The Wireless World

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Editor :
HUGH S. POCOCK.

Editorial,
Advertising and Publishing Offices :
DORSET HOUSE, STAMFORD STREET,
LONDON, S.E.1.

Telephone: Waterloo 3333 (50 lines).
Telegrams: "Ethaworld, Sedist, London."

COVENTRY: Hertford Street.
Telegrams: "Autocar, Coventry." Telephone: 5210 Coventry.

BIRMINGHAM:
Guildhall Buildings, Navigation Street, 2.
Telegrams: "Autopress, Birmingham." Telephone: 2971 Midland (4 lines).

MANCHESTER: 260, Deansgate, 3.
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EDITORIAL COMMENT

High-note Boosting

Would It Be Worth While?

OVERCROWDING of broadcast transmitters sets a limit to the quality of reproduction which our sets can provide, since it becomes impossible to reproduce frequencies above a certain point without introducing heterodyning with adjacent transmissions and "sideband splash."

In last week's issue a reader put forward the suggestion that high notes could be reproduced without heterodynes if the transmitting station deliberately boosted top and receivers were fitted with a simple filter in the loud speaker feed to readjust this to a linear response.

Our correspondent recognises that all receivers would have to be fitted with a suitable filter for this purpose and that this filter would have to be put out of action when it was desired to listen to another station not employing the high-note boost arrangement.

Whilst our correspondent's idea is extremely interesting and would undoubtedly produce the improvement in the way of reducing heterodynes which he predicts, the scheme is one which we do not suppose will be adopted by any broadcast transmitter. It is well known that this arrangement works well in practice in the case of recording where background noise becomes very troublesome at high frequencies. The scheme here adopted is to employ an amplifier for recording with a rising characteristic so that the signal-to-noise ratio is favourable in the record ; then when this record is used for broadcasting or other purposes a correction circuit is used to restore the response to its proper proportions throughout the range.

If, however, we attempt to do this in the case of a broadcast transmission we shall, whilst reducing heterodynes, increase the tendency to the even worse trouble of sideband splash, for we cannot visualise such a scheme being adopted only by the stations we want to listen to !

The subject is interestingly discussed by a correspondent in this issue, who points out some of the objections and expresses the hope that no experiments of this nature will be introduced.

In the interests of quality it has often before been suggested that at the transmitting end adjustments to the response of the amplifier should be made to correct for the average deficiencies of receivers. Fortunately, these suggestions have not been adopted. A deplorable state of affairs would result if designers of receivers had to take into account a non-linear output from the transmitter, and when it is remembered that different transmitting authorities would probably fail to standardise their outputs we should be faced with having to design elaborate variable correcting circuits on all our receivers and adjust them afresh for every station to which we tuned.

The Crystal Set

Revival of Interest

IN this issue we describe the construction of a crystal receiver for the first time for many years. The "By Request" Crystal Set was made as a result of the very many requests we have received for such an instrument.

The endeavour has been made to take advantage of any recent developments which could improve performance, and those readers who construct the set will, we think, be surprised to find how greatly adequate selectivity and the increase in power of transmitting stations have added to the repertoire of a crystal set since the days when its use was so general.

Feeding Push-Pull Amplifiers

Methods of Phase Reversal

By W. T. COCKING

RESISTANCE-COUPLED push-pull amplification is now commonly employed in cases where the highest possible standard of reproduction is required. Some difficulty is often experienced, however, in obtaining a satisfactory method of phase reversal in the input circuits, and in this article the chief methods are discussed in detail and a new system is described.

IN low-frequency amplification the push-pull system is widely recognised as giving a smaller degree of amplitude distortion than the more usual single-sided amplifier. It is consequently becoming more and more commonly employed in all cases where the attainment of the highest standard of reproduction is given serious attention. At one time its use was confined to transformer-coupled amplifiers, but it is now often used with resistance coupling. If the best results are to be secured particular attention must be paid to the input circuit. No difficulty arises when using transformer coupling, of course, for the usual push-pull transformer provides the necessary phase reversal in a straightforward manner. When resistance coupling is employed, however, matters are not quite so straightforward and there are many alternative arrangements possible.

The input circuit of a typical resistance-coupled push-pull amplifier is shown in Fig. 1, and in practice C1, C2 and R1, R2 are given identical capacities and resistances respectively. In feeding an amplifier of this nature the problem resolves itself into obtaining an input voltage between A and E which is at any instant of the same value and of opposite sign to that which exists between B and E. In other words, if the point A be 1 volt positive with respect to E, the point B must be 1 volt negative also with respect to E. When neither terminal of the input need be earthed, this result can be secured very simply indeed. Suppose, for instance, that the amplifier of Fig. 1 is to be fed from an AC generator, which might well be a gramophone pick-up, the phase reversal can be secured by connecting two equal resistances in series across it and earthing their centre-point. This is shown in Fig. 2 where the resistances are denoted by R1 and R2.

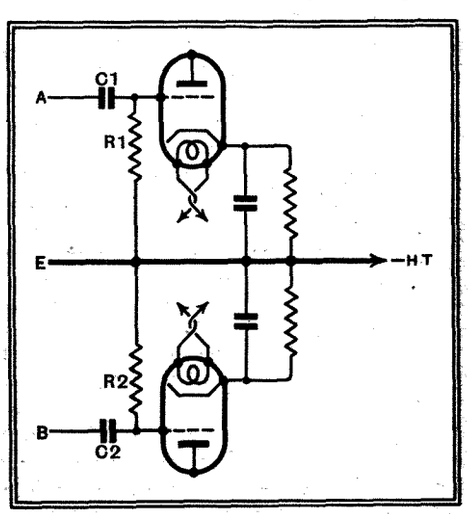

Fig. 1.—The input of a typical push-pull amplifier is shown here.

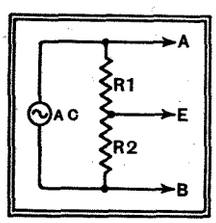

Fig. 2.—The simplest method of phase-reversal for the input consists of a centre-tapped resistance.

The operation of a circuit of this type is very easy to understand. Assuming for the moment that the arrangement of Fig. 2 is not connected to anything else, the generator drives a current through the two resistances. As these have the same value and as there is the same current through them, the voltage drop across each is the same and is one-half the generator voltage when the generator has no internal impedance. The voltage is less when the generator impedance is appreciable, but the voltage across R1 is still equal to that across R2. Now the question of phase arises, and is equally easy to settle. Suppose that at any instant A is 2 volts positive with respect to B. Since the voltage drop across R1 equals that across R2 it is obvious that A must be 1 volt more positive than E, and E 1 volt more positive than B. But if E is 1 volt positive with respect to B, then B must be 1 volt negative with respect to E. Hence A and B are at any instant at equal and opposite potentials with respect to E and the required phase reversal has been obtained. This holds also when another circuit is connected to that of Fig. 2, provided that the external impedance between AE has the same value and is of the same nature as that between BE.

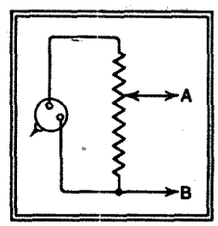

Fig. 3.—When a gramophone pick-up is used, this circuit can feed an amplifier; the input is split by R1 and R2 of Fig. 1.

It follows that an amplifier of the type of Fig. 1, which is really the input of *The Wireless World* Push-Pull Quality Amplifier,[1] can be fed from a gramophone pick-up by connecting it to the terminals A and B, leaving E blank, for the grid leaks R1 and R2 provide the necessary centre-tap to the input. In general, however, this method is not very satisfactory, for a pick-up having a very large output is usually needed; the Quality Amplifier, for instance, requires an input of 7 volts peak. When required, a volume control can be connected as shown in Fig. 3.

This method of phase reversal may still be used when it is desired to couple a diode detector directly to an amplifier as shown in Fig. 4. When a volume control is not wanted, it is best to split the diode load resistance into two equal parts, R1 and R2, as shown at (a); no part of the circuit except the centre-tap must be earthed. If volume control be required, however, the arrangement of (b) can be

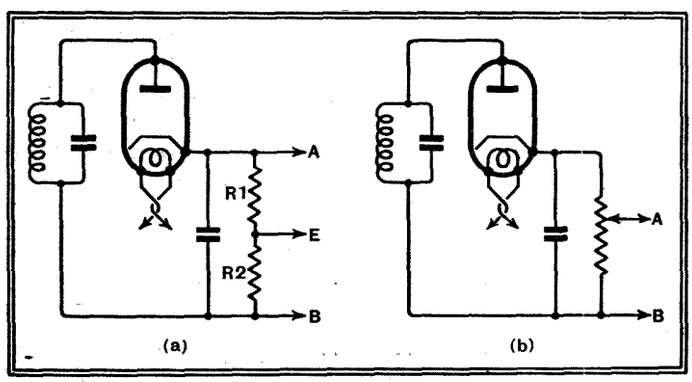

Fig. 4.—The arrangement of Fig. 2, as applied to a diode detector, is shown at (a), and at (b) the connections necessary when volume control is required.

[1] First described May 11th and 18th, 1934, and reprinted February 22nd, 1935. These issues are now out of print, but the original articles are available in booklet form.

Feeding Push-Pull Amplifiers—

used, and here the grid leaks in the amplifier are relied upon for splitting the input to the amplifier.

These precise arrangements, however, are not widely used, because some additional amplification is usually required for gramophone use and this is generally retained on radio also. One very satisfactory arrangement is shown in Fig. 5, and the method of phase reversal is basically the same as in the case of the circuits just discussed. The resistances R1 and R2 must have the same value, usually 20,000-50,000 ohms and the decoupling condenser C1 must be of large capacity, some 8 mfds. Thorough decoupling is usually necessary, and it is wise, even when C1 has a capacity of 8 mfds., to make R4 as high as 50,000 ohms. Grid bias is

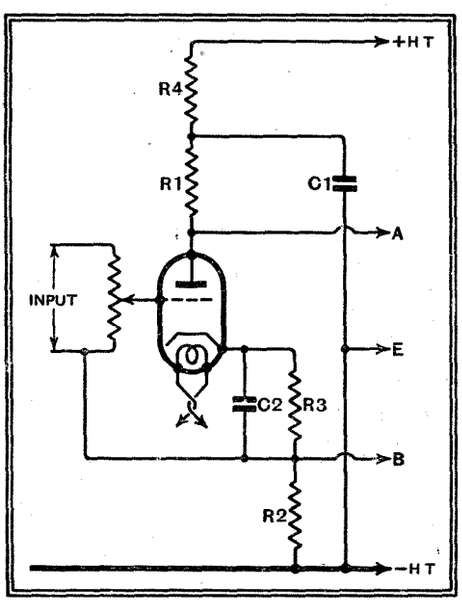

Fig. 5.—One very satisfactory method of feeding an amplifier is obtained by placing equal resistances R1 and R2 in the anode and cathode circuits of a triode.

obtained by the voltage drop across R3 and a value of 1,000-2,000 ohms is normally suitable; the by-pass condenser C2 should be large, at least 25 mfds.

This system may be used on both radio and gramophone and a gain of about 10 times from the input terminals to each half of the output, or 20 times between the input and AB may be expected when suitable components are used. The greatest disadvantage of the arrangement is that neither terminal of the input may be earthed. This does not greatly matter on gramophone, for there is rarely any difficulty in isolating each pick-up lead, but it is often inconvenient on radio. In the first place, it prohibits the use of some detector circuits, and secondly it greatly increases the difficulty of filtering the detector output properly.

There are many cases where it is essential for one terminal of the input to be earthed, and it is then usual to employ the paraphase system. There are many variants of this, but there is actually little to choose between them and one of the simplest arrangements is that of Fig. 6. It will be seen that whereas the "B" output terminal is fed directly from the input, the "A" terminal is fed through the valve which is connected as a conventional resistance-coupled amplifier. Since there is a complete phase reversal in one stage of resistance amplification, it is clear that in this way the output terminals A and B are always at opposing potentials. In order that the magnitude of the potentials be the same, however, the gain of the stage must be unity. The valve grid, therefore, is fed with only a portion of the input from the potentiometer R1; in practice, R1 is adjustable and is set so that the amplifier as a whole is balanced and each output valve gives the same output. Incidentally, any of the other arrangements may be exactly balanced if desired by making the appropriate resistances adjustable.

The Paraphase System

Although the valve used in paraphase gives no effective amplification the phase-reversing stage as a whole gives a gain of 2 times. This is easily seen when it is remembered that the whole of the input appears between the B and E terminals, while the potential between the A and E terminals is derived through the valve. With the direct input split by a tapped resistance (Fig. 2) only one-half the input appears between each pair of output terminals.

The values of components used for the phase-reversing valve of Fig. 6 are the conventional ones for a resistance-coupled stage, but it is important that C1 and R1 be large enough to pass very low frequencies, much lower than those needed for proper bass reproduction. An examination of the circuit will show that with this arrangement there is one more coupling on one side of the amplifier than on the other. Each coupling condenser and grid leak must cause some attenuation which increases with a reduction in frequency. Although the amplifier may be perfectly balanced over the whole range of musical frequencies it cannot be balanced at very

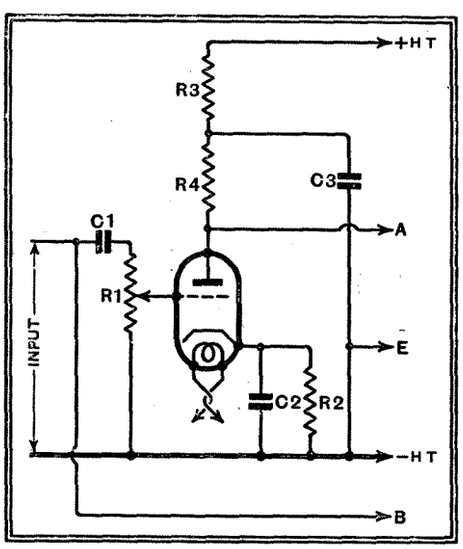

Fig. 6.—The paraphase system embodies an extra valve giving a stage gain of unity.

low frequencies, 10 c/s or lower. Now, one of the greatest advantages of push-pull is that when the amplifier is properly balanced feed-back effects through the HT supply are almost non-existent, and much difficulty in obtaining adequate decoupling of early stages is avoided.

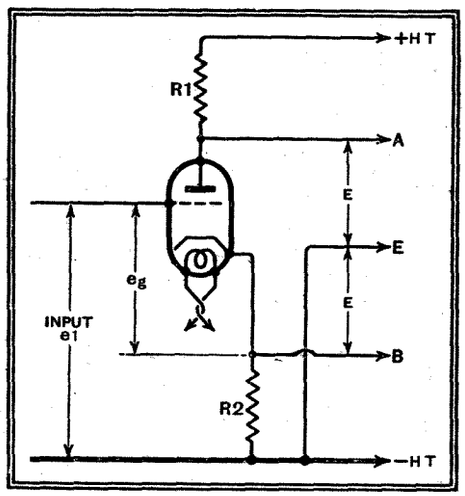

Fig. 7.—The basic connections of a new method. It is similar to the arrangement of Fig. 5, but one side of the input can be earthed.

These feed-back effects manifest themselves as motor-boating and very low frequencies are involved. Unless C1 and R1 (Fig. 6) are large enough to pass these very low frequencies with negligible attenuation, therefore, the advantage of push-pull in reducing feed-back is very largely lost. Experience shows that when R1 is 1 megohm C1 must be at least 0.1 mfd., and it is better larger.

A New Phase-Changer

A modification of the circuit of Fig. 5 has recently been put forward[2] which removes the objection of requiring an unearthed input. The basic circuit without decoupling and biasing arrangements is shown in Fig. 7, and at first sight it would seem that the operation is the same as that of Fig. 5. It is, however, very different save in the method of phase reversal. The voltage which operates the valve is not the true input voltage e1 (Fig. 7.), but the voltage *eg* developed between grid and cathode, and this is less than e1 by the output voltage E, which appears across R2. In other words, there is severe anti-phase feed-back because R2 is common to both input and output circuits. This does not cause distortion as long as R2 is not by-passed by a condenser, but any attempt to reduce the feed-back by shunting R2 by a condenser is foredoomed to failure, for it will not only affect the frequency-response characteristic but will also upset the balance between the two halves of the output.

The true input voltage to the valve $eg = e1 - E$, and as E is the output to one side of the push-pull amplifier, eg must be less than E. The gain of the stage, measured between the input terminals and

[2] Electronics, October, 1935.

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one pair of output terminals (AE or BE) must be less than unity, so that the stage attenuates instead of amplifying. Actually, the "gain" closely approaches unity and is given by $E/e_1 = \mu R_2 / R_a + 2R_2 + \mu R_2$) where μ=valve amplification factor, R_a = valve AC resistance. The other symbols are as shown in Fig. 7, R1 being equal to R2. Using a typical valve having a resistance of 10,000 ohms with an amplification factor of 20, it can be seen that when both R1 and R2 are 25,000 ohms the gain $E/e_1 = 0.893$. The total gain of e1 to the voltage between the AB output terminals is, of course, just double this, or 1.786 times, so that if the push-pull amplifier requires a total input of 7 volts peak this feeder stage needs only 3.92 volts peak or 2.78 volts RMS. The gain is, in fact, nearly 90 per cent. of that given by the paraphase system.

