as well as in the E.

Bright Hydrogen Eruptions

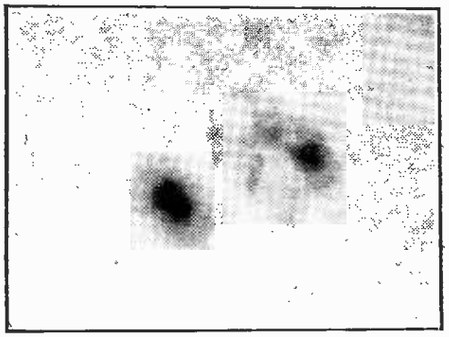
It will be noticed that of the above effects due to increased activity, the first is not a detrimental one if certain modifications are made, while the second is definitely beneficial to short-wave propagation. High sunspot activity sometimes produces, however, a third effect and one which is always detrimental. This is



A pictorial illustration of the paths followed by the long and the short waves in the upper regions of the atmosphere. Only one short-wave ray is shown with an angle of incidence sufficiently oblique to be returned to the earth.

Sunspots and the Short-wave Listener—

usually confined to daylight transmission paths, where there sometimes occur what are known as Dellinger fade-outs, during which all signals on the short-wave bands suddenly fade out more or less completely. These fade-outs may last as long as forty-five minutes, after which all frequencies are gradually restored to normal, signals on the highest frequencies being the first to reappear. It is now almost certain that they are closely connected with the sudden ejection of hydrogen by the sun. These bright hydrogen eruptions are associated with sunspots on the sun's disc, and have been observed by astronomers on at



Close-up of a sunspot group.

Photograph by courtesy of the Journal of the British Astronomical Association and with the permission of the Royal Observatory, Greenwich

least eight occasions at the same time that a Dellinger fade-out was in process on the short waves. The fact that the fade-outs were observed to commence at the same time as, or very shortly after, the beginning of the eruption, and to cease shortly after its cessation, indicates that some agent travelling at the speed of light was being radiated by the sun during the eruption. It is thought that this agent is ultra-violet light, which causes a sudden excessive rise in ionisation in the ionosphere (probably the E layer), such that all frequencies in the short-wave spectrum become completely attenuated. It is interesting to note that when these fade-outs occur propagation conditions for very long radio waves are improved. These waves are not propagated in the form of rays, but by plane propagation of the transmission line type between the earth and the E layer. It is thought that the improvement is due to the big increase in conductivity in the E layer, brought about by the rise in ionisation levels.

Summarising the practical effects of high sunspot activity as far as the short waves are concerned, we may say:—

(1) On days of high activity the ionisation levels in both layers are raised.

(2) Due to the high gas pressure, the E layer level rapidly falls after dark, but the F layer ionisation persists at a high level.

(3) Due to (1), the optimum frequency for daylight paths is raised.

(4) Due to (2), the frequency band for good reception over a darkness path is much broadened, but the optimum frequency for the path is also raised.

(5) Bright hydrogen eruptions occurring in association with sunspots cause immediate excessive rises of the ionisation levels, resulting in Dellinger fade-outs.

Meanwhile, the approaching sunspot maximum is being watched with great interest, not only by astronomers, scientists, and radio transmission engineers, but by numbers of enthusiastic short-wave listeners and amateur transmitters throughout the world. T. W. B.

News from the Clubs

Croydon Radio Society

Headquarters: St. Peter's Hall, Ledbury Road, S. Croydon.
Meetings: Tuesdays at 8 p.m.
Hon. Pub. Sec.: Mr. E. L. Cumbers, 14, Campden Road, S. Croydon.

An entertaining evening was recently spent by the Society in which various aspects of home construction were described. Mr. H. T. Stott, a guest lecturer from the Ilford Radio Society, gave a talk entitled, "Modern Components." On a subsequent evening Mr. J. H. Owen Harries, the well-known valve expert, gave an interesting talk on the design of valves.

International DX'ers Alliance (London Chapter)

Headquarters: Chequers Restaurant, Essex Street, Strand, London, W.C.2.
Meetings: Monthly.
Hon. Sec.: Mr. J. Knight, 6, Fleetwood Street, London, N.16.

The London Chapter has just commenced publication of a new journal entitled "Ama-Touring," which is devoted entirely to amateur radio news compiled from the reports of members in all parts of the globe.

The commencement of the "London and Home Counties Short-Wave Cup Contest" brings the number of competitions now open to British members up to five.

Southall Radio Society

Headquarters: The Three Tuns Hotel, The Green, Southall.
Meetings: Tuesdays at 8.15 p.m.
Hon. Sec.: H. F. Reeve, 26, Green Drive, Southall.

One of the most interesting lectures of the season was recently given by Mr. F. Charman, G6CJ, on the "Propagation of Radio Waves." On a subsequent evening Mr. J. J. Maling, G5JL, exhibited and described a transmitter of his own design.

As a result of a lecture recently given on the amateur radio movement by Mr. J. Clarricoats, G6CL, the Secretary of the R.S.G.B., the Society has decided to become affiliated to the R.S.G.B. Mr. Clarricoats has generously agreed to meet the fees payable in connection with this.

At the annual general meeting it was announced that new and more spacious headquarters had been obtained, this being necessitated owing to the large increase in the Society's membership during the past three months. The new meeting place will seat 150 people. New officers were elected for the coming year.

The International Short-Wave Club

The recent annual dinner was attended by short-wave listeners from all over the British Isles. The American Consul was present, and also representatives of the radio manufacturers.

Nottingham Amateur Radio Society

Headquarters: 2, Bridgford Road, West Bridgford, Nottingham.
Hon. Sec.: Mr. C. Lambert, 199, Sherwood Street, Nottingham.

At a recent meeting Mr. S. Ingram, B.Sc., of Messrs. Belling and Lee, Ltd., gave a lantern lecture on "Aerials and Interference," which members declared to be one of the most interesting and instructive of the session.

Wirral Transmitting and Short-Wave Club

Headquarters: King's Square Café, Birkenhead.
Meetings: Last Wednesday in the month at 7.30 p.m.
Hon. Sec.: Mr. J. R. Williamson, 49, Neville Road, Bromborough, Birkenhead.

At the recently held annual general meeting it was stated that membership had increased tenfold during the year. Among the members were four fully licensed amateur transmitters and nine with artificial aerial licences. New officers were elected for the ensuing year. It was decided to hold an ultra-short-wave field day in July.

Halifax Experimental Radio Society

Headquarters: Friendly and Trades Club, Room 13, St. James' Road, Halifax.
Hon. Sec.: Mr. J. B. Bedford, Oak House, Triangle, near Halifax.

Mr. C. Berg, of Alkium Storage Batteries, Ltd., Halifax, recently gave an instructive lecture on the alkaline battery. Research work began in Sweden in 1893, and it took 16 years to produce a practicable article. Particulars were given both of the nickel-iron and nickel-cadmium batteries, and various practical examples, such as the Milnes H.T. unit, were described.

Exeter and District Wireless Society

Headquarters: Y.W.C.A., 3, Dix's Field, Southernhay, Exeter.
Meetings: Mondays at 8 p.m.
Hon. Sec.: Mr. W. J. Ching, 9, Sivell Place, Heavitree, Exeter.

In his talk on modern telephony methods, Mr. Bateman, of the G.P.O. Telephony Department, first traced the history of the telephone from the time of Graham Bell and then passed on to the modern telephony system. The lecturer also dealt with the work of cable ships in searching out and repairing breakdowns.

CURRENT TOPICS

NEWS OF THE WEEK IN BRIEF REVIEW

Prison Radio

A COMPLETELY new wireless installation has been put into operation at the Michigan State Prison at Jackson. Three programmes are available in each of the 4,000 cells.

Canada's Highest Aerial

THE recently erected aerial mast of the CJRC station in the vicinity of Winnipeg is the highest in Canada. At the base it is 32ft. square and tapers upwards for 404ft. to an area of 22 square inches.

Parachute Radio

ON Sunday (April 25th) M. René Vincent, a well-known figure in French aeronautical circles, will give a running commentary while descending in a parachute. The transmitter will be carried in a special rucksack.

The Coronation in West Africa

A COMPLETE network of permanent public address equipment is being erected in various centres in West Africa. This network will contain a total of over 5,000 loud speakers and will provide the Government with a powerful propaganda weapon among the natives. It is hoped to complete it in time for the Coronation broadcasts.

New Training Institution

THE proprietors of the well-known wireless school at Colwyn Bay have now transformed Loperwood Manor, near Southampton, into a residential training establishment for operators and engineers. The new school, known as the Wireless College, Calmore, Southampton, is situated in pleasant country surroundings, with its own playing fields, and can accommodate 150 resident students.

Cooper's Hill War Memorial Prize

WIRELESS engineers who are under 35 years of age and who are corporate members of the Institution of Electrical Engineers have a chance this year of winning the above prize, which is awarded triennially by the Institution for the best paper on a professional subject.

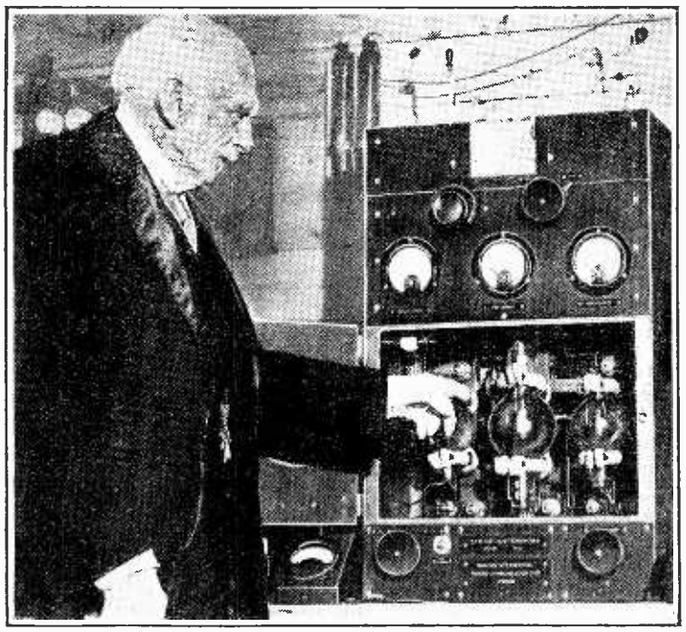
It was founded by members of the Royal Indian Engineering College, Cooper's Hill, in memory of those of their number who fell during the War, and consists of a monetary prize of the value of about £20 in addition to a bronze medal and a parchment certificate. Papers must be sent in not later than October 1st, 1937.

Radio-controlled Targets

IT is reported that a great deal of experimental work is being undertaken by the French naval authorities in connection with marine targets controlled by wireless. A special wirelessly controlled "battleship" which is to be used for target practice is in course of construction.

Signals from the Stratosphere

SOME interesting investigations have been carried out by the U.S. National Bureau of Standards into meteorological conditions in the stratosphere. Several small balloons fitted with self-registering meteorological instruments, and an automatic radio transmitter were released. Messages were received from considerable distances. The whole apparatus including the meteorological instruments weighs only 20 oz. This was made possible by the development of a super-lightweight 45-volt H.T. battery weighing 2 oz.



SIR AMBROSE FLEMING, doyen of valve technicians, at the new Wireless College, Calmore, Southampton, where he performed the opening ceremony last week. Sir Ambrose is examining one of the transmitters installed for instructional purposes.

International SW Congress

FROM July 12th to the 17th there will be a special congress held in Vienna to consider short waves in their relationship to physics, biology, and medicine. The Marchese Marconi, Professor D'Arsonval, and Dr. Zenneck will be Presidents of Honour.

200 Metres and Down

UNDER the above title a book has been written by the Assistant Secretary of the American Radio Relay League, in which are described instances in which wireless amateurs have used their skill in an emergency for the service of their fellowmen. These incidents are being put into dramatic form and broadcast by WMAQ, the well-known NBC station. One incident is dealt with every week.

Police Radio Progress

THE success which has attended the use of a local radio service by one or two police forces has, it is reported, led to the appointment of a special adviser on the subject by the Home Office. In all probability every police force will eventually be equipped with radio and a large national network formed.

Auto-alarm Protest

GRAVE doubts have been expressed by American marine wireless operators concerning the efficacy of the automatic alarm device which, as reported recently in *The Wireless World*, is to be fitted to all American ships carrying operators. The President of the American Radio Telegraphists Association has sent a strongly worded letter to the Federal Communications Commission in which he contends that the reliability of the auto-alarm has not yet been sufficiently proved.

No Danish "Radio Times"

THE proposal of the State Broadcasting Service of Denmark to publish an official programme paper has been abandoned as the result of a strong protest by Danish newspapers. The opponents of the idea state that the official programme papers published in other countries do not set an example worth following.

Trouble with AC Clocks

WHEN the electricity supply mains of Los Angeles were switched over to the new Boulder Dam Power Supply Station thousands of the city's domestic clocks—which are mainly of the synchronous type—commenced to gain. This was due to the fact that the new supply was of a slightly higher frequency than the old. The municipality is now engaged in the task of converting more than 125,000 clocks to the new frequency. AC mains receivers were, of course, not affected by the slight increase in frequency.

Questions in the House

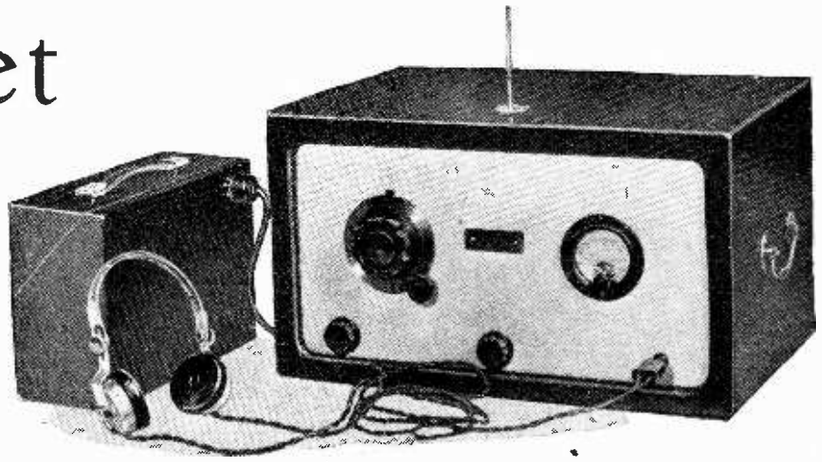
OF the 4,168 wireless pirates prosecuted in the year ending February 28th, 1937, only seven were found not guilty, according to the P.M.G.'s reply to a question in the House. No motorists were prosecuted for failure to take out the additional licence necessary for car radio. In reply to another question, the P.M.G. said that the Television Advisory Committee would consider whether an additional licence was advisable in respect of a television set as soon as sufficient experience has been obtained concerning the cost of the television service.

Coronation Cavalcade

THE glamour of British State Pageantry is reflected in an admirable and dignified work of reference which Messrs. John Player and Sons have just prepared in the form of an album specially planned to take the new Coronation series of 50 cigarette cards. It is obtainable for 3d. from most tobacconists.

Television Interference Test Set

PORTABLE EQUIPMENT TO BE USED BY THE POST OFFICE RADIO BRANCH



Portable ultra-short-wave superheterodyne for interference tests. The batteries are contained in a separate case.

THE investigation of interference on the wavelengths normally used for television reception is a problem now being tackled by the Radio Branch of the Post Office. Such investigation calls for different equipment from that used for the same purpose when the longer wavelengths are being examined. The chief sources of interference are from motor car ignition systems, electro-medical apparatus, thermostats, and electric motors.

A special ultra-short wave superheterodyne has been constructed for the Post Office for this purpose by British Television Supplies, Ltd., to whom we are indebted for the details.

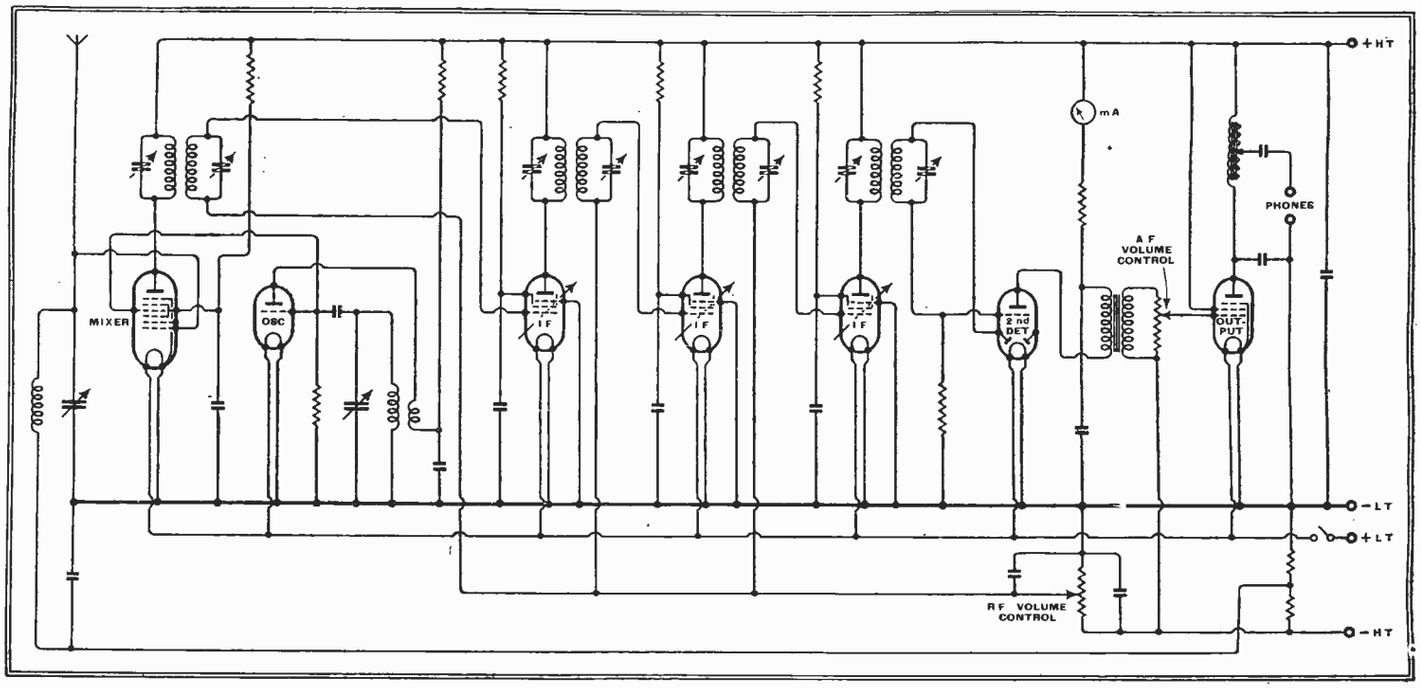
The receiver has been designed to provide headphone reception of the Alexandra Palace transmissions throughout the service area on a 4ft. vertical aerial, and is operated from batteries. The circuit arrangement employs the following combinations: An octode frequency changer with separate triode oscillator followed by three variable-mu pentode IF amplifiers feeding a diode triode which is transformer coupled to an output pentode of the low-consumption type.

Circuit Employed

The frequency range covered is 40-60 megacycles, and the input and oscillator circuits are ganged to give single dial control. The octode has the signal input fed into the usual oscillator grid, while the normal control grid is used for injection. The oscillator triode has a grid top cap providing low valve capacity, which is necessary at the frequencies involved. The three IF stages are tuned to 4 megacycles and arranged to provide a bandwidth of 50 kc/s. The diode triode circuit is of interest, as a meter to provide an indication of signal strength is included here in the following manner: The rectified signal voltage developed across the diode load resistance is applied directly to the grid of the triode without the interposition of a blocking condenser, so that when the receiver is tuned to a carrier wave the anode current is lowered from its normal value.

The illustration shows the milliammeter, which is connected in the anode circuit mounted on the front panel.

Resistances in the negative HT lead provide grid bias for the output pentode and also the variable-mu IF valves. The latter is variable and is controlled by the lower left-hand knob in the illustration, while the lower right-hand knob controls audio-frequency gain by regulating the input to the pentode. The on-off switch is incorporated in the headphone jack.



Theoretical circuit of the ultra-short-wave superheterodyne made by B.T.S. for the Post Office Radio Branch.

Television Interference Test Set—

The receiver is housed in a cabinet constructed of metal-faced plywood to provide screening, while a small separate box contains the HT and LT batteries.

The collapsible aerial, which consists of three lengths of ¼in.-diameter brass rod screwed together, passes through a bush in the cabinet and screws into the small sub-panel which can be seen in the illustration. From the illustration of the chassis it can be seen that a layout providing short connections has been adopted, together with a mechanical construction to ensure rigidity and, therefore, constancy. Wherever possible, the metal parts have been welded together to ensure this.

The total weight of the receiver in cabinet is 28 lb., and the batteries in container weigh 16 lb. It is understood that ultra-short-wave field and interference voltage measuring apparatus is being developed by the Post Office, but until this is available receivers of the type described in this article will no doubt be of considerable use to the Post Office staff engaged in the localisation and suppression of interference with television reception.

Automatic Tuning Control

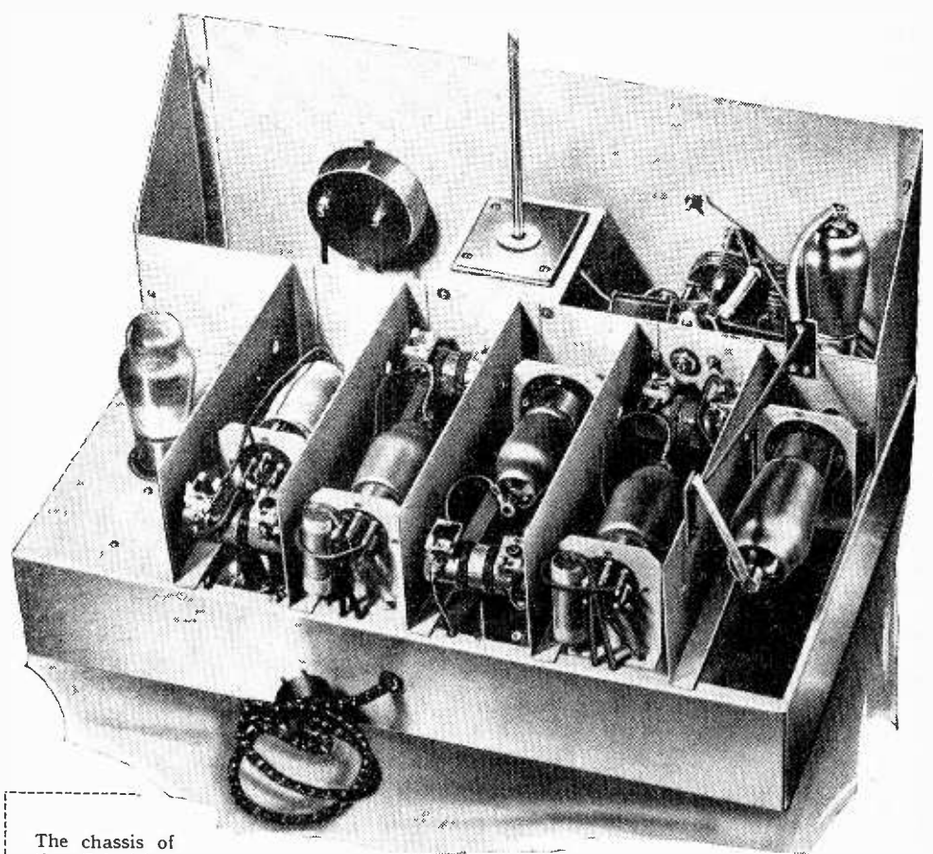
THE use of muting to ensure a "quiet" background when changing-over from one station to another is now becoming standard practice. The effect is pleasing to the ear, but tends to make the tuning somewhat critical. For this reason it often goes hand-in-hand with some form of automatic tuning control.

The object of providing ATC is to prevent any initial inaccuracy in the setting of the tuning knob from spoiling the quality of reproduction. Instead, the initial error is automatically put right, and the circuits brought back, gently but firmly, into true resonance.

Any slight mistuning of a superhet will naturally produce a beat frequency which is either slightly higher or slightly lower than that giving the required beat frequency for the IF amplifier. The latter, in most ATC systems, is coupled to a "balanced" rectifier, which develops a voltage of one polarity or the other, according to whether the initial setting is above or below the proper mark. This voltage is then applied to alter either the inductance or capacity of the local oscillator circuit, so as to change its frequency up or down until it comes into proper relationship with the signal. When this occurs the right beat frequency is being fed into the IF circuits and all is well. The tuning knob can be left where it is without playing ducks and drakes with the performance of the set.

Yet, a little reflection will show that whilst the automatic readjustment may work perfectly for one signal it will not be quite so accurate for a signal of either longer or shorter wavelength, because then the same degree of mistuning will call for a slightly different value of the inductance or capacity required to bring the local oscillator back into correct step with the signal.

Philips (Patent No. 450664) tackle this somewhat elusive problem by providing a superhet receiver with two local oscillators instead of one, and throwing the onus of correction upon the second stage instead of the first. The point is that no matter what wavelength is being received, an initial error of say one degree on the tuning scale will produce a fixed frequency in the first IF circuit. As this is coupled to the second local oscillator, the latter thus has the advantage of always receiving a fixed input frequency, and it therefore produces a correcting voltage which is related only to this fixed frequency and to the original error in tuning. In other words, the automatic tuning control is made equally effective whether the error it has to correct occurs at the top or the bottom of the wavelength scale.



The chassis of the Television Interference Test Set removed from its case. Note the compact lay-out of the IF amplifier shown in the foreground.

BOOK REVIEW

Television Cyclopedia. By Alfred T. Witts. Pp. 151. Published by Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2. Price 7s. 6d.

AS its title implies, this book contains definitions of terms commonly used in television practice and thus naturally includes many expressions which originated in the fields of wireless and optics. The author wisely does not confine himself merely to definitions, and except in the simplest cases they are amplified by some description of the mode of operation of the circuit or apparatus.

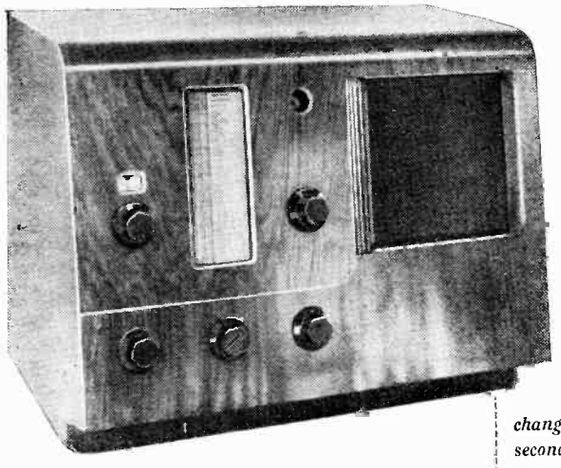
A few errors have unfortunately crept in. In speaking of the deflectional sensitivity of a CR tube it is stated this is proportional to the voltage difference between the plates; actually, it is the deflection which is proportional to this voltage, not the deflectional sensitivity. In defining demodulation the author states that it is an alternative name for detection. It has this meaning in America, but it is more often used in this country to denote a decrease in modulation depth. The explanation given of diode detection is over-simplified, and incorrect since no account is taken of the profound effect of the load circuit impedance.

The description of a fader is more properly that of a mixer which, incidentally, does not find a place in the book, and the definition of Miller Effect is wrong. The definition is "The name given to the action of a thermionic valve that causes the effective input impedance (grid-cathode impedance) to vary"; also ". . . when the load impedance is capacitative the resistance (input) becomes negative." There are other things besides Miller Effect which cause the input impedance to vary—electron transit time, for instance—and a capacitive anode load impedance does not make the input resistance negative. An inductive load impedance is necessary.

These errors in definitions naturally form a blemish upon a book which contains a large number of definitions of which the great majority are accurate and concise. The newcomer to television, who is naturally unfamiliar with its special vocabulary, should find the book of great help. The correction in subsequent editions of the errors referred to will make it more authoritative. W. T. C.

Murphy A36

ALPHABETICAL TUNING AND SHORT-WAVE CIRCUITS OF UNUSUAL INTEREST



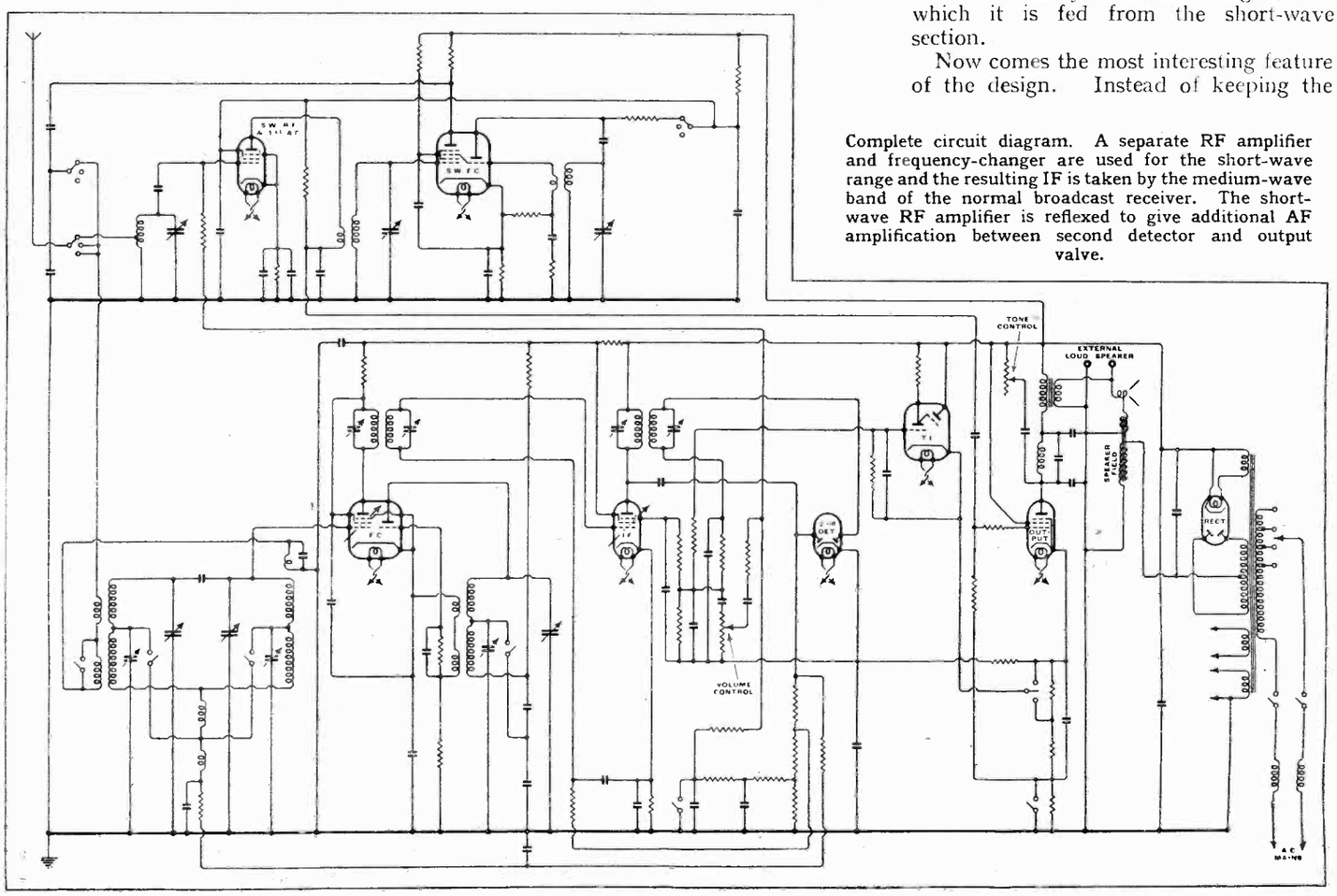
FEATURES.—***Type.***— *Superheterodyne receiver for AC mains.* ***Wave-ranges.*** — *(1) 13-50 metres. (2) 200-550 metres. (3) 900-2,000 metres.* ***Circuit.*** — *(Short-wave section) :— Reflexed pentode RF amplifier and first AF stage—triode hexode frequency-changer (Medium- and long-wave section) : — Triode pentode frequency-changer — pentode IF amplifier— double-diode second detector—pentode output valve. Full-wave valve rectifier.* ***Controls.***—*(1) Tuning. (2) Short-wave band selector. (3) Volume and on-off switch. (4) Wave-range. (5) Tone. (6) Noise suppressor switch.* ***Price.***—*£15 10s.* ***Makers.*** — *Murphy Radio Ltd., Welwyn Garden City, Herts.*

IN designing this receiver the makers have set themselves the task of providing a performance on short waves which shall be comparable with that to which the majority of broadcast listeners have become accustomed on the medium-wave band. Hitherto the short-wave range has been open to criticism under three main heads: (1) Difficulty of tuning; (2) Susceptibility to image or second-channel interference; (3) Inadequate reserve of gain in view of the discrepancy in field strengths between medium- and short-wave signals taken as a whole.

In conventional "all-wave" receivers the first of these difficulties is met by mechanical means associated with the tuning condenser drive, but in the new Murphy set the solution is an electrical one and takes the form of a well-thought-out double frequency-changing circuit which virtually broadens out tuning on short-wave stations to medium-wave standards. In working out this circuit the designers have taken items (2) and (3) in their stride and the result is a receiver which is not only of absorbing interest to the student of technical details, but a set which, in the hands of the average listener, is likely to provide far more reliable entertainment than usual on the short-wave range.

The foundation of the circuit is a four-valve superheterodyne which is a logical development of the Murphy "26," "30" and "34" series. It has an input band-pass filter working on medium and long waves leading to a triode-pentode frequency-changer, pentode IF amplifier, double-diode second detector and pentode output valve. The short waves are handled by a separate section consisting of a signal-frequency amplifier and triode-hexode frequency-changer. This unit has its own three-gang tuning condenser and signals are converted to an intermediate frequency falling in the medium-wave band of the main receiver. Thus the whole of the gain and selectivity of the broadcast receiver is available to supplement the already considerable signal with which it is fed from the short-wave section.

Now comes the most interesting feature of the design. Instead of keeping the



Complete circuit diagram. A separate RF amplifier and frequency-changer are used for the short-wave range and the resulting IF is taken by the medium-wave band of the normal broadcast receiver. The short-wave RF amplifier is reflexed to give additional AF amplification between second detector and output valve.

Murphy A36—

intermediate frequency fixed and varying the short-wave tuning circuits by some form of "vernier" drive, the short-wave tuning condenser is fixed by locating notches at predetermined points—actually the mid-points of the recognised short-wave broadcast bands—and the final tuning is carried out by the main tuning dial of the set. As the majority of the short-wave broadcast bands are less than 1 megacycle in width the short-wave stations in each band are spread out over the medium-wave dial and tuned with the same ease as medium-wave stations. The additional valves in the short-wave section bring the short-wave programmes up to the volume level of medium-wave stations and the additional pre-selection coupled with the high intermediate frequency entirely solves the problem of image or second-channel interference.

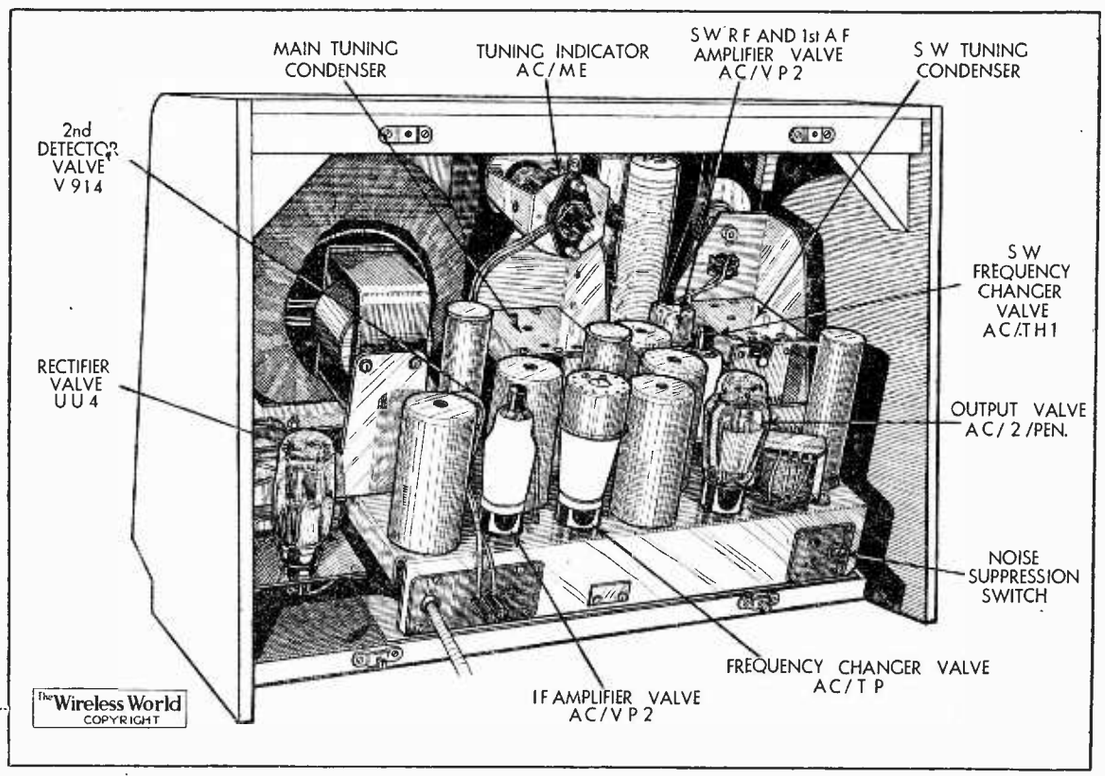
Theoretically, there is one snag. Signals at the extreme ends of any given band to which the short-wave tuning condensers has been temporarily fixed by the locating notch will be off-tune with respect to the peak of the resonance curve of the short-wave circuits and a reduction of input is to be expected. In practice any loss of signal strength or deterioration of image rejection from this cause is negligible. Sufficient over-all gain has been provided to give full volume from any worthwhile signals occurring at the extreme edges of the recognised short-wave broadcast bands, and any relative increase which may accrue from a station being near to the peak of the input resonance curve will be taken care of by AVC.

The circuit is as interesting in detail as it is in general specification. For instance, additional amplification is gleaned by reflexing the short-wave RF amplifier and pressing it into service also as an intermediate stage of AF amplification between the signal rectifying diode and the output valve.

The method of noise suppression is somewhat complicated, but the general principle of the circuit may be stated briefly as follows.

A paralysing bias derived from the cathode circuit of the output valve is applied to the signal diode. In the ordinary way this would cause distortion not only for signals near the threshold, but also for strong signals which are deeply modulated. To overcome this difficulty an auxiliary diode is arranged to remove the noise suppression bias when a sufficiently strong signal is received. Actually the auxiliary diode is provided by the suppressor-grid-to-cathode circuit of the IF amplifier. A change is also made in the AVC delay, and when noise suppression is out of action AVC is increased by applying a small degree of control to the reflexed valve.

Another refinement of interest is that the standing bias on the cathode-ray tuning indicator is automatically adjusted so that the same degree of selectivity is maintained whether the noise-suppression circuit is in or out of action.



A separate three-gang tuning condenser is used for the short-wave range. Increased vane spacing is provided in the oscillator section of both condenser assemblies.

Ease of Tuning

The intricacies of the circuit find no counterpart in the controls or their mode of operation. With the recently introduced "alphabetical" dial, tuning on medium and long waves is simplicity itself. Provided that a station is brought accurately to resonance (and with the sensitive cathode-ray tuning indictor to help there is no possible excuse for carelessness in this matter) the "identification disc" of the station falls exactly into position under the hair line, and by following the lead to the scale at the side the name is easily read off. Conversely, starting from cold, a station can be set on the dial with the certainty that when the valves warm up the transmission will be there and require little, if any, final adjustment. This is undoubtedly an advantage when things have been run fine at the start of the programme which one specially wants to hear.

The drum dial is calibrated for sixty medium- and long-wave stations, and under average conditions good programmes should be obtained from 90 per cent. of these after dark and at a conservative estimate 40 per cent. in daylight. There is also a strong possibility that the list will be supplemented by other stations not marked, and a wavelength scale is provided at the top of the drum as a means of identification. The selectivity is adequate having regard to the requirements of quality of reproduction, and approximately 1½ channels are lost on either side of the Brookmans Park transmissions when using the set at full gain in Central London. There is a commendable reduction of second-channel whistles, heterodyne interference and background noise in general below average standards.

It is probably because of the efficiency of the whistle filter in the anode circuit of the output valve that one's first impressions are of a somewhat deficient high-note response, but perhaps this is to some extent explained by the fact that the reproduction is free from the upper middle register resonances which are frequently called upon to provide a semblance of good high-frequency response. The loud speaker is of a new type with a curved-sided cone and handles the increased power output without any audible trace of amplitude distortion.

On the short-wave range it is difficult to decide which aspect of the performance is the more impressive—ease of tuning or the high volume level and steadiness of signals. No fewer than five American transmissions were received during a single afternoon, and on subsequent occasions Bound Brook and Schenectady were found to give a programme of exceptional volume and clarity whenever they were

Murphy A36—

tuned-in. Much better results than usual were obtained from Pittsburgh, 21.54 Mc/s (13.93 metres), and there was no evidence of any falling off of sensitivity on the 13-metre range which can often be levelled as a criticism of "all-wave" receivers of conventional design.

The newcomer to short-wave reception cannot fail to get good results right from the start, though he may be in the dark as to the identity of any particular station until he has heard an announcement. After he has become familiar with the settings of the principal stations he will be able to make use of a system of calibration which the makers have devised for more advanced listeners. At the top of the drum is a scale which is divided from 0—10. Actually this scale corresponds to a change of frequency of 1 megacycle and is quite accurate in calibration. Thus if the scale reading of a known "key" station is taken as a basis, the settings of other stations on that particular range can be found by addition or subtraction after reference to a list of short-wave stations giving their transmission frequencies in megacycles. The successful operation of this system depends upon the locating notch on the short-wave tuning condenser always being returned exactly to the same point, and in a new receiver it may be necessary to "settle" the short-wave tuning knob slightly to find the right position.

The mechanical details of the chassis are interesting. It goes without saying that the maker's reputation for neatness and sound workmanship has been maintained. Considerations of space and cabinet design have led to the mounting of the loud speaker, mains transformer and rectifier valve on a separate unit overhanging the edge of the chassis. Another unusual feature is the location of the output valve in the short-wave section of the chassis layout. Actually this is the logical position for this valve as it takes its input from the short-wave RF amplifier which has been reflexed to provide a first stage of AF amplification. In a receiver of this type special attention must be given to screening in order to avoid "pulling" of the oscillator, medium-wave pick-up when the short-wave range is in use and mains hum. As an indication of the care which has been taken in small details it may be mentioned that certain of the coupling components associated with the reflexed valve are actually mounted inside the screening cap on the top of the valve.

In spite of its somewhat belated entry into the field we believe that the A36 is a receiver which will have a marked influence on the future trend of commercial short-wave broadcast receiver design.

The Radio Industry

MR. M. K. TAYLOR and Dr. N. H. Searsby, both of the Ferranti Radio and Television Research Department, sailed last week in the *Queen Mary* for America. They will exchange information with representatives of the industry in that country, and are taking with them an example of the latest Ferranti television receiver.

Correx Amplifiers, Peckford Place, London, S.W.9, announces that, due to increased production, the Model W60 MG amplifier has been reduced in price from 70 gns. to 60 gns.

We learn from the G.E.C. that, in anticipation of Coronation broadcasts, an unprecedented demand from overseas has been experienced for receivers capable of receiving the Empire transmissions. Most of the sets to fulfil this demand are destined for South America, India, South Africa, and Malaya.

The increase of price of Film Industries productions is effective from April 1st, and not from May 1st as stated in last week's issue.

The Westinghouse Brake and Signal Co., Ltd., 80, York Road, King's Cross, London, N.1, have issued a useful and highly informative booklet on the use of Westinghouse Metal Rectifiers for electrical measuring instruments.

The Trix Electrical Co., Ltd., of 8-9, Clerkenwell Green, London, E.C.1, announces the introduction of two new portable universal amplifiers (Models U70 and U82). Model U82 is a complete 10-watt equipment arranged as a single unit, but with a demountable speaker.

Aladdin Radio Industries, Inc., 466, West Superior Street, Chicago, U.S.A., have issued a new booklet describing Polyiron coils of various types, and will send copies to anyone who is interested.

The business of Lectrolinx, Ltd., the sole proprietors of the well-known Clix specialities, will in future be conducted by a new company under the name of British Mechanical Productions, Ltd.

Articles dealing with the technical and commercial aspects of television are now included in "The Broadcaster" Trade Annual, of which the 1937 edition is now on sale at 5s. post free (trade circulation only) from 20, Bedford Street, Strand, London, W.C.2. The book contains much useful information for dealers and servicemen.

A Portable Level Meter, just brought out by the G.E.C.'s instrument works at Salford, embodies essentially an amplifier and a log-scale voltmeter of the rectifier type. The meter covers a wide frequency range and has many applications in audio-frequency work.

FERRANTI "837"

A NEW superheterodyne for AC mains has just been released under this title by Ferranti, Ltd., Moston, Manchester. The circuit employs a heptode frequency-changer, var.mu pentode IF amplifier and double-diode pentode combined second detector and output valve. Special attention has been given to selectivity, and second-channel interference on the short waveband is reduced by the employment of a 450 kc/s intermediate frequency.

The tuning scale is of the circular type, and the three waveranges are distinguished by different colours. An additional 180-degree scale enables exact settings of stations on all wavebands to be logged. The short-wave range is from 16.7 to 52 metres.

The price of the new set, which is housed in a bakelite cabinet, is 8 gns.

New Series of Marconi Valves

Fitted with Octal Bases and 6.3-volt Filaments

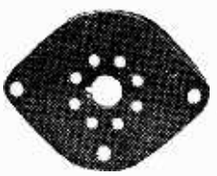
A NEW range of Marconi valves fitted with what is described as International bases has now become available. These valves have characteristics similar to the American G series, or glass equivalents of the metal range. Self-locating Octal bases are fitted, and the filaments of the valves in this series are designed for 6.3 volts.

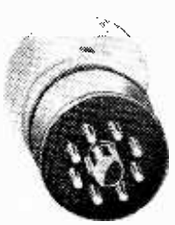
The medium mutual conductance values of the valves allow for generous clearances in the electrode assembly, giving an increased reliability and high degree of consistency.

With but a few exceptions the current rating is 0.3 amp., which makes series operation possible in AC/DC sets, and the 6.3-volt heater is particularly well suited for car radio purposes. Thus the new series has truly universal application.

The principal characteristics and prices of the new Marconi International valves are given in the table.

Marconi Type W.63 variable-mu RF pentode with Octal base and 6.3-volt heater.





Valve holder and Octal base are also shown.

MARCONI INTERNATIONAL RANGE.

Type.	Description.	Heater.		Volts.		A.C. Resistance (ohms).	Amplif. Factor.	Mutual Conductance (mA/V.).	Price.
		Volts.	Amps.	Anode.	Screen.				
X63	Heptode FC	6.3	0.3	250	100	—	—	0.5	15/-
W63	Var. Mu RF Pen. ..	6.3	0.3	250	125	—	—	1.5	12/6
Z63	RF Pentode	6.3	0.3	250	125	—	—	1.2	12/6
H63	Triode	6.3	0.3	250	—	66,000	100	1.5	9/6
D63	Double Diode	6.3	0.3	—	—	—	—	—	5/6
DH63	Double Diode Triode ..	6.3	0.3	250	—	58,000	70	1.2	12/6
N63	Output Tetrode ..	6.3	0.7	250	250	—	—	2.5	13/6
N66	Output Tetrode ..	6.3	1.27	400	300	—	—	6.3	25/-
U50	Full-wave Rectifier ..	5.0	2.0	350 + 350 Max. Rectified current 120 mA.					10/6

BROADCAST BREVITIES

NEWS FROM PORTLAND PLACE

Pronouncing Przemyśl

"BROADCAST English" is the more or less appropriate title of the B.B.C.'s "recommendations to announcers regarding the pronunciation of some foreign place-names." It is No. VI in the series of "recommendations," and will go down in history, perhaps, as the first effort in black and white to convince the English-speaking world that Mengtszhsien is pronounced "mungtsĕsyen" and Przemyśl "pshemmissĕl."

A Courageous Work

In a word, it is a courageous publication, likely to set tongues wagging in Clubland and other places where they wrangle, but calculated to bring peace of mind to announcers for generations to come. Even now people quarrel over the pronunciation of Addis Ababa and Adowa, and the book tackles not only these but names which no one as yet has even begun to argue about, such as Anuradhapura and Pya-Pun. "Be prepared" is evidently the motto of the B.B.C. Advisory Committee on Spoken English, which sponsors the list, and to be absolutely on the safe side it also throws in a few old favourites like Amsterdam and Stamboul (formerly pronounced "Constantinople").

Jaws of Rubber

On paper the recommended pronunciations are not too terrifying, though it is obvious that the compleat broadcast announcer must still have jaws of rubber. The difference, however, is that the names have been adapted for English jaws.

Announcers, Please Note!

As Fowler says in "Modern English Usage"—the passage is quoted by Professor A. Lloyd James in his preface to this book—"To say a French word in the middle of an English sentence exactly as it would be said by a Frenchman in a French sentence is a feat demanding an acrobatic mouth . . . it is a feat that should not be attempted. . . . Your collocutor, aware that he would not have done it himself, has his attention distracted, whether he admires or is humiliated."

Would that B.B.C. announcers always remembered this counsel!

Here, There and Everywhere

MAY 1st will probably be the most notable outside broadcast day, with emphasis on *outside*, in the history of the B.B.C.

An artist's impression of the imposing entrance to the Wireless Pavilion at the Paris International Exhibition.

First on the agenda is the commentary by George Allison and Ivan Sharpe on the great match between Sunderland and Preston North End at Wembley. Then the control room will switch over to Old Trafford, where Lancashire and Derby will be opening the cricket season, with P. G. H. Fender as commentator. The second and third day of this match will also come into the relative programmes.

Other Events

"Over," then, to Brooklands, where F. J. Findon will be describing the annual Brooklands Road Race. The next venue will be Bournemouth for the Annual Hard Courts Championship, where Mr. Cooper Hart will be the commentator. After that listeners will be taken to "somewhere south of the Mendips" to explore the Mendip potholes.

Finally, there will be two "O.B.'s" indoors, the final of the Billiards Championship at Thurston's, and "Tommy" Woodroffe will attend the Royal Academy, to describe a tour round the galleries, before the microphones come into circuit at the annual banquet itself for the presidential speech by Sir William Llewellyn.

The Spithead Review

ALTHOUGH B.B.C. engineers are in the throes of their elaborate arrangements for Coronation Day broadcasts to the world, they are simultaneously preparing for the technical requirements connected with the King's review of the Fleet at Spithead on May 20th. O.B.'s will have a short-wave receiving station at Southsea Castle, where commentaries will be received by line from the jetty from which the Royal yacht is to leave. The commentary from H.M.S. Nelson will also be picked up at Southsea Castle by radio link, and the whole of the material sent thence by land line to Broadcasting House. In addition to the observers' microphones, others will be installed ashore and on H.M.S. Nelson for picking up atmosphere and effects. It will be a trying day for the B.B.C.'s microphones, what with the thunder of the guns, the roar of the engines of the Fleet Air Arm as the squadrons dip in salute, and in close formation dive over the Royal yacht.

More May O.B.'s.

EVEN if the Coronation broadcasts were omitted, next month will be a memorable one for outside broadcasts. On May 5th there is the Chester Cup, and on May 8th the Rugby League Final. The Coronation Cup polo match at Hurlingham will be broadcast on the 17th, and the international rink hockey match at Herne Bay on the day after.

B.B.C.'s First Staff Reporter

FIRST staff reporter to be appointed by the B.B.C., Frederick Grisewood, is now swotting up methods which he and his counsellors of the Outside Broadcast Department consider most suitable to his new calling. As the job develops it will become something more elaborate than that of the ordinary broadcast commentator, and will partake of the character of descriptive reports rather than the mere narration of incidents. The first really big event to be covered by Grisewood will be the description which accompanies the televising of the Coronation procession at Hyde Park Corner on May 12th.

Rocking the Ship

LAST week's problem at Alexandra Palace: Take one ship's deck—for Harry Pringle's cruising programme—and give it the appearance of rocking in a gentle swell. Neither the stage nor the camera must be moved.

A senior studio engineer took home this problem for the week-end, and, after a bout of sea-sickness, returned on Monday with the perfect solution. Before reading further, see if you can guess what the solution was.

So Simple

What he did *not* do was to attempt an electrical method by slowly lifting the picture frame.

First he mounted the camera "broadside on" to the deck scene. About four inches from the lens he placed a mirror of post card size at an angle of 45 degrees, so that the scene was reflected into the camera. The mirror itself was attached to a wire rod, one end of which was held by a spring against an eccentric cam rotated by a carefully governed gramophone motor. The effect was to give a gentle rocking motion to the mirror. And that was all.

Coronation Highlights

GRACIE FIELDS has been booked for the B.B.C.'s Gala Concert on May 12th. . . . Jack Payne and his band will also be heard on Coronation Night. . . . Booking Department has also secured the Band of the 2nd Battalion Royal Scots Fusiliers.

India Calling the Empire

A FOUR-YEAR-OLD custom will be perpetuated on May 24th, when India and Ceylon provide the Empire Day programme for diffusion throughout the King's Dominions. The programme is now being devised by "A.I.R."—All-India Radio.

The first of these annual radio festivals was arranged by the B.B.C. in 1933. Australia followed in 1934, and the 1935 and 1936 concerts were given by Canada and South Africa.

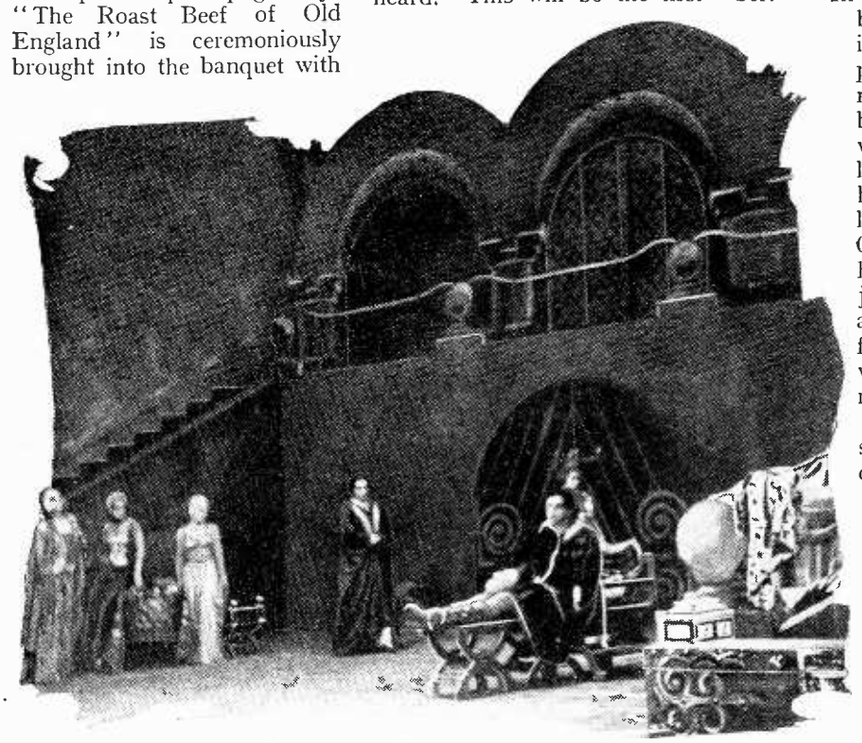
Listeners' Guide for t

Outstanding Broadcasts at Home and Abroac

UNUSUAL significance is given this Coronation Year to the festival of the patron saint of England. Dating as it does from before the Norman Conquest, and falling only a few days before the crowning of the King, it will serve as a timely symbol of our age-long heritage of patriotism. Special broadcasts in commemoration of this day will include the production by Val Gielgud of "King Arthur," devised and written by G. D. Bridson.

From the annual banquet of the Royal Society of St. George, the Lord Chief Justice, Lord Hewart, will be heard at 8.40 (Reg.). He is one of the most outstanding and wittiest of speakers. On this occasion he will propose the toast of England. At this annual celebration on England's patron saint's day, there is age-old and picturesque pageantry. "The Roast Beef of Old England" is ceremoniously brought into the banquet with a guard of honour heralded by a band.

"King Arthur" will tell of the life and death of that great King who, with his Knights of the Round Table, typifies chivalry. Special illustrative music has been written by Benjamin Britten. This 23-year-old composer has already made a name for himself as a writer of choral and other works of great beauty. A distinguished cast has been collected for the production. Leon Quartermaine and Hilary Eaves will be heard as Arthur and Guinevere, while Esmé Percy will play Merlin, the wizard. A newcomer to the microphone is Griffith Jones, whom many will remember for his fine performances with Elisabeth Bergner in "Escape Me Never." He will play the part of Sir Lancelot. "King Arthur" will be broadcast Nationally at 7.30 to-night (Friday) and again Regionally at 8.30 on Saturday.



BLUEBEARD'S CASTLE. A scene from Paul Dukas' "Ariane et Barbe Bleue" which the Opéra Comique Company is performing at Covent Garden. The whole opera will be broadcast on Monday.

FROM COVENT GARDEN

THERE will be an important operatic relay from the Royal Opera House on Monday when the whole of "Ariane et Barbe Bleue" by Paul Dukas will be heard. This will be the first performance in England of this opera, and both artists and production will be straight from the Paris Opéra Comique. First performed in Paris in 1907, it tells the story of Ariane, one of Bluebeard's legendary wives who attempts to liberate her sisters to show them the path to freedom, but they were too timid to follow her, preferring to continue their life of slavery. The music is highly coloured and lyrical in character, and the opera contains some very picturesque scenes.

TALKS

TWO well-known and brilliant writers are broadcasting talks on Tuesday. The first in the Regional programme at 8.40, when H. V. Morton gives the first of two talks which are designed for Coronation visitors to London, the title of which is "Off the Route." No better speaker could have been chosen to initiate the visitor to London into the byways of the great metropolis than H. V. Morton, whose writings on London are so well known. Later in the evening, at 9.20 (Nat.), Compton Mackenzie will talk on "The First Things I Remember." In the pamphlet on broadcast talks the illustration accompanying the note referring to this broadcast shows a wee Scots laddie looking up to a hand holding a large size in slippers. Compton Mackenzie has chosen the subject for his talk, and we can therefore be sure of a well-spent twenty minutes.

Although not strictly a talk, a discussion which National listeners will hear at 9.50 on Sunday should be of great interest as the topic is Sunday games. I need say no more, as it is always a debatable one.

CORONATION CONCERT

A GRAND CORONATION CONCERT in aid of the Musicians' Benevolent Fund will be broadcast from the Royal Albert Hall on Sunday at 2.30. The programme, an all-British one, will include "Coronation Flourish," by Arthur Bliss, which will be played by trum-

HIGHLIGHTS OF THE WEEK

FRIDAY, APRIL 23rd.

Nat., 7.30, "King Arthur." 9.20, The Budget: Lt.-Col. Colville. 9.30, "The Three Must-Get-Beers."

Reg., 6.30, Music of the Western Isles. 7.30, "Twinkle." 8.40, Annual Banquet of the Royal Society of St. George.

Abroad.

Budapest 1, 7.30, "The Rhinegold" (Wagner).

SATURDAY, APRIL 24th.

Nat., 3, "Twinkle." 5, Erith British Legion Band and Robert Easton. 7.30, ABC-C. 8, Music Hall including Alberta Hunter and Wee Georgie Wood.

Reg., 6, Seven-a-side Rugger Final. 7.30, The Railway Clearing House Choir. 8.30, "King Arthur."

Abroad.

Frankfurt, 8.10, Love in song, music and dance.

SUNDAY, APRIL 25th.

Nat., 2.30, Musicians' Benevolent Fund Concert. 5.30, Pianoforte recital: Brailowsky. 7.45, The Bishop of Chelmsford. 9.50, Discussion: Sunday games.

Reg., 5, The Eastbourne Municipal Orchestra. ¶Recital, Peter Dawson. 10, Melodies of Christendom.

Abroad.

Leipzig, 8, Excerpts from operetta and musical comedy.

MONDAY, APRIL 26th.

Nat., 7, The Music Shop—XV. ¶Towards National Health: Nutrition. 8.20, A revue: "Among Those Present." 10, Act III of "Ariane et Barbe Bleue."

Reg., 7.30, 'Cello recital: Lauri Kennedy. 8, and 8.55, Acts I and II of "Ariane et Barbe Bleue."

Abroad.

Radio Paris, 8.30, "La Vida Breve," opera (de Falla).

TUESDAY, APRIL 27th.

Nat., 7, Almonds and Raisins: Jewish variety. 9.20, Compton Mackenzie. 9.40, "The Little Show": a radio cabaret.

Reg., 7.30, Rhythm Music: the Theatre Orchestra. ¶Variety from the Concert Hall, Bournville. 8.40, H. V. Morton.

Abroad.

Warsaw, 8.15, Symphony concert.

WEDNESDAY, APRIL 28th.

Nat., 5, Prelude to cricket. 8, "East Lynne."

Reg., 6, Falkman and his Apache Band. 6.40, From the London Theatre. ¶"Swing that Music": the Ramblers band from Holland.

Abroad.

Munich, 8.45, "April Moonlight," operetta potpourri.

THURSDAY, APRIL 29th.

Nat., 6.40, B.B.C. Dance Orchestra. 8.40, "Words Fail Me."

Reg., 6, "East Lynne." 7.40, Western Salon: Chamber Music from Marston Magna, Somerset.

Abroad.

Paris, Eiffel Tower. 8.30, Excerpts from "Julien" (Charpentier).

Week

"TWINKLE," a holiday show, will be produced by Clarkson Rose for listeners to-night and Saturday. He is here seen with his leading lady, Olive Fox. The Twinkle Company will again be at Eastbourne during the summer.

peters. This will be its first performance. Muriel Brunskill and Harold Williams will be the soloists, and the concert is being given in co-operation with the Kneller Hall Military Band and fifty trumpeters from the Royal Military School of Music, the London Symphony Orchestra, the Royal Choral Society, and the B.B.C. Choral Society.

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CABARET

"THE LITTLE SHOW," originated by Bryan Michie as a radio cabaret for broadcasting in the late evening, returns to the microphone on Tuesday in the National programme at 9.40. The Coronation season will bring to the "floor shows" of the big hotels the greatest cabaret artistes of the world, and it is Bryan Michie's desire to produce many of these famous acts in a series of "little shows." This week the artistes include Odette and Kay; Dim Drams and Georges Gladyrevsky; and Walsh and Barker. The Variety Orchestra and the new combination within that orchestra known as "The Variety Swingers," will support the cabaret stars.

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BURLESQUE

LISTENERS will remember John Dighton's successful burlesques of "The Scarlet Pimpernel" and "The Speckled Band." He has now turned his ironic pen to Dumas' "The Three Musketeers," which title for his burlesque becomes "The Three Must-get-Beers." No guarantee can be given that John Dighton's story will follow accurately the lines of the classic. The famous charactor D'Artagnan will be played by Claude Hulbert under the name of D'Artchampion, while the three musketeers become Bathos, Pathos and Amorus, to be played by Bobbie Comber, Horace Kenney and Eric Anderson. Robert Ashley will double the parts of the Duke of Backgammon and the King of France. This will be the first occasion that this young singer has taken a dialogue part. This burlesque will be heard by National listeners to-night (Friday) at 9.30.

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EAST LYNNE

TOD SLAUGHTER, king of melodrama, has adapted for broadcasting Mrs. Henry Wood's famous novel "East Lynne." This Victorian story sold in its millions, and though it is now mainly interesting as a period piece, Tod Slaughter's play, with himself as Sir Francis Levison, the homewrecker, should prove ideal for broadcasting. This will be heard by National listeners on Wednesday at 8 and Regionally on Thursday at 6.