The precise arrangement of Fig. 7 can rarely be used, because the grid cannot normally be returned to the earth line. The steady anode current passing through R2 makes the cathode considerably positive with respect to the earth line—if the anode current be 1 mA. and R2 be 25,000 ohms, the cathode is 25 volts above earth. If the grid were returned to the earth line it would be negative with respect to cathode by the drop across R2—with the figures just mentioned it would be negative by 25 volts—which is usually far too great a bias.

Practical Circuit Values

There are several ways in which the circuit can be modified to obtain the correct grid bias, and one of the simplest is shown in Fig. 8. It will be seen that a bias resistance of 1,000-2,000 ohms, R2, with a by-pass condenser C2 of at least 25 mfds., is introduced in the cathode circuit. The grid is returned to the negative side of this through the grid leak R1, so that the bias on the valve is merely the voltage drop across R2. If these modifications are not to upset the operation of the circuit it is necessary for the reactance of C2 to be small compared with R2 at the lowest frequency, and R1 must be very large compared with R3. In the anode circuit the reactance of C3 at the lowest frequency should be small in comparison with R4, but this depends to some extent upon the value of R5. In practice, satisfactory values for the components are: C1=0.1 mfd., C2=50 mfds., C3=8 mfds., R1 = 2 megohms, R2 = 2,000 ohms, R3=R4=25,000 ohms, R5=50,000 ohms. The valve selected does not greatly influence the results, and the MH4 and MHL4 classes are entirely suitable. The HT supply can be from 200 volts to 300 volts without necessitating any change in the values of the components.

Perhaps one of the greatest advantages of this system of feeding a push-pull amplifier is the way in which a tone control can be devised. If both R3 and R4 be shunted by condensers of suitable value—0.002 mfd. to 0.01 mfd.—the higher audible frequencies are greatly attenuated,

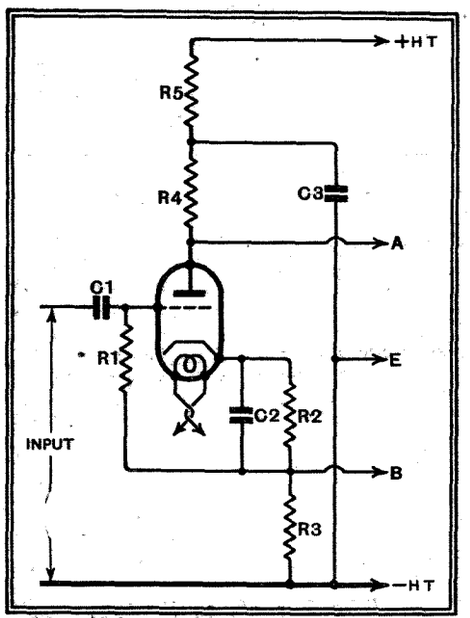
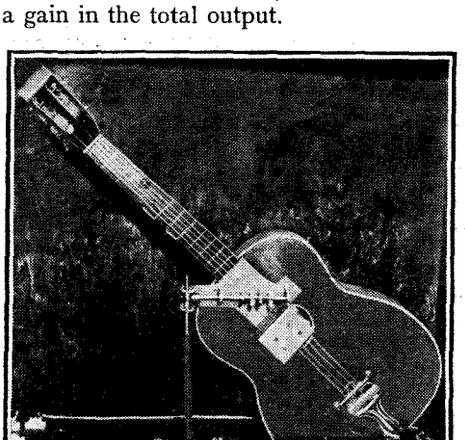


Fig. 8.—In practice, the new system is arranged in the manner shown in this diagram.

as one would expect. If only R3 be shunted, however, the total output of the push-pull amplifier is increased at high frequencies! What happens is this. When R3 and R4 are both shunted the amplification of the valve falls at high frequencies owing to the by-pass effect of the condensers; the feed-back to the grid circuit is reduced, however, so that the effect of the by-pass condensers is not as great as with an ordinary circuit. Now when only R3 is shunted the voltage developed by the signal between cathode and earth is reduced at high frequencies, the feed-back is less, and a larger proportion of the input is effective in operating the valve. In other words, the effect of shunting the resistance R3 by a condenser is to increase the voltage between grid and cathode at high frequencies. Consequently a larger voltage is developed across R4. It can thus be seen that at high frequencies the voltage at the AE terminals rises, while that at the BE terminals falls. The rise at the one pair, however, is greater than the fall at the other, so that there is a gain in the total output.



CRACOW'S NEW INTERVAL SIGNAL is produced by a real guitar played by an automatic hand, which can be seen in the picture just above the small microphone. The only disadvantage in the arrangement is that the guitar must be tuned daily.

A very useful accentuation of the upper register can be obtained in this way, but it is, of course, accompanied by a loss of balance in the push-pull amplifier, for at high frequencies one-half of the chain does most of the work. This does not always matter, however, for two reasons—first, the signal amplitudes at high frequencies are usually small, and secondly, the harmonics introduced by any non-linearity are likely to be above audibility. Considering this point first, if the method be used to accentuate frequencies above 5,000 c/s only, there will be no lack of balance at lower frequencies, and all the advantages of push-pull will be obtained for such frequencies. Now if the lack of balance at higher frequencies does introduce harmonic distortion, it is unlikely to be present on any frequency lower than 7,000 c/s, for if the amplifier be balanced at 5,000 c/s the lack of balance between 5,000 c/s and 7,000 c/s will be quite small. The second harmonic of 7,000 c/s is 14,000 c/s, which is getting near the upper limit of audibility. It is fairly certain that such a frequency could not be heard unless it were of considerable intensity, and in any case it is unlikely to be reproduced by any but the very best loud speaker. The other point which helps to make the lack of balance unlikely to result in distortion is that the amplitudes at frequencies over 5,000 c/s are normally quite small compared with those at low frequencies. The large amplitudes occur at low frequencies, and it is at these frequencies that the amplifier must be balanced if distortion is to be avoided.

It can thus be seen that this method of tone control, although at first sight inadmissible, is actually quite permissible, and a useful increase in the high-frequency response to compensate for sideband cutting or other deficiencies can be obtained very simply and without reducing the gain of the amplifier. This last is the most important point, for most other effective methods of tone-correction only give a relative increase in the high-frequency response, and it is actually obtained by reducing the amplification at low and medium frequencies. This is undoubtedly rather wasteful.

THE RADIO INDUSTRY

AN arrangement has been concluded whereby Baird "Televisors" are to be manufactured and distributed by Bush Radio, Ltd. Television courses for Bush agents' service engineers will commence in February, and will be conducted by Baird Television, Ltd.

◇ ◇ ◇

W. Bryan Savage, Ltd., have again moved to a larger factory; the new address is: Westmoreland Road, Stanmore, Middx. Telephone number: Colindale 7131.

◇ ◇ ◇

Wireless exhibits on the T.M.C.-Harwell stand at the British Industries Fair at Birmingham (No. Cb.821-720), will comprise condensers of all types, together with the new T.M.C.-Hydra Interference Suppressor Units.

◇ ◇ ◇

The Newcastle branch office of Siemens' Electric Lamps and Supplies, Ltd., has been transferred to Siemens' House, Carliol Square, Newcastle-on-Tyne. Telephone number: Newcastle 20641.

CURRENT TOPICS

Moscow Television

TELEVISED scenes from the life of Lenin were broadcast in Moscow on January 21st on the eleventh anniversary of his death.

Direct Television in Germany

DIRECT television of the Winter Olympic Games at Garmisch is to be carried out daily from the Witzleben broadcasting tower in Berlin.

Radio Weeks

THE Radio Manufacturers' Association is to consider the inauguration of a "radio week" in the early spring. Another project is a "radio progress week" at the beginning of October to emphasise the latest technical improvements in radio sets.

New Zealand Amateurs' "Mourning Whistle"

ALL transmitting members of the Radio Society of Great Britain closed down for the whole of Sunday, January 26th, as a mark of respect for King George.

Nearly 200 New Zealand amateur transmitters sent out a continuous whistle on the 80-metre wavelength for three minutes on the "day of mourning," January 28th.

"Apex" Waves

ULTRA-SHORT-WAVE experimental transmitters now being licensed in America are known as "apex" stations because their aerials must be located at high points. Besieged by applications for ultra-short-wave licences, the Federal Communications Commission is understood to be reserving the "apex" group of waves for visual broadcasting. Half the applicants for "apex" permits are newspapers.

Radio Prison

A STRANGE fate awaits the Norwegian wireless station at Udlanhaug, which closed down on Saturday last. The premises are being purchased by the Stavanger City Council for conversion into a prison. Broadcast listeners in the district who have been troubled by the Udlanhaug spark transmitter hope that the station *personnel* will be retained after the change.

Broadcasts for Bedridden

THE Ravag station in Vienna is to inaugurate a weekly hour for invalid listeners.

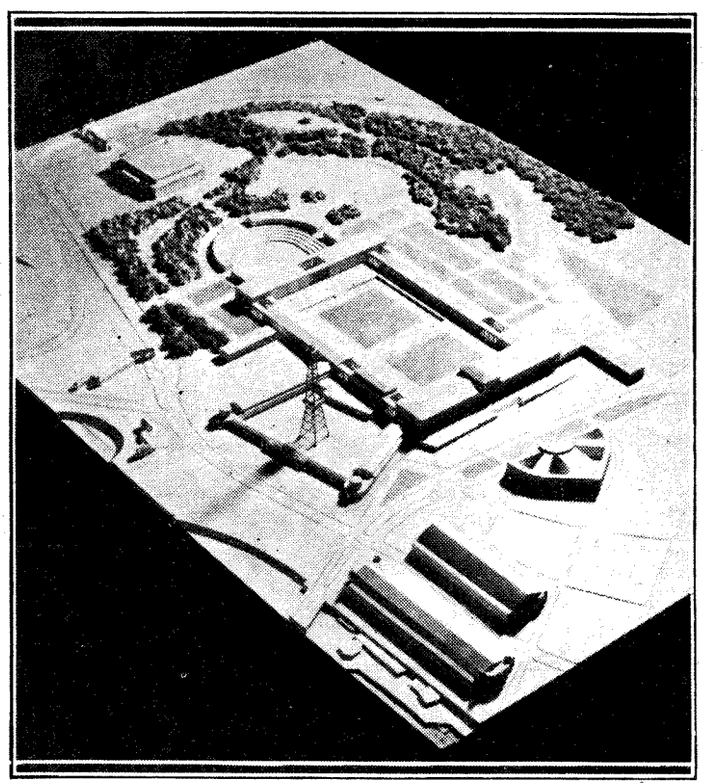
How France Listens

REGISTERED radio sets in France now number 2,625,677. Nearly half of these are in the Paris region.

40 Years On

SUNDAY last, February 2nd, was the fortieth anniversary of Marchese Marconi's first arrival in England with the crude apparatus which was so soon to startle the British Post Office with its feats of communication without wires.

Marconi's initial demonstration was before Sir William Preece, Chief Electrical Engineer of the Post Office, in July, 1896.



SHOW FORECAST.—Already the Berlin Radio Exhibition for 1936 is planned in detail, as this architect's model indicates. The main exhibition building is in the centre. Note the famous Radio Tower and, to the right, the semi-circular "Broadcasting House" from which programmes will be relayed.

Are "Hams" Amateurs?

STRONG protests against the use of the term "amateur" by U.S. broadcasting tyros are being made by the American Radio Relay League, which contends that a radio amateur is "a person interested in radio technique solely with a personal aim and without pecuniary interest." In a special statement the League urges "the puzzled broadcast listener to do his best to get his definitions straight and try not to confuse the gulping crooner with the amateur expert next door."

Is it possible that our American colleagues have deprived themselves of proprietary rights in the word "amateur" through reverting to the porcine appellation "ham"? British amateurs, with a few notable exceptions, have been content to be known as amateurs, leaving the terminology of the meat industry to those who feel better for it.

Cycle-Radio

CAR radio is common enough among the police forces of Great Britain, but cycle radio is more of a novelty. Indeed, Liverpool Police Force are believed to be the first to adopt it. Many of their officers on cycle patrol carry midget receivers to keep them in touch with headquarters. A wavelength of about 148 metres is used.

Set Making in Palestine

HAS the British radio trade missed an opportunity? It is recorded that 75 per cent. of the radio receivers now in demand in Palestine following the opening of the Jerusalem transmitter are being supplied by a new radio firm working at high pressure in Tel-Aviv.

Events of the Week in Brief Review

Recording Demonstrations

A RECORD made on the spot will be reproduced at the meeting of the Golders Green and Hendon Radio Society on Wednesday next, February 12th, when Mr. A. L. Royer will lecture on "Home Recording" at the Hampstead Art Galleries, 343, Finchley Road. The meeting opens at 8.15 p.m.

For Surrey Transmitters

A NEW British transmitting pentode will be demonstrated by Mr. B. G. Wardman (G5GQ) at a meeting of the Surrey Radio Contact Club on February 11th at the Railway Bell Hotel, West Croydon Station. *Wireless World* readers wishing to attend are asked to communicate with the hon. sec., Mr. E. C. Taylor, 35, Grant Road, Addiscombe.

Overdrafts Not Allowed

ITALIAN listeners are now provided with "cheque books" for the payment of their radio licence fees. When paying the tax for a particular year the subscriber fills up one of the forms, detaches it and hands it in, together with the licence money, at any post office.

Mandel Remains

MEN may come and men may go, but, like Tennyson's brook, M. Mandel, French Postmaster-General, goes on for ever. The recent change of Ministry has left the radio-minded P.M.G. at his post; in fact, his disappearance, according to our Paris correspondent, is regarded as unthinkable.

The Policeman's Lot

THE week's best story comes from Moscow, where, it is stated, policemen undergoing the rigours of point duty in cold weather are to be provided with thick coats having wire netting stitched into the lining. "This wire net," writes our informant, "will be radio-electrically heated by neighbouring broadcasting stations."

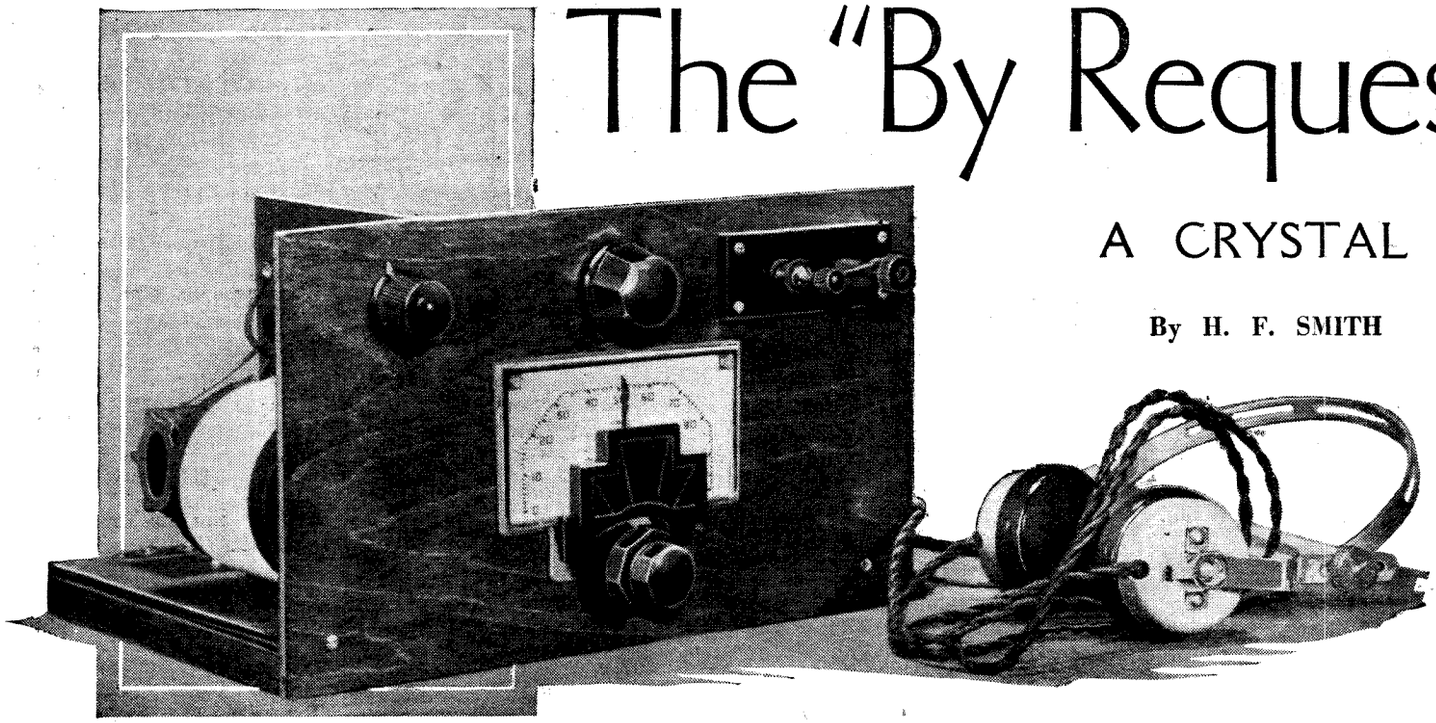
Shut the Door

ROCHDALE radio dealers must keep the door closed when operating a loud speaker in the shop. This new by-law was given publicity last week when a local dealer was summoned for operating a shop loud speaker in such a manner as to cause annoyance to the public. He pleaded that the door was left only slightly ajar and the magistrates dismissed the case on payment of costs.