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OPERA FROM ABROAD

WAGNER needs no introduction to opera-lovers, and certainly not where his "Ring" is concerned. "The Rhinegold" is the great composer's preludial opera to that work which for grandeur and breadth of conception has no parallel in music—a work which occupied Wagner a full quarter of a century. The Royal Hungarian Opera has chosen "The Rhinegold" for to-day's (Friday) 7.30 programme, which Budapest 1 relays. Warsaw, too, announces a relay of its own Opera House programme at 8.15, when, contrary to the usual intense nationalistic aspect of Warsaw's opera broadcasts, the Austrian composer Kienzl's three-act "Der Kuhreigen" is billed. Kienzl resided for some time in Bayreuth as an intimate friend of the Wagner family, and all his work shows the constructive features of the Wagnerian creed.

The "high spot" of Saturday is undoubtedly the relay by Rome of the 9 o'clock programme from La Scala, Milan. The opera chosen is Donizetti's "The Love Potion." It is interesting to note that December of last year saw the centenary of the opera's first performance in this country, which took place at the Lyceum Theatre on December 10th, 1836. It was while Caruso was singing the role of Nemorino at the Brooklyn Academy of Music in 1920 that he burst a small blood vessel in the throat—the first sign of his fatal illness.

Wagner is again on the air on Sunday, this time from Breslau, which bills his "Valkyrie" for 7.

Paris (Eiffel Tower) can count on a great concourse of listeners at 8.30 on Thursday, when the great modern French composer, Charpentier, conducts excerpts from his opera "Julien" at the Salle Gaveau. For the instrumental section one can be certain of perfection, the National Orchestra being billed. This opportunity of hearing one of Charpentier's unfamiliar operas performed in accordance with the composer's own ideas, is not likely to be missed.

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TEAM WORK

AN interesting item portraying the team spirit with which the Scandinavian broadcasting authorities are preparing programmes will be relayed by all stations in Scandinavia from 8-9.15 on Saturday. It will consist of contributions in quick succession from Denmark, Norway, Sweden and Finland by leading variety artistes, the whole forming a complete radio cabaret.

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FINNISH THEATRELAND

ALL the leading theatres in Helsingfors will be visited by the microphone to-night (Friday) at 7.10. This sequence of broadcasts will be followed by a Radio Revue which will continue until 11. All Finnish stations will be radiating this programme.

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NEGROID MUSIC

POPULAR hot rhythm will be presented by a new Norwegian rhythm band directed by Pete Siwers over the Norwegian network at 8 to-night (Friday). The following evening at 8.45 Norway radiates Negroid music of a different style. The Drammen Mixed Choir and the Drammen Municipal Orchestra will be giving a recital of Negro spirituals.

THE AUDITOR.

BILLY BISSETT, Canada's No. 1 band leader, looking over a new number with some of his band. He will be heard with his Canadians by Regional listeners at 10.25 to-night, playing from the May Fair Hotel.

Details of this week's Television programmes will be found on p. 409

About Push-Push

CURRENT CONSUMPTION DEPENDENT ON VOLUME

By "CATHODE RAY"

THE term "Push-push" is not in general use, probably because it sounds rather babyish. The only reason for using it at the head of this page is also rather babyish—it would be amusing to know how many readers thought at first glance that a previous title* had accidentally been duplicated. These two terms, like the names "Tweedledum" and "Tweedledee," have at least the merit that their similarity reflects the apparent similarity of the systems to which they apply, the difference sometimes being no more than the voltage of the grid bias. Yet although the circuit diagrams may be identical, this difference in grid voltage has rather far-reaching results.

I pointed out recently that the original push-pull circuit of 1915 was actually worked as push-push—each of the two valves taking turns to amplify alternate half-cycles of the signal wave—and that after gathering dust for a number of years this scheme was rubbed up a bit and offered to the public as QPP—Quiescent Push-pull. Incidentally, I believe it was a design of mine that was actually the first to be put on the market in 1930. Any rival claimants? A still more faithful copy of the original patent appeared a little later as Class "B"—one of those strange American names that everybody is compelled to accept and use, as the rabbit is compelled by the eye of the snake to stand to attention. Class "B" is now, I believe, generally understood to refer to any system in which the working point of the valves is at or near the anode current cut-off point, or bottom bend of the characteristic curve, whether that result is obtained by using more than normal grid bias or by special design of valve. But when Class "B" is mentioned in contrast to QPP it means the special valve system as distinct from the over-biasing system.

Economy in Anode Current

The original object (in 1915) was to overcome a defect in the valves then available; the revival occurred at the point in history when the design of valves had progressed so far as to enable them to fill a room with sound without being hopelessly overloaded. The fact that they drew a lot of current in order to do so was unimportant, or not, according as they were mains driven or battery driven. To supply a pennyworth of mains power by batteries costs £1, so it does make a difference. Mains volume from battery power either costs exhorbitantly or else something must be done to employ the power more economically.

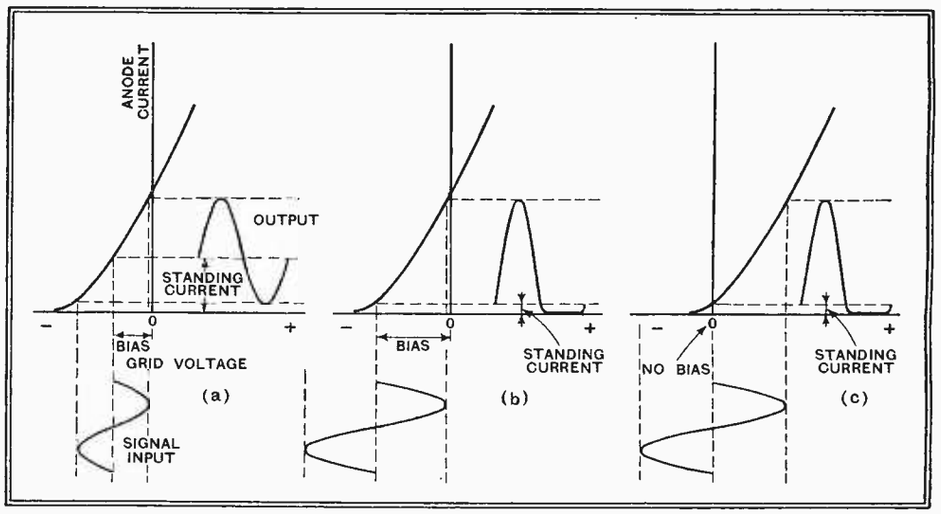
The first idea that occurs is that the current drawn by the ordinary power valve is calculated on the basis of the topmost peak of the fiercest climax of the loudest programme ever to be heard. That occupies only a matter of seconds, perhaps, in weeks of listening. Most of the time the volume is turned down (next door neighbours may challenge this statement, of course), and the programme is relatively quiet, and often it ceases entirely while we are waiting for the next one to come on. During this time anything up to 100 per cent. of the power going into the valve is being wasted. What is wanted is a system in which the current drawn bears some relation to the work done; piecework, in fact, rather than time-work. If the grid bias of a single output valve is increased until the anode current is practically nil in the absence of a signal, it is reduced to 1915 conditions, and one half of every signal wave is entirely suppressed, causing fearful distortion. But by using two valves, connected as in push-pull, both half waves continue to be amplified in these circumstances. When there is no signal the anode current is quite small—it cannot be reduced to nil without distortion, owing to the curved foot of the characteristic—but when a signal is applied the anode current rises correspondingly. That is what was called QPP, and although pentodes were and are generally used for it they are not essential.

The reason why they are used in preference to triodes comes into the second economic principle. It is not enough to make sure that battery power is being used only in proportion to the volume of sound created; the next thing is to see that, whether the volume is much or little at any moment, it is efficiently produced.

Triode versus Pentode

The efficiency of a small triode valve, even when working to full capacity, is generally no more than about 20 per cent.; for every watt put into the loud speaker five must be supplied as HT current. The efficiency of the pentode is 30 per cent. to 35 per cent.; so although it costs more it may be worth it in the long run, so far as mere cash is concerned. This comparison applies to any sort of output stage, not QPP only. But whatever the efficiency of the valve, used singly or in push-pull with normal bias, it is at least half as much again with QPP (or Class "B"). The reason can hardly be explained non-mathematically, so I am not going to do it here; but I want to emphasise that this second economy of QPP is absolutely in addition to the first, and would be gained even if the output stage were working all-out all the time, when the first would show no advantage.

The combined effect of these two economies is to put the battery set on more nearly level terms with the mains



The three diagrams provide a quick comparison between (a) Class "A," or normal operation; (b) QPP; (c) Positive-drive Class "B." Points to note are the economical standing current of (b) and (c) compared with (a); the double normal bias in (b) and zero bias in (c); the slight distortion of (a) and enormous distortion of (b) and (c), all of which can be practically eliminated by using a balanced pair of valves; and the positive grid voltages of (c).

* "About Push-Pull."

About Push-Push—

driven. The obvious thing to think of is to do the same for the mains-driven set, to make it still cheaper to run. But the saving in the ordinary receiver is so small as not to be worth certain drawbacks of the system (which I will describe in a moment), and in any case it is more difficult to design a mains power unit to supply a fluctuating current. In public address work, or amplifiers to modulate transmitters, where the power bill is a serious matter, it may pay to take some trouble over the design in order to economise. A sort of compromise, called Class "AB," has recently become popular, in which the bias is adjusted to an intermediate value, giving Class "A" operation for small volume (but with correspondingly small current drain) and something like Class "B" for large.

I have hinted that although the change from one class to another can be effected merely by suitably increasing the grid bias voltage, this involves rather more than at first sight appears. There are the advantages already described. There is also in QPP the necessity for increasing the input signal voltage. The grid bias is usually about double and so must be the signal voltage to work each valve fully. Remember that instead of both valves working all the time they alternately work and rest, so when they are working they must work doubly hard to keep up the output. Therefore, a QPP intervalve transformer is generally designed to give an exceptionally high step-up ratio. This means either some falling off in goodness or an increase in cost.

Hum Cancellation

Then one advantage of push-pull, that the signal current is kept out of the HT supply, so that much decoupling of the previous stages is unnecessary, is sacrificed. Hum cancellation (if mains drive *is* used) is also sacrificed, except during intervals or very quiet periods; but as that is about the only time hum is noticeable, even when present, this disadvantage is not very serious. In fact, the smallness of the HT current during the quiet periods makes it particularly easy to smooth. The real disadvantage is that unless conditions are just right, particularly as regards the valves being perfectly matched, there is a decided tendency towards an unpleasant sort of distortion.

With reasonable care, which means adjusting the screen voltages of the valves (if pentodes) and using decent components, the QPP system can be very satisfactory. The other sort of Class "B" requires much more care in the design of each part of the system, as well as adjustment, to avoid a fuzziness or rattle in the reproduction; and at the best it is never quite as good as the best QPP. The essential difference is that whereas QPP follows normal amplifier practice in keeping the signal voltage entirely on the negative side, so as to prevent the flow of grid current, Class "B" proper employs no grid bias, or very little; and the positive half waves of the signal consequently draw grid current. This means that at such moments the valve, from grid to filament, is no longer an almost infinitely high resistance, but quite a low one of only a few thousand ohms. With ordinary amplifiers this would cause the intervalve transformer to be so heavily loaded that the positive half cycles would be distorted almost to vanishing point. So several modifications have to be made: (a) the transformer must have a step-*down* ratio; (b) the previous valve must be of the smaller power type; (c) the output transformer ratio must be calculated rather differently from usual. In fact, compared with Class "A," the whole design is frightfully involved to calculate properly, and it must be done properly to be even tolerably successful. For these reasons it has largely lost its original popularity, and comparatively few sets now on the market include it. The maximum power obtainable is higher than with QPP, there is no grid-bias system to provide and the cost of a double valve is considerably lower, but to offset this an extra stage of amplification is generally needed. And, on the whole, reproduction is inferior.

A good deal of criticism is levelled against both systems on the ground that the momentary high peaks of current, amounting perhaps to 40 mA., are a great strain on the battery. So perhaps they are if the set is kept blaring away on full power all the time. But it must be remembered that cells no bigger than those in HT batteries are used to supply 300 mA. in small torches for more than momentary periods.

Finally, let me remind you that in America (and therefore, generally, here) "Class 'B'" now covers all half-wave amplifying systems, so the full name of the second system is strictly "positive-drive Class 'B.'"

"WIRED WIRELESS" INTER-COMMUNICATION SYSTEM.—A combined transmitter-receiver introduced by a New York firm as a substitute for—or supplement to—the ordinary type of telephone. Connection to the mains (AC or DC), which provide operating power and act as a guide for modulated RF current, is made through a single plug. The speaker is of the moving-coil type and four valves are employed in the instrument, which is intended for use in offices, factories, etc., as well as in the home.

RANDOM RADIATIONS

By "DIALLIST"

Who Invented the Telephone ?

MOST people if asked that question would reply without hesitation that it was Alexander Graham Bell. But at Frankfort there is a monument, erected over the grave of Philipp Reis in 1878, which describes him as the inventor of the telephone. Bell's invention was made in 1875, but in 1860 Reis had produced an electrical apparatus, which he named the telephone. Was Reis's device really a telephone? And if so was it the foundation of Bell's invention? The subject is full of interest, and it is dealt with in a most entertaining leading article by Professor G. W. O. Howe in the April issue of *The Wireless Engineer*. Professor Howe's conclusions are that Reis did in fact invent an electric telephone by which certain sounds of the human voice could be transmitted and received, but there is no satisfactory evidence that it succeeded in making speech intelligible. He was certainly not the inventor of the true telephone, though his transmitter may possibly have inspired the development of the microphone.

Queer Instruments

Reis's transmitter contained a diaphragm of sausage-skin or something similar with a small piece of platinum attached to its centre. This made contact with another piece of platinum attached to a spring. Sound waves striking the diaphragm and setting up vibrations thus caused a make-and-break, but *not* a varying resistance, as in Bell's microphone. The receiver, which utilised a principle known and described as early as 1837, consisted of a steel knitting needle, surrounded by a solenoid carrying the received current, and supported at its ends by little pillars attached to a sounding board. At each "make" the needle is magnetised and increases its length. The "break" causes it to return to its original length with a slight click. If a note is sung into the receiver the clicks correspond in frequency and a sound of the same pitch is reproduced. To some extent inflexions of the speaking voice would be recognisable, and from these occasional simple words might be guessed; but intelligible speech did not become possible, and the telephone was not really invented till Bell conceived the idea of applying the principle of continuously variable resistance.

Not Guilty

TWO readers hailing respectively from Basingstoke and Cambridge have taken rather violent exception to the paragraph in which I suggested a week or two ago that "a capable and well-trained man might make a good living in many districts by setting up as a curer of radio troubles. . . . Once he had established a bit of a reputation for good work and fair charges he should be able to make wireless servicing a whole-time occupation." For some reason both seem to think that I am encouraging the dabbler, the fellow who learns as he earns. Well, the heading of the paragraph was "Experts Wanted," and since I specified that the would-be service man should be capable and well trained, I think I can plead not guilty on that score. It's just the half-baked service-man, who is wont to take on jobs that are quite beyond him, that I was hitting at. And nobody can build up a reputation for good work if he doesn't know his job and do it conscientiously.

Television Aerial Problem

A NEAR neighbour of mine has just installed a television set and is getting first-rate reception from the Alexandra Palace even on a temporary and not very high aerial. According to the B.B.C.'s field strength map his house is quite close to the 0.5 millivolt-per-metre contour line for an aerial of roof height. His present one certainly isn't that. In fact, to get a high enough aerial is going to be his big difficulty. Passing cars and lorries, of which there are many, cause a good deal of interference, and it's going to be a bit of a problem to raise that aerial above the zone of the interference that comes from their ignition systems. For certain reasons it can't be erected above the roof, and the house stands on so steep a slope that the garden behind is a good ten feet below the level of the roadway in front. The only solution seems to be to put up a mast about 45 feet high in the garden. But even so a complication may be introduced by a couple of tall lime trees which may exercise a blanketing effect when they are in full summer foliage. In one of the graphs drawn by B.B.C. engineers from measurements taken in a stationary van on Balham Hill the field strength shows variations of more than four to one from moment to moment. These variations are stated to be entirely due to reflection and absorption effects of passing traffic. If passing cars can do that intermittently, what about the permanent effects of big trees?

A Case of Leakage

THE other day I was preparing a brand new 6-volt car starting battery for use as an aid to certain experiments. The three cells of the battery are not connected in series, though they are arranged in the usual way to enable this to be done by short straps when required. That is, negative of cell A is next door to positive of cell B and negative of cell B to positive of cell C. I was checking up the EMF of each cell with a 500-ohm-per-volt volt meter when I happened quite by chance to put the prods on to adjacent positive and negative terminals belonging to two different cells. To my surprise the meter registered a PD of 0.9 volt. Other pairs of terminals were then tried, and in every case the volt meter had something to say, the readings ranging from about a quarter of a volt upwards. This of course showed that the cell-to-cell insulation was pretty poor, a thing one would hardly expect in a new battery with a perfectly clean and dry moulded case. You can't wonder if a battery like that runs down when it is standing idle!

Television Test Transmissions

THOSE whose business it is to install television receivers will welcome the news that the B.B.C. is thinking of sending out test transmissions each week-day between 11 o'clock and noon. As things are, if you don't manage to get the aerial up and the set in by 3 p.m. there's nothing available inside ordinary working hours until the following afternoon. It is proposed that the transmission shall be just a cross on the vision wavelength and a tuning note on that belonging to sound. Any reason why whatever the London Regional or National is doing shouldn't go out on the sound wavelength instead of the tuning note? If that could be arranged as a stop-gap until the whole of the Regional programme is broadcast on the ultra-short waves it would enable owners of television sets to get a little more use out of their apparatus. Some that I have met feel that two hours a day is a somewhat meagre ration.

A Wanted Switch

And that brings me to another point. In view of the fact that we are likely to have eventually a high-fidelity transmission of the London Regional programmes on a wavelength in the neighbourhood of seven metres, every television receiver ought surely to be fitted with a switching arrangement enabling the vision part of the receiver to be thrown out of action and the "sound" part to be used independently. With some receivers this can be done; with others it can't. The switching shouldn't be difficult to arrange, and its presence may be a biggish selling point in the not-so-distant future.

A Heart Cry

"MY life's ambition," writes a service man reader, "is to retire to Dartmoor, my native heath, and to have enough money saved to buy one cheap and nasty commercial receiver a day and kick it down over Yes Tor." My sympathy and best wishes!

POLICE RADIO IN U.S.A. So far as his radio burden is concerned, the lot of the American patrolman seems to be less happy than that of his confrere the British policeman. Though it lacks a calling device, the American receiver shown here is considerably more bulky (and conspicuous) than the set used by the Brighton Police. Note the triangular frame aerial ; the two outside wallets contain HT and LT batteries while the single-valve receiver is in the centre.

DISTANT RECEPTION NOTES

MAY I thank the Henley reader and others who have been kind enough to send me information about Radio Nacional and Radio Verdad? I determined to try to get to the bottom of the matter, and to that end tuned in Milan on 368.6 metres at 10.45 p.m. on Sunday, April 11th. At 10.55 the station's own programme came to a close, and nothing was heard for five minutes. At 11 o'clock Radio Verdad announced itself, the speaker stating that the daily transmission in Catalan was about to begin. This continued until about 11.20.

One thing I can say definitely: whatever else it may be, Radio Verdad is not the same as Radio Nacional. Just before 11.15 I turned to 270 metres and heard the latter announced. Flicking rapidly from 270 to 368.6 metres, I found that two quite different transmissions were in progress. A speaker with a rather high-pitched voice was delivering a harangue to Viscaya from Radio Nacional: Radio Verdad's deep-voiced announcer was giving out news.

At about 11.20 Radio Verdad's Catalan transmission ended, and after a brief interval it was announced in ordinary Spanish that a transmission in that language was about to start, and that it took place every day (I could not quite catch the hour, but I think it was at 11 p.m.) simultaneously on 304, 368, 420 and 491 metres. Round figures were given with no decimals. I tried the other three wavelengths, finding nothing in the neighbourhood of 304 or 420 metres. The 368.6-metre transmission, however, was being given simultaneously on 491.8 metres.

Well, that is what I heard. I offer the facts without further comment. Those who want to check them will find Sunday night a good time; the medium-wave band is pretty clear by 11 p.m. or a little earlier as so many stations have then closed down.

The Future of Long Waves

Some time ago I suggested tentatively in these notes that it might be a good thing if long-wave broadcasting ceased to be, since so many long-wave stations occupy not only their own channels with their fundamental transmissions, but also a good many others with their harmonics. And then there's the "Luxembourg Effect." I don't feel at all sure, after spending some time recently in exploring it, that broadcasting on this band will not die a natural death. In the daytime (atmospherics permitting) reception is reasonably good from Radio Paris, Hilversum, Kalundborg, Luxembourg, and Droitwich.

But after dark the long-wave band is just a mess. Radio-Paris and Droitwich are then the only stations that are usable as a rule, if one demands any sort of quality. Heterodynes, jamming and sideband-splash ruin the rest, and I don't know that Droitwich will be able very easily to avoid interference from the new Deutschlandsender when it gets to work. The long-wave band might just have pulled through if the provisions of the Lucerne Plan had been carried out to the letter. But they haven't been by any manner of means.

Every country seemed to have regarded this band as a kind of radio Eldorado. There was a regular gold rush, and so many claims have been staked that they overlap one another. Unfortunately, there is no international authority powerful enough to play the part of the two-gun tough sheriff of the mining camp!

Here are a couple of forthcoming cleared channel broadcasts by small-powered stations in the U.S.A. that may lure dyed-in-the-wool D-xers who thirst for fresh conquests. Every Friday the 1-kilowatt WORK (York, Philadelphia) transmits on 1,320 kc/s or 227.1 metres between 1.45 and 2 a.m. On Sunday KGER (Long Beach, California), also 1 kilowatt, transmits on 1,360 kc/s, or 220.4 metres, from 6.30 a.m. till 6.45. Stations of higher power in other parts of America that give special broadcasts are: CFRB, Toronto, Canada, 10 kilowatts, 690 kc/s, or 4,345 metres, Saturdays 5-5.5 a.m.; TGW, Guatemala City, Guatemala, 10 kilowatts, 1,210 kc/s, or 247.8 metres, Sundays 5 a.m. onwards; PRE3, Rio de Janeiro, 10 kilowatts, 1,220 kc/s, or 245.8 metres, Sundays 5-8 a.m.

D. EXER.

Television Programmes

Transmission times are from 3-4 and 9-10 daily.

Vision :	Sound :
45 Mc/s.	41.5 Mc/s.

FRIDAY, APRIL 23rd.

3, Rawicz and Landauer: two pianos. **3.10,** Friends from the Zoo. **3.25,** Gaumont-British News. **3.35,** "A Midsummer Night's Dream": mask arranged from the fairy scenes of Shakespeare's play.

9, Victor Hotchkiss and his marionettes. **9.10,** Repetition of 3.10 programme. **9.25,** British Movietonews. **9.35,** Repetition of 3.35 programme.

SATURDAY, APRIL 24th.

3, For the Children: Zenora the Clown. **3.10,** Demonstration of horse-riding by Major Faudel-Phillips. **3.25,** British Movietonews. **3.35,** Variety.

9, Starlight: Lina Menova in songs. **9.10,** Bridge: Hubert Phillips, President of the London and Home Counties Contract Bridge Association, will, with three others, play a game of bridge and give explanations. **9.25,** Gaumont-British News. **9.35,** Play Parade.

MONDAY, APRIL 26th.

3, "The Proposal": a jest in one act by Tchekov. **3.20,** British Movietonews. **3.30,** The Vagabond King.

9, Light Musical Act. **9.10,** Coffee Stall: a light entertainment. **9.30,** Gaumont-British News. **9.40,** Cabaret Revue

TUESDAY, APRIL 27th.

3, Music Makers: Eugene Pini (violin). **3.10,** The World of Women. **3.25,** Gaumont-British News. **3.35,** Cabaret Parade: scenes from the Grosvenor House "Midnight Variety."

9, Carnations: exhibits from the British Carnation Societies Show. **9.10,** Repetition of 3.10 programme. **9.25,** British Movietonews. **9.35,** Cabaret Parade.

WEDNESDAY, APRIL 28th.

3, Coffee Stall: a light entertainment. **3.20,** British Movietonews. **3.30,** Forty-ninth Picture Page.

9, A Little Show. **9.20,** Gaumont-British News. **9.30,** Fiftieth Picture Page.

THURSDAY, APRIL 29th.

3, The Composer at the piano: Marc Anthony. **3.10,** Masks through the Ages—III. **3.25,** Gaumont-British News. **3.35,** The Mizzen Cross-Trees: a revue of nautical songs through the ages.

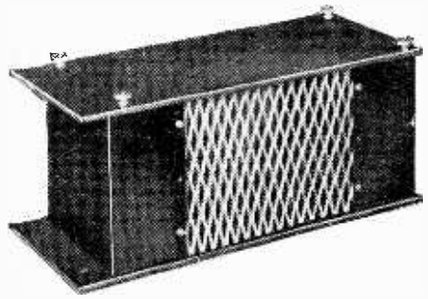
9, Josef Marais and his "Camp-fire on the Karoo" trio. **9.10,** Repetition of 3.10 programme. **9.25,** British Movietonews. **9.35,** "The Young Visiters," from the book by Daisy Ashford.

New Apparatus Reviewed

RECENT PRODUCTS OF THE MANUFACTURERS

RIDCO CHASSIS AND CABINETS

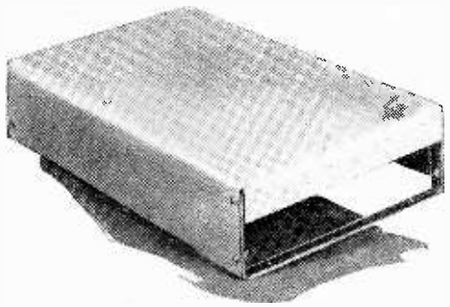
THE latest addition to the range of radio products made by Radio Industries Development Co., Birch Street, Hanley, Stoke-on-Trent, is a series of semi-metal cabinets and an aluminium chassis.



Semi-screened cabinet Type R/C2 made by Ridco.

The cabinets will be useful in the construction of oscillators, amplifiers and similar pieces of apparatus. They provide partial screening only, since the top and bottom are closed with panels of insulating material on which the components can be assembled. The sides only are made of metal. The two models sent in for examination are the R/C1 and the R/C2; the former measures 6in. by 5in. by 5in. and costs 4s. 6d., and the size of the latter is 12in. by 6in. by 6in. and its price is 8s. 6d. In the larger model two of the sides are fitted with expanded metal to provide ventilation as well as screening. They are finished in black enamel.

The Ridco standard chassis is made of No. 20 gauge aluminium and measures 12⅝in. by 8⅜in. by 3in. deep, and it is finished in



Ridco cellulose-finished aluminium chassis.

grey cellulose. It costs 6s. 6d. The chassis can be supplied drilled to specification and for this a charge of 2s. 6d. is made.

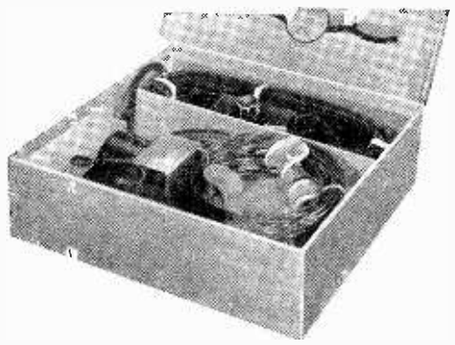
H.M.V. ALL-WAVE AERIAL

THE H.M.V. all-wave aerial is designed for use on all wavelengths from 7 to 2,000 metres, and it is of the type that discriminates between radio signals and man-made static.

Actually it comprises three aerials 60ft., 39ft., and 5ft. long respectively, all three being joined to a special aerial transformer from where a screened downlead is taken to another transformer unit that should be screwed to the receiver close to the aerial and earth terminals.

The receiver transformer unit is fitted with a three-position switch marked 7-30, 30-200, and 200-2,000 metres respectively, and this switch has to be set to the appropriate position according to the waveband on which reception is required. Though the best way to erect the aerial is with the two long lengths of wire horizontal and in line, other arrangements are permissible when space is restricted, and these are all described very fully in the instructional booklet.

To be effective as a noise-reducing system, the horizontal part must be located outside the interference zone, which means it must be as high as possible and well away from buildings.



H.M.V. all-wave anti-static aerial, Type No. 213.

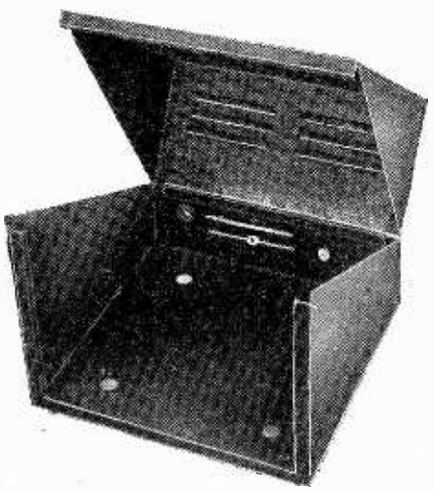
Tests made with one of these aerials show that it compares very favourably in efficiency with an ordinary aerial of equivalent length and height; there is no noticeable reduction in signal strength due to the anti-interference properties, and a better signal-to-noise ratio is definitely obtained when the aforementioned precautions are taken. Good reception on all bands down to the television sound wavelength was obtained during the tests.

The aerial is made by the Gramophone Co., Ltd., 98-108, Clerkenwell Road, London, E.C.1, and the price complete with wire, insulators, and assembled ready for erection is 37s. 6d.

B.T.S. COIL UNIT FOR SW CONVERTER

BRITISH Television Supplies, Ltd., Faraday House, 8-10, Charing Cross Road, London, W.C.2, has sent in for examination a complete coil unit for the AC Short-wave Converter described in last week's issue of *The Wireless World*.

The unit is made exactly to the specification so far as the construction, winding, and mounting of the coils and other components are concerned, and the only difference is that the box is made of steel instead of aluminium. All the joints in the box are spot



B.T.S. steel cabinet for "W.W." AC Short-Wave Converter.

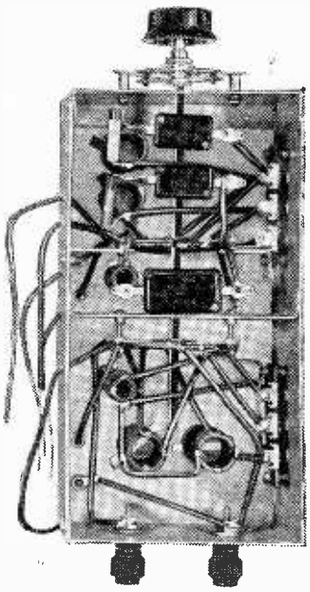
welded, and it is finished inside and out in grey cellulose.

Since the metal of the box is sprayed, the makers have, with our approval, provided an earthing terminal on the top of the signal circuit compartment, and this should be joined to the moving-vanes terminal on the condenser C4.

The coil unit is exceptionally well made and satisfactory in all respects for use in the converter. The price is 30s.

B.T.S. have at the same time submitted a metal cabinet of the correct size for housing the converter. It is made of steel and finished in black crackle enamel. Two small holes only need to be drilled in the front panel of the converter to secure it.

Ventilation holes and louvres have been



Coil unit made by B.T.S. for "W.W." AC Short-Wave Converter.

provided in the correct places and as suggested in the article, so that this cabinet makes an ideal housing for the converter.

The price of the cabinet is 18s. 6d.

Letters to the Editor

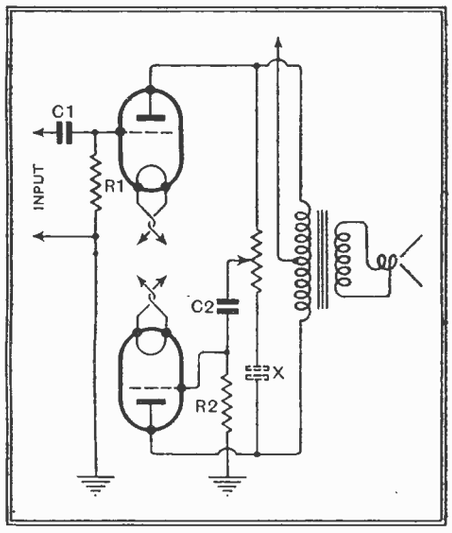
The Editor does not hold himself responsible for the opinions of his correspondents

Flutter

I WAS very interested to read the letter submitted by Mr. G. H. Bradbury in your April 2nd issue. He appears to be under a misapprehension regarding my previous letter *re* "AVC Flutter" (February 26th).

He states that the effect as he has observed it occurs above 9 Mc/s, and appears to be due to frequency-changer "wander." As, however, the particular receiver on which I experimented was a straight six-stage (or should I say five-valve?) model of my own design, which operated solely on a range of 200-2,000 metres (1,500-150 kc/s), it seems that the type of flutter he is referring to is of a different character to that which I described.

I think, therefore, that my explanation of the effect is vindicated as "wander" is scarcely likely to occur on these wavelengths, least of all with a straight receiver.



Balancing a Push-pull output stage.

To this statement I should like to add that superhets behave in much the same way, but that I used a straight receiver in my observations, as it happened to be the type I was using for my normal listening at the time.

Incidentally, my original statement that "Push-pull AF . . . is, perhaps, the best method of all," should have the proviso added that *true* push-pull should be used, and not a system which is out of balance at 5 c/s. I say this because I find some people favour the system shown in the diagram, which cannot be balanced at 5 c/s and 400 c/s simultaneously unless a condenser is inserted at "X" of such value as to counteract the loss due to C2 R2.

Wimbledon, S.W.19. R. G. YOUNG.

Recording

AS I have no immediate interest in recording and no money to waste on patents I send the following which may be useful to others, and which I have not seen advocated so far, though it may be used under some fancy title, of course.

Cellophane, the wrapping material of boxes of chocolates, etc. (usually thought to be gelatine by the uninformed), is regenerated cellulose and is produced by the action of caustic soda in the cold and carbon bisulphide (method of Cross & Bevan), i.e., Viscose.

It is easily cut and can be obtained fairly thick from makers such as the Cellophane Co. in London.

It possesses a curious property of reacting direct with acetic anhydride without the necessity for any catalyst and forms the exceedingly hard and horny cellulose acetate.

If, therefore, a disc of thick cellophane sheet be mounted with a suitable adhesive (not water soluble) on a disc and cut, treatment with acetic anhydride will produce a record of considerable durability.

Acetic anhydride is not materially more nasty than some of the substances already used for hardening, though it also reacts with fingers, clothes, etc., and would probably be best applied with a rubber sponge stuck in the end of a test-tube.

WM. A. RICHARDSON.

Ashford, Kent.

Coronation "Street Parties"

I HAVE been asked to fix up PA apparatus for two "Street Parties" during the Coronation celebrations, but have been compelled to refuse because of the prohibitive cost of separate licences for gramophone record reproduction.

As these "Street Parties" are for poor people, I would have to do the job almost "free, gratis and for nothing," and suggest that the gramophone licensing authorities might similarly do their part by granting licences at a nominal fee for an occasion that is only likely to arise twice in a lifetime. J. E. H.

London, E.C.2.

Set Prices in India

I RECENTLY came across a peculiar fact relating to prices of radio sets in India.

A six-valve model with C.R. tuning indicator, by a well-known English maker, costs 16 guineas in England and 300 rupees in India. A four-valve set of the same make is priced at 13½ guineas in England and 295 rupees in India.

These Indian prices are equivalent to £22 10s. and £22 2s. 6d. respectively, so the difference in prices of the two sets, fixed by the maker at 2½ guineas, is only 7s. 6d. in this country.

One fails to see why the four-valve is almost as dear as the larger model.

Perhaps some reader may be able to suggest a reason. Can it be that the six-valve receiver is being sold cheaply? I doubt it.

Peshawar, N. HANSFORD.

N.W.F.P., India.

Recent Inventions

Brief Specifications of the more interesting radio devices and improvements issued as patents will be included in this section

SOUND AND PICTURE RECEIVERS

WHEN tuning a combined sound and picture receiver from one alternative programme to another, the usual inter-station "noise," as experienced on an ordinary broadcast receiver, is likely to be greatly aggravated, since the picture signals will also affect the loud speaker. In addition, the sound-modulated carrier waves are liable to produce "flashes" of light on the screen of the cathode-ray tube. These effects are not only disagreeable, but may result in actual damage to the apparatus, particularly to the cathode-ray tube.

According to the inventions, steps are taken to keep the whole receiver inoperative, until both the sound carrier and the picture carrier of the desired station are present at the same time. The required control may be exercised by making use of the beat frequency between the desired sound and picture carrier waves, when both are present, to remove a "muting" bias, which normally paralyses one or more of the amplifying valves of the set.

Marconi's Wireless Telegraph Co., Ltd. (assignees of R. S. Holmes). Convention date (U.S.A.) June 28th, 1934. No. 458798.

o o o o

MODULATING SYSTEMS

THE figure shows a chain of cathode-coupled amplifiers V, V1, V2 supplying a push-pull modulator stage A, B, which is fed with carrier oscillations from a source O. The object of the invention is to prevent distortion due to grid-current.

The grid of the second amplifier V1 is given a slightly positive bias from the source GB, and the resulting grid current which flows through resistances R, R1 is opposed by the output current from the anode of the first amplifier V. The current through the resistance R reduces the negative grid bias on the amplifier V and so increases its output current. This action is assisted by the potential drop across R1, which increases the effective anode voltage applied to the amplifier V from its H.T. source.

In the same way the tendency for the grids of the push-pull modulator A, B to accumulate a negative charge, and so cause distortion, is counterbalanced by the effect of the resistance R2 on the grid-bias and anode voltage of the amplifier V2. The grid-biasing voltages are derived from a floating battery G.B.

Baird Television, Ltd.; G. W. White; A. J. Brown; and P. W. Willans. Application date May 27th, 1935. No. 458861 *(Drg.).*

o o o o

SCANNING SYSTEMS

SCANNING is effected in groups or strips of parallel lines, the inclination of one group of lines being varied with respect to the next group, so as to give a "criss-cross" effect. As applied to a cathode-ray tube, the desired result is obtained by periodically changing the connections between the saw-toothed oscillators and the deflecting-plates inside the tube.

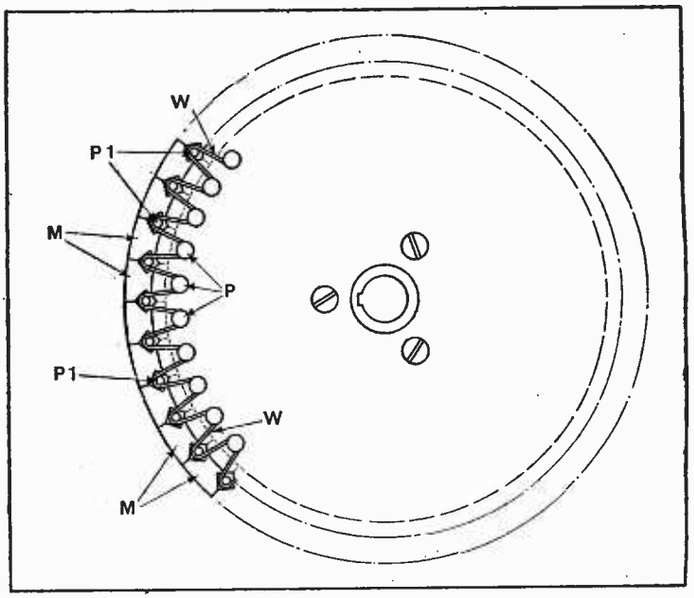
For instance, at one moment the horizontal pair of deflector plates is connected to the output from one saw-toothed oscillator, whilst at the next moment the same oscillator is connected to the vertical pair of deflecting plates. The change-over can conveniently be effected by a commutator switch inserted in the leads from the time-base circuits to the deflecting-electrodes.

J. L. Baird and Baird Television, Ltd. Application date July 4th, 1935. No. 459177.

o o o o

MIRROR DRUMS FOR TELEVISION

THE small mirrors M of a television scanning-drum are anchored firmly in position by a wire W, which is threaded as shown between pins P fastened on each side of the disc, and pins P1 laid in V-shaped grooves cut in each of the abutting edges of the mirrors. The ends of the pins are notched to prevent the wire from slipping off.



Method of securing mirrors on scanning drum in television apparatus.

The arrangement prevents any tendency for the mirrors to be displaced by centrifugal force when the disc is rotated at high speed.

Ferranti, Ltd., and M. K. Taylor. Application date September 26th, 1935. No. 458618 *(Drg.).*

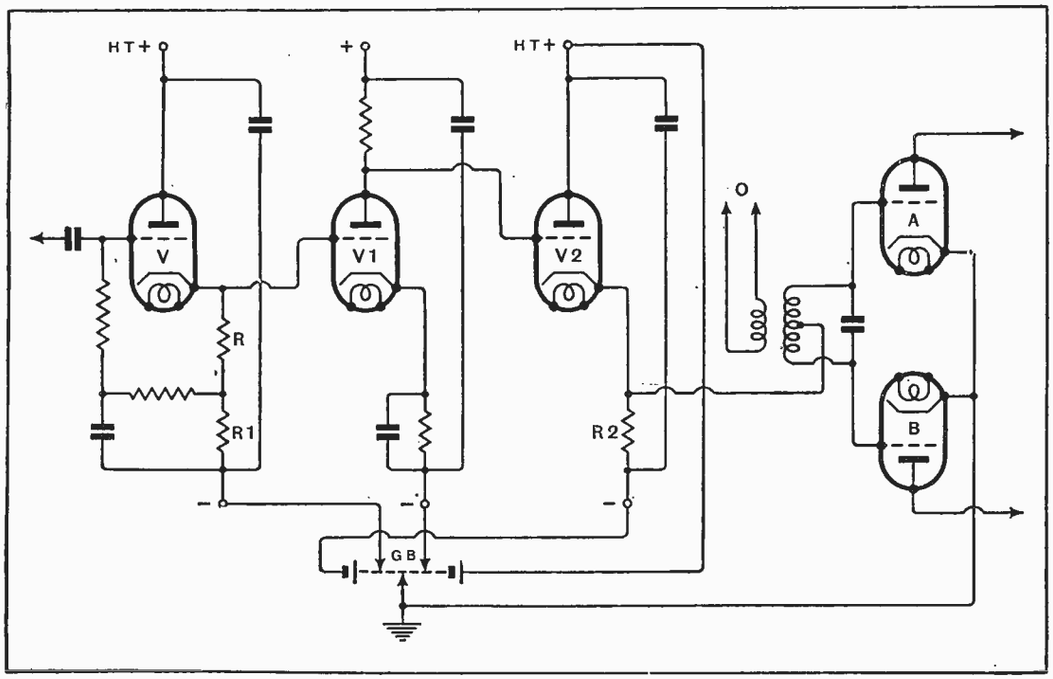
o o o o

RADIO-NAVIGATION SYSTEMS

IN the ordinary overlapping-beam method of marking-out a navigational course through the air, the aviator steers his way by comparing the strength of the received signals. The two beams are usually modulated with "complementary" Morse signals, such as the letters A and N, which merge together into a continuous note, so long as the aviator keeps to the correct course, along the centre line of overlap. Should he stray to one side or other, the received note breaks up, and either the letter A or the letter N predominates, thereby indicating a deviation to port or starboard.

According to the invention, the true course is determined by a comparison of the time-interval between the two signals instead of by a comparison of their relative strengths. A sharply-defined radio beam is swung to and fro at constant frequency over a small angle on each side of the course to be flown. So long as the pilot keeps to the centre line the modulating notes recur at equal intervals, but if he deviates to one side or other the intervals become unequal. If the beam is modulated with different notes on each side of the centre line, the variation in sequence, as well as duration, will indicate whether the deviation is to port or starboard.

Telefunken Ges fur drahtlose Telegraphie M.B.H. Convention date (Germany) May 27th, 1935. No. 458347.



Modulation amplifier designed to prevent distortion due to grid current.

The Wireless World

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EDITORIAL COMMENT

Television

Make Haste Slowly

THE establishment of a co-axial cable between London and Birmingham, to which we referred in last week's issue, has already resulted in talk about the next television transmitter, and we find that Birmingham is looking forward to an early move on the part of the B.B.C. to put up a transmitter in that city, whilst other localities expect to be similarly served in the near future.

We have ourselves said that the co-axial cable to Birmingham paves the way for more stations. We would not, however, like it to be thought that *The Wireless World* regards it as expedient that additional stations should be put up at this juncture. Whilst not desiring to curb the progress of television in any way, we would urge that the B.B.C., as well as radio manufacturers, should move very warily as yet in the matter of extending the number of stations beyond the present one at Alexandra Palace.

The Palace station is doing excellent pioneering work ; success has attended the efforts and a large number of television receivers have been purchased by the public in the London area, but up to date we do not consider that the public response to the television service in the London area has been sufficient to create extreme optimism regarding the potential success of other stations in different parts of the country.

Before a second station is contemplated, we think it imperative that the success of television in London should have been established beyond all possible doubt, and, further, that the maintenance of suitable programme material at a reasonable cost to the B.B.C., as well as an assurance that the sale of receivers provides a reasonable profit to the manufacturers, should both be established before further ventures are embarked upon.

Only if television is a complete success in the London area can we expect that it will be reasonably successful in other centres, for in the Metropolis facilities for the programme side are freely available, whilst the average wealth of the population is higher than elsewhere, thus ensuring a better prospect for the sale of expensive sets.

The Coronation

P.A. Along the Route

BY the date of the Coronation it is expected that loud speakers for public address purposes will have been installed along the entire route of the procession. The main object will be to reproduce for the benefit of those lining the procession route the ceremony within the Abbey. In addition, it is understood, B.B.C. commentaries from different points will be reproduced as they will be broadcast. Arrangements have been made, we are told, for these commentaries to be faded out at those points where the procession is actually passing, so that at any section of the route the loud speakers will be silent so long as the procession is in view.

We do not think that this procedure has been adopted on any previous occasion of a public procession, and we venture to suggest the advisability of a rehearsal of this arrangement before the date.

The sound from loud speakers along the route will be capable of carrying for very great distances. The grandeur of the occasion would be sadly marred if during any interval in the processional music a noisy commentary were audible issuing from loud speakers farther down the route. The risk of such an occurrence should be most carefully guarded against.

New Band-Pass

OBTAINING FLAT-TOPPED RESONANCE CURVES

IF a modulated carrier is to be received without distortion it is necessary for the tuned circuits to have a characteristic which embraces both sidebands. Ordinary resonant circuits show maximum response at one frequency only, with the result that when the selectivity is high the upper modulation frequencies are seriously attenuated.

The use of a band-pass filter enables this effect to be overcome, for in its ideal form the response curve exhibits a flat top over the wanted range of frequencies, and has steeply sloping sides so that all frequencies which differ from the carrier by appreciably more than the highest modulation frequency are greatly attenuated. Such filters can be built but they are, in general, practicable only at low carrier frequencies; consequently, they are usually possible only in a superheterodyne having an intermediate frequency

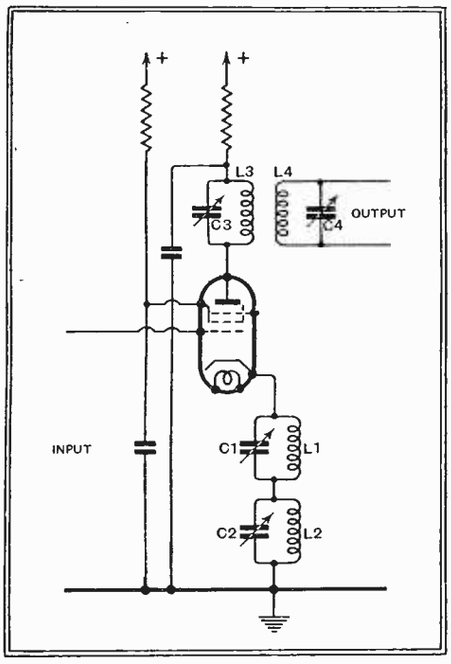


Fig. 1.—Conventional types of IF transformer are used, but the tuned circuits L1 C1 and L2 C2 are included in the cathode lead of the valve.

below 100 kc/s. The reason why true band-pass filters are impracticable at higher frequencies is that it becomes impossible to build components which have the values dictated by theory. For operation at 465 kc/s, for instance, it might easily happen that a coil of several thousand microhenrys would be needed in a position where a shunt capacity of more than one or two micromicrofarads would be intolerable. Such a coil is out of the question since the self-capacity alone would be 10 $\mu\mu$F or more.

Because of this the circuits which are generally used are coupled resonant circuits, and they are often known as band-pass filters although they are not truly of this type. Two circuits are usually em-

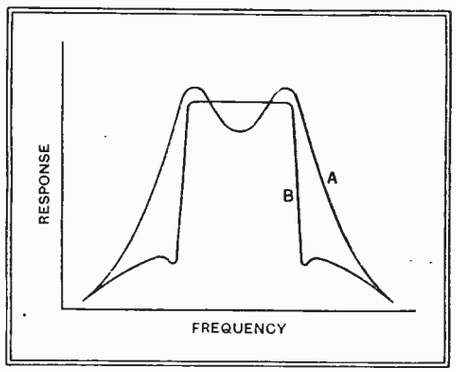


Fig. 2.—Curve A shows the response of an overcoupled pair of circuits, while curve B illustrates the improvement effected by the use of cathode circuits.

ployed and unless the coupling exceeds a certain critical value the resonance curve is similar to that of a single tuned circuit, but has a more rounded top and more steeply sloping sides. It thus represents an approach to a band-pass characteristic.

When the coupling exceeds the critical value the curve shows two peaks with a trough between them and this is again an unsuitable characteristic for it tends to accentuate the higher modulation frequencies. Many attempts have been made to combine such circuits with others having a single peaked response so that the peak of the one would fill up the trough of the other and give a combined response curve having a flat top.

Variable Selectivity

Some of these attempts have proved successful and it can be shown that the best result is obtained when each coupled pair of circuits has associated with it a single circuit of one-half the Q ($= \omega L/R$). Unfortunately, the necessity for using some circuits of low Q reduces the selectivity, and to obtain normal selectivity a greater number of tuned circuits must be employed than in a less scientifically designed amplifier. The band-pass characteristics will be much better, however.

A new method of obtaining a flat-topped resonance curve which, so far from reducing selectivity, increases it, has been developed by Marconi's Wireless Telegraph Co., Ltd., and it makes use of the principle of negative feed-back. The circuit is shown in Fig. 1, and it will be seen to differ from the usual only by the inclusion of the circuits L1 C1 and L2 C2 in the cathode lead.

An IF transformer is included in the anode circuit and the circuits L3 C3 and L4 C4, which are individually tuned to the intermediate frequency, are coupled sufficiently tightly for a double-humped resonance curve, such as curve A of Fig. 2, to be produced. The cathode circuits are not tuned to the intermediate frequency; one is tuned to a slightly higher frequency and the other to a lower. Thus L1 C1 might be tuned to 475 kc/s and L2 C2 to 455 kc/s when the circuits L3 C3 and L4 C4 are tuned to the intermediate frequency of 465 kc/s.

The Cathode Tuned Circuits

Now two parallel-resonant circuits connected in series have an impedance characteristic like that of Fig. 3. At the resonance frequency of each circuit the impedance is very high, being little different from the dynamic resistance of the circuit. At a frequency between these two frequencies of parallel resonance, however, series resonance occurs between the inductive reactance of one circuit and the capacitive reactance of the other and at this frequency the impedance is very low, being only the RF resistance of the circuit.

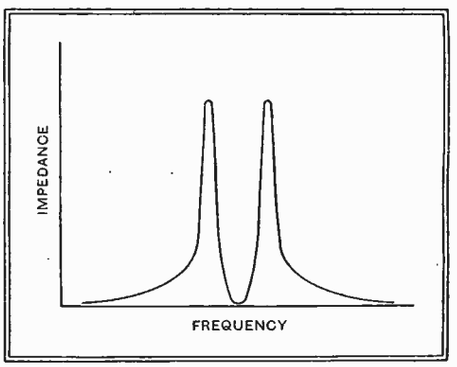


Fig. 3.—The impedance of the cathode circuits varies in the manner shown by this curve.

Because these circuits are in the cathode lead of the valve they are common to both grid and anode circuits and negative feed-back occurs just as it does in an AF stage in which the bias resistance by-pass condenser is omitted. The amount of feed-back depends on the impedance of the cathode circuit and as the impedance varies with frequency the feed-back varies

Circuit

ONE of the greatest problems in modern reception is the attainment of selectivity and quality together. The true band-pass filter theoretically offers a solution but is usually impracticable for broadcast receivers. A new circuit is described in this article, however, which enables exceptionally good band-pass characteristics to be secured, the good performance being obtained by means of negative feed-back.

also. At the intermediate frequency the impedance is very low so that there is little feed-back and the amplification is nearly equal to the normal stage gain. As the impedance rises the feed-back increases and the amplification falls until it reaches a minimum at the two frequencies of maximum cathode circuit impedance.

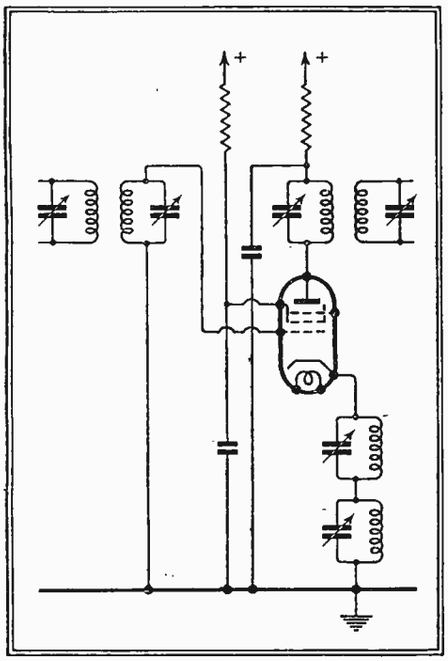


Fig. 4.—A complete amplifier is shown here and it will be seen that the cathode circuits can correct for two IF transformers.

The net result is to transform the curve A of Fig. 2 into a characteristic similar to that of curve B. The circuit causes some loss of amplification, but not a great deal; it makes the top of the resonance curve almost completely flat, and the sides slope so steeply that the selectivity is actually increased by its use. In practice, the pair of cathode coils can correct for two over-coupled IF transformers and the arrangement of Fig. 4 would normally be adopted. This arrangement is parcularly well adapted to variable selectivity for it is only necessary to use variable-selectivity types of IF transformer to achieve this in an almost ideal manner. Both transformers should have variable coupling between the coils and the controls should be mechanically linked in the usual way.

When the cathode circuits are correctly adjusted for a flat-top at maximum bandwidth, the curve remains flat-topped as the coupling in the IF transformers is loosened, but the width of the top decreases and the selectivity naturally rises. When the coupling becomes loose, the flat top to the resonance curve becomes rounded and extremely high selectivity is obtained. These characteristics are well brought out by the curves of Fig. 5 which show the performance at several different settings of the selectivity control and, for comparison, the results with the two IF transformers alone.

The design of the system is naturally somewhat complex, for the constants of all tuned circuits and of the valve are inter-related. For the guidance of the experimenter, however, it may be said that when IF transformers of ordinary commercial efficiency are used with a valve having a mutual conductance of about 2.0 mA/v. the cathode circuits should have a Q of about 50 with a dynamic resistance of some 10,000 ohms. This means coils of about 70 μH for a frequency of 465 kc/s, so that the condensers should be about 0.0017 μF. The condensers must, of course, be adjustable.

Aligning the Circuit

Cathode-ray gear is really desirable when setting up a system of this nature, for it is very difficult to find out just what is happening without it. It is, however, possible to align the circuits with nothing more than a test oscillator and output meter, and the correct procedure is then as follows: Short-circuit the cathode coils and set the selectivity control for maximum selectivity. Connect up the test oscillator, and set it to the desired intermediate frequency, say, 465 kc/s, and adjust each IF transformer trimmer for maximum output. Then set the variable selectivity control to minimum, swing the oscillator through the band and check that the two humps are of approximately equal height and that the trough is midway between them. Adjust the coupling to the point at which the peaks are about 30 kc/s apart.

Remove the cathode short-circuit and set the oscillator to a frequency 30 kc/s higher than the intermediate frequency (495 kc/s) and then adjust the trimmer

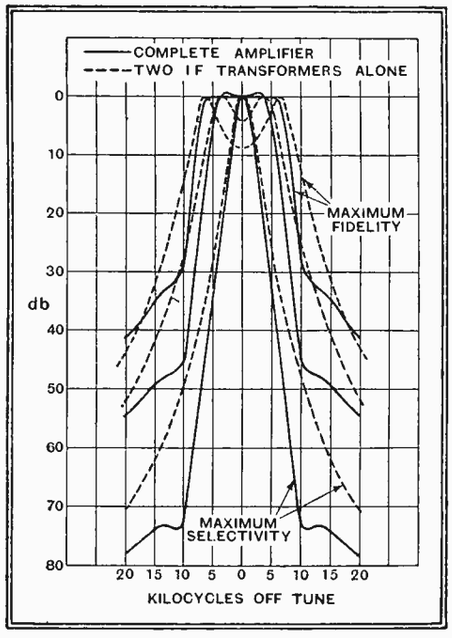


Fig. 5.—These curves illustrate the actual performance of an amplifier similar to that of Fig. 4 and embodying high-Q coils.

on one cathode circuit for *minimum* output. Set the oscillator to a frequency 30 kc/s lower than the intermediate frequency (435 kc/s), and adjust the other cathode circuit trimmer for minimum output. Then swing the oscillator through the band and check that the resonance curve is of the form shown in Fig. 5. This procedure will only give correct results if carefully carried out and if the circuit constants are correct. It is possible to obtain a flat-topped curve, however, even when there are discrepancies in circuit values by mistuning one of the cathode circuits slightly, but the selectivity on one side of resonance will then be somewhat lower than on the other. If the check shows that the curve is not flat-topped, therefore, an endeavour should be made to correct it by adjusting one of the cathode trimmers.

It should be emphasised that thorough screening and decoupling must be adopted and the amount required naturally increases with the efficiency of the circuits; it is hopeless to expect satisfactory results if there is a tendency to instability. Capacity couplings between primary and secondary in the IF transformers must also be reduced to a minimum if a symmetrical resonance curve is to be obtained.

WIRELESS ENGINEER.

Contents of the May Issue.

"Superheterodyne Padding Capacities," by W. T. Cocking, deals with the tolerances permissible to maintain satisfactory ganging. A diode voltmeter for the measurement of very high frequencies is described by Manfred von Ardenne. A method of measuring the self-capacity of iron-cored coils is explained by M. Reed, M.Sc., and there is an interesting article by a member of the Oxford University Arctic Expedition on radio communication in the Far North.

The issue also contains the usual monthly abstracts of the world's radio papers

Phase Reversal

By C. C. INGLIS

A NEW METHOD OF FEEDING PUSH-PULL AMPLIFIERS

THE author describes a novel method of introducing phase reversal in push-pull amplifiers; an ordinary heptode valve is used, with appropriate load resistances in its anode and screen circuits.

ONE of the most satisfactory methods of phase reversal for push-pull amplifiers is that incorporated in the various *Wireless World* Quality Amplifiers, and shown in Fig. 1. But in the experience of the writer it seems that, if cathode-heater insulation is not of a high order, hum can result. If there is a small leakage between the heater and the cathode AC potentials are bound to develop at the cathode, whence they are passed on farther into the amplifier. In addition, this method, while successful in many cases, does not line up with the symmetry associated with push-pull working. Steps were therefore taken to devise some scheme which would overcome these difficulties.

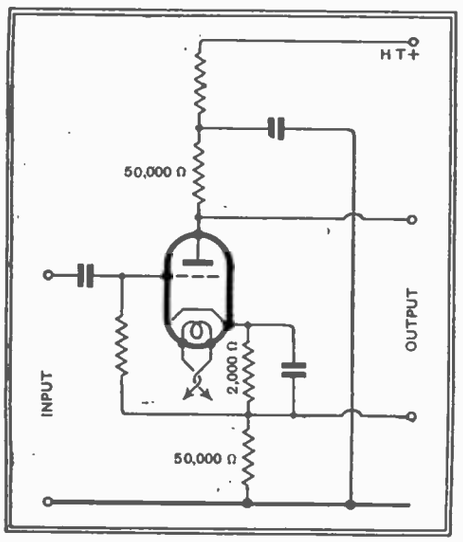


Fig. 1.—The system of phase reversal used in the Quality Amplifier.

It is clear that if a valve can be produced in which the change of a control grid voltage produces a rise of current in one electrode and a fall in another, and if suitable load resistances are introduced in these circuits, then the required effect is produced, and it has been found that this effect occurs in frequency-changer valves of the heptode type such as the MX40, etc. Fig. 2 shows characteristic curves of such a valve. The actual valve from which the curves were obtained was a Triotron 2A7.

It will be seen that the screen current falls when the grid bias is decreased and the anode current simultaneously rises, and vice versa, so that load resistances in these circuits, as shown in Fig. 2*a*, will produce voltages at the anode and screen respectively in phase opposition. In taking all curves and throughout the series of experiments which were made, the oscillator anode and grid were strapped to the cathode, and are of no value for the present purpose of the valve.

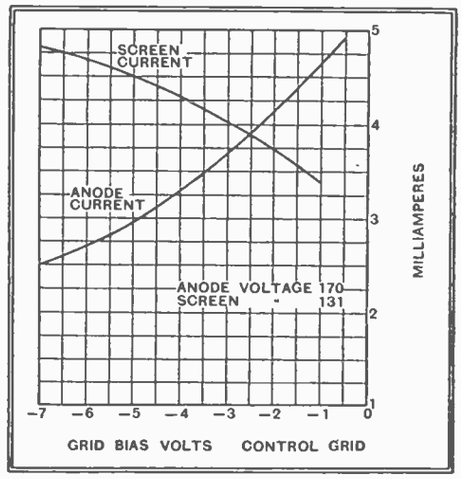


Fig. 2.—Explaining how the properties of the heptode valve are used for phase reversal.

In explaining the reason for these effects it is assumed that the screens G3 and G5 (Fig. 3) collect some of the electrons in their passage from the cathode to the anode, the anode serving as the final collector.

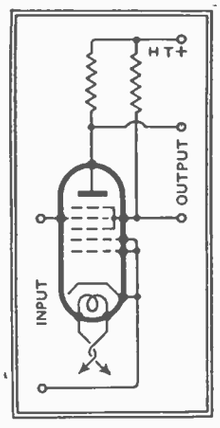


Fig. 2*a*.—Connections of a heptode valve for phase reversing.

Now, G4 is at a negative potential with respect to G3, and, therefore, has a retarding effect on the flow of the electrons due to the negative field round it. Increase in this negative field will deflect or, rather, force more electrons to be collected by G3, with resulting increase in current.

The action of G5 is not clear, and it could not be investigated, as the electrode is strapped internally to G3. The ultimate effect, however, is that the sum of the currents in G3 and G5 rises with increasing negative bias on G4. The anode current falls under these conditions due to the normal effect.

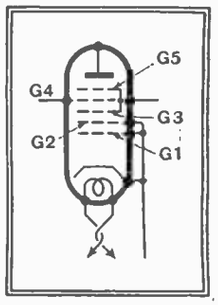


Fig. 3.—Illustrating the action of the various electrodes.

It may well be asked why an ordinary screen-grid valve was not tried. The reason is that to produce the effect required the screen would have to be used as the control grid, and the grid usually used for this purpose would have to have a positive bias of about 100 V., and it was doubted whether it would stand this owing to its closeness to the cathode. In a heptode valve the three outer grids are well spaced from the cathode, due to the presence of the oscillator anode and grid between them and the cathode.