The "By Request"

A CRYSTAL SET

By H. F. SMITH



MANY readers have expressed a desire for the publication of constructional details of an up-to-date crystal set, for use either as a "stand-by" in the event of a breakdown, or for headphone-listening in normal circumstances. The receiver described below is interesting in that it shows how far comparatively recent developments may be applied to one of the earliest types of receiver.

WHEN the popularity of the crystal set began to wane, some ten years ago, none of our modern conveniences such as ganged tuning and waveband switching had found their way into receivers generally. In planning a modern crystal set the first task is clearly to work these features into its design, and, even more important, to provide enough selectivity for conditions as they exist to-day.

The fate of the crude crystal set, as we knew it originally, was finally sealed when the twin-station "Regional" system of broadcasting came into being some six years ago. Its selectivity was insufficient to separate a pair of local stations. The only practicable way of overcoming this weakness lies in the use of a pair of tuned circuits, and this plan is adopted in the present set.

But this, in itself, is hardly enough. It is also necessary to reduce damping due to the crystal, and at the same time to see that in all the various transferences of energy from circuit to circuit there is as little wastage of power as possible. This question of matching input impedance to output impedance is much more important than in a valve set, since we have no local source of energy to call upon.

Matching is most important of all in the case of the crystal coupling, and the matter is closely analogous to the problem of obtaining the maximum power output from, say, a dry battery. To do so, it is necessary that the resistance of the external load should be equal to the internal resistance of the battery; anything more or less will be responsible for a falling-off in power. With the help of Ohm's Law, this may easily be verified by working out an example.

Without stretching the analogy too far, we may consider that the crystal detector represents the external load, and the tuned circuit (source of energy) which feeds it represents the battery. At first sight it might appear that maximum power would be obtained by connecting the crystal across the whole of the tuned circuit, but the relative impedances of the two are actually such that a stepdown transformer is required. The crystal is therefore connected to a tapping on the tuning coil, across a part only of the tuned circuit—in effect, an auto-transformer. Unfortunately, the matter can hardly be carried to its logical conclusion, as the impedances to be matched are not constant, and so a compromise must be struck in practice. But the arrangement advocated is demonstrably superior, both from the aspects of selectivity and output, to the crude arrangements with which we used to content ourselves.

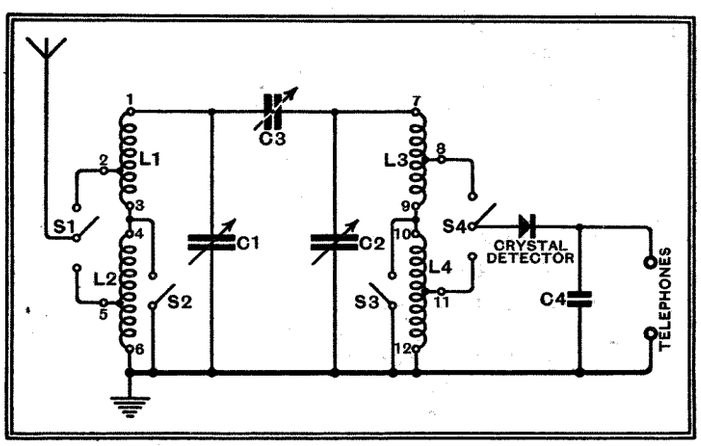


Fig. 1.—Complete circuit diagram. All the wave-change switches are mechanically linked, and operated by a single knob.

The circuit adopted, then, is that shown in Fig. 1. Aerial coupling to the primary circuit comprising L1, L2, and C1 is changed over by the wave-range switch S1; coupling to the secondary circuit L3, L4, C2 is controlled by means of the small condenser C3. As the various switches are linked, the crystal connection is appropriately changed over to a centre tapping on L3 or L4, depending on whether the medium or long waveband is in use. The gang condenser (C1, C2) embodies built-in trimmers, that in parallel with C1 being controllable through an external knob; need for accurate matching of coils is thus avoided.

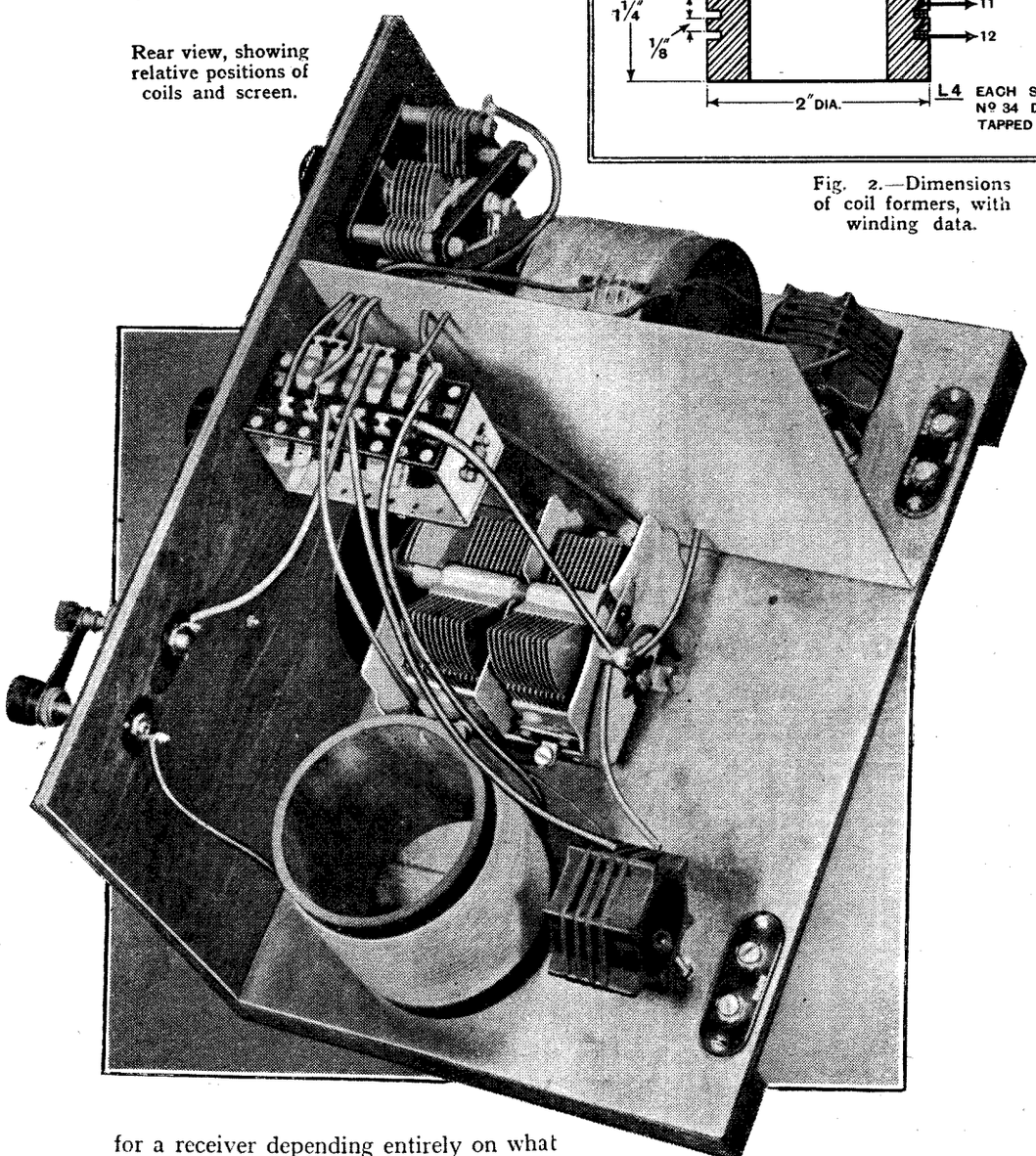
Construction is greatly facilitated by the adoption of the capacity-coupled two-circuit tuner, which does not require complicated mechanism for variation of inter-circuit coupling. The system works out quite happily in practice, and simple screening afforded by a single vertically mounted sheet of aluminium is sufficient

Receiver

DESIGNED ON MODERN LINES

to prevent excessive stray magnetic linkage between the fields of primary and secondary coils. But the positions of these coils, without being highly critical, should be roughly that shown in the accompanying drawings and photographs.

Ordinary screened coils as used nowadays in valve sets are hardly good enough for a receiver depending entirely on what it picks up from the aerial. Iron-cored coils, if suitably tapped, would do well, but are somewhat expensive and do not readily permit of experimental circuit alterations which may be desirable in certain circumstances. Home-made coils of large diameter and of as high efficiency as is reasonably practicable were decided on; those who prefer it will doubtless be able to obtain them ready-made from one or other of the firms specialising in such work.



Rear view, showing relative positions of coils and screen.

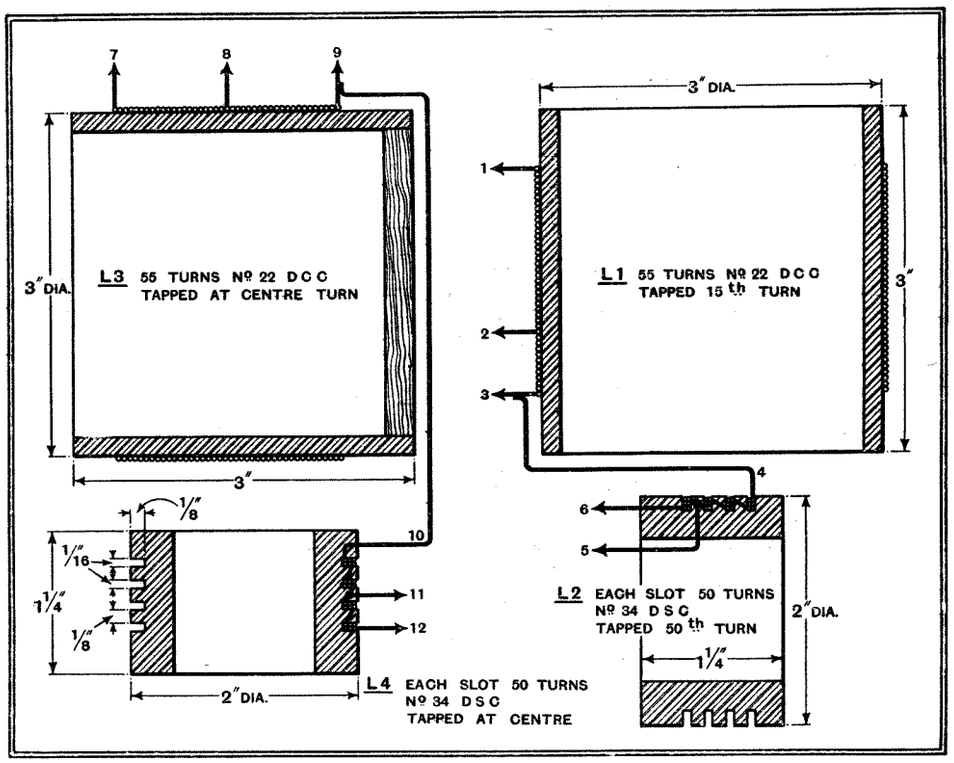


Fig. 2.—Dimensions of coil formers, with winding data.

As shown in Fig. 2, the medium-wave coils are single-layer solenoids on tubular formers (ebonite or paxolin will do), while the long-wave windings are in sections, being wound in slots cut in ribbed ebonite formers. All necessary data is given in the drawings, and the ultimate connections of the various ends and tappings are indicated by numbers corresponding to those in the other diagrams.

Layout and mounting of components in the manner illustrated will be found convenient and simple, but, provided the warning already given as to relative position of coils is observed, there is no reason why other forms of construction should not be adopted. The crystal detector is mounted on a small piece of ebonite with clearance holes drilled through the wooden front panel to pass the shanks.

Aids to Circuit Alignment

When making initial adjustments the first step is temporarily to eliminate the primary circuit by connecting the aerial lead-in wire directly to the lead between the crystal and wave-range switch. The set will now be very unselective, and no difficulty will be found in getting a signal on which to adjust the crystal. Having done so, connect the aerial to its proper terminal, and, with tight coupling (vanes of C_3 nearly fully enmeshed), tune-in the signal, making the necessary adjustment of the trimming condenser.

Finally, reduce coupling progressively till maximum signal strength combined with the desired degree of selectivity is obtained, retuning and retrimming after each adjustment of coupling. In general, the vanes of C_3 must be more nearly fully enmeshed for long-wave than for medium-wave reception.

If still higher selectivity is needed, as it may be in the immediate vicinity of a twin-wave station, the connection of the

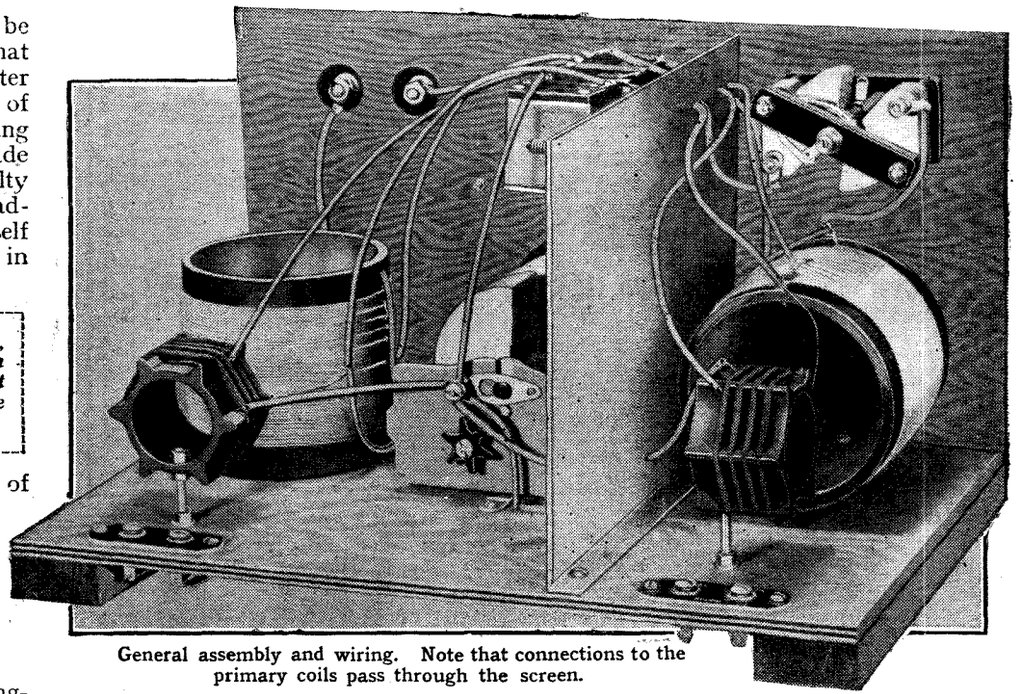
The "By Request" Receiver—

crystal on the secondary coil may be transferred experimentally to a point that will include one-third or even one-quarter (instead of a half) of the total number of turns in the output circuit. By working on these lines the selectivity may be made so high that a certain amount of difficulty will be experienced in making initial adjustments unless one has made oneself familiar with the set by operating it in its less selective condition.

A full-size blue print of the wiring diagram, together with the coil winding data given in Fig. 2, is available from the Publishers, Dorset House, Stamford Street, London, S.E.1. Price 1s. 6d. post free.

Thanks to the present high power of transmitters, a dependable range of 40 miles is well within the capabilities of a crystal set such as that described. Of course, a good deal depends on the aerial, but, under favourable conditions after dark, foreign stations are often receivable.

As it cannot be expected that the long-wave Droitwich station will be audible in all parts of the country, many prospective constructors in remote districts will not consider it worth while to go to the length of fitting the wave-change switch and long-wave coils in order to gain the questionable advantage of occasional "freak" reception on this band. There is, of course, no reason why they should not be omitted in such cases, and the circuit alterations involved will be obvious.



General assembly and wiring. Note that connections to the primary coils pass through the screen.

One cannot get something for nothing; the high selectivity of the two-circuit tuner is obtained at the cost of a little sensitivity. But the loss, as compared with the gain, is so insignificant that it is hardly worth while considering.

Finally, it may be pointed out that while the position of the aerial tappings as specified suits average conditions, it is sometimes as well in abnormal circumstances to try the effect of moving the connections: nearer to the earthed end of the coils when maximum selectivity is needed, and perhaps a little further away when the aerial is exceptionally short.

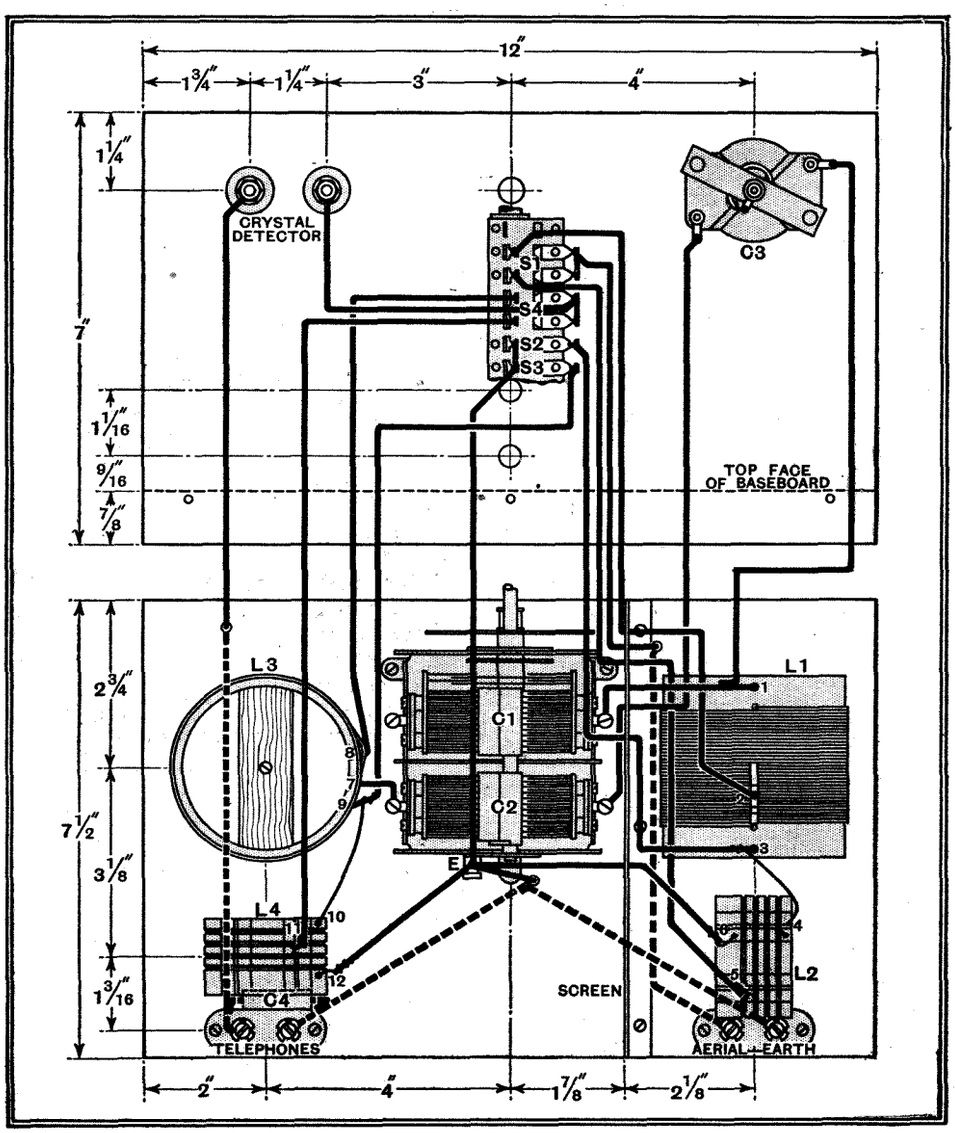


Fig. 3.—Practical wiring plan; leading dimensions are shown, together with measurements of panel and baseboard. Connections below the baseboard are dotted.

List of Parts.

1 2-gang condenser, 0.0005 mfd. with air-dielectric trimmer and drive. **C1, C2** **Formo DU5a** (J.B.)

1 Variable condenser, 0.000025 mfd. **C3** **Ormond R/149** (Eddystone, Polar.)

1 Fixed condenser, 0.001 mfd. **C4** **Graham Farish Tubular** (Dubilier, Ferranti, T.C.C.)

1 Change-over switch, 6-point, with knob. **S1—S4** **Magnum WW6**

1 Crystal detector **Hinderlich (Zincite-Tellurium)** (Goltone, Red Diamond.)

2 Double terminal strips **Bulgin T10** (Belling-Lee, Clix.)

Miscellaneous:— **Scientific Supply Stores**

4 ozs. No. 22 DCC wire; 2 ozs. No. 34 DSC wire; small quantity No. 22 tinned copper wire; 3 lengths sleeving; 2 ebonite formers, 3in. dia. × 3in. long; 2 6-ribbed formers, 2in. dia. × 1¼in. long; mountings for coils; wood panel, 12 × 7 × ¼in.; wood baseboard, 12 × 7½ × ¼in.; 2 wood battens, 7½ × 1¼ × ⅝in.; aluminium for screen. Screws: 6 ¼in. No. 4 R/hd, 7 ½in. No. 4 R/hd, 4 ½in. No. 2 R/hd.

1 Pair headphones 2,000 ohms **Ericsson** (N.R.S.)

"QUALITY"

Modifying Broadcast Transmission to Aid the Listener

By P. P. ECKERSLEY, M.I.E.E.

WE have become so accustomed to taking the excellence of broadcast transmission quality for granted, and considering possible improvements only in terms of the receiver, that this article, coming from so experienced an authority on broadcast transmission, will be read with unusual interest.

THE general public does not appear to worry very much about "quality." This is most fortunate for an industry which has progressed more in terms of cheapening the product than in improving its æsthetic qualities. There is no desire upon the writer's part to disparage these achievements; any firm which is to survive competition must give the public what it wants. The public is sufficiently pleased if the sounds coming from its wireless set are robust and intelligible, and if, occasionally, it can pick up this or that foreign station. The public is very sensible—it knows how it is entertained. Just because a minority doesn't like—or, to be different, pretends it doesn't like—what the public likes, nevertheless that minority should recognise facts. In sum, questions of quality remain rather a basis for arguments among technicians than a foundation of commercial service.

On the other hand, it would be a thousand pities if a faithful few did not continually strive to improve technique, believing that to-day's laboratory results will be embodied in to-morrow's commercial product.

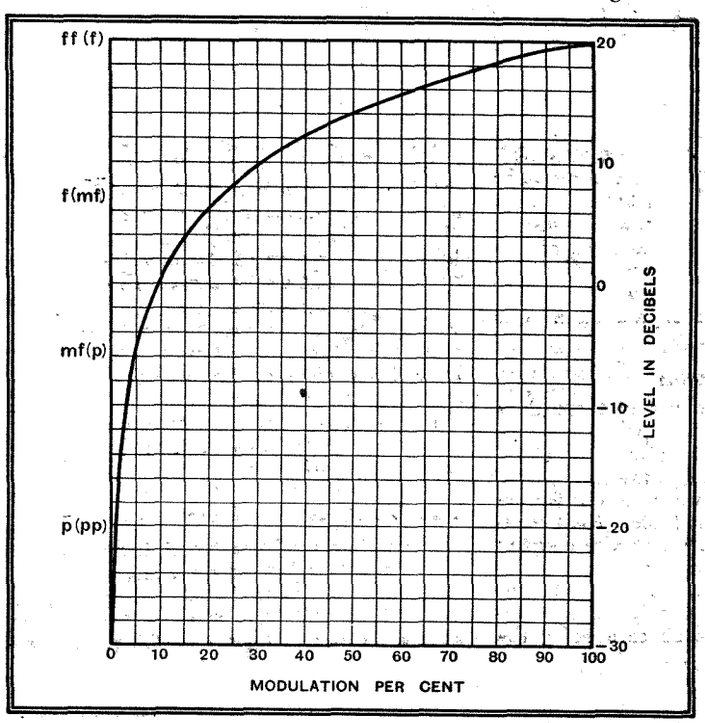
Influence of Transmission

It is impossible to expect, however, that quality of reproduction can be improved if the conditions of transmission forbid it. Transmission is to reception what environment is to species in evolution; if, in wireless technique, for example, any set which reproduces the upper frequencies also reproduces sideband jamming, then that set is not commercially marketable. Of course, the high quality set, reproducing frequencies up to six or even eight thousand cycles a second, will give good results when tuned to a station of 50 kilowatts power located a few miles away from the point of reception. Very few people are, however, interested in the faultless reproduction of monotony—they prefer to have a variety of choice of programme material even though this may be indifferently reproduced. This may be very naughty of them, but then their waywardness is a fact.

Although I have not been occupied, since I resigned from the B.B.C., with the problems of wireless broadcasting transmission as such, my work has continually brought me into contact with allied technique. I hoped, therefore, that readers of *The Wireless World* might be interested to read about some of the ways and means which, in my opinion, if taken up, would give an opportunity to the ubiquitous set to improve its performance.

In this article, as a typical illustration of the kind of way in which transmission might be modified to help reception, it is proposed to deal with the question of modulation depth.

While talking to an engineer who has been responsible for the design of many of Europe's high-power broadcasting stations, he told me that the latest demands are for a maximum depth of modulation (with a specified harmonic distortion which I think was 4 per cent.) of 90 per cent.



Curve showing modulation and resulting level.

Now the ear can detect differences in terms of decibels. It is said that one can detect a difference of one decibel in two sound levels available for comparison and that it is possible to detect two decibels in absolute level without any reference standard.

In the old days of telegraphy an operator had a code of R values; a signal was R9 R7 R5 down to R1. R9 was very loud, R1 was too weak to read; one knew it was there. It was found that the difference R9 to R7 was two decibels and that any good operator, without any reference standard, could say if a signal was R3 or R5 or R7 or R9. He could not say if it was R8 or R4, but he could tell that R8 was louder than R7. The R8 to R7, R6 to R5, etc., difference was one decibel; the R9 to R7, etc., two decibels.

In the diagram I have drawn a graph on a scale of modulation percentage against decibels of output. I have chosen 10 per cent. modulation as zero level. It is immediately apparent that all the major changes in level are concentrated between ranges in the lower modulations. More dramatically, the change of level between 80 per cent. and 90 per cent. modulation is less than 1 db. It is therefore only just detectable, in terms of comparison, by the human ear; there is less than 6 dbs. change between 50 per cent. and 80 per cent. modulation.

The diagram is given further significance by labelling the decibel scale with the musical notations of light and shade contrast.

The notations in brackets are those probably sufficing for wireless reproduction. Those not in brackets would approximate to true reproduction. As a matter of fact, in real listening 80 db. or more light and shade contrast is sometimes required when a full symphony orchestra is performing under certain conductors.

But the point made here is that all the normal light and shade contrast, between *pp* and *mf*, is given by a modulation change between 5 per cent. and 25 per cent. The rest of the range only awaits the *fortissimo* crash to give it its full significance.

That *fortissimo* crash requires a range between 25 per cent. and 100 per cent. modulation! Surely, therefore, if it were decided never to modulate more than 60 per cent., few would notice much change in the light and shade contrast. To-day the upper limit is fixed at 80 per cent. to 90 per cent., and the difference in level between the *fortissimo* of 60 per cent. and 80 per cent. is a little over 4 db.,

"Quality"—
one-tenth of the scale which the ear appreciates.

But if maximum modulation were reduced to such limits as are indicated—say a maximum of 60 per cent.—then harmonic distortion would be vastly reduced. It has been the fashion to measure up valve characteristics and to design load impedances so that the distortion shall never exceed 5 per cent. But there is more than one valve in the chain between microphone and loud speaker. There is also a detector, which is seldom linear over much more than a 60 per cent. modulation range. Harmonics may cancel, but harmonics may add. Moreover, any valve which is "non-linear" may produce intermodulation between the various frequencies present in a *fortissimo* crash—it makes one shudder to think about, and some of us shudder to hear, the consequent "mush" which is created when modulation exceeds a certain rather small minimum.

All harmonics increase rapidly with increasing amplitudes; that is why, with an eye on the diagram and an ear to a loud speaker, one suggests that the worship of modulation depth—90 per cent. instead of 80 per cent.—is as false as the joy in the aerial amp!

Random Radiations

By "DIALLIST"

The King and the Microphone

A GOOD many old hands will remember King Edward VIII's broadcast, made when he was Prince of Wales, on October 7th, 1922. On that day a great rally of Boy Scouts took place at the Alexandra Palace, and the Prince addressed them with the help of one of the earliest specimens of public-address equipment. That evening he spoke from York House to Scouts throughout the country. The only existing British broadcasting station was the original 2LO, which was not to be officially opened for another five or six weeks.

The Prince gave his address from his own study, using a microphone of the type seen in the now old-fashioned "candlestick" telephone. So far as I know, the ordinary telephone line was employed between York House and 2LO's transmitter, and, since on the receiving side such refinements as the use of power valves and of negative grid-bias were still mysteries, it is a wonder that intelligible loud speaker reproduction was obtained.

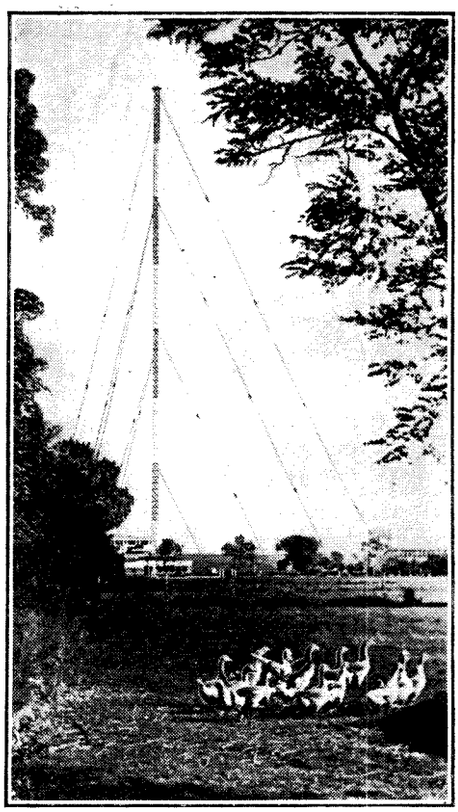
A Memorable Occasion

The set that I had in use in those days was a unit affair, housed partly in, but mainly upon, five small cabinets of cigar-box size. The first unit was the tuner, with swinging coils. The variable condensers stood separately upon the table. Next came the high-frequency unit, which was coupled by means of a Sullivan semi-aperiodic transformer to the detector. The third and fourth units were of the low-frequency order, the coupling in each case being the original Sullivan LF transformer of gigantic size, and weighing, so far as I recollect, about two and a half pounds. The valves throughout were most likely of the R type, though they may have been DER's, for I acquired my first set of dull-emitters at about that time, the price being about £2 apiece. This receiver operated a Brown loud speaker of the horn type, and reproduction must really have been pretty horrible, though everyone admired it in those days. By the time that the Prince was due to speak an audience of about forty people had somehow packed themselves into the room. At that time 2LO was rated at only 1.5 kilowatt, and its distance from me was twenty-five miles. Such were the sound-absorption effects of my audience and its clothing that a considerable amount of boosting by means of the reaction coil was necessary. But we heard every word of the Prince's speech for all that, and when it was over everyone was saying to everyone else, "Isn't it marvellous? It couldn't have been clearer; he might have been speaking in the same room!"

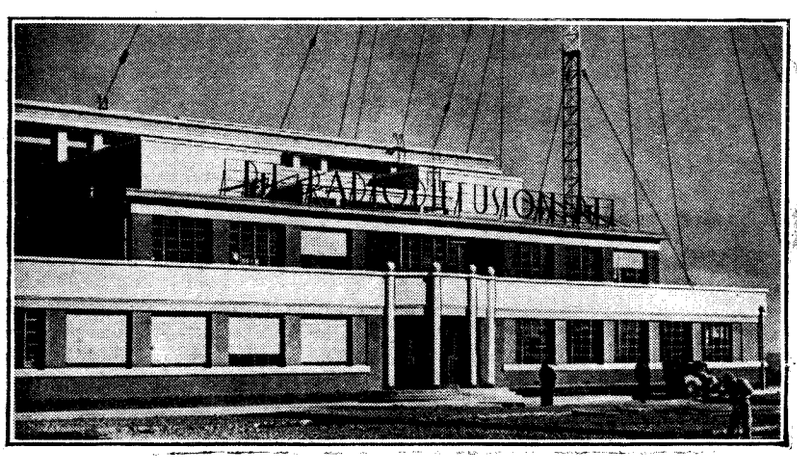
I wonder what modern critiics of quality would say if they could hear that quaint old set to-day?

The Voice of the King

Since then we have heard King Edward VIII as a broadcaster on many occasions. Possibly by the time that these notes appear in print he will have spoken to us in our homes for the first time as King. In any event, he is fully conscious of the wonderful work done by his great father in forging the wireless link between Crown and people. We may be sure, therefore, that our King, who was the first Royal personage to speak to a great audience by means of the microphone, will continue to maintain that close personal touch with his subjects throughout the Empire that wireless alone can ensure. He has an excellent microphone voice, and during his career as Prince of Wales he has shown us that he has the happy knack of broadcasting, not as an unapproachable Royal personage, but as one thoroughly in touch with and completely understanding the lives and the difficulties of all of us.



TOULOUSE-MURET is situated some distance from the town in a distinctly rural setting.



TOULOUSE-MURET, typical of the new French regional stations, can be heard at good strength on most evenings. The nominal power is 60kW. though the plant is capable of a 120kW. output. The wavelength is 328.6 metres.

Interference and Television

INTERFERENCE with television due to electrical machinery, and in particular to the ignition system of motor vehicles, may prove a difficult problem in many places in the near future. I have not yet tried reception in my own house on wavelengths below ten metres, but I doubt whether I should be able to make much of it, since the house stands at no great distance from a main road along which the traffic is pretty heavy. Even on the short-wave bands between ten and sixty metres certain kinds of vehicles cause a great deal of interference as they pass. There must be ways and means of preventing electrical interference with ultra-short-wave reception, for I went several times to see demonstrations of high-definition television in Wardour Street, and there was no trace of trouble on either the speech or the vision channel—and this in a narrow street where the traffic is continuous and in a building equipped with electric lifts, ciné projectors and other electric appliances. I hear that motor car manufacturers have already been approached about the advisability of fitting suppressor devices to their vehicles.

Signal-to-Noise

THE RATIO THAT REALLY MATTERS TO-DAY

By "CATHODE RAY"

JUST as geologists amuse themselves by dividing up the last few hundred million years into various periods —Eocene, Miocene, Pliocene, Pleistocene, etc. (finishing up in the modern nursery with Plasticene)—so we may find it instructive to classify the few years covered by broadcast radio according to the trends of progress therein.