In order to find out what would happen under working conditions, and to decide what values of load resistances would be most suitable, further curves were taken of the anode and screen currents plotted against grid voltages, but with load resistances included, and three of these are shown in Figs. 4, 4*a*, and 4*b*. The values of the voltages and resistances are shown, and it can be assumed that these curves are dynamic and not static. It will be seen that for the particular values of load resist-

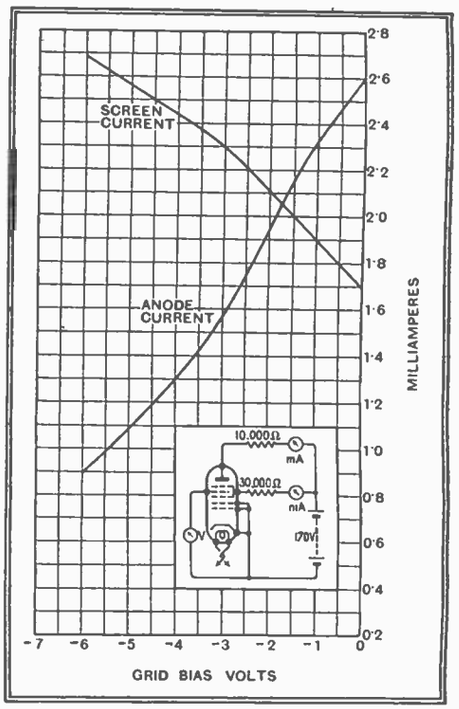


Fig. 4.—To obtain the desired working characteristics, various valves of anode and screen resistances were tried.

Phase Reversal—

ance shown in Fig. 4 a change in grid volts between 3 and 2 produced a change of 4 mA. in the anode circuit, resulting in a change of 4 volts giving an amplification of 4. The screen circuit, however, produced a change of 2 mA. resulting in a change of voltage in the screen circuit of 6 volts. The output voltages will, therefore, be these and the screen load would have to be tapped down to produce equal AC voltages at anode and screen.

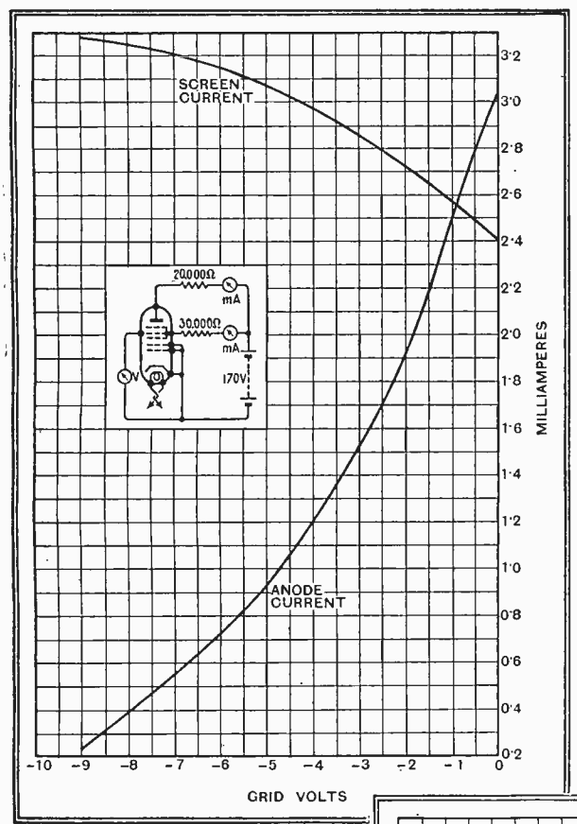


Fig. 4a.—The effect of increasing the screen load resistance.

The final arrangement as used by the writer for his Quality Amplifier is that shown in Fig. 4*b* and dynamic curves are shown also.

A point of criticism arises in the fact that these dynamic graphs are not straight, as they should be for distortionless working. A reason for this is that the control grid has a multiple characteristic, and a valve in which the control grid has a fixed characteristic would enable higher input voltages to be handled. A further reason may be that secondary emission may play a part in determining the actual shape of the curves.

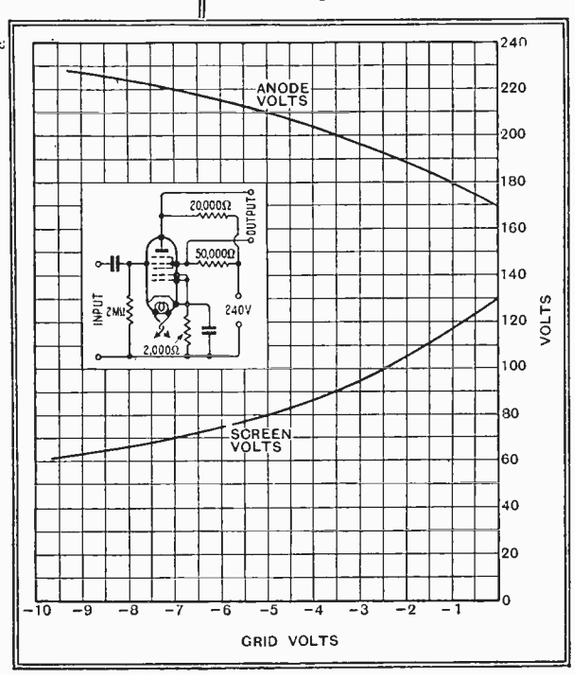


Fig. 4b.—Characteristics of the arrangement finally used in the author's amplifier.

In order, therefore, to determine the maximum output voltage of the arrangement (Fig. 4*b*) without distortion due to the curvature of the characteristics, an AC voltage at 50 cycles which could be varied between limits was applied to the control grid at a mean voltage of −8 and was gradually increased to such value that, on switching on and off, a change in value of anode and screen current could be detected. The change consisted in a rise of anode current and a fall in screen current.

When this happened, rectification was taking place and occurred at a value of 2 volts AC applied to the grid. The output volts obtained from this are of the order of 8/10 volts, which is ample to supply the *Wireless World* Quality Amplifier. The maximum input voltage of the Quality Amplifier must be 3 or 4 volts so that this phase reversal valve is working well within its capacity.

The grid bias is 8 V, and at this point there was very little difference in the amplification factor of the screen and anode circuits, so that the output voltages were substantially the same and potentiometers in these circuits were unnecessary in order to preserve balance.

It will also be noticed that the ordinates show the anode and screen voltages and the abscissæ the grid voltage. These curves are obtained from the milliamp. readings by multiplying the currents of the anode and screen by their respective load resistances and subtracting these amounts from the supply voltage. It will be appreciated that accurate results are impossible by direct measurement of the anode and screen voltages, due to the load of the voltmeter, and electrostatic voltmeters were not available.

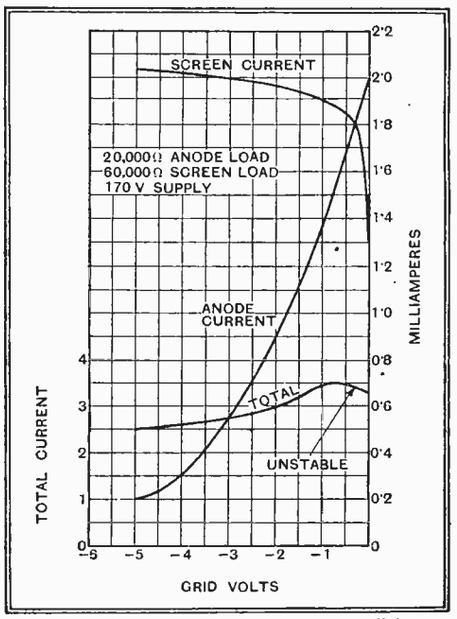


Fig. 5.—Under certain operating conditions a negative resistance effect, resulting in instability, will occur.

The scheme has been tried with an amplifier and works with considerable success and a complete absence of hum. In addition, extra amplification is obtained.

It is interesting to note that with a reasonable change in grid voltage the change in the supply current to the anode and screen together varies very little, so that anode decoupling need not be very complete. Similarly the cathode biasing resistance theoretically need have no bypass condensers but these have been added for safety's sake.

During the experiments one interesting point was noticed: if for a change in control grid voltage the change in screen current is more than that of the anode current, then the system will be unstable, and will have in it a negative resistance effect. This effect has been obtained with the 2A7 valve, and is shown in Fig. 5; it will only take effect if automatic biasing is used at low values of control grid bias and with unusual values of anode and screen voltages.

The writer would be interested to hear from anyone who tries this method with other makes of frequency-change valves or any valve with the necessary electrodes.

One word of warning should, however, be offered: valve manufacturers are in general adverse to the use of series resistances in screen circuits, due to the difficulty of producing consistent characteristics, also the variation in tail characteristics of the anode circuit makes it quite possible that with a similar valve to that used by the writer different values of load resistances would be found more suitable. Those interested, therefore, would be well advised to make their own series of experiments to determine the best values of loads and voltages. Experimenters will also find that the success of the system rather depends upon the adjustment of cathode temperature, and it is advisable to provide some means to adjust this.

UNBIASED

By Free Grid

Some Startling Revelations

IT is astonishing what a lot you can learn about the petty fads and foibles of the eminent if you only get to know the right people. It has been said—by Julius Cæsar in one of his letters home from the Flanders trenches, if I recollect rightly—that one half of the world doesn't know how the other half lives, and I am constantly proving for myself how very true this observation is. Had I not once made the acquaintance of one of the down-trodden slaves in Portland Place, for instance, I should never have learnt that a certain eminent personage—I simply dare not mention his name—has a kipper with his tea every day at Broadcasting House.

My accommodating acquaintance who gave me this startling information used to chat over the 'phone with me, but now that we have learnt about the tapping of telephone conversations, we simply dare not run any risk, and are therefore compelled to meet in a secret milk bar about a couple of wavelengths distant from Broadcasting House for a quiet chat over a glass of milk-and-it. Even now I do not know if we are quite safe, as I have long suspected the peroxided milkmaid, who usually serves us, of being a secret agent of the corporation, if indeed she is not one of the very eminent ones himself in disguise. I rather suspect the latter, for although the disguise is well nigh perfect,

A glass of milk-and-it

her false teeth show that peculiar form of wear that is caused by the habitual grinding of a pipe stem.

However, I digress. What I intended to say was that it is in this *rendezvous* that I have learned some very astonishing things, not only about the goings on at Broadcasting House, but elsewhere also, and curiously enough the most astonishing of them all does not concern the B.B.C. at all, but has to do with the meteorological experts who provide the corporation with its daily weather forecasts.

Now as most of you know, these are prepared by a committee of highbrows who base their prophecies—or at least, I used to think so—on reports sent in from observers here, there and everywhere, concerning the prevalence, in their particular area, of various things such as millibars, a word which old listeners will recollect was much beloved by the B.B.C. until some purity league or other protested against it on moral grounds, although the precise nature of the grounds escapes me for the moment. However, it is not a particularly important point, and doubtless the more sophisticated among you will know what I mean.

Although it is still true, of course, that these highly scientific reports arrive daily at the meteorological office, the weather forecasting experts have, according to my informant, long since given up making any real use of them. It appears that there used to be a committee to discuss these reports, but like all scientists, each member of it had his own pet interpretation of them, and this accounted for the highly ambiguous phrases in which the forecasts used to be couched, and also for their lack of accuracy.

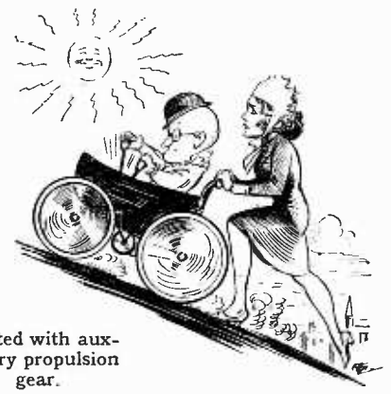
It appears that the chairman of this committee of experts got so fed up with the whole business of adjudicating in the wrangles of his subordinates that when they went on their annual treat to Blackpool, he made a point of bringing back with him a quantity of seaweed from that delightful resort, and nowadays he invariably ignores the millibar reports of the observers and the wrangles of his expert committee, and draws up the forecast himself after duly feeling his seaweed, and this, I am told, accounts for the much greater percentage of accuracy which has attended them of late years.

Indelicate Programmes

ALTHOUGH I have always been a keen scientific experimenter right from my childhood days, when I fitted my pram with auxiliary propulsion gear to assist the nursemaid on the somewhat steep slopes of my native town, I have always had a horror of fooling about with the insides of the human body in any shape or form. Somehow or other it has always seemed to me such a messy pastime and it is for this reason that I always resent the strong medical flavour associated with the sponsored programmes with which certain Continental stations inundate us on Sundays.

I cordially dislike the embarrassment of being compelled to listen to indelicate discussions concerning the undulations of my uvula and other intimate physiological details, more especially when ladies are present, although, alas! with the so-called broad-mindedness of this modern generation, my embarrassment is seldom reciprocated.

Unfortunately there is very little else available for the average monoglot British listener, and he is between Scylla and Charybdis in the shape of the B.B.C.'s Sabbath efforts and the medical lewdness with which certain Anglo-Continental stations intersperse the ululations of their crooners. I am delighted to see, therefore,



Fitted with auxiliary propulsion gear.

that one of the aforementioned monoglot listeners has proved once more the old proverb about necessity being the mother of invention by producing an automatic record-changer of a very unusual type in order to get over the difficulty.

Solace on the Sabbath

The unusual point about the apparatus is that it is not intended for use in connection with the reproduction of records but for the recording of them. Actually, it is a very simple adaptation of one of the many instruments on the market which change eight records at a time. The inventor, in a letter which he has sent to me asking me to give publicity to his efforts, tells me that he has never been able to listen to the B.B.C.'s praiseworthy Saturday night efforts as they have always clashed with a standing engagement at his darts club which holds its weekly championship contests at the local pub on Saturday evenings.

The result has been the production of this remarkable device, and nowadays the inventor merely sets his adapted record-changing apparatus into operation before leaving the house on Saturday evening and so has the B.B.C. Saturday night programme bottled up ready to serve up to the family on Sunday afternoons thus saving them from B.B.C. boredom on the one hand and Continental indelicacy on the other.

Further Notes on the Short-Wave Converter

By

H. B. DENT

AC Short-Wave Converter arranged for use with the Experimenter's IF amplifier.

MODIFICATIONS FOR ITS USE WITH THE EXPERIMENTER'S IF AMPLIFIER

DURING the early stages in the design of the AC Short-Wave Converter consideration was given to the likelihood of it being used with the Experimenter's IF Amplifier which was described in *The Wireless World* of January 29th last. This was one of the reasons why 550 kc/s was chosen for the intermediate frequency as it is the nearest approach to 465 kc/s possible with an average broadcast set.

By using this particular IF it would require only a few alterations to make the converter operate satisfactorily with the amplifier in question. Actually fewer changes are needed than was at first expected for it has transpired that only on range 3 is it necessary to make any modifications to the coils. This is, of course, in addition to omitting the special IF transformer on the converter as the input transformer on the Experimenter's Amplifier takes its place.

Best Position

If the two units were placed side by side with the converter on the left, which seems the natural position for it, the trimming condensers in the short-wave unit will be obscured by the amplifier, and furthermore a longer lead than is actually desirable would be required to join the anode of the frequency-changer to the first IF transformer.

It would be better to locate the short-wave unit on the right, which shortens the connections, though it will entail a minor alteration to the input lead on the amplifier.

It is suggested that in place of the screened lead used in the original model of the Experimenter's Amplifier a Belling-Lee screened socket connector be fitted on the right-hand side of the chassis. A short screened lead can then be connected to the anode of the frequency-changer and by fitting the companion plug part of the Belling-Lee connector to it a convenient inter-unit connection is made.

The HT and LT voltages for the converter can be taken from the power pack supplying the IF amplifier, but it should be remembered that the centre tap on the four-volt winding supplying filament current must be disconnected from the power-pack chassis. This is essential, as in the converter one side of the heater wiring is joined direct to the earth line.

Now, with regard to the modifications to range 3 of the converter. All that this entails is the rewinding of the oscillator coil L9, which requires one extra turn, making 26½ in all, but using, of course, the same gauge of wire.

There is no need to make any changes in the winding of the other coils or in the values of the series-tracking condensers as they hold good for the lower intermediate frequency.

Oscillator Voltage

One other change is advised, though it is not absolutely essential. The converter's own power unit supplies about 300 volts HT, since it is operating with a comparatively light current load, but when the HT is taken from the power pack of the Experimenter's Amplifier, which with the heavier load is delivering 250 volts, the frequency changer screen and oscillator anode voltages suffer a proportionate reduction. This is of little consequence in the case of the former, but in order to restore the latter to its original value the resistance R7 should be changed for one of 50,000 ohms.

Comparisons made between the two alternative arrangements, viz., broadcast set and Experimenter's Amplifier, show that in general the latter gives the better performance. Not only is the IF gain greater than in an ordinary broadcast set, but it is possible to arrange for a more efficient coupling to the short-wave unit.

The Radio Industry

MANY business organisations are placing large advance orders for copies of the official Coronation programme for distribution among their staffs and customers. As is well known, the programme is issued by King George's Jubilee Trust (St. James's Palace, London, S.W.), to which the whole of the profits will be devoted. It is hoped that the radio industry generally will help this excellent cause by following suit.

By the addition of a valve rectifier and smoothing equipment, the Ridco "Ranger" Short-Wave Unit has now been made suitable for either A.C. or D.C. mains. The makers are Radio Industries Development Co., Birch Street, Hanley, Stoke-on-Trent.

Large export shipments of the new Ekco models would indicate the intense interest of overseas listeners in the Coronation broadcasts.

A series of "Coronation" HT batteries, in red, white and blue cartons, has been introduced by Pertrix.

Mr. S. R. Burbridge, appearing in the television "Picture Page" feature on April 21st, described his experiments in receiving television programmes from Alexandra Palace at Brighton, a distance of over 50 miles. Mr. Burbridge uses a G.E.C. receiver.

Current Topics

Events of the Week in Brief Review

Wireless Transmitting Contest

A CONTEST under the auspices of the Radio Society of Northern Ireland, open to all licensed transmitters in the world, is to be held from midnight on each of the Fridays in May to midnight on the corresponding Sundays. At the end of the contest the leading Irish transmitter will be awarded the Leonard Trophy for one year, a gold medal being presented to the leading non-Irish station. Full details may be obtained by writing to the Secretary of the R.S.N.I., Mr. F. A. Robb, 46, Victoria Avenue, Sydenham, Belfast, Northern Ireland.

Indian Broadcasting

THE Madras Government is proposing to install 100 communal receiving sets in villages all over the Presidency. The Government will also erect short-wave broadcasting stations near Saidapet and a medium-wave station at Trichinopoly.

The Bombay Government has already installed eighteen receiving sets in nine villages under its jurisdiction. They have been fitted in public buildings such as schools, and are fully automatic, being provided with a time-switch. A special motor truck has been equipped for servicing, and visits the villages at regular intervals.

The Theatre and Broadcasting

AN international theatrical conference to be held in Prague from May 8th to the 17th is to make a thorough examination of the relationship between the theatre and broadcasting. An effort is to be made to put it on a more satisfactory basis.

New Wireless Stamp

THE Austrian postal authorities have just produced a new stamp bearing the features of the inventor, Von Lieben, together with the first wireless valve which he made.

Piracy in Germany

DURING the past three months 144 German listeners have been convicted of using wireless sets without a licence. Fines ranging from 3 to 100 marks have been inflicted.

Discontent in France

GREAT dissatisfaction is being expressed in the French Press with the ever-increasing educational tendencies of the wireless programmes. In addition, complaints are made of too much inter-station relaying of programmes and of "diagonalising" after the manner of the B.B.C.

The Tell-tale Microphone

IN certain schools in America, and also in Russia, classrooms have been equipped with microphones connected via suitable amplifiers to the headmaster's study. By means of a selector switch the headmaster is enabled to listen to the doings of any particular class without warning. A report of a somewhat similar arrangement in an English school appeared in certain newspapers two years ago.

American Valves for Denmark?

A STRONG move is being made to get the Danish Government to permit the importing of American valves on the ground that they cost about half the amount of equivalent European ones. No new American valves have appeared in Denmark since the special import regulations were imposed by the Danish Government in 1931.

Licence Figures

THE total number of wireless licences in force in Great Britain at the end of March was 8,127,747. French listeners are now rapidly approaching the four million mark, Japanese being a little short of three million.

Holiday with Pay

BRITISH Rola employees are to observe Coronation Week as a complete holiday. The works will close on the evening of May 11th and will reopen on the morning of May 19th. All workers will receive a full week's wages for the holiday period. For some time this firm has been working a forty-hour five-day week, pay being given for Saturdays, although no work is done on that day.

Ultima Thule

FOLLOWING the marooning of the film company taking part in the production of "The Edge of the World," on the island of Foula, a beam wireless station is to be established to link the island with the mainland.

"Suppressing" Malayan Cars

THE Government of the Federated Malay States has recently passed legislation compelling all motor cars to be fitted with devices to prevent the radiation of short-wave interference. Vauxhall Motors, which does an extensive export trade with Malaya, entrusted to Philco the task of finding means of making their cars comply with the new ordinance. Philco engineers have now devised a method which, it is stated, is simpler, more effective, and more foolproof than the usual resistance system; the cost is only 1s. per car.

Broadcasting Censorship

BY a decree just issued in Italy, the powers of the Ministry of Press and Propaganda are increased to embrace all wireless and television broadcasting.

A Well-known Amateur

CAPTAIN ALEXANDER PATTERSON, the pilot of the ill-fated flying boat "Capricornus," was a very well-known amateur transmitter in Egypt, his call-letters being SU1AP.

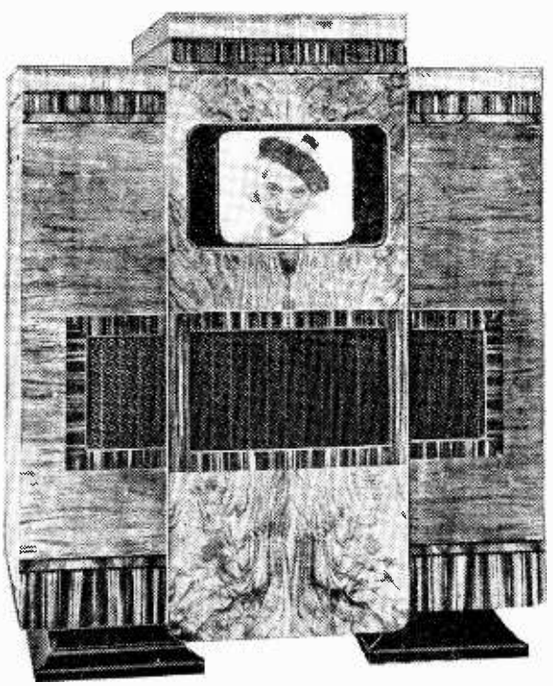
Australian SW Transmissions

DURING May, Sydney (VK2ME) may be heard on 9,590 kc/s (31.28 metres) from 0600 to 0800, 1000 to 1400, and 1530 to 1730 on Sundays only. Melbourne (VK3ME) will be working on 9,510 (31.5 metres) from 0900 to 1200 daily, except Sundays.

Polytechnic Television Lectures

A SPECIAL course of lectures on television is to be given at the Polytechnic from 7.30 p.m. to 9 p.m. on May 31st and the three subsequent Mondays. The lectures will be delivered by Mr. H. J. Barton Chapple. Full details can be obtained by writing to the head of the Telecommunications Section at the Polytechnic, Regent Street, W.1.

H.M.V. Television Autoradiogram Model 902



Three instruments in one, the new H.M.V. Model 902.

TO meet the demand for a television instrument which shall at the same time provide all the facilities of an up-to-date radiogramophone, a new receiver to be known as the Model 902 has been introduced by the Gramophone Company, Ltd.

There are virtually three distinct elements in this comprehensive instrument—the vision receiver, a multi-range receiver covering 16.7 to 2,200 metres in four wavebands with an additional range for the television sound accompaniment, and an automatic record-changer playing up to eight 10-in. or 12-in. records. The record-changer occupies a central position in the cabinet, and is raised above the level of the television and sound receiver controls, which occupy panels to the left and right respectively. A separate lid is provided for each unit.

The price of the Model 902 is 120 guineas, including a special television aerial, free installation and maintenance for one year.

The Television Receiver

VIII.—THE STRAIGHT SET

By W. T. COCKING

IT was pointed out in Part VII that the straight set offers considerable advantages over the superheterodyne in that it is not subject to certain types of interference and that it is easier to secure the optimum signal-noise ratio.

LET us now consider the design of a straight set just as we did in the case of a superheterodyne, for by comparing the two paper designs we shall be in a better position to judge their merits on a financial basis. We require a gain of 50,000 times; if we use six RF stages the stage gain must be $\sqrt[6]{50{,}000} = 6.06$, or about 6 times. With valves having a mutual conductance of 6.0 mA/V this means a dynamic resistance of 1,000 ohms for the tuned anode circuits. With the circuit capacity equal to 27.5 $\mu\mu$F., CR = 27,500 and reference to Fig. 6 (Part III) shows that for a band-width of 4.0 Mc/s the response at the edges of the band is −1.7 db. With six RF valves there will be seven couplings, so that the overall response will be −11.9 db. and the response at 3.5 Mc/s off-tune will be −28.0 db.

We can probably improve the response in the pass-band and increase the rejection at the frequency of the sound channel by using somewhat more efficient circuits and staggering their resonance frequencies. Alternatively we can use pairs of coupled circuits for the couplings. It is unlikely, however, that we can obtain the necessary gain with fewer than six RF stages.

The Output Stage

We come up against one difficulty in the last RF stage, however. Owing to the higher frequency the detector as a whole is likely to be rather more efficient than that of a superheterodyne, but the difference will not be great and we shall still require a large output from the last RF valve. We have seen that it is necessary to use a valve such as the N43 in this stage if we are to obtain a detector output of 30 volts p-p, but this valve has a grid anode capacity of 0.3 $\mu\mu$F. Although it is possible to use it at 10.0 Mc/s without instability, it will be over twice as difficult at 45.0 Mc/s. Indeed, the theoretical limit to the grid and anode circuit impedances is of the order of 1,500 ohms if stability is to be obtained in this stage alone. With all the earlier stages operative, these circuit impedances would certainly have to be reduced to maintain stability.

Unless we adopt neutralising, therefore, we are forced to abandon this type of valve as an RF amplifier. With an RF pentode in the last RF stage we cannot obtain sufficient output for a single detector. It would probably be possible to obtain adequate output by using a voltage-doubler detector, but this is open to the objections that there will be nothing to spare, that an extra valve will be needed, and that the gain obtained through this extra valve will only be 2.

If we could use post-detector amplification all these difficulties would disappear. The case for and against VF amplification was presented in some detail in Part II, and it was shown that there were certain disadvantages, notably in connection with synchronising, which made us decide not to use it. For the moment let us ignore these disadvantages and see how the design of our receiver will progress if we use one stage. If the finished design appears much better than that of the receiver without such amplification, then it will be worth while to try to overcome its drawbacks

Using a TSP4 as a VF amplifier with the series resistance and coil type of coupling, the stray capacities are likely to total 35 $\mu\mu$F. including the input capacity of the CR tube. With the aid of Fig. 10 (Part IV) we can calculate the values and find that R = 3,500 ohms, L = 217 μH, and A = 21 for a drop in response to −2.0 db. at 2.0 Mc/s. Moreover, the valve characteristics show that an output of 30.0 volts p-p is easily obtainable with this load.

A stage gain of 21 is quite respectable, and assuming that the detector efficiency remains unaltered we shall require an RF gain of only 50,000/21 = 2,375 times. With five RF stages the gain per stage would be 4.74, with four stages 7.0, and with three stages 11.2 times. With g = 6.0 mA/V, this means dynamic resistances for the tuned circuits of 795, 1,160, and 1,870 ohms rsepectively, giving CR products of 19,900, 29,000, and 46,000 when C = 25 $\mu\mu$F. From Fig. 6 we obtain the drop per circuit for a 4.0 Mc/s band-width and the figures are shown in the table.

Among the requirements laid down in Part I for our receiver were a response at 1.5 Mc/s of −6.0 db. and at 3.5 Mc/s off-tune of at least −30.0 db. The former is satisfied by four RF stages, the latter very nearly by three. The fewer stages thus enable greater selectivity to be secured, but at the expense of the modulation frequency response, because, although the number of tuned circuits is less, each circuit is sharper. If design is carried out for the same degree of sideband cutting in each case, however, then the selectivity increases with the number of tuned circuits.

What are we to do in this case, since five circuits are not selective enough and yet four cut sidebands too much? One solution would be to adopt five circuits, each one of which is damped somewhat less so that the overall selectivity equals that of the four sharper circuits. The increase in gain could be offset by increasing the grid bias of the valves a little. We should then have a modulation frequency response lying between those of the three and four valve arrangements in the table. Alternatively, we can reduce the gain and broaden the resonance curve by staggering the tuning of the circuits and this is probably the better course.

How Many RF Valves?

The three-valve arrangement is very attractive, however, because it involves less material and is consequently cheaper. It gives the necessary gain and selectivity, but cuts sidebands more than we should like. Is there any chance of obtaining good results with it? The answer is "Yes." In the first place, the frequency requirements which we have laid down are rather arbitrary. The size of the spot on the CR tube places one limit to the response; if the spot is larger than one picture element, then there is no point in supplying the tube with the highest frequencies for the proper response cannot be secured. Furthermore, the falling-off in definition when the high frequencies are attenuated is small at first, just as in the case of sound reproduction quite large attenuation of frequencies around 10,000 c/s may have very little audible effect.

The second point is that we shall only obtain the response given in the table if

PERFORMANCE v. NUMBER OF STAGES.

No. of RF Valves	5	4	3
Gain per stage	4.74	7.0	11.2
R (ohms)	795	1,160	1,870
CR (C in $\mu\mu$F. = 25 $\mu\mu$F.)	19,900	29,000	46,700
DB drop per circuit 4 Mc/s band-width	− 0.95	− 1.85	− 3.87
DB drop per circuit at 3.5 Mc/s off tune	− 2.4	− 4.3	− 7.3
Overall DB drop 4 Mc/s band-width...	− 5.7	− 9.25	−14.48
Overall DB drop at 3.5 Mc/s off tune	−14.4	−21.5	−29.2
Overall drop in response at 2.0 Mc/s, including VF stage	− 7.7	−11.25	−16.48
DB drop per circuit 3 Mc/s band-width	− 0.55	− 1.12	− 2.45
Overall DB drop 3 Mc/s band-width...	− 3.3	− 3.6	− 9.8
Overall drop at 1.5, including VF stage	− 3.6	− 5.9	−10.1

The Television Receiver—

all four circuits are tuned to resonance. We can broaden the resonance curve by staggering the resonance frequencies of two circuits. This will reduce the gain to some degree and also the selectivity. We have also the possibility of mistuning all the circuits a little towards the high-frequency side of the signal. This will leave the gain at about its normal figure, improve the rejection of the sound signal, and improve the modulation frequency response because, although the band-width will remain the same, we shall virtually be adopting single sideband working.

Incidentally, the full gain of the RF stages is not always needed. In fact, it is required only when the receiver is at a considerable distance from the transmitter. At shorter distances, therefore, it is good practice to reduce gain by mistuning circuits to some degree, and under these conditions the response in the pass-band can be made as good as desired.

It would thus appear that we can build a straight set which will give the required performance using only three RF stages, detector, and one VF stage, a total of five valves as compared with the seven or eight which would be needed if we fed the CR tube directly from the detector. Provided that we can overcome its disadvantages, therefore, the use of a VF stage leads to a considerable saving in cost. It also assists in promoting stability, for as it ceases to amplify at 45.0 Mc/s the effective gain from input to output at signal frequency is only the RF gain, about 2,375 times, as compared with 50,000 times if a VF stage were not used. Less screening is consequently needed.

Now for the three-valve amplifier we require tuned circuits with dynamic resistances of 1,870 ohms. At 45.0 Mc/s we certainly cannot obtain this merely by shunting the coil by a resistance of this value, for owing to the transit time of the electron the input impedance of an RF pentode is of the order of 3,000 ohms only. The coil losses will also be appreciable, and we shall actually be doing quite well if we succeed in obtaining an effective dynamic resistance of 1,870 ohms without intentional damping. In fact, unless we are careful, we shall have to use four RF stages to provide the gain because we cannot build good enough circuits to get it with three.