First, we went all out for *sensitivity*. The main thing was to receive anything at all. The means available were so poor, and the transmitters so few and weak, that the possibility of receiving too much simply did not occur to one. The idea of a volume control seemed at one time to be fantastic, for there was never any excess volume to control. And it was so wonderful to hear any sound, be it music, morse or atmospheric, that nobody had the heart to grumble about the *quality*. That was the next thing to be considered, when the first novelty had worn off.

When we had learned to capture transmissions originating hundreds of miles away, and to reproduce programmes with a fair degree of fidelity to the original, and stations sprang up everywhere and increased their power, the emphasis shifted from bringing things in to keeping things out. *Selectivity* was the cry. The superhet, born in the interests of sensitivity, and killed in the interests of quality, was brought to life again because it was and is the most practicable means of obtaining high selectivity. With the introduction and (more or less) perfecting of variable selectivity, the last phase of this era closes. We are now—unless I am greatly mistaken—well embarked on the fourth period; that of *anti-noise*.

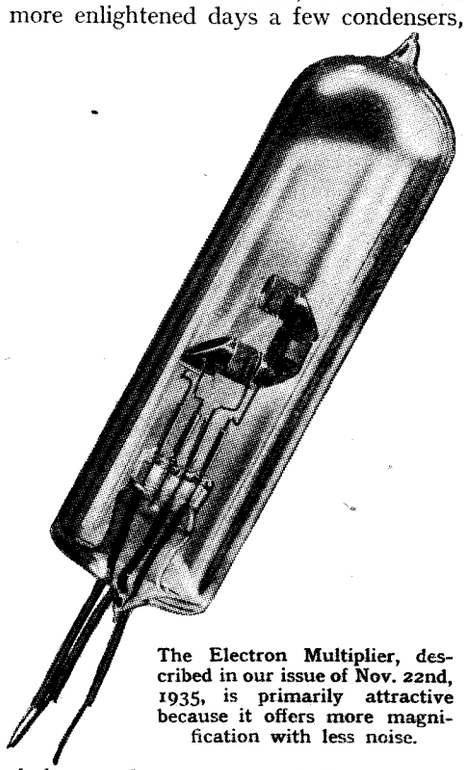
In the first three directions the closeness of approach to perfection is almost entirely a question of how much one is prepared to spend. But the greater the range, and to some extent the better the quality, the more likely are one's efforts to be marred by *noise*.

Selectivity, though theoretically helpful up to a point, does not solve the problem.

Wanted: A Better Name

There are several quite distinct species of noise. This is so even if the term is used in its specialised technical sense, excluding such nevertheless serious types as those generated by children, itinerant "musicians," and pneumatic drills. There is the type, much discussed for some time past by committees and others, for which there appears to be no other brief term than the hateful expression "man-made static." As the name suggests, this is a variety which was non-existent at the dawn of creation, but is more or less proportional to modern civilisation with its multifarious applications of electricity. These need not be named in detail, but a large proportion of them cause interference with radio when they are in good working condition, and all of them are liable to interfere when they are not. Even the common electric lamp, when it is on the point of burning out, can simulate a massed machine gun attack on the loud speaker front.

There are two main lines of attacking this form of noise: to silence the interfering source with an appropriate "suppressor"; or to exclude the interference from the receiver. The former is by far the most satisfactory and effective. In an earlier age the appropriate suppressor would no doubt be deemed to consist of a well-wielded battle-axe, but in these more enlightened days a few condensers, chokes and screens serve the purpose without loss of life. The difficulties are almost entirely economic. The owner of an interfering appliance tells the radio listener to go to blazes before he will spend money on suppressors which do nothing for him (the owner) except slightly increase the risk of breakdown. It seems reasonable to hold that it is the listener who should see to it that his receiver doesn't receive the noise. But, unfortunately, all he can possibly do may not in every case overcome the trouble. And day by day the use of electrical appliances grows. And what manufacturer of them is voluntarily going to increase their cost by fitting suppressors unless all his competitors are compelled to do likewise?



The Electron Multiplier, described in our issue of Nov. 22nd, 1935, is primarily attractive because it offers more magnification with less noise.

Atmospherics, on the contrary, were here before radio or even man himself had been thought of. And although numerous patents have been filed for the complete conquest of atmospherics, we still seem to be pretty much where we stood at first with regard to them. Fortunately in this country it is only during unfavourable conditions—which are least likely to coincide with long winter evenings—that they are a serious bar to broadcast reception.

Undisciplined Electrons

The aforementioned noises originate outside the receiver. There are others for which the receiver itself is responsible. I remember that even in the early days novices were instructed in such things as noisy HT batteries, valves and switches. And these evils are still with us. They are, however, the province of that person who, in America, is picturesquely referred to as the "trouble-shooter." So far as the serious investigator is concerned they do not rank as a problem. When all has been done to put a set into perfect working order there are still sources of noise in it that no science has succeeded in eliminating. They are due to the fact that a stream of water in a pipe, or an electric current in a wire, is not so smooth and continuous as it may seem. A column of infantry on the march, viewed from a distant aeroplane, might seem to be one continuous stream; a closer view reveals that it consists of many separate units. But infantry is at least orderly and disciplined. Imagine an immense crowd of people in a street, jostling hither and thither. In spite of the random movement there may be a constant drift of, say, 500 an hour from east to west. Although at a great distance the crowd may appear a continuous mass of humanity, closer investigation would reveal the separate individuals causing instantaneous fluctuations in the flow. That represents an electric current in a wire. It may average out at so many milliamps, but if the voltage it sets up along the wire is amplified sufficiently the irregularities due to the "crowd" nature of electricity may give rise to a rushing sound in a loud speaker.

That would be so even if a perfectly "quiet" amplifier were used. But valves themselves are necessarily noisy. The flow of current across the vacuum in a valve may be likened to the silent flow of flour down a chute—the separate particles are too small to produce audible impacts. But just as a microscope makes grains of flour look like boulders, the effect of high

Signal-to-Noise—

amplification is to make the valve current sound like boulders!

There is no longer great enthusiasm in professional circles when a means of getting greater amplification is invented. That is easy. But it is also useless, when it brings up the noise in the same proportion as the desired signal. What matters now is an increase in the signal/noise ratio. That is why Zworykin made a hit at the Institute of Radio Engineers when recently he demonstrated his "electron multiplier." An amplification of several millions in one valve was accepted with mild interest. But an estimated improvement of 20 decibels in the signal/noise ratio captured attention all over the world.

At the same time Armstrong (of superhet fame) demonstrated his new system of frequency-modulation. A novel system of transmission and reception successfully demonstrated—very interesting. But 30 decibels better signal/noise ratio—Ah! now he's talking!

There is no real difficulty in receiving and reproducing at any desired volume signals of less than one microvolt—corresponding to very weak and distant stations indeed. But even in the most favourable conditions such reception is submerged in noise. Increased range depends now almost entirely on our ability to overcome noise.

Below 100 Metres

THE 54-day cycle of high frequency radio fade-outs, first reported by Dr. J. H. Dellinger in *Science* for October 11th, 1935, is still receiving the attention of the experts.

So far this phenomenon has been noted only on transmissions over the illuminated portion of the globe and occurs at a frequency of only half the normal 27-day solar cycle.

The original dates concerned were March 20th, May 12th, July 6th and August 30th,[1] but October 24th has since been added to the list. This last date is given in the Technical News Bulletin of the Bureau of Standards for December, 1935, and the following quotation from the announcement is interesting: "A remarkable increase in sunspot activity began on October 10th, 1935, and this was accompanied by a general improvement in radio transmission on the higher frequencies. Amateurs and others found that they received excellent daytime signals on much higher frequencies than usual. By October 21st to 23rd the upper limit of frequency reached the highest value ever observed at the Bureau. Then, for a single day, October 24th, this was completely reversed. The upper limit of frequency on this one day dropped to half its value on the preceding days. On October 25th and succeeding days it returned to the high previous values . . . the height of the layer jumped from 150 to 290 miles on October 24th, and it was a day of considerable magnetic disturbance."

I have been fortunate enough to secure the co-operation of G2MV in my ultra short-wave studies, and from the combined logs of G2YL/G2HG/BRS250/G2MV it is interesting to note that there was a complete ultra short-wave wipe-out from May 14th to 18th[2] inclusive (not on May 12th), and again on May 21st, June 18 (27-day cycle May 21st-June 18th), July 7th, July 25th, August 2nd, 4th, 6th and 8th (July 7th-August 2nd, 26 days), August 18th to 22nd and August 26th to 30th, and September 1st to 3rd.

Only one of these dates coincides with those originally given by Dr. Dellinger, namely, August 30th.

Unfortunately, no data is yet available for October, but perhaps readers will let me have their comments on reception conditions during daylight (and night) on October 24th and, if possible, the days preceding and following it. When such information becomes available any deductions made from it will be published, but now we have to turn to our regular study of conditions.

For the fortnight under review we have once more to record an extreme range of wavelengths audible, from WCN, on 59 metres, down to 8 metres.

Much ultra short-wave activity has again been noted, an outstanding station having been the 9-metre relay of WHAM Rochester, New York. This transmitter has peaked to a local station signal with very good quality some evenings about sunset, and remained audible for a period of over one and a half hours on January 28th, with a complete absence of selective fading, and marred only by ignition interference from passing motors.

The unidentified 8.5 metre station referred to in my last notes may be a beacon at the Tempelhof Airport, Berlin.

Turning now to a more detailed study, we find that on Wednesday afternoon, January 15th, W3XAL on 16.87 metres was a strong signal, but with deep fading; later in the evening conditions were very "short wave" and the transatlantic telephone service was using 20 metres as late as 8.30 p.m., and at 10.30 p.m. strong signals from the U.S. were being received on waves from WON on 30 metres to WQN on 57 metres.

Thursday saw the best performance to date this year by W8XK on 25.27 metres, and this station was R6 and of fair merit at 10.30 p.m., whilst at the same time W2XAF on 31.48 metres was R9, merit good to excellent, being for once free from heterodyne interference from LKJ1.

Conditions on Friday were even better. W2XAF was a local station signal at 10 p.m., and W8XK on 25.27 metres was still very good at 10.50 p.m.

The 20-metre amateur band had also been very good at 9 p.m., very late for this time of the year, and several U.S. 'phone transmitters were giving results quite comparable to W2XE and W8XK in the 19-metre broadcasting band. Even CRCX Bowmanville was at R8, merit fair to good, on 49 metres at 10.55 p.m., in spite of interference from RWJ.

Saturday afternoon, January 18th, saw W3XAL again good at 2 p.m., and at 4 p.m. the 15.8 metre transatlantic 'phone WKF appeared to be putting up rather a better performance than the more regular WLA on 16.36 metres; later, at 5 p.m., W2XAD was about the strongest carrier on the air—at least between 15 and 25 metres—but in the evening conditions seemed to have deteriorated and were "long-wavish" again.

As a result of this fall in ionisation, the South Americans in the 49-metre band were rather better towards midnight, whilst W2XAF was very poor.

The half-wave of Moscow (25 metres) was fairly good on 12½ metres at midday on Sunday, but, apart from good signals from W3XAL on 16.87 metres and W8XK on 19.72 metres at 2 p.m., there was relatively little doing. Budapest HAS3 was very strong and slightly overmodulated on 19.52 metres, from 2 to 3 p.m., and W2XAD on 19.56 metres was very loud from 5.30 p.m. Incidentally, the characteristic hum on W2XAD seems now almost to have disappeared.

Conditions were very poor late on Sunday evening, but were normal again, and even improved, on Monday evening, January 20th, W1XK on 31.35 metres being excellent at 8 p.m., apart from carrier hum.

Conditions remained good throughout the week, and the 20-metre band was again good at 8 p.m. on Wednesday, January 22nd, W2AYJ, W2JJ, W2HBB, W2BST and W2EDW all being good 'phone signals on the loud speaker.

Almost summertime conditions were experienced on January 23rd, and WLA on 16.36 metres was still steady R9 at 9.30 p.m.! On January 24th conditions were again reversed, being very poor during the evening; all stations showed a pronounced "echo" or ripple.

On Saturday, conditions were back to very good, and W3XAL on 49.18 metres and COCD Havana on 48.8 metres were abnormally good at midnight, with W2XAF also excellent.

On Sunday, January 26th, VK2ME and VLK, on 31.28 and 28.5 metres respectively, were heard calling W2XAF. VK2ME was good, but VLK was very weak.

Changes in the times of transmissions from W2XE came into effect as from February 1st. The schedule is as follows: GMT. 1230-1600 21,520 kc/s, or 13.94 metres

1600-1800	17,760	,,	,, 16.89	,,
1800-2000	15,270	,,	,, 19.64	,,
2000-03	11,830	,,	,, 25.36	,,
03-04	6,120	,,	,, 49.02	,,

A new short-wave station is proposed for Western Australia, which will probably be called VK6ME.

One cannot conclude this fortnightly review without some reference to the part which short-wave broadcasting has played in the past week's broadcasts, associated with the passing of King George V. Many people must first have heard the sad news *via* the Empire transmitters at Daventry—in particular is this true of South Africa—whilst the Proclamation of King Edward VIII from St. James's Palace was heard in this country being relayed by W3XAL, W2XAF, W3XAU, W1XK, CRCX and VK3LR.

The Prime Minister's speech was relayed by at least W2XAF and W1XK, whilst the eloquent broadcast of the King's last journey to Windsor was relayed by W3XAL, W2XAD, W2XAF, DJE, W2XE, FYA and PHI, and perhaps others unheard in this country. Surely a fitting tribute.

[1] Reception of Empire stations GSJ 13·93m and GSG 16·86m *better* than normal in Hong Kong on 30th August from 1100—1330 GMT. Considerable sunspot activity. (1900—2130 HKT.)

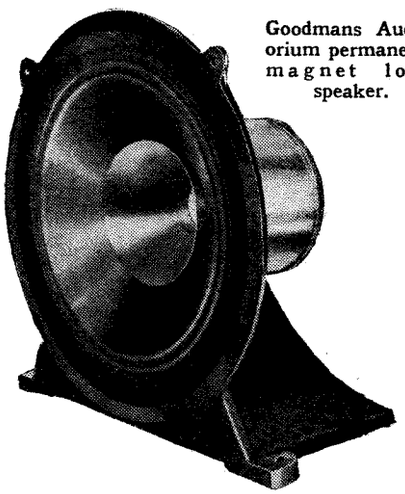
[2] *No* sunspots from May 15th—27th.

New Apparatus Reviewed

Recent Products of the Manufacturers

GOODMANS PERMANENT-MAGNET AUDITORIUM LOUD SPEAKER

FOR some unaccountable reason the range of choice among really high-quality loud speakers of the permanent-magnet type is not nearly so wide as it is in the case of speakers with energised fields.



Goodmans Auditorium permanent-magnet loud speaker.

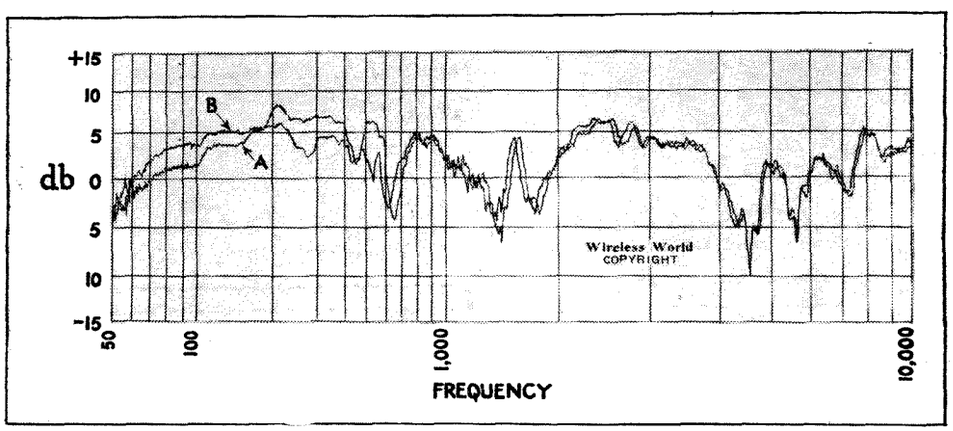
The introduction of this new Goodmans unit is, therefore, of special interest. Its magnet is an unusually massive affair of nickel-cobalt-aluminium alloy giving a working flux of no less than 16,000 lines per square centimetre, which compares more than favourably with the best energised magnets.

A wide frequency response has been achieved by the use of twin diaphragms driven by a single aluminium speech coil with an average impedance of 10 ohms. The high frequency cone is exponential in form and is of thin bakelised paper combining lightness with rigidity. Like the main cone it is a seamless moulding.

The outstanding features of the performance are the excellence of the high frequency response, which is maintained well above 10,000 cycles, and the absence of the prevalent peak in the region of 2,000-3,000 cycles which so often gives coloration to the treble response in cone diaphragm units.

In the accompanying axial response curve it will be seen that two records are superimposed. One was taken on a symmetrical baffle 3ft. square, and the other with extension pieces added to increase the area and also to give back-to-front paths of different lengths. With the exception of the slight difference in the bass response, the effects of changing the baffle area and shape are confined to the region between 200 and 600 cycles.

The price of the Auditorium speaker with cast aluminium stand and complete with output transformer wound to the customer's requirements is £9 5s. The unit will also be available without stand and transformer at £7 13s. The transformer may be purchased separately at 22s.



Axial response curves of Goodmans Auditorium speaker : (A) with symmetrical baffle; (B) with irregular baffle. Microphone distance 4 ft., power input 1 watt.

RESLO MICROPHONES

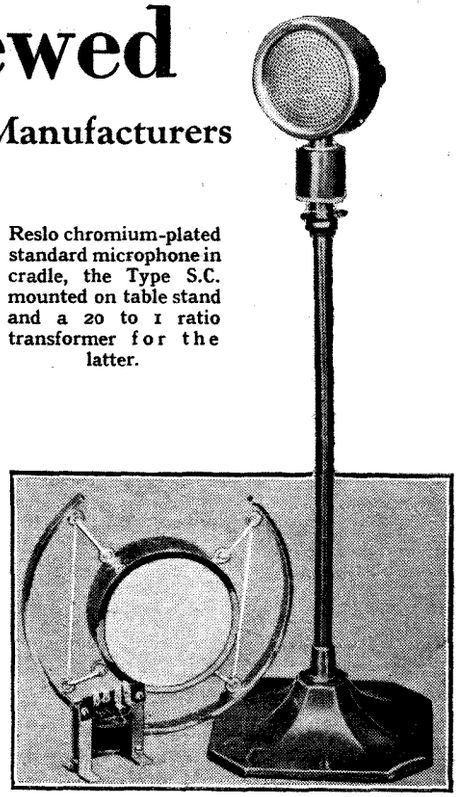
TWO carbon microphones have been submitted for test by Reslo Sound Equipments. One model, described as the standard type, has been available for some time, but the other is a comparatively recent addition, having been produced especially for home recording. This is a small model, but embodies most of the salient features, at least so far as the construction is concerned, of the other.

It is a robust microphone measuring 2½in. in diameter and 1in. deep, and can be obtained either fitted with suspension eyes or with a vibration absorber for fitting on a small telescopic stand as shown in the illustration. The standard model is 3¼in. in diameter and 1¼in. deep, and it is suspended in a cradle for mounting on a stand.

The characteristics of these two microphones are not very dissimilar, though the larger model appears to have a slightly better high-note response than the smaller. It is not that the output is greater in the upper register, but that it is maintained at the mean level to a higher point in the audible scale.

This may be due partially to the use of different transformers, for we used the one supplied with the small microphone, but a very much larger component of our own for the standard model, as the transformer was not included.

The home recording model, or Type S.C. as it is known, was only a shade less pleasing in its response, which is, perhaps, quite understandable, as it is a cheaper model, yet no real faults can be found with either. They are well designed and perfectly satisfactory microphones, and compare favourably with many more expensive models.



Reslo chromium-plated standard microphone in cradle, the Type S.C. mounted on table stand and a 20 to 1 ratio transformer for the latter.

The standard model has an impedance of 500 ohms, and requires a 15 to 1 ratio transfomer, while the S.C. model's impedance is approximately 200 ohms and a 20 to 1 ratio transformer is advised.

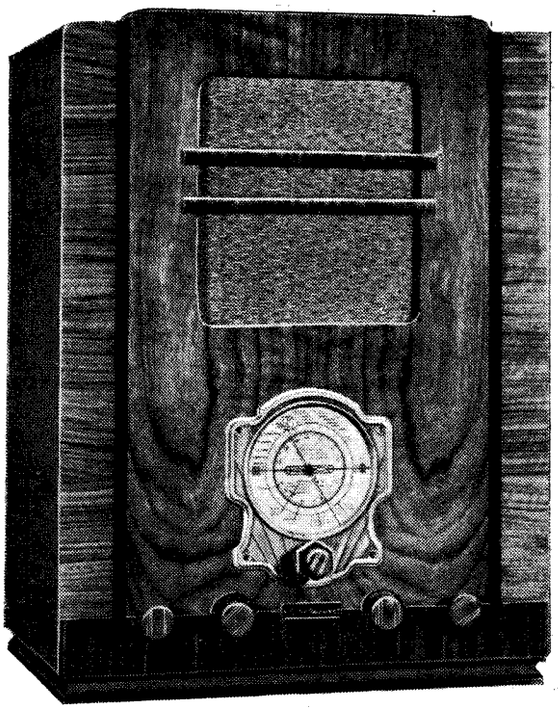
The standard type costs £2 14s. in a chromium-plated case and cradle as illustrated, while various styles of stands are available ranging from 8s. 6d. to 35s. The smaller model costs 30s., or 37s. 6d. complete with table stand, the finish being bronze. A transformer costs 8s. 6d.

EDDYSTONE COIL FORMERS FOR IMPERIAL S-W SIX

COIL formers especially moulded in DL9 insulating material and of the correct size and shape specified for *The Wireless World* Imperial Short-Wave Six can now be obtained from Stratton & Co., Ltd.

The double former, part of which is reduced in diameter for the ultra-short wave coil, is threaded throughout for winding 8 tpi as required. The other style is left with plain ribs. The surface of the former is glazed and hard and should prove perfectly satisfactory in the tropics. Double formers cost 1s. 8d., and the single pattern 1s. 3d. each.

Eddystone moulded formers for Imperial Short-Wave Six receiver.



Challenger 8

AN ALL-WAVE SUPERHETERODYNE COVERING 12—2,050 METRES

FEATURES.—Type.—*All-wave superheterodyne for AC Mains.* **Ranges.**—*(1) 12-39 metres; (2) 36-108 metres: (3) 180-550 metres; (4) 850-2,050 metres.* **Circuit.**—*HF amplifier—heptode frequency changer.—IF amplifier—double-diode-triode second detector—triode LF amplifier—push-pull triode output valves. Full-wave valve rectifier.* **Controls.**—*(1) Tuning. (2) Volume and on-off switch. (3) Waverange. (4) Tone. (5) Sensitivity.* **Price.**—*13 guineas.* **Distributors.**—*Degallier's, Ltd.*

ALTHOUGH the chassis of this receiver is of American origin the walnut cabinet is in the English style. Further, a special scale has been produced for the clock-type dial, which is calibrated in metres instead of the usual kilocycles, and carries the names of the principal British and European broadcasting stations. The two short wavebands occupy the lower half of the dial, while the medium and long waves are at the top.

The six-stage circuit begins with an HF pentode signal-frequency amplifier which is coupled to a heptode frequency changer. The aerial input circuit is arranged for use either with a single wire aerial or a doublet antenna, which sometimes gives improved results on the short waves. Switches associated with the four waveranges are arranged so that the coil next lower in frequency to that in use is short-circuited. In this way absorption points on the waverange in use are avoided.

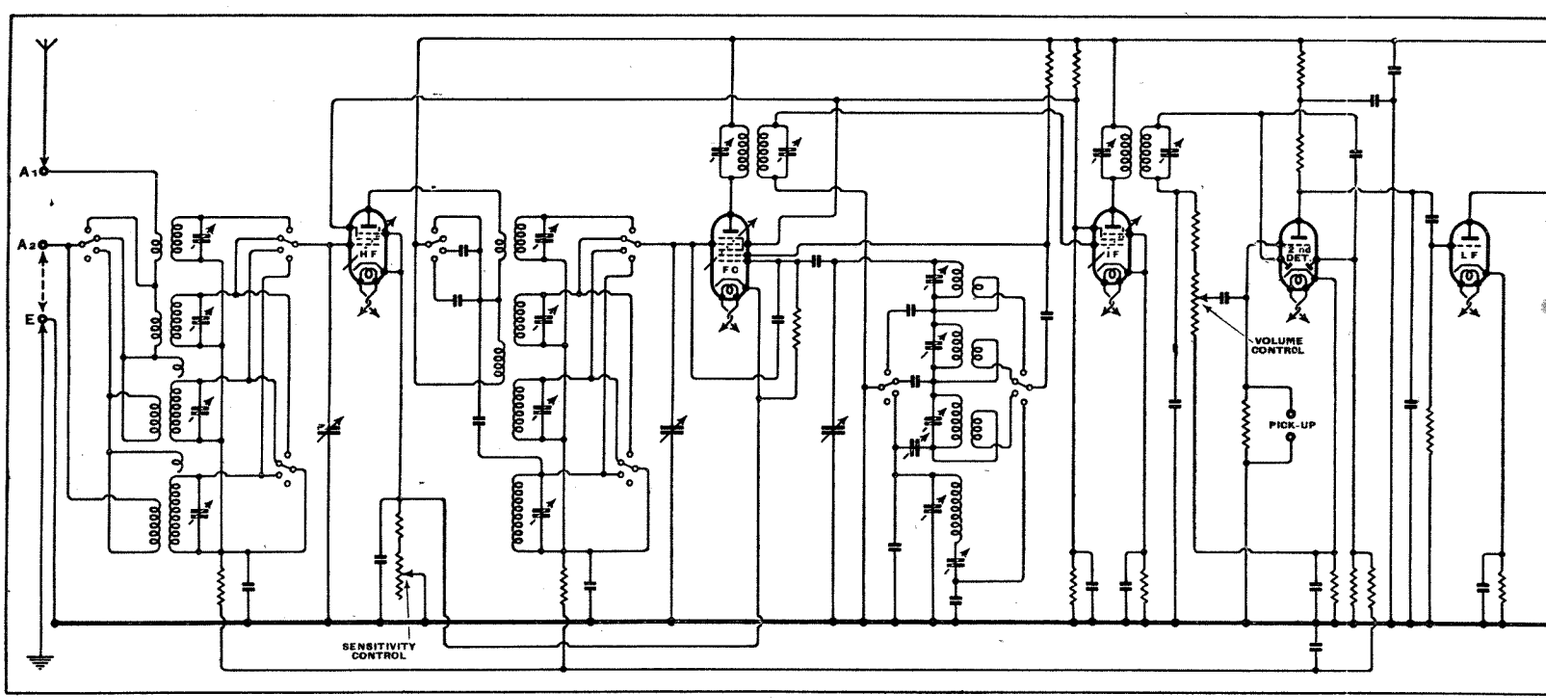
The IF amplifier, which functions at a frequency of 456 kc/s, is a valve of similar type to that used in the HF stage. The second detector is a double-diode-triode combining the functions of signal rectification, AVC and a first stage of LF amplification. This is followed by a second LF amplifier which is a triode and is transformer-coupled to the push-pull triode output valves. A resistance-capacity tone control is shunted across the two anodes.

There are five tuning controls, and in addition to the usual waverange, tone, and volume controls there is a sensitivity control which in its action produces an effect very similar to that of quiet automatic volume control. It is arranged to vary the bias on the HF amplifier, and in so doing sets a threshhold to the strength of the incoming signal which is able to actuate the automatic volume control. In this way signals which are appreciably above the prevailing level of background noise can be received without any diminution in strength and with an absolutely silent background between stations.

The slow-motion drive for the tuning dial has two speeds. Here we should have liked to have seen a slightly wider separation between the ratios, but this is purely a matter of personal choice and in no way affects the performance of the set.

With an output stage rated at 7 watts and the overall sensitivity enhanced by the presence of the signal-frequency HF amplifier, the receiver gives a satisfying impression of power and range. This is particularly noticeable on the two short-waveranges where reception has a clear-cut quality. The American transmissions were readily identified in the midst of their European neighbours in wavelength,

A straightforward six-stage circuit is employed. The sensitivity control in the HF stage gives an effect similar to QAVC with a silent background between stations.



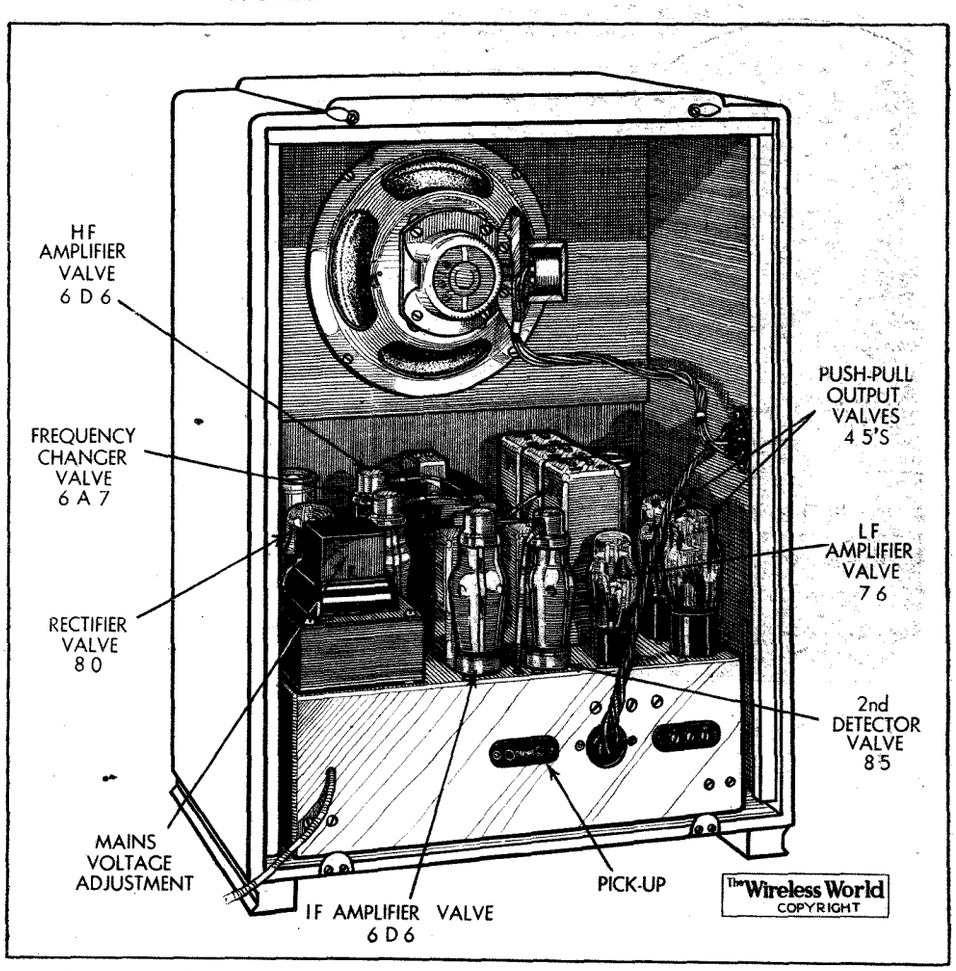
and if a certain amount of fading was noticed on the long-distance stations on the short waveband there was nothing in the behaviour of the AVC on the medium and long waves to indicate any serious fault in this aspect of the performance.

The selectivity on the medium and long waveranges left nothing to be desired, and only 1½ channels were lost on either side of the National and Regional Brookmans Park transmissions when using the set in Central London. The Deutschlandsender gave an excellent programme free from serious side-band interference when the tone control was turned down slightly from the high position. Normally, when using the long waveband the tone control could be turned to the full brilliant position with advantage, as the high selectivity on this band might otherwise result in some loss of top. On the medium waveband, on the other hand, there was an ample reserve of top response, and the tone control could be turned down to suit one's personal taste in the matter of tonal balance. Due to the generous proportions of the cabinet there is an ample bass response, and if cabinet resonance contributes to this to some extent it does so without being in the least objectionable.

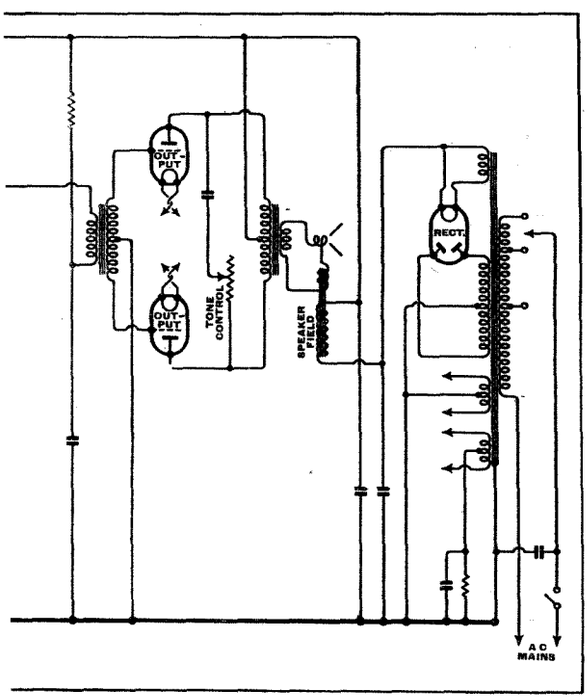
Thorough Screening

The chassis is mechanically sound and is cadmium plated throughout. Double screens are used for many of the tuning inductances, and the valves which handle HF currents are enclosed in close-fitting shields built in two halves and held together by screening caps at the top. The chassis as a whole is rubber mounted, and the tuning condenser is sprung separately to minimise microphonic troubles which might otherwise be experienced on the short-waveranges. There was, in fact, a trace of this trouble when the sensitivity control was set at maximum, but this occurred only when carrier waves of exceptional strength were picked up and from which ample volume would in any case be available with the control well turned down from the maximum. Incidentally, the sensitivity control had some slight effect on the tuning, and in skilful hands might be used to put the finishing touches on the work of tuning in a distant station on the shortest wavelengths where adjustments are usually critical.

To sum up, we can confidently recommend this as a good example of the best practice in the design of American all-wave receivers of moderate price.