ON THE SHORT-WAVES

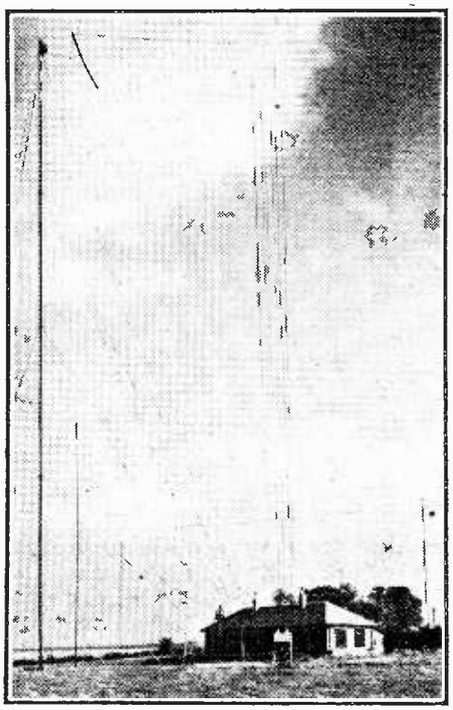
As there must be many listeners not familiar with the B.B.C.'s system of short-wave relays, a brief explanation of how they are arranged might be of general interest.

These relays are made either from the Tatsfield receiving station or via the G.P.O. radio-telephone system.

In the case of the former the relay is always by direct reception of the U.S. short-wave *broadcasting* stations, such as W2XAD, W3XAL, etc., and these stations do not increase power for this purpose, but they undoubtedly use their European beam aerials whenever possible.

"Five Hours Back" and the commentaries on the America Cup Races are some examples of this type of relay.

The G.P.O. Transatlantic radio-telephone service is generally used for programmes especially arranged overseas for the B.B.C. and not generally radiated in the country of origin, i.e., America, Australia, India, etc. For these relays the radio-telephone transmitters of the American Telephone and Telegraph Company at Lawrenceville are used. These excellent transmitters, WLA, WKN, WKF, WMF, etc., generally appear on the dial with wobbled carriers modulated with inverted speech, but may occasionally be heard (see broadcast licence) radiating high-quality programme material with the inverter and wobbler inactive. They are then probably being intercepted at Baldock,



The B.B.C. receiving station near Tatsfield where short-wave transmissions are picked up for re-broadcasting in this country.

in Herts, and the low-frequency signal passed to Broadcasting House by land-line.

Examples of this type have been Rudy Vallée in the recent Savoy Orpheans' programme and the regular broadcasts by Raymond Gram Swing, a popular Trans-atlantic feature.

A most interesting mixture of these two types was the recent inaugural address of President Roosevelt, when the commentary by Felix Greene prior to the President's address arrived by radio-telephone—but the voice of the President himself was taken via Tatsfield, using, I am informed, four receivers in diversity and giving really excellent reception from W2XAD.

The transmitters of the R.C.A. group at Rocky Point are not used for programme transmission to this country except for special experiments, although they have often in the past been observed working Geneva and Berlin.

I hope that this explanation will clear up any doubts which may have existed in the minds of readers. At present the reception via Tatsfield generally seems to be a little up on the G.P.O. relays, probably due to the use of the diversity scheme, which, under all but very unfavourable conditions, practically eliminates fading and distortion.

The statement made by Professor Appleton in his broadcast talk recently, that the effect of sunspot activity on the reflecting layers may be likened to impairing the reflecting properties of a mirror by breathing on it, seems to me a rather unfortunate choice of an analogy.

It has always been understood, and it has been adequately demonstrated, that the effect of sunspot activity is to improve the reflecting properties of the layers enormously for about 90 per cent. or more of the time; during the rest of the time, generally for not more than a few hours every 27 days, the absorption in the E region (i.e., a cloudiness in the glass face of the mirror) is enormously increased due to bright hydrogen eruptions, so that the signals during these brief periods never reach the reflecting layer.

It is very interesting to note that the peak European short-wave field strengths received in New York since my records were started occurred around February 23rd-25th of this year, a period of exceptionally great sunspot activity. On one day the Empire transmitter GSD produced a field of 67,000 microvolts and very strong signals were recorded from the vision transmitter at Alexandra Palace on 45 Mc/s!

Turning once again to a review of conditions, it will be seen that reception has deteriorated on the very high frequencies from April 8th, no signals at all having been heard on 28 Mc/s recently, at least in the evenings. Reception has generally been good on 15 Mc/s and lower.

On Thursday, April 8th, W9XAZ was fair at 7.30 p.m. (G.M.T.) and W1HLH good on 28 Mc/s 'phone; at this time W2XAD was good but W3XAL was unheard.

Reception on 28 Mc/s was good on Saturday, April 10th, whilst W9XPD, St. Louis, was very good on 31.6 Mc/s at 6 p.m. The Brazilian transmitter PRF5 on 9.50 Mc/s was quite good at 10.45 p.m. (French transmission).

Ten metre conditions were a bit poorer on Sunday, but W3XAL on 17.78 Mc/s was very good at 9.30 p.m., and W1XK very good at 11.30 p.m. on 9.57 Mc/s, but rather spoilt by carrier hum; W2XAF was good, too, but weaker and HJU Buenaventura heard as a heterodyne under GSB.

Conditions were definitely poor on Monday, April 12th, but improved again on Tuesday.

One was particularly amused by PCJ on 9.59 Mc/s at 7.55 p.m. on Tuesday, the announcer stating after some English records of a distinctly nautical flavour, "Join the PCJ Navy, we have for ten years the best navy on the short waves." Well done, PCJ, we who remember PCJJ!

Excellent reception was obtained from W2XAD on Wednesday—this first-class station now appears to be working until later than midnight (G.M.T.).

An outstanding signal Saturday afternoon was W2XE on 21.52 Mc/s, it being understood that the increase in signal, a considerable increase, was due to the use of the new transmitter.

Up to Tuesday, April 20th, conditions have remained good, all the regulars, W2XAD, W1XK, W8XK, W1XAL, etc., have been of programme value; W3XAL has been good, too, when radiating, but is operating irregularly at the moment. Reception of W2XAD has generally been "local station" after 10.30 p.m. B.S.T.

ETHACOMBER.

BROADCAST BREVITIES

NEWS FROM PORTLAND PLACE

A Coronation Problem

ALTHOUGH Coronation Day will be a public holiday, nearly 150 people will be on duty for the day's broadcasting activities. Some of the luckier ones may have no difficulty in reaching Broadcasting House on the morning of the great day, but others, less fortunately domiciled, already foresee impassable traffic barriers and are arranging to spend the previous night in the neighbourhood of Portland Place.

Camping in Portland Place

Luckily, there is close at hand the shell of an old family hotel which has been denuded of its furniture, having passed into the hands of the B.B.C. for the purpose of big studio extensions during the next two years. In this building more than a hundred camp beds are to be installed, with Army blankets and other military appurtenances for the convenience (sic) of the hard-worked officials. Furnaces will be started up once more, so that h-and-c will be available in all rooms and there will be eggs and bacon for breakfast.

Among the hardy pioneers will be the Chief Engineer himself.

Too Comfortable ?

The B.B.C. is anxious not to make this ancient hostelry too comfortable, the fear being that the staff may actually enjoy their stay there. If this happened, it might be difficult to turf them out, and a building destined to become a hall of Terpsichore might degenerate into a home of rest for tired broadcasters.

Welcome to St. George's Hall !

THE secret is out! When next you receive a gold-edged invitation to attend a broadcast performance in St. George's Hall, pause to reflect that you go as a welcome guest—but welcome for reasons you may not have considered.

Human Sound Absorbers

The truth is that the rearrangement of studio acoustics is a difficult and expensive undertaking, particularly when reverberation response has to be altered at short notice. It can be done, of course, with movable walls, or with vast supplies of damping material, but the engineers find that by far the most expeditious way is to import human sound absorbers.

A Mixed Bag

It is all carefully worked out. To reduce the reverberation period by two seconds you must employ, say, fifty human sound absorbers. So this is one reason why fifty or seventy-five, or perhaps a hundred neatly typed invitations to Music Hall find their way into the homes of the people. Fat people, of course, absorb more sound than the thin ones, but by the law of averages fifty invitations yield a nice mixed bag. . .

Coronation Commentators : Who's Who

THE seven Coronation commentators have had varied careers. The Rev. F. A. Iremonger, who will be stationed with Howard Marshall in the triforium of Westminster Abbey, has been Religious Director of the B.B.C. since 1933. He was made Chaplain to the King in 1927. Howard Marshall gained a Rugby Blue at Oxford, and has the distinction of having joined the B.B.C. staff twice, and left it twice. This all happened between May, 1929, and September, 1930. He can paint a word-picture of anything from a Royal Jubilee to a boxing match.

Versatile Talkers

John Snagge, who will be installed opposite Buckingham Palace, is an Oxford man and loves boats. Excels at boat races and launchings of liners. Lieut.-Commander "Tommy" Woodrooffe makes a commentary sound like a man-to-man talk. He also can tackle anything from a Rugger match to a State occasion.

New Opportunities

George Blake is Scotch, but not dour. First leaped into fame with his ecstatic commentary on the launching of the "Queen Mary." Harold Abrahams, the great Cambridge athlete who holds the English long jump record of 24 ft. 2½ in., has previously specialised in sporting commentaries. The Coronation Procession will give him his big chance to describe a slow-moving event. Michael Standing worked in the City for eight years before joining the B.B.C. Talks Department in 1935. Later he joined the "O.B." Department. Coronation Day provides him with his first big occasion as a radio observer.

Historic Television Camera

TELEVISION as an art is still in the self-conscious stage, and a happy token of this will be observed when the Coronation Procession is televised. Just before the procession comes into view in the East Carriage Drive beside Stanhope Gate the camera on the platform to the north of Apsley Gate will be trained on the pavement to show viewers the camera which is to have the honour of televising Their Majesties the King and Queen for the first time.

The camera operator will also come into the picture, and later in the proceedings the whole of the television squad in Hyde Park will be shown.

INDIAN STUDIO SCENE. Under the New Rural Development Scheme the Government of India is rapidly arousing interest in broadcasting.

Freddie Grisewood's Problem

Mr. Gerald Cock, Director of Television, is personally supervising the arrangements in Hyde Park, and an elaborate continuity has already been prepared, provision being made for every conceivable eventuality, from a stampeded crowd to a thunderstorm.

There will be two microphone points, one on each side of the Arch, and Mr. Freddie Grisewood, who is giving the commentary, will oscillate between the two in a laudable attempt to see both ways at once.

Fortunately, the "mikes" will be movable.

Telephoto . . . if Weather Permits

Telephoto lenses will be used only if the light is really good. Their use is not so vital as many people think ; in fact, one school of thought considers that telephoto lenses involve too big a sacrifice of light and also give an artificial effect to the picture owing to the flattening out of the perspectives, which is particularly noticeable in the case of objects approaching the camera.

Televising the King and Queen

The pavement camera will "take over" from its companion on the plinth platform when the head of the procession comes within thirty or forty feet of the Gate. It will be less than six feet from the Royal coach, and should yield excellent close-ups of Their Majesties.

Co-axial Festoons

There will be no risk of public gate-crashing on the camera positions. Two of the cameras will be inside the railings of the Gate throughout the proceedings, and the pavement camera will be similarly protected until the Gate is closed to pedestrian traffic at about 9 a.m.

An inconspicuous festoon of co-axial cable will link cameras with the mobile television unit, which will be located in a special enclosure about 100 yards away in Hyde Park just north of the park-keeper's lodge.

Practical Push-Pull

HARMONIC DISTORTION AND PARASITIC OSCILLATION

THE two earlier articles[1] have prepared the ground for this one, which is intended to help you make a success of actually using the push-pull circuit. But as the first practical point is to be a reminder that one of the main advantages of push-pull applies to triodes and not to pentodes, and as I hate anything like throat-ramming, here is a quick bit of theory to justify my statement.

Looking at the characteristic curves of a triode, Fig. 1, it is easy for anybody who is accustomed to diagrams to see that in so far as the curves are not straight lines the tendency is for them to yield a lopsided output wave, with the positive half bigger than the negative half. Drawing an undistorted wave and, on the same base line, another of twice the frequency (a so-called second harmonic), by adding them together (Fig. 2*a*) one can see that the result is also a lopsided wave with the positive half bigger than the negative half. "Things equal to the same thing are equal to one another." Therefore, the distortion introduced by a triode is equivalent to the introduction of a second harmonic. Now, in a Class "A" push-pull system there is an additional valve amplifying at the same time but connected so that the signal wave is reversed (Fig. 2*b*). The second harmonic is still in such a direction as to stunt the negative half-wave, however. To get the output the output transformer is connected so as to reverse the waves once more, and by adding Fig. 2*a* upside down to Fig. 2*b* it is seen that the true, original and undistorted waves add up, while the false and spurious distortion waves cancel out.

[1] "About Push-Pull," April 9th; "About Push-Push," April 23rd.

Now, going through the same reasoning for a pentode when the slope of the load line (i.e., the selected resistance of the load) is chosen, as it usually is, to give equal up-and-down swings, avoiding the lopsidedness or second harmonic, it is possible, though not quite so easy, to see that owing to the relative crowdedness of the grid voltage lines towards the ends of the load line, corresponding to the peaks of the wave, there is a tendency for the peaks to be flattened. Fig. 4*a* shows how a *third* harmonic duly yields this result. Fig. 4*b* is the output from the second valve; turning it upside down and adding it to Fig. 4*a*, one finds that unfortunately the distortion is additive as well.

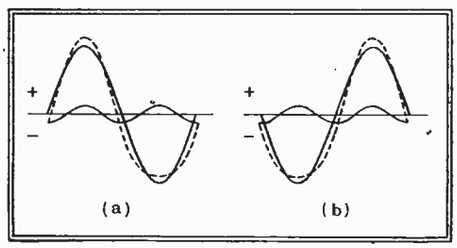


Fig. 2.—Diagram (a) shows that the result of asymmetrical amplification (see Fig. 1) is equivalent to an undistorted wave plus a second harmonic; meanwhile, the other valve is acting as in dia. (b). Adding the inverted result to Fig. 2 (a) the pure waves and the distortion cancel out.

Please note that this argument depends on the pentode being used in its normal fashion, with the grid bias and the load resistance adjusted for negligible second harmonic. If it is worked quite differently, as in Class "B," the conclusion of the argument is, of course, different, and some reduction of distortion may be effective. But whereas third harmonic is almost negligible when triodes are used in any normal fashion, it is always a prominent ingredient in pentode distortion, and no sort of push-pull is able to purge it of this blemish. So this is a point to be set off against the increased power efficiency of pentodes. Another, but perhaps less important, bad mark against pentodes in push-pull is that, unless precautions are taken, parasitic oscillation is the rule, rather than the exception that it is with triodes. That brings us to parasitic oscillation. At the end of the first article I briefly mentioned the usefulness of the push-pull circuit in stimulating difficult (e.g., ultra-short-wave) circuits to oscillate. This trait is less admirable in audio-frequency amplifiers. If the wiring to the grids and anodes, together with the capacities of those electrodes, comprises an ultra-short-wave oscillating circuit; or if leakage inductances of input and output transformers help in setting up oscillation at some frequency above audibility, the valves are in no fit state to undertake high-quality amplification.

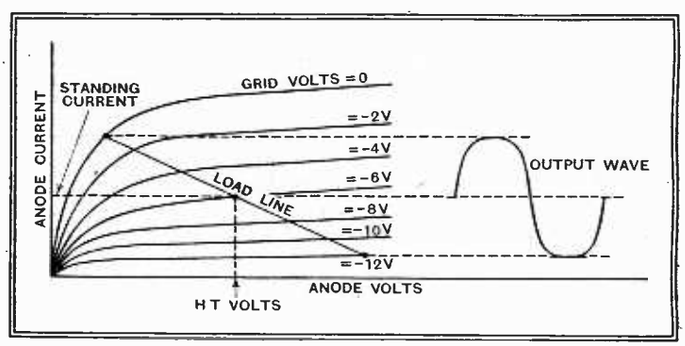


Fig. 3.—Typical pentode characteristic curves; compare with Fig. 1.

The awkward thing is that without special equipment the existence of these oscillations may go undetected; one is merely disappointed by the poor show put up by the amplifier. If the oscillation is continuous it may often be spotted with the help of nothing more than a milliammeter and a damp finger, by connecting the one to read anode current and applying the other to each grid in turn. A change in anode current gives a clue to oscillation. But much more elusive is the intermittent variety, which occurs only when the amplifier is delivering volume, perhaps at some particular stage in the signal wave (Fig. 5), or at some particular frequency. The audible effects are elusive, too. A variable-frequency oscillator and cathode-ray tube are needed to detect this positively, and as such equipment is not

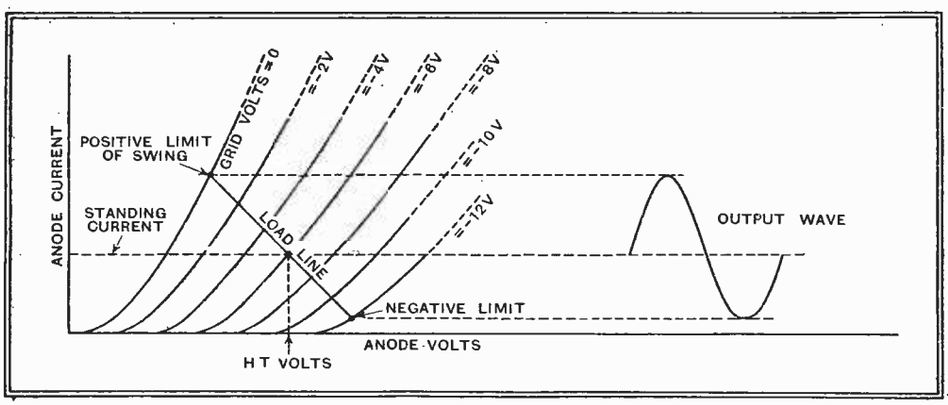


Fig. 1.—Typical triode characteristic curves, showing that one half-wave is amplified slightly more than the other.

Points

By "CATHODE RAY"

generally at hand the only thing to do is to take suitable precautions. Long grid and anode leads, particularly if they are curved or run close together, encourage oscillation. Make them absolutely as short and direct as practicable. Small non-inductive resistors connected close up to the valves in each grid and anode lead are sometimes helpful; 100 ohms is about as much as can be put in the anodes without undue loss of volts, but 1,000 ohms is

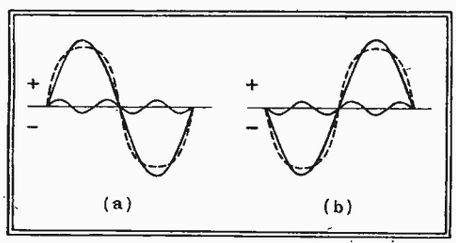


Fig. 4.—Equivalent to Fig. 2, but applying to pentode valves. The unfortunate difference is that both pure wave and distortion appear in the final output.

suitable for grids. A simpler and more effective method is to connect a resistance of about 100,000 ohms as in Fig. 6, but if this is done it is even more than usually desirable that the intervalve transformer, or other coupling, should be well balanced. When a transformer secondary is just wound on straightforwardly and a centre-tap made, the two halves of the winding are far from being equal in resistance and stray capacities. It is preferable, but slightly more expensive, for the two halves of the secondary to be symmetrical.

Transformer v. Resistance

Incidentally, is the transformer the best sort of coupling for push-pull, and, if so, why? It has the advantage of giving the necessary two-phase output for providing the push-pull valves with signals of opposite polarity. Resistance and choke couplings can be made to do this only by means of some dodge or another, which may even involve an extra valve. Then the transformer gives a step-up in voltage, which is particularly valuable because each push-pull valve gets only a half share, and if each requires perhaps 100 volts swing the total needs a rather big preceding stage to supply it without a step-up. Another advantage, provided it is not sacrificed by including a high-resistance grid decoupling filter, is that if the amplifier *is* occasionally overloaded, the resulting pulses of grid current pass rapidly to cathode, instead of causing a more unpleasant form of distortion due to momentarily choking the valve by charging up a grid condenser, as happens with resistance coupling. The effect of this is to give a much larger output on ordinary programmes (in which extreme peaks occur only seldom) before distortion becomes intolerable. The rated output in watts is therefore not an infallible guide to the relative volumes obtainable from different amplifiers under working conditions.

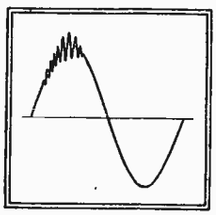


Fig. 5.—Example of intermittent oscillation, very difficult to trace in an amplifier.

There are two sorts of intervalve transformer that may be favourably considered for push-pull, assuming one is going for a high-quality outfit. The first is a small parallel-fed nickel-iron core type, which is very cheap. It also gives a flatter frequency characteristic than the most expensive straight type, and the stray capacities are lower. But the very small ones, about an inch cube, are liable to saturate at the lowest frequencies—50 cycles and downwards—if called upon to supply more than 20 or 30 volts from grid to grid. Within these limits the performance is practically perfect over the widest audio-frequency band. But for valves requiring large grid voltages, to maintain full undistorted output at the lowest frequencies it is necessary either to go in for a larger parallel-feed transformer or a high-quality and expensive example of the directly connected sort, and to make sure that the preceding valve is working well within its capabilities.

Some makers bring both ends of both secondaries out to separate terminals, which gives rather more scope in arranging the circuit, particularly as regards grid bias. That is our next point, and a more important one than might at first sight appear. There are so many variations, all having their special advantages and snags. Fig. 7 shows a few of them. If the cathodes of the valves are indirectly heated, each valve can be separately biased by a voltage-dropping resistor R as in (*a*). The great advantage of this scheme is its self-compensating property. The anode current of a valve, taken at random and supplied with the rated anode and grid voltages, may be considerably different from normal. It is impracticable to make valves within very close limits. But with self-bias the abnormal anode current automatically adjusts the grid bias in such a way as to bring itself nearer normal. And if a separate resistor is provided for each valve, any wide difference between them in current is very much reduced. As the success of push-pull depends largely on the two sides being reasonably well matched, that is a very great point in favour. Again, a change in valve characteristics due to age is automatically counteracted. And the risk of damage to valve or power unit due to the grid bias coming off is a minimum.

The only criticism of the circuit as shown is that the signal currents produced by each valve also flow through R, and feed back voltages to the grids. In certain circumstances this may be good—I explained what happens in "Degeneration" (5.3.37)—but if it takes place in the way shown here the adverse effects are the most likely to be felt. So condensers CC (*b*) are used to short-circuit the signal currents. Unless the short-circuit is effective at all the desired frequencies, such condensers are rather worse than nothing at all: A 500-ohm bias resistance needs at least 25 mfds., and a smaller resistance a proportionately larger one. A condenser, say 50 mfds. to work at 50 volts, even if of the electrolytic type, is quite costly, so a possible alternative is (*c*), in which the choice of condensers CC is calculated on resistances R′R′, which may be as high as can safely be allowed in the grid circuits of the power valves. Values of 0.1 megohm and 1 mfd. are typical. The disadvantages are liability to the overloading distortion effect (which I mentioned in connection with resistance coupling), the necessity for separate secondary windings, and ineffectiveness when applied to parallel-feed or other condenser-coupled systems.

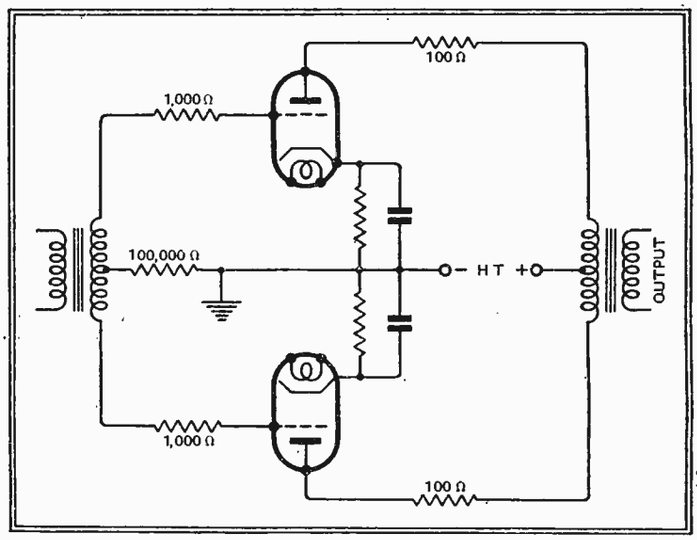


Fig. 6.—Anti-oscillation devices.

If the self-balancing property of separate biasing resistors is sacrificed, the delightfully simple (*d*) circuit abolishes these tiresome feed-back difficulties. The signal currents of the two valves cancel out. But it is cleverer even than that. If the valves are not perfectly matched for mutual conductance, and there is a balance of signal current, it works in such

Practical Push-Pull Points—

a way as to strengthen the weaker valve and hold back the strong one. Valves are more easily matched for anode current than for conductance, so this circuit has much to recommend it. Not least is the fact that, unlike (*a*) (*b*) and (*c*), it can be used for directly heated valves in which only one battery or transformer winding is available, as in (*e*). The (*a*) (*b*) (*c*) systems, if applied to directly heated valves, require separate supplies; (*f*) is an example.

diode in one of the valves (*h*). The disadvantage of these independent bias systems, apart from absence of the self-compensating property, is that if anything goes wrong with them there may be some heavy consequential damage.

There is a certain amount of strain on the remaining valve if one is pulled out when the power is on, and this applies especially to circuits such as (*d*) and (*e*). But if you do unplug one and think there is something wrong because it makes very little apparent difference, it is quite all

circuit. One is wise to allow for *some* polarising current in the transformer, and to include *some* decoupling of the anode supplies to preceding valves.

Then as regards transformer ratios there is sometimes confusion. When an intervalve transformer is marked "4 : 1 ratio," it should be "1 : 4" unless it is a positive-drive Class "B" type. And presumably it refers to the ratio between primary turns and the *whole* of the secondary turns, grid to grid. To steer clear of all confusion it would be helpful

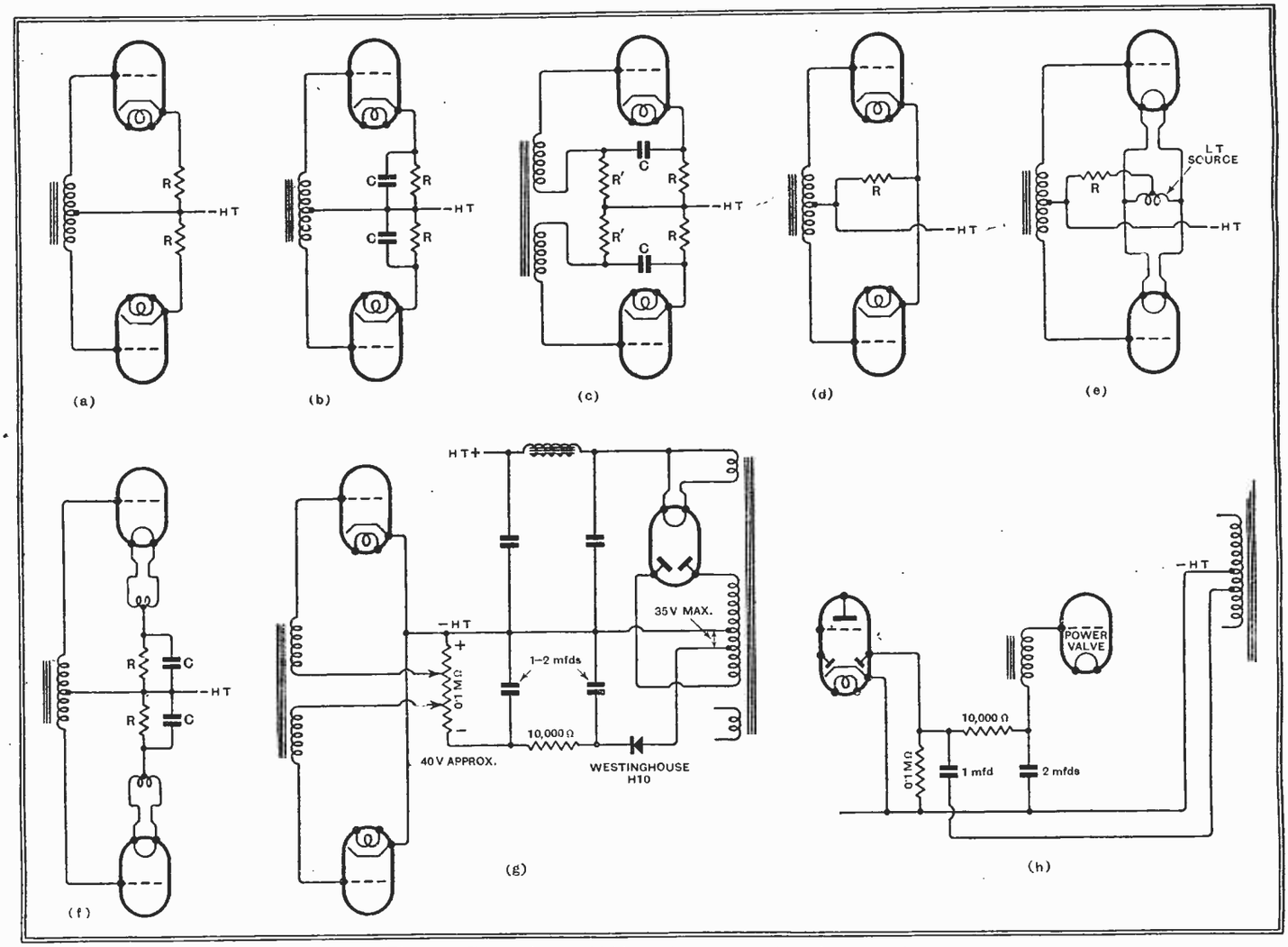


Fig. 7.—The various grid-bias schemes described in the text.

Systems in which the anode current when giving full output is more than the quiescent anode current—Class "AB," QPP, etc.—are not satisfactory with self-bias, and some source of bias which does not depend on anode current must be found. It is extraordinarily difficult to find, unless, of course, one descends to the use of a grid battery. A method that has been successfully used is shown in (*g*); a tapping on the HT winding of the power transformer supplies a suitable voltage through a metal rectifier and simple filter. Typical circuit values are given. And note the method of using separately adjustable bias to equalise anode currents. But don't put the bias controls on the front panel for *anybody* to use! An alternative rectifier is a spare

right really. The usual reason for pulling out one valve at a time is to measure the separate anode currents; but this is a futile and risky proceeding, so a better way is to connect a milliammeter to read the current to either or both valves.

In my discussion of the benefits of push-pull I mentioned such things as the absence of polarising current in the output transformer, the absence of signal currents in the HT source, and so on, leading to certain simplifications in the design of the circuit. In a practical article such as this it is necessary to point out that such conditions will in general be only approximate—and not even that if one is careless about matching valves. They are not results that follow perfectly and inevitably from using the push-pull

if makers listed it as "1 : 2 + 2." As push-pull valves are, so far as signal voltages are concerned, in series, the optimum load resistance approximates to twice that specified for a single valve of the same type. *Approximates*; because ideally it is seldom exactly double, and under special conditions of working may be quite a lot different.

MATERIALS AND TESTING

A BODY under the title of "The Joint Committee on Materials and their Testing" has now been set up by a number of technical institutions and societies (including the I.E.E.). The address of the committee is: c/o The Institution of Mechanical Engineers, Storey's Gate, London, S.W.1. It will promote discussions of the wider aspects of its subject, assist co-operating institutions and undertake duties with respect to certain international matters.

New Apparatus Reviewed

Recent Products of the Manufacturers

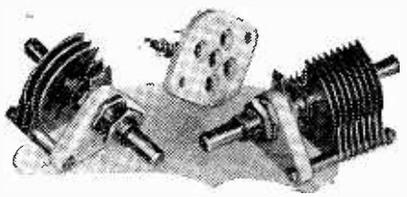
WEBB'S APEX SW CONDENSERS

A RANGE of short-wave condensers described as the Apex Economy models has been introduced by C. Webb, Ltd., 14, Soho Street, London, W.1, and these are made in sizes of 15, 40 and 100 mmfds.