The chassis is noteworthy for the application of detachable close-fitting shields to all valves carrying HF currents.



An American Service Manual

Modern Radio Servicing.—By Alfred E. Ghiradi, E.E. Pp. 1300, with 706 illustrations and diagrams. Radio and Technical Publishing Co., 45, Astor Place, New York City, N.Y., U.S.A. Price $4.00.

TO be successful, the writer of a technical book should obviously have before him a clear mental picture of the type of reader to whom he is appealing. The book with which we are now dealing is avowedly written not for the raw beginner but for the service man of some experience who has found out that the "hit and miss" methods that were good enough in the days of comparatively simple sets are no longer applicable to the refined and complex modern receiver. This viewpoint is well maintained throughout. Although the book is American, most of the matter is useful to the English reader; with hardly an exception, all the diagrams are so drawn as to be perfectly comprehensible to him.

About a third of the book is devoted to meters, analysers, and measuring apparatus of various kinds. The service section proper starts by treating faults of the kind that are found by logical point-to-point tests made more or less as a matter of routine. More obscure defects are discussed separately, and a very useful section of the book deals with the complicating effects of such innovations as AVC, all-wave tuning, etc.

Other sections describe the fitting and servicing of car radio and yacht installations, while the whole subject of interference suppression, both at the source and at the listener's end, has been given a good deal of space.

The reader is assumed to have a certain amount of knowledge of fundamentals, and, though the general treatment is practical rather than theoretical, the more obscure defects are explained where necessary. "Modern Radio Servicing" is undoubtedly a valuable work of reference to either the professional or keen amateur. A companion book, "Radio Field Servicing Data," price $1.50, deals specifically with faults in typical American receivers and so is of less interest to the English reader. H. F. S.

Next Set Review:—

FERRANTI ALL-WAVE SUPERHET

Listeners' Guide

Outstanding Broadcasts at Home and Abroad

TWO-PIANO RECITALISTS, Rawicz and Landauer, photographed during a B.B.C. broadcast. This brilliant Viennese pianoforte "team" will be heard again at 8.35 on Monday in the Regional programme.

HOW historically minded we can become for ten shillings a year! Not a week passes in which the B.B.C. does not probe into the past to resurrect for our benefit memories of "far-off unhappy things and battles long ago."

This week the B.B.C. will take us to the lonely shores of Loch Leven to re-enact the opening stages of the tragedy of Mary, Queen of Scots. The drama of Mary's capture at Carberry Hill and escape from Loch Leven castle will be presented in the form of a radio play by Horton Giddy. Jean Taylor-Smith will take the part of the unhappy Queen. The Queen was kept in the fortress while the Lords were making up their minds what they should do with her, and the fact that the castle was held by a Douglas, a member of a family bitterly opposed to the Queen, did not help her case.

"The Queen at Lochleven" will be heard in the National programme on Monday (8.35) and in the Regional on Tuesday (8).

◈ ◈ ◈

PEPTONISED OPERA

GORDON MCCONNEL'S comic opera programmes are sure favourites, and we may expect some rich fare in the fourth of the series, which is to be broadcast Nationally on Thursday at 8.30, and Regionally on Friday, February 14th. The two operas to be featured are "Marthe" (Flotow) and "Merrie England" (German). "Marthe" is essentially light in touch, and there is more than a hint of Offenbach pervading its music. Everyone knows Sir Edward German's ever-popular "Merrie England."

The cast is headed by Nora Gruhn (soprano), Gwladys Garside, Francis Russell, Morgan Davis, and Dick Francis, and the music is being arranged by Mark Lubbock in co-operation with the producer.

◈ ◈ ◈

STRAIGHT FROM THE ROCKIES

THAT the Hillbillies have won the hearts of the British public is evident from the letters received at Broadcasting House. More Hillbilly songs will be heard on Monday at 8, when Big Bill Campbell brings his team of Rocky Mountaineers to the National microphone. They import a breath of fresh air straight from the Rocky Mountains of Canada.

◈ ◈ ◈

COMPOSER AND THE ELEPHANT

A FAMOUS British politician comes into the story of Albert Roussel, whose Fourth Symphony Dr. Boult is conducting in the Sunday Orchestral Concert at 9.20. M. Roussel was once touring India when he and his wife became lost in a lonely place during a search for the temple of Udaipur. At that moment a Briton came up and offered to lend the composer an elephant and horses. Thus M. Roussel was able to proceed to Udaipur, and the result of his visit was a magnificent opera oratorio based on an early Hindu legend. It was only afterwards that M. Roussel learnt that his friend in need was Mr. Ramsay MacDonald.

"ŒDIPUS REX"

A DAZZLING musical highlight next week is the broadcasting of Stravinsky's "Œdipus Rex"—the main event in the B.B.C. Symphony Concert on Wednesday. M. Ansermet, the Swiss conductor, will be directing a big body of soloists and the Philharmonic Choir. "Œdipus Rex" is in the form of an oratorio sung in a Latin version of the original French text by Jean Cocteau, after Sophocles. It was first performed in Paris in 1927 during a Diaghilev season. Walter Widdop will take the part of Œdipus.

◈ ◈ ◈

A BARK PROGRAMME

CANINE artistes will take part in a broadcast from Cruft's Dog Show at the Royal Agricultural Hall, Islington, in the Children's Hour on February 12th.

◈ ◈ ◈

AVIATION BROADCAST

A NEW method of introducing talks will be adopted on February 11th (Nat., 10), when a feature programme, "Conquest of the Air," will serve as a send-off for a talks series on this topic.

The progress of aviation science will be pictured from the early days of experiments with man-lifting kites. The programme will describe in turn the reckless but valuable exploits of the early pioneers, the amazingly rapid development during the War, and the almost equally rapid organisation and expansion which has continued from then to the present day.

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OLYMPIC WINTER SPORTS

ALTHOUGH the B.B.C. will not give us an actual running commentary on the Olympic Winter Sports in Bavaria until Saturday, February 15th, there will be an eye-witness account to-morrow night (Saturday) at 6.30 in the National programme dealing with the ski-running and jumping, skating, and the toboggan contests.

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SUGGIA'S HINT TO BROADCASTERS

MADAME GUILHELMINA SUGGIA is one of the world's great musical artistes who are usually known by surname alone. In her broadcast at 7.20 on Sunday (Nat.) her programme will include Valentini's Sonata in E.

It was Suggia who in 1927

MARY, QUEEN OF SCOTS. A little-known portrait, attributed to Zucchero, of the unhappy Queen whose escape from Lochleven Castle is the theme of Horton Giddy's radio play on Monday and Tuesday next.

for the Week

HIGHLIGHTS OF THE WEEK

FRIDAY, FEBRUARY 7th.

Nat., 8, "War Calls the Tune." 10, Transatlantic Bulletin.
Reg., 7.10, B.B.C. Dance Band. 8.30, Cavalcade of Lyrics. 10.20, Harry Roy and his Band.
Abroad.
Radio-Paris, 8.45, Offenbach operettas: "Orpheus in the Underworld" and "Les deux Aveugles."

SATURDAY, FEBRUARY 8th.

Nat., 2.35, Ireland v. England Rugger. 8.30, Band Box.
Reg., 8, "Tosca" (Puccini), from Sadler's Wells. ¶Medvedeff's Balalaika Orchestra.
Abroad.
Stuttgart, 7.10, "Carnival Cavalcade of Opera and Operetta."

SUNDAY, FEBRUARY 9th.

Nat., Troise and his Mandoliers. 5.20, "Coriolanus," by William Shakespeare. 7.20, 'Cello Recital by Suggia. ¶Leslie Jeffries and Orchestra, Grand Hotel, Eastbourne.
Reg., 6.30, B.B.C. Orchestra. ¶Sunday Orchestral Concert.
Abroad.
Leipzig, 7, Dresden Philharmonic Orchestra.

MONDAY, FEBRUARY 10th.

Nat., 7.20, Talk: Galsworthy's "Loyalties," by Eric Gillett. ¶"The Rocky Mountaineers." 8.35, Radio Play: "The Queen at Lochleven."
Reg., 8, Estonian and Latvian Song Recital. ¶Rawicz and Landauer (Two-piano recital).
Abroad.
Königsberg, 8.10, Contemporary German Music.

TUESDAY, FEBRUARY 11th.

Nat., 8, Leonard Henry in Variety Programme. ¶Piano Recital by Clifford Curzon.
Reg., 8, "The Queen at Lochleven." ¶B.B.C. Theatre Orchestra. ¶Sydney Kyte and his Band.
Abroad.
Paris P.T.T., 8.30, Symphony Concert by the French National Orchestra.

WEDNESDAY, FEBRUARY 12th.

Nat., B.B.C. Dance Orchestra. 8.30, B.B.C. Symphony Concert.
Reg., "Tunes from the Town." 8.15, Café Colette Orchestra. ¶Joe Loss and his Band.
Abroad.
Breslau, 7.45, Waltz Evening.

THURSDAY, FEBRUARY 13th.

Nat., Alfredo Campoli Trio. 8.30, Comic Opera: "Marthe" (Flotow), "Merrie England" (German).
Reg., Organ Recital by Quentin Maclean. 8.15, Royal Philharmonic Society's Concert. Conductor: Sir Thomas Beecham.
Abroad.
Kalundborg, 7.10, Wagner Festival Concert.

gave excellent advice which might be studied by all broadcasters. It was on the occasion of her first appearance before the microphone, and she likened the experience to that of having her photograph taken. "If one thinks about it," she said, "one loses the natural expression."

◈ ◈ ◈

A GREAT MUSICAL JOKE

ONE of the greatest musical jokes in history can be enjoyed again by those who tune in Beromunster to-night at 7 o'clock. The opera is "Il Signor Bruschino," by Rossini. The composer, who was fond of practical jokes, had accepted a commission from the Grand Theatre, Venice, for a serious opera, but the manager of another Venice theatre, with whom there was a previous agreement, forced upon Rossini the "book" for an opera-bouffe which would have ruined the music already

JENS FREDERIKSEN, Denmark's "master-fiddler," with three of his sons. They are contributing to-night to a folk music festival programme to be relayed by the Danish stations from Aalborg, Jutland. M. Frederiksen played in the Royal Albert Hall, London, a few years ago.

drafted—but for Rossini's ingenuity. By various tricks, including the introduction of a funeral march into one of the most comical scenes, Rossini extricated himself from the dilemma, to the great joy of that section of the audience who were in the secret. Over forty years later the "joke" was produced in Paris, and it is this version which will be heard from Beromunster.

To-morrow's most attractive opera broadcasts are Puccini's "Tosca" from Radio-Normandie at 8.45 (clashing with the Sadler's Wells broadcast of the same opera) and Boito's "Mefistofele" from Rome at 7.35.

Sunday's 6 p.m. transmission from Berlin (Funkstunde) should please a large audience, consisting as it does of Ecklebe's very modern four-act opera, "Genoveva." Ecklebe is regarded as representative of the spirit of the nation at the present time.

◈ ◈ ◈

NOTABLE CONCERTS

THERE are few outstanding concerts this week, but mention should be made of the Frankfurt transmission at 7.10 to-night—a festival of Mozart and Beethoven music by the Station Orchestra and soloists. Another item worthy of note is Breslau's Winter Relief Fund programme to-morrow night at 7.10, provided by a military band with soloists, orchestra, and dance band. The programme is made up by items requested by listeners who have sent donations towards the Relief Fund.

◈ ◈ ◈

ORGAN MUSIC

ORGAN-LOVERS should not miss the recital of modern French organ music which Sottens is giving at 6.35 to-morrow (Saturday). At 8 on Tuesday, Brussels No. 1 offers us an organ recital of Belgian music from the Dominican Church.

LEONARD HENRY makes a welcome return to the microphone in Tuesday's Variety at 8 in the National programme.

"WHITE HORSE INN"

"THE WHITE HORSE INN," which had a big run at the London Coliseum some years ago, is featured in Vienna's 6.30 transmission to-morrow (Saturday). Another favourite will be Offenbach's "La belle Helene" from Brussels No. 1 at 8 on the same evening.

◈ ◈ ◈

"JOURNEY'S END" IN GERMAN

LISTENERS who understand German should not miss "Journey's End," Sheriff's War play, which Cologne gives in a radio version at 7.10 this evening.

◈ ◈ ◈

DANCE BANDS COMPETE

THERE should be some musical fun at 7.10 on Monday, when Stuttgart relays a competition between new German dance bands who have not hitherto broadcast.

◈ ◈ ◈

ALSATIAN MELODIES

NATIONAL music is well to the fore this week. Among the "star" items must be mentioned the Alsatian evening, which Strasbourg offers at 8.15 on Sunday. A genuine Schrammel ensemble contributes to Munich's folk music programme on Wednesday at 7.45.

◈ ◈ ◈

MODERN RHYTHM: ANCIENT FOLK MUSIC

A TRADITIONAL dance and song piece called "Liegstouw" (play assembly) is being relayed from Kilden, Jutland, by the Danish stations to-night from 9.10 to 11.30. The Liegstouw is an ancient rural barn dance played by village fiddlers, but a modern note will be struck by a rhythm orchestra which will help to build up a composite programme of outstanding interest.

THE AUDITOR.

UNBIASED

By FREE GRID

Scrap-book for 1066

TO my mind the "Scrap-Books" are among the most interesting features churned out by the B.B.C., and I always listen to them avidly even though my own recollections do not always tally with those of the B.B.C.'s official remembrancer.

I do think, however, that in the case of all "Scrap-Books" so far broadcast the people responsible are making a very great error indeed. The years dealt with have been those falling within living memory; indeed, they almost fall within the memory of our grandchildren. Nothing is more stale and boring than a repetition of familiar things.

What is wanted, of course, is a review of the years long since gone, and I myself propose to step into the breach and prepare a series of programmes which I intend

Sameness of the programme.

to offer to the B.B.C. I propose to commence with the year 1066 as it so happens that I already have documentary evidence of certain momentous happenings in that year. The year was unique in many respects, Westminster Abbey having been built and a successful French invasion having taken place. In connection with the latter event I possess some unique documents that have come down to me from an ancestor who was in the entourage of the invader. These are no less than the actual "telegraphic" forms recording the messages exchanged between various ships by means of a very primitive heliograph, wireless as we understand it being quite undeveloped at that time.

These early wireless messages are interesting, insomuch as they throw much light on the social habits and aspirations of the times and show that these did not differ greatly from those of our own age. Thus, one heliogram contains a cryptic reference to the anticipated delights of "lamphreys and malmsey" at some apparently well-known Hastings fish-and-chip stall, while another contains references to the sender's pleasant time at "the pictures" the previous night, the aforementioned "pictures" being in all probability the Bayeux tapestry which the young bucks of those days apparently used for the same base ends as their modern counterparts do the talkies.

The most interesting reference, however, is one relating to the "sameness of the programmes in different places." This apparently refers to the well-known habits of the strolling players and wandering minstrels of those days who trudged from one baronial hall to another so that anybody who was a guest at a ducal court on a Wednesday would probably hear the same programme which had been dished up to him at a neighbouring baronial hall on the previous evening. Truly there is nothing new under the sun, as is proved by this remarkable pre-B.B.C. instance of complaints against "diagonalising" of programmes.

I hope to be in a position to make a more definite announcement concerning my "Scrap-Book" as soon as I have completed my negotiations with the B.B.C. and the question of remuneration has been settled to our mutual satisfaction. Meanwhile, if any of you have any ideas for other years which might be dealt with, or other noteworthy historical happenings which would lend themselves to a vivid running commentary, please let me know as soon as possible.

A Woman's Page

ALTHOUGH appreciating the criticisms which readers send me from time to time concerning the contents of *The Wireless World*, and their many suggestions for its improvement, I must, in my own interests, hasten to point out that I am not responsible for the contents of this journal—apart, of course, from those things to be found on this page. In fact, I wash my hands of the whole business, leaving the Editor to hang his head in shame and murmur the time-honoured words: "I done it."

New position for the wireless set each week.

Lately I have received a large number of complaints concerning the complete absence of a woman's page. It has been pointed out to me that most journals run an "Aunt Martha's Page," or something of that sort, to relieve the tedium of family life, *The Wireless World* being one of the few home journals which leave women completely out in the cold.

While admitting this to be the case I fail to see what can be done about it, for the interest which women have in the technical side of wireless is even smaller than their knowledge of it, if such a thing be conceivable. It would, of course, be possible to incite them to knit jumpers for the family receiver. It would be fairly easy to work up a craze for women to dress up the wireless receiver to match their own attire, and in this manner the poor old receiver would have an extensive wardrobe of frocks for various social occasions. I quite fail to see, however, what else there would be to put in the woman's page each week. True, fashions change, so there would always be some new garment to make for the set, but would this be enough to fill the page each week?

It is true also that there is nothing women like so much as change—really only a polite term for chaos and disorder. It might, therefore, be fairly easy to persuade them to experiment with a new position for the wireless set each week, this, of course, entailing an entire rearrangement of the furniture, than which there is nothing so dear to the heart of a woman unless it be cluttering up the place with mops and pails. Whilst I cannot definitely promise anything I will pass these suggestions on to the Editor for what they are worth.