These are of quite small dimensions. For example, the 100 mmfds. model measures only 1½in. by 1⅜in. by 2⅛in. with the vanes extended. The 2⅛in. is from back to front, being the space taken up behind the panel.

They are made of brass with one large bearing for the rotor, this and the fixed vanes being supported on a triangular-shaped plate of ceramic insulating material. Provision is made for ganging.

Tests have been made with the 15 and 100 mmfds. condensers and these have been found satisfactory for both short- and ultra-short-wave use. There is no trace of end or side play, and they are quite silent in use on all frequencies.



Webb's new Apex Economy condensers and short-wave valve-holder.

The measured capacities of the 15 mmfds. specimen were 3.5 mmfds. minimum and 16.3 mmfds. maximum. The larger model had a minimum value of 6.3 mmfds. and a maximum of 84 mmfds.

Though extremely well made the prices are very low, being 1s. 6d. for the 15 mmfds., 1s. 9d. for the 40 mmfds., and 2s. for the 100 mmfds. sizes respectively.

At the same time we have examined some samples of the new Webb's short-wave chassis valve-holder. Available in 5- and 7-pin types, it has a ceramic plate and the price is 6d. for the former and 9d. for the latter.

They are quite satisfactory for all short- and ultra-short-wave work.

WOLF ELECTRIC SOLDERING IRONS

ALTHOUGH an elaborate kit of tools is not essential for home constructional work the radio amateur can rarely do without a soldering iron. Electric models have been available for some years, but improvements are continuously being made and the latest types are extremely reliable.

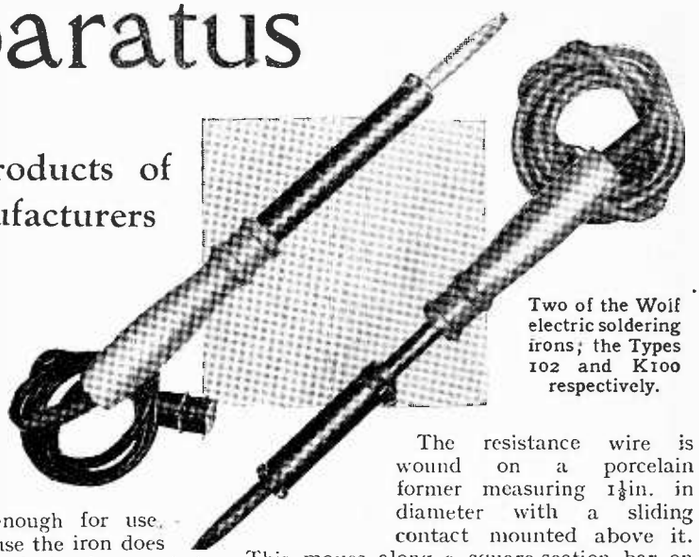
Among the many different models made by S. Wolf and Co., Ltd., Pioneer Works, Hanger Lane, Ealing, London, W.5, are several that are intended especially for the type of work undertaken by the radio amateur. Of these possibly the Model 102, which is fitted with an 80-watt heater element, is the most suitable. It has a copper bit ¼in. in diameter.

One of these 80-watt electric soldering irons has been tested and found very satisfactory for all types of radio construction. The iron heats up quite quickly and very soon after switching on is hot enough for use. When continuously in use the iron does not become too hot, but during long periods of idleness there is a tendency to overheat unless the copper bit is rested on a block of iron—though a moderately large piece of sheet iron or aluminium would serve just as well—to conduct away the surplus heat.

This iron, known as the Type 102, costs 9s. 6d.

The other model we had sent to us for examination was the K100, which consumes 100 watts and is well suited for continuous work, such as in factories, etc., though the amateur requiring an iron that will handle somewhat heavier work than merely soldering wires and light joints as in radio construction will find it very useful. This costs 16s. 6d.

There are many other styles of electric soldering irons in the Wolf range, and it will be of interest to readers to know that copper bits of various shapes and sizes are available for all the models. Bits and heater elements can be easily replaced whenever necessary.

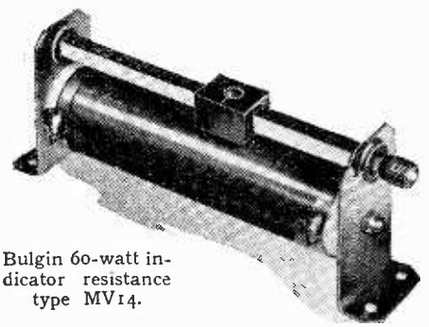


Two of the Wolf electric soldering irons; the Types 102 and K100 respectively.

BULGIN INDICATOR RESISTANCE

THERE are many uses to which a calibrated variable resistance can be put in experimental work. By including it in the circuit the correct value for a fixed resistance is easily found by adjusting the variable and then reading off from its scale the amount of resistance in use.

It provides a ready means for ascertaining the actual value of an unmarked resistance when other means for resistance measurement are not available, so that servicemen and radio dealers can find many uses for it.



Bulgin 60-watt indicator resistance type MV14.

A. F. Bulgin and Co., Ltd., Abbey Road, Barking, Essex, make two models of this kind; one has a total value of 10,000 ohms and the other of 50,000 ohms.

The resistance wire is wound on a porcelain former measuring 1⅛in. in diameter with a sliding contact mounted above it. This moves along a square-section bar on which a 0-10 scale with sub-divisions is engraved. These divisions are visible through an aperture in the slider on which an indicator line is engraved.

Tests were made with the 10,000-ohm model Type M.V.14, and measurements show that the calibration is accurate to within two per cent. at all parts of the scale.

This resistance is rated at 60 watts and as it is intended to carry up to 77 mA it was also tested with a current of this value flowing through it.

When dissipating 60 watts considerable heat is, of course, generated, but the wire did not show any signs of being overtaxed, nor did the turns become loose. The resistance was as sound after the full-load test as it was before.

As three terminals are fitted the resistance can be used as a calibrated potential divider, and if supplied with a known AC voltage it provides the means for calibrating valve voltmeters and other test apparatus of a like nature.

This resistance is very robust, it is well made, and all the metal parts are nickel-plated. The 10,000- and the 50,000-ohm types each cost 10s. 6d.

CR Tube Data

WE are informed that in the data given for the Baird cathode-ray tube in *The Wireless World* for April 2nd, 1937, the figure of 70 volts p-p for the modulation input may be misleading as the tube normally operates with an input of 30 volts p-p only. The figure given of 70 volts is correct for the limits of black and defocusing.

42 YEARS OF MOTORING

Pioneer Journal's Notable Coronation Number

THE oldest of the motoring journals, *The Autocar*, which was founded in 1895, the year in which His Majesty King George VI was born, is fittingly celebrating the Coronation with a special issue dated April 30th.

This Coronation Number is printed with full colour sections on art paper and with other special two-colour sections. Superb coloured portraits from oil paintings of their Majesties are included, and a history of the British automobile industry from the inception makes this greatly enlarged issue a permanent record of value to all interested in motoring. The price is sixpence.

Listeners' Guide for

Outstanding Broadcasts at Home and Abroad

MAY Day always conjures up in one's mind the idea of the open-air and the countryside. The B.B.C. must have been infused with a longing for the wide, open spaces when planning the programmes for Saturday, May 1st. As announced in Broadcast Brevities last week, the Outside Broadcast Department will have a very full day. At 1.15 and 4.45, P. G. H. Fender will describe the progress in the county cricket match between Lancashire and Derby from Old Trafford, Manchester. George Allison and Ivan Sharpe, at Wembley Stadium, will, from 2.45 to 4.45, describe the great battle between Sunderland and Preston North End for the F.A. Cup.

Brooklands motor race track will be visited at 5, where F. J. Findon will comment upon the scenes at the first race over the recently completed road circuit, and will describe the efforts of the competitors during this 220-mile race. Leaving Brooklands at 5.15, the listener will then be taken over to Bournemouth, where, until 6 o'clock, Major Cooper-Hunt will describe the progress of the competition in the finals of the Hard Courts Tennis Championships of Great Britain. All the above will be radiated Nationally, but the Outside Broadcast Department's May Day activities are not even then exhausted, for Regional listeners will later in the evening have three further O.B.s.

At 9 the microphone will be taken to the Mendips, where a party will be heard descending into Swildon's Hole. For some four hundred feet they will be crawling along slippery ledges in the caves, ever and anon guarding against a false step which might thrust them into what appears to be a bottomless pit.

Bidding farewell to potholes, listeners will, at 9.20, be switched over to the first of two "indoor" O.B.s. Willie Smith at Thurston's Hall will describe the last session of the match between Joe Davis and Tom Newman in the United Kingdom Professional Billiards Championship. Following this at 9.45 "Tommy" Woodroffe will describe for listeners the scene and some of the pictures at Burlington House prior to the Royal Academy Banquet. From the banquet itself Lord Macmillan will be heard proposing the toast, "The Royal Academy of Arts." With this broadcast ends a hectic day for the O.B. engineers.

MUSIC

ON Sunday, at 10, Regional listeners will hear the second broadcast in the new series, "Music for Worship," the work chosen being Handel's anthem, "O Come, Let us Sing Unto the Lord," which will be sung by the B.B.C. Chorus. This anthem is one of the twelve Chandos anthems so-called because they were written when Handel was Kapellmeister to the Duke of Chandos and were intended for performance in his private chapel at Edgware.

There will be a first performance on Thursday at 9.20 (Nat.) of a new work by Sir Granville Bantock entitled "King Solomon" which the composer himself will conduct. The work which is for chorus and orchestra, will be sung by the London Select Choir. It is based on the 21st and 148th Psalms, and the first chapter of the second book of Chronicles. There is a part for a narrator which will be taken by Harmon Grisewood, the announcer.

HILDEGARDE, the well-known American cabaret artiste who will be heard in a cabaret entertainment, Caf' Chant,' to be presented by Archie Campbell on Tuesday at 9.40 (Nat.). She starred in the N.B.C.'s first television Press demonstration and will be seen by viewers on Thursday at 9.30.

RADIO REVIEW

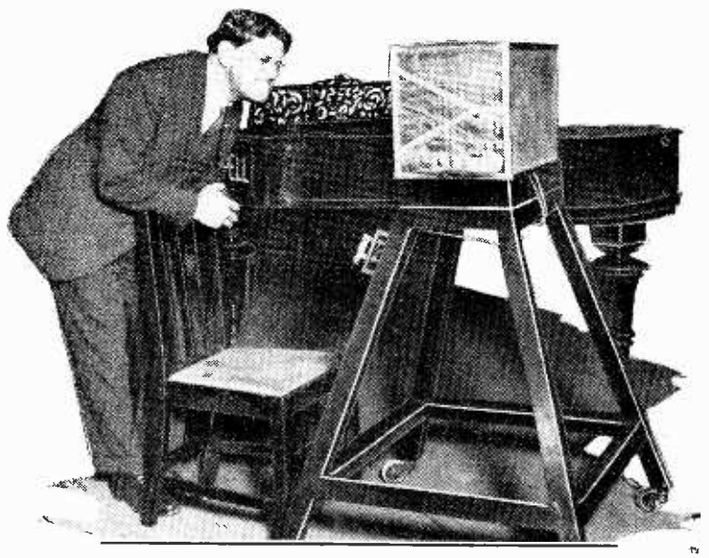
THIS week's Saturday night alternative to the fortnightly Music Hall programme is entitled "Radio Review," which Bryan Michie will present as a review of radio artistes from 1922 to 1937. "Radio Review" will be heard by National listeners at 8. It will be an intimate, personal programme introducing many well-known artistes. This will be the first occasion that C. H. Middleton, the gardening expert, has come into a variety programme. Others who will be heard include Hughie Greene, *without* his gang, Henry Hall at the piano, Jeanne de Casalis, and Gypsy Petulengro.

SATIRE ON SELFISHNESS

IN 1924 Richard Hughes wrote "Danger," the first play ever written solely for British broadcasting. His latest radio play "We Gave Our Grandmother," a light comedy satirising the selfishness of the younger generation, will be produced for Regional listeners on Monday at 7.30 and Nationally on Wednesday at 9.20. Students of radio-dramatic technique will be interested in the style adopted by the author for the presentation of this microphone play.

QUACK REMEDIES

PETER CRESSWELL is to present a farce entitled "Beware of Influalgia," specially written for the microphone by a new author, H. R. Jeans, on Sunday at 9.55 (Nat.). The play deals with the rivalry between two firms who manufacture patent medicines. The proprietors of "Flyo," who are on the verge of bankruptcy, hit upon the idea of inventing a new disease that can only be cured by taking their medicine.



SAVOY HILL DAYS. This photo of Bransby Williams was taken during a broadcast in 1925. He will be heard on Sunday at 7.30 (Nat.) in selections from his repertoire with Reginald Foort at the Theatre Organ.

The manufacturer of "Choko," finding his sales dropping, persuades his daughter to go as a typist with the rival firm in order to steal their formula. A series of diverting situations results, and with romance by no means neglected the farce should prove ideal for broadcasting.

CINEMA VARIETY

WE are to hear another variety programme from the Union Cinema, Kingston-on-Thames, on Thursday at 7.50 (Nat.). Harold Ramsay, the organist at the cinema, is responsible for this May edition of "Radio Rodeo." He has "roped in" many well-known radio artistes, including George Robey, Clapham and Dwyer, the Carlyle Cousins, Gypsy Nina, the Ladies' Accordeon Band, and the Gordon Ray

eWeek

HIGHLIGHTS OF THE WEEK

FRIDAY, APRIL 30th.

Nat., 8, Songs from the Films. 9.20, The Rt. Hon. Winston Churchill on The Responsibilities of Empire.

Reg., 7.30, Melody Out of the Sky. 8.15, Act I of "Turandot" from Covent Garden. 9, Robinson Crusoe, music from comic opera.

Abroad.

Vienna, 9, Vienna Philharmonic, conductor Bruno Walter.

SATURDAY, MAY 1st.

Nat., Commentaries: 1.15, County Cricket; 2.45, Cup Final; 4.45, County Cricket; 5, Brooklands Road Race; 5.15, Tennis Championships. 8, Radio Review.

Reg., 6, Songs from the Films. 7.30, Recital of Gretchaninov's songs by Tatiana Makushina with the composer at the piano. 8, "Music in the Air": the life and work of Edward Elgar.

Abroad.

Bucharest, 8.15, "Eva"; three-act operetta (Léhar).

SUNDAY, MAY 2nd.

Nat., 6, "I Knew a Man"; Tom Clarke on Lord Northcliffe. 7.30, Bransby Williams. 9.55, "Beware of Influalgia."

Reg., 5.40, Talk: the Paris Exhibition. ¶Students' Songs. 7.15, Pianoforte Recital, Kathleen Long.

Abroad.

Frankfurt, 8, Puccini's "Tosca."

MONDAY, MAY 3rd.

Nat., 7, "Monday at Seven." ¶Julius Harrison String Ensemble.

Reg., 7.30, "We Gave Our Grandmother." 8.20, "Antigone" from Swansea.

Abroad.

Munich, 8.10, Gala Military Concert—bands and soldiers' chorus.

TUESDAY, MAY 4th.

Nat., 5.15, Julius Kantrovitch and his Orchestra. 9.20, Sir James Jeans. 9.40, Caf' Chant'—cabaret entertainment.

Reg., 7.30, Tommy Matthews and his Concert Orchestra. 8, Kai Ewans and his Orchestra from Copenhagen. 8.40, H. V. Morton, "Off the Route."

Abroad.

Strasbourg, 8.30, Vienna Singing Boys and the Radio Orchestra.

WEDNESDAY MAY 5th.

Nat, 6.40, Recital of Folk Songs by Surya Sena (Sinhalase singer). ¶The Fol-de-Rols. 9.20, "We Gave Our Grandmother."

Reg., 7.30, "The Hey-day of the Music Halls"—records. ¶Filson Young, "In Western Lands."

Abroad.

Radio Paris, 8.30, "The Black Domino," comic opera (Auber).

THURSDAY, MAY 6th.

Nat., 7.50, "Radio Rodeo" from the Union Cinema, Kingston. 10.20, The Theatre Orchestra and Mischa Motte (entertainer).

Reg., 8, Act I of Gluck's "Alceste" from Covent Garden. ¶"Paradise Isle"; music of the South Seas.

Abroad.

Königsburg, 8, Puccini's "Madame Butterfly," conductor Brückner.

WHAT NEXT? Listeners to the National programme at 7.15 on Sunday will hear a Transatlantic contest in progress to discover the world's champion singing mouse. Aspirants from Canada, London, New York and Chicago will be taking part via the N.B.C. of America, the Canadian Broadcasting Commission and the B.B.C.

Radiolympia Girls. Harold Ramsay, Sidney Torch and Robinson Cleaver will be at the organ. The last variety show from Kingston was a great success, and listeners can be sure of a first-class entertainment.

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OPERA

Home: From the Royal Opera House two opera excerpts will be heard this week. To-night (Friday) the first act of Puccini's "Turandot" will be relayed at 8 (Reg.). The scene of this act is by the walls of the Imperial Palace at Pekin in legendary times. Eva Turner will appear in the title rôle, and the part of Calaf will be sung by Martinelli, who has not appeared at Covent Garden since 1914. The second relay comes to Regional listeners on Thursday at 8 when Act I of Gluck's "Alceste" will be heard, presented by a joint company of artistes from the Paris Opéra and Opéra-Comique. The action takes place in Greece in ancient times. This performance will be the only one of this opera during the present season.

Abroad: Budapest 1 favours us again with the relay of the Royal Hungarian Opera programme at 7.30 to-night (Friday). The first item is a short opera, "The Love Letter," by Count Franz Esterházy, a member of the very distinguished Hungarian princely family. Although I have no data to hand about this particular composition, the record of this family is such as to make it certain that the theme of the opera is a national one.

Beromunster gives us a seldom-heard side of Hugo Wolf. "Der Corregidor," the only opera composed by this eminent writer of songs, is announced for its 8.50 programme to-night. Wolf actually commenced the composition of a second opera, but it was never finished.

Wolf-Ferrari's most successful opera has been chosen by Rome for its 9 o'clock programme on Saturday, his one-act "Suzanna's Secret" being relayed at that hour from the Teatro Massimo, Palermo. Hilversum 1 completes Saturday's opera transmissions with a truly classical programme. At 10.25 Act III of Wagner's "Dusk of the Gods" will be heard, and an excellent performance may be expected, since the Wagner Association's Choir and Concertgebouw Orchestra are responsible.

Frankfurt will give Puccini's "Tosca" at 8 on Sunday. This has long been a favourite of the English opera-goer. Its first Covent Garden performance was in 1900, the year of its Rome *première*.

Radio-Paris at 8.30 on Wedday announces "The Black Domino," an opéra-comique of the typically French school composed by Auber, who resided in London for a number of years, and whose "Mesaniello"—the best known of his operas in this country—is reputed to have started the 1830 Brussels riots which drove the Dutch out of Belgium.

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BOYS' ORCHESTRAS

THE regular Boys' Orchestra of the Norwegian Broadcasting organisation and the orchestra from the Drammen Grammar School combine to give a programme at 8.10 on Monday, which will be broadcast from all Norwegian stations. The programme will conclude with a choir of 400 boys uniting with the orchestras in a rendering of Strauss' "Blue Danube."

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MISCELLANY

A RADIO Ball for the younger generation, which will consist of visits to many Copenhagen dance clubs, will be radiated from Kalundborg from 8.15 on Sunday until 2 a.m. on Monday.

Paris PTT is to broadcast a programme of folklore centred round Lille at 8.30 on Wednesday.

If ladies tune in to Leipzig at 8 on Wednesday, they are warned that they do so at their own risk, for a Stag party will be in progress.

THE AUDITOR.

SWING. For the next "Swing that Music" programme Kai Ewans and his orchestra will be heard from Copenhagen on Tuesday at 8 (Reg.). Two new Danish compositions will be heard for the first time. They are "The Girl I Knew" and "The Copenhagen Girl," the latter item has been composed specially for this occasion. The team which is considered the best swing band in Scandinavia plays at the Nimb Restaurant, Copenhagen, Kai Ewans is seen seated in the centre.

"Distortionless" Driver

FOR AUDIO OUTPUT STAGE

By W. N. WEEDEN

AN interesting and important circuit application involving negative feed-back is the employment of such an amplifier to drive the grids of Class AB (quiescent pp) power output valves in high-quality amplifiers. Even though the valves in the output stage may be characterised by inherent low distortion performance, the amplifier output may be seriously affected by distortion introduced by the driver stage. The data given here were supplied to the writer by the Hygrade Sylvania Corp. on a suitably degenerative AF amplifier employed to drive a pair of 6L6 valves in push-pull. The following curves show the performance which may be expected from such an AF system. Average production valves were employed in securing this data.

The circuit of Fig. 1(a) shows a conventional power output stage—from the secondary of its input transformer. The interesting feature, however, is the connection of the driver transformer in the cathode circuit of the driver valve, instead of in the conventional position in the anode circuit. This involves certain changes in transformer design. T1 has an overall turns ratio of slightly less than unity, and should follow standard practice for the design of Class AB input, or driver, transformers, considering the effective output impedance in ohms in the cathode circuit to be approximately $1/g$. For a type 6C5 this value is 500 ohms. In series with the primary of the driver transformer is a resistance of the proper value to give a total cathode resistance which will bias the grid by the correct amount. In this particular case the transformer primary has a DC resistance of 500 ohms, while 1,000 ohms is necessary to produce

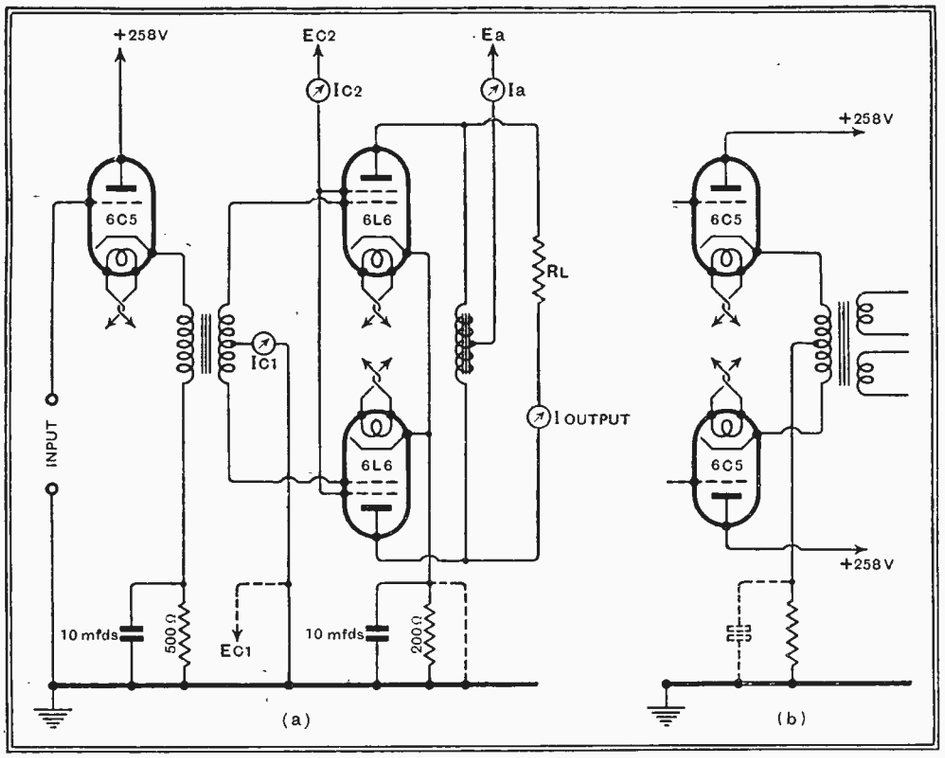


Fig. 1.—Distortion in a driver valve can be greatly reduced by adopting cathode coupling as shown at (a) for a single and at (b) for a push-pull driver stage.

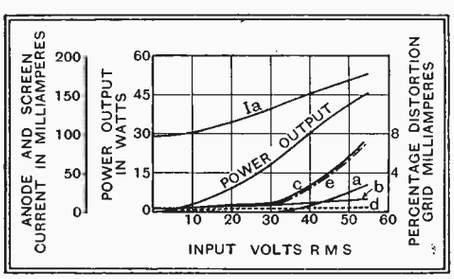


Fig. 2.—These curves show the performance of two 6L6 valves in push-pull with a 6C5 driver valve. The 6L6 valves have 400 volts anode and 250 volts screen supplies and a load impedance of 7,500 ohms.

Key to Lettering in Illustrations:

a = Ic1 = grid current
b = Ic2 = screen current
c = total distortion
d = 2nd harmonic distortion
e = 3rd ,, ,,
f = 5th ,, ,,
g = 7th ,, ,,
h = 9th ,, ,,
k = 75 volts RMS
m = 50 ,, ,,
n = 25 ,, ,,
p = 80 ,, ,,
q = 55 ,, ,,
r = 30 ,, ,,

eight volts of bias with 258 volts on the 6C5 anode, and 8 mA. anode current. Thus a 500-ohm resistance, thoroughly by-passed, is placed in series with the 500-ohm primary of the input transformer. This resistance varies, of course, with both the valve and transformer used.

As pointed out by Cocking, degeneration decreases the gain of a stage in which it is present. Therefore, the signal input to the driver grid must be much larger than with the input transformer connected normally. However, the very low inherent distortion and low output impedance characterised by this arrangement contribute to a marked improvement in overall performance.

Figs. 2 and 3 show operation characteristics with self-bias on the output valves, under two standard operating conditions for the 6L6 valves. Anode, screen and input grid currents, power output and distortion are shown as functions of the

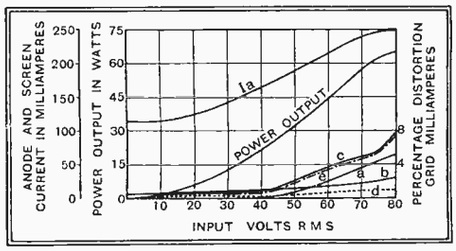


Fig. 3.—These curves are similar to those of Fig. 2, but are for the case when the 6L6 valves have screen potentials of 300 volts. The optimum load is then 5,500 ohms.

RMS signal to the driver grid. In Fig. 3 the 6C5 driver begins to draw grid current at an input of approximately 75 volts.

Similar data are given in Figs. 4 and 5 except that the output valves are operated with fixed-bias. The driver conditions were the same as above.

The load resistance employed in each case was different. The optimum loads which were chosen were obtained from the output characteristics given in Figs. 6 and 7. Power output and distortion readings

"Distortionless" Driver for Audio Output Stage

were taken for three different values of input signals, as the load was varied. Small deviations from the load values selected may be desirable, depending on the power level at which the amplifier is worked. The effects of load changes are

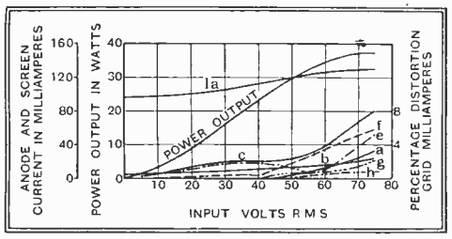


Fig. 4. These curves are again like those of Fig. 2, but here a fixed grid bias of −20 volts is used for the output valves. The load is 6,000 ohms.

clearly indicated and the choice will be governed by the individual requirements.

The circuit shown indicates that the 6L6 output valves are operating as high impedance pentodes, which is not desirable from the point of view of speaker damping and transient reproduction. To secure best results from this point of view, it is almost essential to apply negative feed-back to the output stage both in order to decrease harmonic distortion, and to reduce the effective anode resistance of

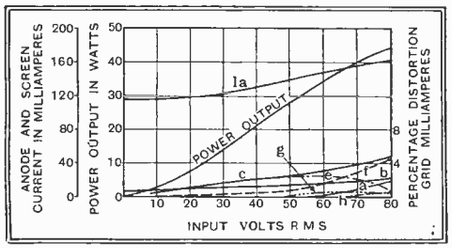


Fig. 5.—In this illustration the conditions for the 6L6 valves are the same as in Fig. 3, but fixed bias of −25 volts is used. The load is 3,800 ohms.

the 6L6s so that the speaker looks back into a low resistance, thus securing the same damping that would be secured with low-resistance triodes. Unfortunately, this use of degeneration decreases the power sensitivity, so that from twice to four times the input or signal voltage is required for a given output. Due to the loss of gain in the driver, the 6C5 is already being worked to its limit, consequently the use of either a push-pull driver arrangement, as shown in the diagram Fig. 1b, or one of the small power

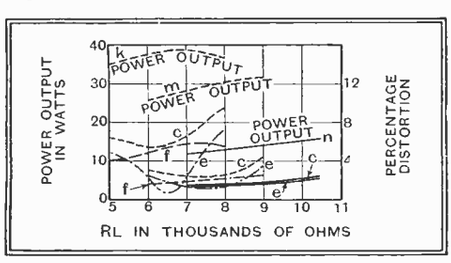


Fig. 6.—The effect of the load impedance RL for the conditions of Fig. 2 is shown here for various signal inputs.

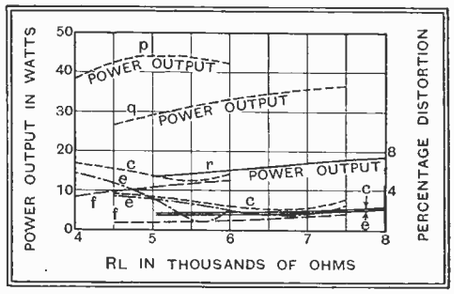


Fig. 7.—Here again the load impedance is the variable factor, but the screen potential is now 300 volts.

output triodes, or two of them in push-pull, will be required in order to supply the increased grid voltage of the 6L6s.

Television Programmes

Transmission times are from 3-4 and 9-10 daily.

Vision 45 Mc/s. Sound 41.5 Mc/s.

FRIDAY, APRIL 30th.

3, Esther Coleman—Songs. **3.10,** Artists and their work; drawings by James Thurber of "The New Yorker." **3.20,** British Movietonews. **3.30,** Sports Review: Howard Marshall makes his first television appearance interviewing sporting personalities of the month. **3.50,** Starlight—Leonard Henry.

9, Eric Wild and his Tea-Timers. **9.10,** Repetition of 3.10 programme. **9.25,** Gaumont-British News. **9.35,** Repetition of 3.30 programme. **9.50,** Starlight—Cornelia Otis Skinner.

SATURDAY, MAY 1st.

3, Summer Gardening: Demonstration by C. H. Middleton on a garden bed in the grounds of Alexandra Palace. **3.15,** Herschel Henlere at the piano. **3.25,** Gaumont-British News. **3.35,** Alice in Wonderland adapted for television with Ursula Hanray as Alice.

9, "Fugue for four cameras," danced by Maude Lloyd. This programme will show the interesting effects made possible by using four television cameras. **9.10,** Summer Gardening; Studio talk by C. H. Middleton. **9.25,** British Movietonews. **9.35,** "The Mizzen Cross-trees." Nautical songs and dances.

MONDAY, MAY 3rd.

3, Fashion Parade. **3.15,** Billiards demonstration by Joe Davis and Tom Newman, finalists in the United Kingdom Professional Billiards Championship. **3.25,** Gaumont-British News. **3.35,** The Vic-Wells Ballet in "Les Patineurs." **9** and **9.15,** Repetition of 3 and 3.15 programmes. **9.25,** British Movietonews. **9.35,** Repetition of 3.25 programme.

TUESDAY, MAY 4th.

3, Health Exercises by members of the Women's League of Health and Beauty. **3.25,** "The 'ole in the Road": sketch by Seamark, with George Graves and Myles Clifton. **3.40,** British Movietonews. **3.50,** Starlight—The Western Brothers.

9, Personalities II. **9.10,** Cascade; a mixed programme. **9.25,** Gaumont-British News. **9.35,** Ballroom Dancing; Alex Moore and Pat Kilpatrick. **9.50,** Starlight.

WEDNESDAY, MAY 5th.

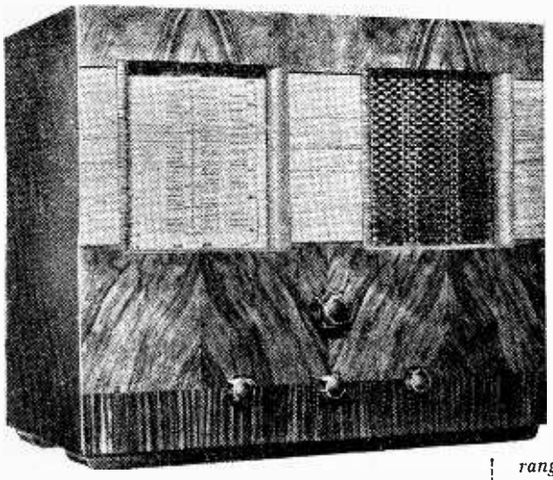
3, Charlot Starlets. **3.20,** Gaumont-British News. **3.30,** Fifty-first Picture Page.

9, Repetition of 3 programme. **9.20,** British Movietonews. **9.30,** Fifty-second Picture Page

THURSDAY, MAY 6th.

3, Wynne Ajello—Songs. **3.10,** Architecture—III. **3.25,** British Movietonews. **3.35,** Television production of John Drinkwater's "Abraham Lincoln."

9, Instrumental item. **9.5,** Repetition of 3.10 programme. **9.20,** Gaumont-British News. **9.30,** Cabaret, including Hildegarde.



Marconiphone

MODEL 222

A Sensitive Battery Superheterodyne with Three Waveranges

FEATURES. ***Type.***—*Table model superheterodyne for operation from batteries.* ***Waveranges.***—*(1) 18-50 metres. (2) 195-580 metres. (3) 840-2,000 metres.* ***Circuit.***—*Heptode frequency-changer—var.-mu screen-grid IF amplifier — double - diode - triode second detector—double pentode output valve.* ***Controls.***—*(1) Tuning. (2) Volume and on-off switch. (3) Wave-range. (4) Tone.* ***Price.*** *— 13 guineas.* ***Makers.***—*Marconiphone Co., Ltd, 210/212, Tottenham Court Road, London, W.1*

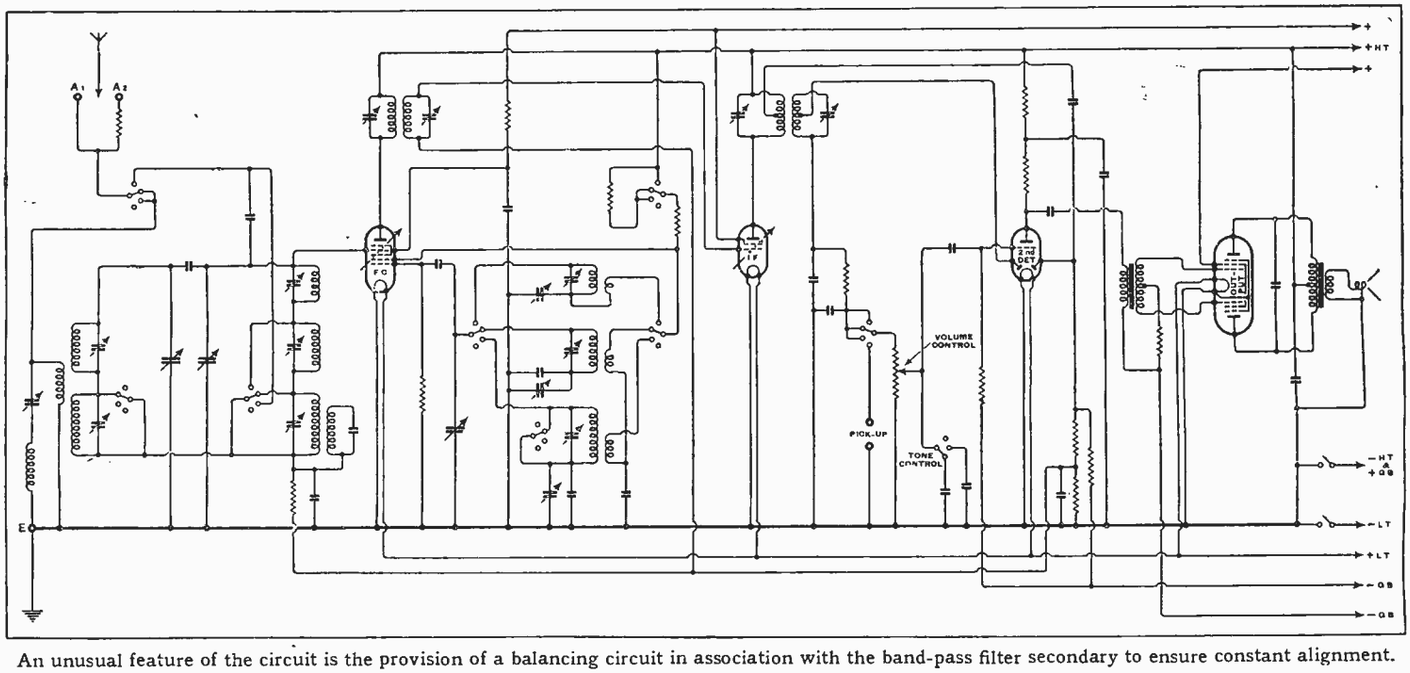
THIS receiver, which is the leading model in the Marconiphone series of battery sets, is notable alike for its good performance in the matter of sensitivity and for many neat features in its design and construction. The four-valve superheterodyne circuit includes a QPP output stage, which is acknowledged to give a very high standard of volume and quality for a small expenditure of HT battery current, and there are many refinements in the earlier stages which contribute materially to the efficiency and smooth working of the receiver.

There are two aerial tappings, one of which incorporates a series resistance for use with large aerials or when situated near to a powerful transmitting station. The coupling is through a single tuned circuit on the short waves and through a band-pass filter, with top- and bottom-end capacity coupling, on medium and long waves. Across the aerial and earth circuit is connected an IF filter, and an unusual refinement is the provision of a subsidiary "dummy" coupling coil in association with the secondary circuit to simulate the aerial loading and thus to enable more accurate alignment of the circuits throughout the range.

The heptode frequency-changer has separate oscillator circuits for each waveband, and the oscillator anode voltage is increased on the short-wave range. Litz-wound IF transformers tuned to 465 kc/s are associated with the IF amplifier, which is a variable-mu screen-grid valve instead of the usual pentode. The output IF transformer is tapped down both on primary and secondary windings to feed the AVC and signal diodes respectively. A suitable delay is obtained by returning the AVC diode load to 1.5 v. negative, and a small additional bias is also gained by virtue of the fact that the AVC diode is situated near the positive end of the filament.

Both the frequency-changer and the IF valve are controlled, and the circuit is arranged to keep a small initial bias on both valves. The output from the signal diode is taken through a volume control potentiometer to the triode amplifying section of the second detector stage, and the circuit is arranged so that the input from the gramophone pick-up is also introduced at this point through the same volume control. The push-pull transformer preceding the QPP output valve is resistance-capacity fed from the triode.

A small but efficient permanent-magnet loud speaker takes the output from the QPP stage and gives quality and volume of reproduction which would put to shame many receivers operating under the advantage of a mains supply. There is a three-stage tone control, which can, in general, be left in the high position on all wavebands, owing to the low level of background noise. The bass response is good and there is just the right amount of top to give well-balanced reproduction —this in spite of the high selectivity. On long waves we have seldom before had such clear reception from the Deutschlandsender with so little interference from Droitwich and Radio-Paris, and on the medium-wave band with the aerial connected to the A2 tapping it was found possible to approach to within less than one channel on either side of the Brookmans Park transmitters at a distance of fifteen miles before signs of interference showed themselves.



An unusual feature of the circuit is the provision of a balancing circuit in association with the band-pass filter secondary to ensure constant alignment.

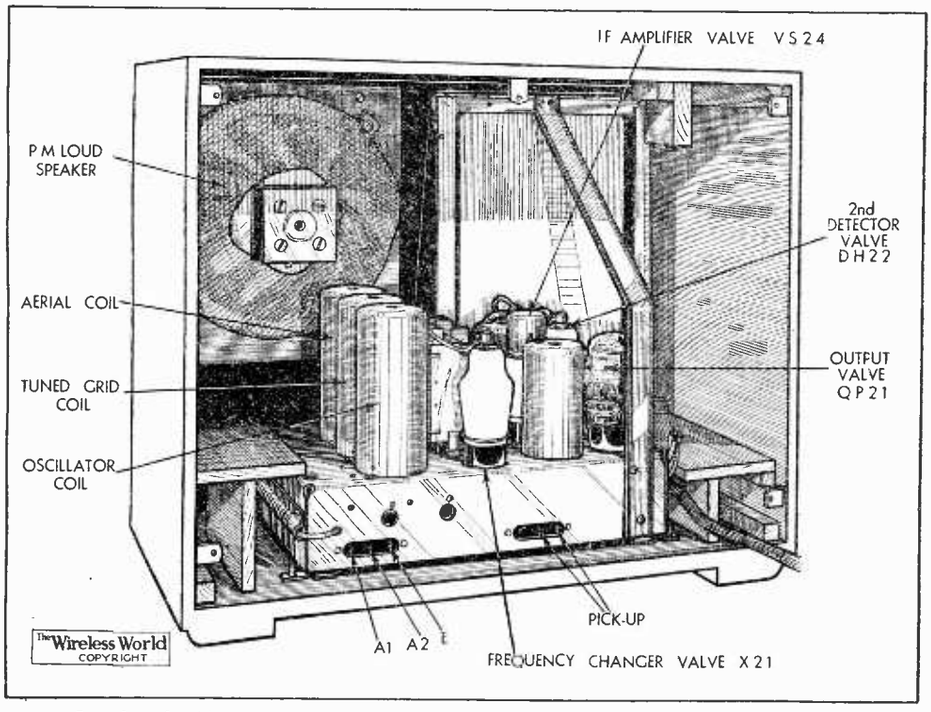
The excellent effective range and sensitivity of the Model 222 is undoubtedly due to some extent to the low level of background noise, which on the short-wave range at first aroused suspicions of comparatively low sensitivity. This impression was soon dispelled, however, when Schenectady (W2XAD) was picked up and held for upwards of an hour during the late afternoon. It is only fair to say that, while many of the European transmissions were easily located by virtue of their higher field strength, the American station was at first overlooked, and we put this down to the fact that the slow-motion drive might with advantage have been given a somewhat higher ratio. However, when the feel of the controls has been acquired, tuning on short waves presents little difficulty.

An unusually large and well-set-out tuning scale has been provided in which the three waveranges are calibrated on vertical scales. The indicator takes the form of a horizontal hair line on a strip of celluloid which moves up and down the scale very much after the style of a slide rule cursor. Station names are indicated on the medium- and long-wave scales, and the principal broadcast bands have been marked on the short-wave scale. At the bottom of the panel is a small circular window with a pilot light which shows when the set is in operation. The rectangular tuning scale is matched by a loud speaker grille of similar size and shape, which is faced with the "sound-permeable" metal grille which is a feature of this firm's products.

The chassis is mounted centrally in the cabinet, and the tuning scale is offset, being supported rigidly by a channel-section bracket. Strong shelves are provided at each side of the chassis for the HT and LT batteries, and the fibre back panel of the cabinet has been constructed with a suitable recess so that the LT accumulator can be removed for charging without having to remove the panel.

Measurements on the HT consumption indicated that the standing current with no signal on the aerial—i.e., with the first two valves working at maximum sensitivity—was 8.5 mA. The unmodulated carrier of the local station reduced the HT to 5.5 mA, and, although it is difficult to estimate the average current under normal working conditions, it would not be far wrong to put this at 8 to 9 mA for the best compromise between volume and quality on an orchestral transmission.

The efficient working of the QPP stage is at all times dependent on careful adjustment of the auxiliary supply voltages in relation to the maximum HT voltage, and the makers' instructions should be followed implicitly. There is no provision for an external loud speaker, but the set can be used for the reproduction of gramophone records, for which an ample reserve of amplification is provided.



Interior of cabinet, showing offset tuning scale and shelves for HT and LT batteries.

"Stentorian" Extension Speakers

HITHERTO all the loud speakers in the "Stentorian" range made by Whiteley Electrical Radio, Ltd., have been fitted with "Microlode" universal matching transformers which make them suitable for use with sets requiring output loads of either high or low impedance.

As nowadays a very large percentage of commercial receivers call for a low impedance load it has been decided to issue the standard cabinet models without transformer if desired, and at a proportionately reduced price. A speech coil impedance of 2 ohms has been standardised, and those speakers which have been designed to work with the "Long Arm" remote control unit will not be affected.

RANDOM RADIATIONS

By "DIALLIST"

Coronation Figures

IT'S rather interesting to figure out what wireless users are going to spend on current during the Coronation Week celebrations. A conservative estimate of the number of sets in the country is 9,000,000, divided into 4,500,000 mains receivers, 4,000,000 battery and 500,000 crystal. Not every one of them, of course, will be at work during the week, but we shan't be far out in estimating 135,000,000 hours of listening in the seven days with mains sets and 120,000,000 with battery sets. If we assess the average mains set at 60 watts, this comes to 8,100,000 units, or a total expenditure, allowing threepence a unit, of £100,000 in round figures. Not so bad for the mains sets! And what of the rest? The crystal receivers we can leave out of our reckoning, for they have at any rate one advantage; they cost nothing to run. But battery sets account for a big sum.

The Cost of Watts

To arrive at the average watt-hour demands of the battery set is not quite so easy as for its main opposite number. Battery sets range from the tiny affair with a couple of valves, drawing perhaps 0.25 ampere at 2 volts from the LT accumulator and 5-6 milliamperes at anything down to 50 volts from the HTB, to the seven-valve superhet with an LT load of over an ampere and an HT load of 25-30 milliamperes at 150 volts. Probably a fair average estimate would be 0.4 ampere at 2 volts, or 0.8 watt LT and 10 milliamperes at 100 volts, or 1.0 watt HT. Taking it that a 2-volt 30-ampere-hour accumulator costs sixpence for a charge, we have 10 watt-hours for a penny. The price per unit of LT current is thus 8s. 4d., or, say, eight shillings in those round figures that are so much less trouble than the other sort. High-tension current is not simple to cost out. Some people use accumulators, and these may spend little more per unit on HT than on LT supplies, depreciation and so on being left out of account in both instances.

An Amazing Total

At the other end of the scale are those who rely on hopelessly overloaded small-capacity dry HTB's. Their HT current may cost them the best (or worst!) part of a couple of pounds per unit. Taking it by and large, 15s. per HT unit is probably well within the mark for battery supplies of all kinds. With the 120,000,000 hours of work allotted to them during Coronation Week, battery sets will thus require 96,000 units at 8s. for their LT circuits, with a value of over £38,000, and 120,000 units at 15s., or £90,000 worth, for their HT circuits. Adding together the £100,000 for mains sets and £128,000 for battery sets, we arrive at a total of £228,000. The figures err, if anything, on the low side; the total expenditure on current for wireless sets probably won't be very much under a quarter of a million pounds. It seems a lot at first sight—until you realise that it means less than sevenpence per set, or perhaps twopence per listener, for a whole week of "gala" entertainment.

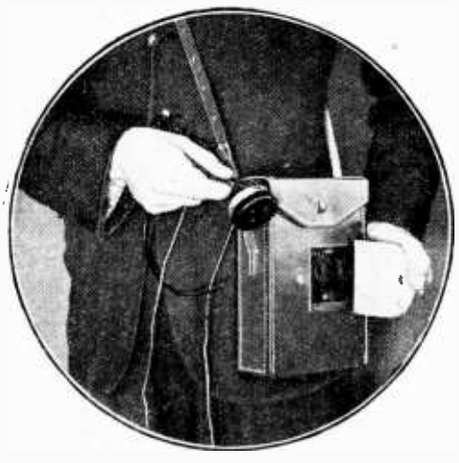
Be Prepared

ONLY eight days remain now till Coronation Week begins with its wonderful programmes and historic running commentaries. This is just the gentlest of reminders that should there be an if or a but about your set it may be as well to see to it or have it seen to at once, ere wireless shops run out of stock of the things that you must have and service men become harder to get hold of than admirals in Switzerland. That valve with the loose cap, of which the connections are, so to speak, hanging on by their eyelashes; that wave-change switch with the contacts that have been getting chancier and chancier for weeks; those spare fuses that you have been meaning to buy since heaven knows when; that HTB that is crying out for renewal—all these and others like them are things that let you down if they're not seen to just at the critical moment. Then go to it, my hearties, without more of that procrastination that is dear to most of us. And I only hope I myself will remember to renew the ancient earth wire that is down to about its last sound strand!

Television in the Country

HALF an hour before writing this note a neighbour of mine was showing me and letting me hear what the television set that he has recently installed can do. This is the first time that I have seen television reception outside London, and I must say that I was agreeably surprised to find both sound and vision excellent. This locality is just over 20 miles as the crow flies from the Alexandra Palace, and according to the B.B.C.'s field-strength map, it lies only a little way inside the 0.5 millivolt-per-metre contour. It would seem that 1 millivolt per metre is by no means the minimum field strength for good reception, for we had a rock-steady image all the time with fine contrasts and excellent definition. The only trouble experienced at all was from passing motor vehicles; as I anticipated, it has so far proved a bit of a problem to get the aerial high enough to be outside the zone of ignition interference. But even though there was a good deal of traffic going right past the windows of the room in which the set stands, the interference was seldom severe enough to spoil reception for more than a second or two.

Portable Receiver in a Camera Case



When closed up the "Pocketphone" portable, fuller particulars of which are given on the opposite page, might easily be mistaken for a camera.

Pill for the B.B.C.

SIR THOMAS BEECHAM, I observe, has been getting it off his chest again. He objects to the B.B.C.'s sending out what he describes as the biggest nonsense ever heard in music for three-quarters of the day. His only consolation is that "such musical toys as the wireless and the gramophone" have a very short life, by which I take it he means that both broadcasting and the making of gramophone records will pass ere long into the limbo of forgotten things. That both will eventually be superseded by something far superior to what we have now I haven't the smallest doubt, but they're going to develop—possibly in amazing ways—and not to fade out. Sir Thomas forgets, I think, the enormous debt that music owes to both. But for the record and the loud-speaker millions of folk would never have heard Caruso or Melba or Mischa Elman or Mark Hambourg; opera would have been unknown to them—and so would the conducting of Sir Thomas Beecham. He mustn't grudge us the musical nonsense that many of us find so diverting at times. Serious music from early morn to midnight would be a little indigestible.

Peccavi!

A CORRESPONDENT castigates me for having written in a recent paragraph of "the now almost traditional three-valve-plus-rectifier superhet." He has been to the trouble of analysing the particulars of 288 mains-operated superhets made by 30 different firms, and finds that only 32 of these are of the three-valve type. *Peccavi!* 'Twas a slip of the pen; I should have written—did indeed mean to write—"three or four valves." Be it noted, too, that I was referring to the moderately priced set and not to that which costs from £15 upwards as an "all-wave" receiver. I am very glad to have my correspondent's figures; I hadn't made such a careful analysis myself, but was writing rather from the general impression gained as a result of examining and trying out the biggest selection of sets sent along to me this season.

Another Explosion

A WEEK or two ago I told how a gassing accumulator had resolved itself into powdered glass and a shower of dilute sulphuric acid when a naked light was thoughtlessly brought near it. A correspondent who does a good deal of charging tells me that he has known the same thing happen through a loose connection in a line of batteries on charge. His footsteps shook the bench on which they stood as he was passing; there was a spark, a flash and one accumulator less on the line. Those who do their charging at home might do well to bear this in mind. The accumulator cell is a perfectly safe thing so long as you treat it with ordinary care. But when it is gassing it gives off hydrogen, and a mixture of hydrogen and air can explode with surprising violence if ignited.

THE POCKETPHONE

A Portable Receiver in a Camera Case

AS a result of a recent paragraph by "Free Grid" on the subject of portable sets for use on the route of the Coronation procession we have received for test from A. Reid Manufacturing Co., Ltd., 14a, Clerkenwell Green, London, E.C.1, a neat little receiver costing £3 19s. 6d., which seems to conform exactly to the specification which was envisaged.

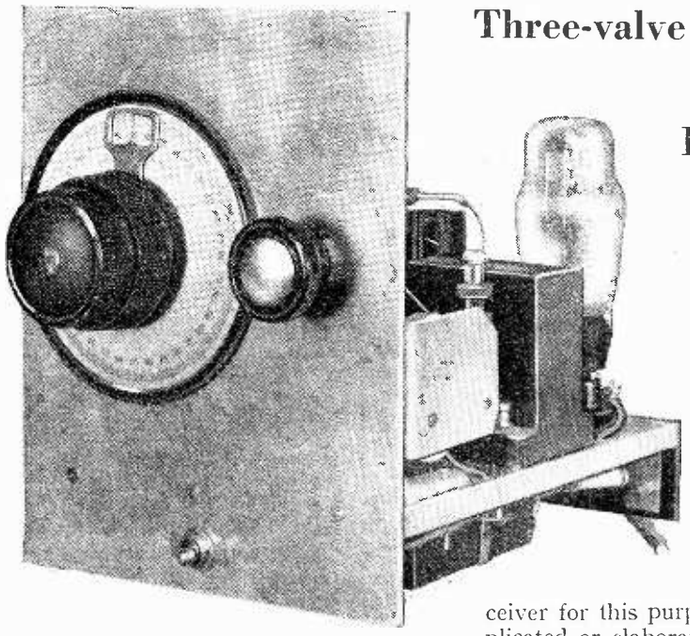
The leather carrying case measures only 8½in. by 6in. by 2½in., and is provided with a strap so that the set can be slung across the shoulders, leaving both hands free. Access to the controls is gained through a flap which when shut automatically switches off the set.

A three-valve circuit is employed, and an interesting feature is the use of resistance coupling for the RF amplifying stage. The frame aerial is wound round the inside of the case and is tuned to cover the usual medium-wave band.

Tested in London adjacent to the Coronation route excellent reception was obtained from the two Brookmans Park stations and the volume was sufficient to give intelligible speech above the traffic noise. On the local stations tuning is by no means critical, and with a little care it was found possible to bring in Fécamp, though a quiet corner would be necessary for the proper enjoyment of this station's programme out of doors.

The set is little heavier than a pair of binoculars, and there can be no doubt that it forms a valuable addition to the impedimenta of the sightseer.

IN NEXT WEEK'S ISSUE



Three-valve Battery Set for the Experimenter

5-15 Metre Reception

SINCE the original idea that the ultra-short waves were suitable only for communication over comparatively short distances has now been definitely disproved, attention is being focused on this portion of the radio spectrum.

Investigating receiving conditions prevailing from time to time will provide a new interest for the amateur experimenter. The receiver for this purpose need not be complicated or elaborate, and quite a simple set will suffice provided it is correctly designed.

In this article an inexpensive yet efficient receiver for use on these very high frequencies will be described. It includes three valves and is battery-operated.

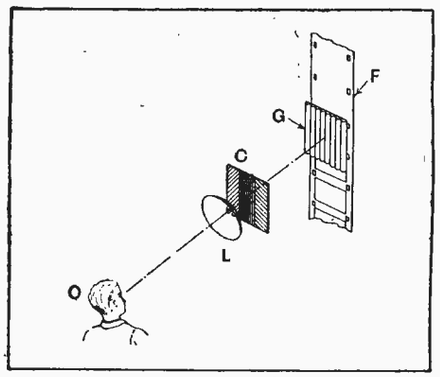
LIST OF PARTS.

Certain components of other makes but of similar characteristics may be used as alternatives to those given in the following list.

Condensers:
Variable
2 40 mmfds.
Eddystone "Microdenser" 900/40
1 20 mmfds.
Eddystone "Microdenser" 900/20
1 30 mmfds. mica **Eddystone 1023**
Fixed
1 0.00005 mfd. mica **Hunt's 1121**
1 0.01 mfd. non-inductive, tubular
Dubilier 4401
1 2 mfds. 700 volts test **Wego**
1 Dial, slow motion
Utility "Micro-dial" W181
1 Flexible coupler **Bulgin EH12**
1 Resistance, 5 megohms, ½ watt **Dubilier**
2 Section-wound SW chokes **Denco**
2 Small RF 'phone chokes **Denco**
1 Set of 6 coils (3 ranges) and 2 bases
Denco
1 Switch, QMB on/off **Bulgin S80**
1 Transcoupler **Bulgin LF10**
2 Valve holders, 4-pin
Eddystone "Frequentite" 949
1 Valve holder, 5-pin **W.B. Rigid Type**
1 Battery cable, 5-way **Bulgin BC3**
4 Terminals **Eelex**
5 Wander plugs **Eelex**
2 Spade ends **Eelex**
2 Plug-top valve connectors **Belling-Lee 1175**
1 Grid Bias battery, 9 volts
1 Knob for reaction condenser **Bulgin K44**
Plymax base, 7×8×¾in. **Peto-Scott**
Aluminium panel 7×8 5/16in. and 2 brackets for RF condenser and detector valve holder
Miscellaneous: **Peto-Scott**
Small quantity wire, screws, nuts, bolts, ebonite strip 7×1½×¼in., two small panel brackets, etc.
Valves: **Hivac**
1 SG220SW, 1 D210SW, 1 Y220.

Recent Inventions

Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section



Optical system for televising in natural colours.

GENERATING SYNCHRONISING SIGNALS

IN modern high-definition television, the apertures in the scanning disc are only 0.002in. in diameter. If the synchronising impulses are to be accurate, the leading edge of the generating slots must be correctly set to within a distance of the same order. As this is not possible in practice, instead of the proper frequency, there appears a complex frequency containing components of the order of the rotation of the disc. These must then be passed through a band-pass filter, followed by a non-linear amplifier.

According to the invention accurately-timed impulses are obtained by piercing the scanning-disc with circular holes, spaced apart at distances equal to their diameter. The fixed slit which determines the cross-section of the beam of light, across which the holes travel, is also made of equal diameter. This results in the production of a sinusoidal variation of light, which can be directly and simply converted into synchronising impulses of the required form.

The General Electric Co., Ltd., and D. C. Espley. Application date November 22nd, 1935. No. 458883.

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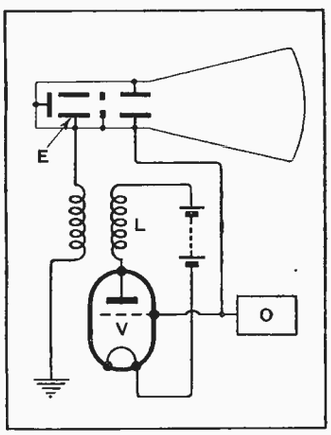
CATHODE-RAY TUBES

VOLTAGE to be measured is applied from a source O to the grid of a valve V, the anode inductance L of which is coupled to the modulating-electrode E of a cathode-ray tube. The potential across L is then proportional to the rate of change of the applied voltage, and the coupling with E is such that an increase in the rate-of-change causes a more positive voltage to be applied, and, therefore, produces a larger ionic content of the electron stream.

In other words, the spot tends to be brightest when it is moving at its highest speed across the screen, thus offsetting the otherwise poor fluorescent response due to its transverse velocity.

R. A. Watson Watt. Application date March 26th, 1935. No. 459041.



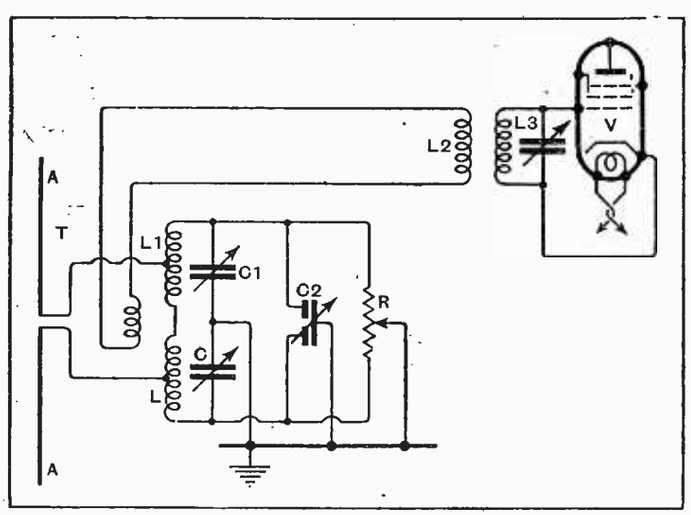
Arrangement of the apparatus described in Patent No. 459041.

ELIMINATING INTERFERENCE

TO cut out interference, the dipole aerial A is coupled to the input of the first valve V through a transmisison line T, which terminates in two balanced circuits L, C and L1, C1. Any inductive pick-up along the line T is thus balanced out, instead of being transferred to the input coupling L2, L3. The balance is made more effective by means of a differential condenser C2 and variable resistance R.

Adjustment of the resistance R damps one or other of the tuned circuits until the fields due to interference currents cancel out. Adjustment of the differential condenser C2 detunes the circuits L, C and L1, C1 to such a degree as to enable the phase of the interfering currents to be accurately opposed. One adjustment may slightly affect the other, but it is always possible to arrive at a stage when the signals come through free from any noise.

Kolster Brandes, Ltd., and C. W. Earp. Application date June 28th, 1935. No. 458801.



Anti-interference system using a balanced input circuit.

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HIGH-FREQUENCY "CONDUCTORS"

IT is pointed out that for high-frequency work conductors having a continuous surface (a) possess considerable inductance and (b) give rise to eddy-current loss. The inventor, therefore, uses a "composite" material, having a dielectric such as colloidal graphite as base, but containing a high proportion of metallic powder, both magnetic and non-magnetic.

The conductive particles act in much the same way as a large number of condensers arranged in series and in parallel, and so ensure a substantially-uniform distribution of capacity throughout the body of the material. For very high frequencies, the net effect is not substantially different from that of ordinary conduction. The material is particularly useful in high-frequency therapy. It can also be moulded into rods or tubes for making tuning coils, leads, etc.

F. K. Nagelschmidt. Application date April 17th, 1935. No. 458505.

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TELEVISION IN COLOURS

COLOUR effects are obtained by passing the light from the object O through a lenticular grating G before it falls on to a photographic film F. The front face of the grating consists of a series of closely set cylindrical lenses, whilst the rear face is plane. A colour-filter C, consisting of the usual "red," "green," and "blue" strips, is interposed in the path of the light, together with a lens L.

The arrangement is such that an image of the filter C is projected on to the film by each cylinder of the grating, and contains one, two, or three portions of light, depending upon the colour of each particular part of the object from which the light reaches the grating. The film is developed and fixed in monochrome, appearing as a series of "groups" of strips (each group formed by one cylindrical lens).

These strips are next scanned across their length, and the resulting signals (containing the three colours) are then transmitted to the receiving station, where they are reproduced as a "replica" film. This is finally projected on to a viewing screen through a "reversed" optical system, and appears in natural colours. By substituting a double lens for that shown at L, a stereoscopic effect can be obtained.

Baird Television, Ltd.; T. M. C. Lance; and E. H. Foden-Pattinson. Application date June 27th, 1935. No. 458791.

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AERODROME SIGNALS

AT an aerodrome it is usual to provide both visual signals, such as Neon lamps, and wireless transmitting equipment. According to the invention, instead of using a separate source of supply, both the lamps and the wireless transmitter are energised from the same high-frequency source, which may be a valve generator. Amongst other advantages, this allows Morse code signals to be superposed on the light from the lamps, as well as on the wireless transmitters, reception in the former case being effected by means of photo-electric cells. The system can also be used for communicating from aeroplane to aerodrome, or from aeroplane to aeroplane, by light signals when flying in close formation, and by wireless over longer distances or in fog.

J. Fodor. Application date March 16th, 1935. No. 458307.

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SOUND AND PICTURE RECEIVERS

THE local oscillator of a super-het. receiver produces two beat frequencies, one for the sound and the other for the picture signals. As both beats occur close together in the frequency range, they are fed, according to the invention, to a common IF amplifier. This comprises several resistance-capacity-coupled stages, which are neutralised to prevent loss of the higher frequencies.

The sound and picture signals are separated out in the last stage of the common IF amplifier. They are then applied to independent detectors and are amplified along separate channels.

The British Thomson-Houston Co., Ltd.; T. H. Kinman; and D. S. Watson. Application date June 26th, 1935. No. 459070.

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