Three Years Ago

IT has ever been the fate of pioneers, more especially those in the scientific field, to be the object of scorn and obloquy not only on the part of the uninstructed public but also at the hands of their fellow-scientists. It is, of course, part of the price one has to pay for greatness, and I, therefore, make no complaint against it. I would merely call attention to the fact that, now that set manufacturers are all breaking their necks in a mad, competitive rush to get out all-wave sets, it is almost exactly three years since scorn was heaped on my head for suggesting that such sets should be produced. Similar scorn is now my lot for suggesting that next season's sets should be designed to include the sonic side of the television programmes.

Readers' Problems

THESE columns are reserved for the publication of matter of general interest arising out of problems submitted by our readers. Readers requiring an individual reply to their technical questions by post are referred to "The Wireless World" Information Bureau, of which brief particulars, with the fee charged, are to be found at the foot of this page.

Heavier Fuse Needed

AFTER estimating the total AC consumption of his receiver and allowing a reasonable percentage for losses in the power transformer, a correspondent has decided that a ½-amp. fuse in series with the primary of the power transformer should allow a fair margin of safety.

It is found, however, that fuses of this rating "blow" repeatedly, and we are asked to say whether this is an indication that anything is wrong.

We do not think so. Although the steady AC consumption of the average receiver is much less than ½ amp., heavy surges will inevitably take place, and as a general rule a fuse of not less than 1 amp. is recommended.

Tunable Whistle Suppressor

AS a general rule it is safe to assume that alterations are more easily—and more safely—made to the LF circuits of a receiver than to its HF or IF sections. Bearing this in mind, a reader asks us to suggest a circuit for a filter capable of eliminating heterodyne whistles and which can be connected to the LF inter-valve transformer of his receiver.

The arrangement shown in Fig. 1 represents an effective type of tunable whistle suppressor which was described in our pages some time ago. As the diagram shows, fixed condensers of 0.001 mfd. or 0.0005 mfd. may be switched into circuit in parallel with a

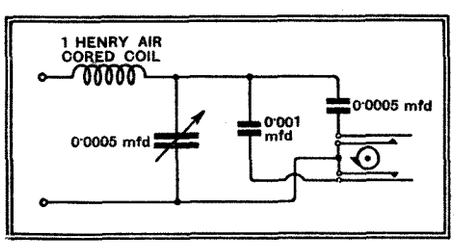


Fig. 1.—A heterodyne whistle filter of this type may be connected in the LF or loud-speaker circuits, and so is particularly easy to fit.

variable condenser, and in this way it is possible to cover a range of from 4,000-9,000 c/s—sufficient to deal with the type of whistle that usually gives trouble. It is also possible to connect a filter of this kind across the loud-speaker terminals, but, generally speaking, this position is less effective.

At Many Wavelengths

ALMOST everyone knows that the most certain way of testing the oscillator of a superheterodyne is to insert a milliammeter in the anode circuit and then to short-circuit either the grid or the anode coil—whichever is the most convenient. If everything is in order, an appreciable change in current should become evident.

In many cases oscillation is "patchy"; in other words the valve oscillates at some wavelengths and not at others. Hence the advisability of making the test described at a number of tuning positions. A querist, writing about the matter, appreciates this point, and has noticed that the change in anode current is by no means the same at different settings of the tuning condenser; he asks whether this is an indication that anything is wrong.

We do not think so; indeed, there is bound to be an appreciable variation in the strength of oscillation, and therefore in change of anode current, at different wavelengths. Provided that there is a decided change, the oscillator is probably working satisfactorily.

A Redundant Lead

SEVERAL constructors of the Variable Selectivity IV have been puzzled by a red lead which passes through the base of the aerial coil and for which no connection is shown in the wiring diagram.

The lead in question is not required for this particular receiver, and it may best be disposed of by cutting it off short at the point where it emerges from the base plate.

Morse Interference

AS pointed out in the Hints and Tips section of last week's issue, superheterodynes operating on the "fashionable" IF frequency of 465 kc/s are occasionally liable to interference from telegraphic transmitters, which affect the IF amplifier by direct breakthrough. To judge by correspondence received from several readers, the trouble appears to be confined strictly to areas in the immediate vicinity of coastal stations operating generally on the closely adjacent frequency of 500 kc/s (600 metres).

The best advice we can offer to those who are experiencing this difficulty is that they should adopt the plan suggested in the paragraph referred to and to fit a wave-trap, tuned to the interfering station, in the aerial circuit. But when doing so it would be worth while to see whether any part of the interference is coming in through the receiver wiring, and a test can be made by disconnecting the aerial and noting whether interference persists. If it does, screening of the high-potential grid wiring of the frequency changer and IF valve is indicated.

To revert to the question of a wave-trap. The very simple connections of this helpful piece of apparatus are indicated in Fig. 2. In this diagram we have attempted to kill two birds with one stone, as it will also serve as a guide to other querists who find it necessary to connect a dual wave-trap for reducing interference from a local twin-wave transmitter.

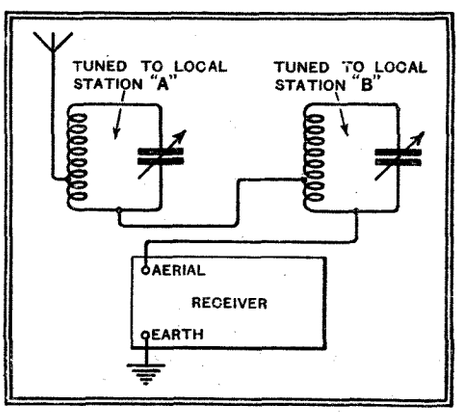


Fig. 2.—Wavetraps connected in series for the elimination of interference on two different wavelengths.

Insufficient Volts

REFERRING to the Universal Gramophone Amplifier described in our issue of January 24th, several querists have asked whether this piece of apparatus is suitable for, or could be modified for, operation on 110-volt and 120-volt supplies.

We are afraid that the answer to these questions is in the negative. It is almost impossible to obtain an adequate output in such cases; the amplifier would give no more than about a quarter of the output obtainable with the more normal higher voltage for which it was planned.

The best way out of the difficulty would undoubtedly be to employ a DC-to-AC rotary converter feeding an AC amplifier of normal design, but it should be possible to obtain tolerable results from an amplifier based on the circuit of that in question, but with a supplementary HT accumulator battery for augmenting the mains voltage, so far as anode current supply is concerned. The battery would naturally be recharged from the DC mains supply.

Tuning Indicator

FOR the benefit of a querist who wishes to fit a neon tuning indicator to his Variable Selectivity IV, it should be pointed out that this device requires the presence of a fairly high resistance in the anode circuit of one of the controlled valves. In the Variable Selectivity IV, the addition of a suitable resistance would be undesirable, and it is therefore recommended that some other type of indicator be used.

The Wireless World INFORMATION BUREAU

THE service is intended primarily for readers meeting with difficulties in connection with receivers described in *The Wireless World*, or those of commercial design which from time to time are reviewed in the pages of *The Wireless World*. Every endeavour will be made to deal with queries on all wireless matters, provided that they are of such a nature that they can be dealt with satisfactorily in a letter.

Communications should be by letter to *The Wireless World* Information Bureau, Dorset House, Stamford Street, London, S.E.1, and must be accompanied by a remittance of 5s. to cover the cost of the service.

Personal interviews are not given by the technical staff, nor can technical enquiries be dealt with by telephone.

Letters to the Editor

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

High Notes Without Heterodynes

IN your issue of January 24th, under "Letters to the Editor," Mr. Anthony Fearnley advances a scheme which would be fine if the solution he proposes to radio's greatest weakness — *vide*, interference— would not itself cause yet more intolerable interference than we actually have to cope with at present.

First, I do not agree with Mr. Fearnley that it is more annoying to hear heterodynes and "frying bacon" than an audition in which the treble is so attenuated that interference is inaudible. When one is used to really good quality one simply cannot stand a high-note cut-off. This, of course, is a matter of personal taste, but many of my friends agree with me that it is preferable to tolerate, to a certain extent, some interference in order to enjoy the real music— be it dance or classical music.

Of all interference, the most annoying is what has been called in *The Wireless World* "monkey chatter"—the side-band splash.

A heterodyne on a next-channel station can be eliminated by a sharply tuned filter, as already described in *The Wireless World*, but the heterodyne with side-bands cannot be eliminated except by attenuating the high notes to such an extent that the music drops in quality to that of an old reaction set of ten years ago. The side-bands are actually the strongest when, on the next channel, a talk is going on—the lower frequency predominating at short and sharp intervals and causing a series of chattering noises in the high frequency—i.e., 9 kc/s minus the frequency of the modulation. No trouble is occasioned by the highs and the harmonics, because their level is very low. But by driving up the higher frequencies to 20 or 30 db. the level will no longer be so small, and the higher side-bands of the next channel station will interfere with the reception, not as higher chatter, but as frequencies of 9 kc/s minus 5 to 9 kc/s, being frequencies from 4,000 cycles down to 0 and further up again, which is the most annoying of all imaginable annoyances.

Mr. Fearnley's scheme is all right, of course, if the local station only sends out a specially amplified treble, but what if any other station should adopt the same scheme and what would be received when listening with an ordinary (quality?) receiver to a station on the next channel to a station sending out such shrieks?

P. WINKELER,
Radio Engineer, Bell Telephone Mfg. Co., Antwerp.

January 29th, 1936.

A Deaf-aid Ramp

YOU have given us a number of valuable articles on the subject of deaf-aids, and as one who has experience of constructing receivers and amplifiers over a number of years, I recently proposed to make up an instrument for my own use.

I feel that you and your readers ought to know of the difficulties which I came up against when I tried. I found the design of a suitable amplifier a straightforward affair, but when it came to trying to buy a suitable microphone and midget type earphone I found that these articles were unobtainable unless (1) I bought a complete deaf-aid at a price which I could not afford and which seemed excessively high for such an article, or (2) I already had a commercial instrument and wanted a replacement.

My experiences have led me to conclude that some unfortunate ramp has grown up in the deaf-aid business whereby the manufacturers of special parts for any deaf-aid purveyor are prevented from selling these articles separately.

It seems to me a deplorable state of affairs, and if any source of supply of these parts exists your readers would be glad to know.

Will some manufacturer please have the courage to come forward and supply midget headphones and microphones and so break up the ramp? I am sure there would be a good demand. H. B. HOUGHTON.

London, N.10.

The W.W. Quality Amplifier

IT might be of interest to you to know that on Tuesday, January 21st, I took my Quality Amplifier equipment (with Epoch Domini) over to my school to give the Proclamation broadcast to the school assembled in the hall.

The quality of the reproduction was an eye-opener to the rest of the staff and to the children. I was amazed at the questions and praise bestowed upon it. Certainly none there had heard reproduction like it!

There is a general opinion that "home construction" is dead and commercial reproduction has it beaten. I have constantly argued that price for price one can still build better stuff, and particularly is this so in the quality section. Certainly some converts were made on that Tuesday.

Many thanks for your ever-ready helps, and again, thank you for the Q.A. and its associated equipment. W. BROWN.

Liverpool.

Home Recording

FOLLOWING your remarks deploring the apparent lack of interest displayed by manufacturing concerns in the home-recording market, we feel that it is our duty to inform you that this company has for some six months past been marketing a home-recording device known as the "Recordagraph."

This apparatus, which is obtainable as an extra (price 3 gns.) to any of our standard AC Radiogram models, is simple to operate and does not involve the use of lubricants, cleaning brushes, or special after processing of any description.

Chemically tested aluminium discs are used for recording, and these are obtainable at the price of 1s. each.

The whole assembly is no more obtrusive than an ordinary radiogram unit, the lead screw and the drive mechanism being completely concealed beneath the turntable.

A single switch is used to convert the recording apparatus, both electrically and mechanically, for playing-back purposes, and a further switch is incorporated in the unit in order to make provision for either microphone or radio recordings. Provision is also made for both moving-coil and transverse-current type microphones.

It is necessary to use fibre needles for playing purposes, but, nevertheless, quite reasonable reproduction is obtained even at 5,000 cycles per second.

A high-impedance dual-purpose head is used, and damping is arranged to provide a satisfactory compromise for both recording and reproducing purposes.

As most readers are probably aware, demonstrations of this apparatus by well-known celebrities were given at Radiolympia and elsewhere, and, judging from results obtained in our own laboratories and reports received from various customers, we are confident that, provided our apparatus is used with a fair degree of intelligence, really first-class entertainment is obtainable for a very reasonable initial outlay, the running costs being no greater than that of an ordinary radio-gramophone.

We would like to endorse Mr. L. Collier's remarks concerning the amusement obtainable from home-recording apparatus, and can definitely assure readers that mistakes made in recording and reproducing are very often greater sources of entertainment than the actual recording itself.

C. E. OSMOND, Chief Engineer,
Burgoyne Wireless (1930), Ltd.

Brentford.

Double Channel Transmission

I NOTE with interest the revived question of Stereophonic Broadcasting. Is it not a feasible proposition to arrange a double-channel relay on the lines of the one in America? If it met with success the B.B.C. would have some tangible proof that a portion of the public had been impressed by it and would, therefore, be more inclined to attempt an actual broadcast.

When anything new comes along there is an old saying about "trying it on the dog," but the B.B.C., as far as I can see, dare not keep a dog, so private enterprise must show the way.

Perhaps some well-known firm which is known for its high quality PA outfits would be willing to set up the gear; if two small halls and a good orchestra could be found the expense incurred might be covered by charging a nominal entrance fee and saving two or three separate demonstrations one evening or Sunday afternoon.

I have only given the bare outlines of the idea, but if a thing is worth doing . . .

Bayswater. G. L. SIDGREAVES.

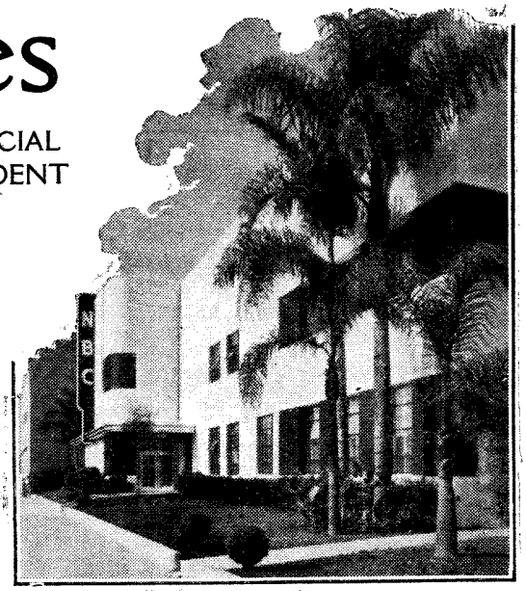
"Spotting the Spots"

ONCE again the question arises whether *any* one, radio amateur or not, can afford not to read *The Wireless World*. In your issue of August 7th, 1929, you published an article in which, under the heading "There are More Things in Aerials and Earths, O Radio, than are Dreamed of in Your Philosophy," I described the attractions of electromagnetic waves other than those used in "Wireless." On page 135 I wrote: "Is there not a chance that long before the rash appears in—say—measles, some change has taken place beneath the skin which could be revealed by ultra-violet or some other radiation? How about it, O Medical Researchers?"

And now, over six years later, I find in your issue of January 17th the announcement of a new use for infra-red photography, just developed at the Middlesex Hospital, "which may have very far-reaching results," the detection of ailments such as measles long before the rash is visible to the eye. D'ORSAY BELL.

Broadcast Brevities

By OUR SPECIAL CORRESPONDENT



HOLLYWOOD RADIO. The beautifully situated new studios of the N.B.C. at the FilmCity. They cost £100,000 to build, and are proof against earthquakes and fire.

High Speed Reception

DOING a good 40 along a road near Potters Bar, a green-coloured motor van excited my curiosity, for projecting upwards from the roof was, unmistakably, an ultra-short-wave aerial. Enquiries satisfied me that this was indeed a B.B.C. mobile receiver engaged in ultra-short-wave experiments, and this led to the discovery that, with tremendous "hush-hush," the B.B.C. engineers have been carrying out transmissions again from the 7-metre transmitter on the roof of Broadcasting House.

Preparing for Television

These transmissions are going on almost every day, while field strength in London and its environs is carefully plotted. Sound only is transmitted (any handy National or Regional programme is used)—not vision. But undoubtedly the tests are preliminary measures in connection with the inauguration of the Alexandra Palace station.

I understand that the object is (1) to obtain data regarding field strength, and (2) to test-out ultra-short wave receivers.

High-fidelity Transmissions

Television or no television, this is to be an ultra-short-wave summer. Anyone without access to the "ultra-shorts" will be missing a lot of fun, not to mention those "high-fidelity" transmissions which Sir Noel Ashbridge tells me we may definitely expect from the Alexandra Palace.

Spring Cleaning

THE story got around last week that spring cleaning had begun at Broadcasting House. This is obviously wrong, because the official spring cleaning began several years ago and has never left off. The painters are always at work somewhere in the building; as in the case of the Forth Bridge, when they have finished at one end they begin again at the other.

Cut Flowers

I made one discovery last week which will interest those people who consider that life in the artificial atmosphere of the B.B.C. studios must be very devitalising. Cut flowers left in the studios on Tuesday retain their freshness until Friday. They are then taken out, and, with a little coaxing, can be made to brighten the outer offices for two or three days more. Rumour has it that they eventually find their way into canteen sandwiches.

The Indiarubber Plant

The most elderly vegetable in Broadcasting House is an indiarubber plant, which has flourished on a third-floor landing for four years and is now putting out fresh shoots.

Haunted House Broadcast

MARCH 10th is to be the date of the much-heralded broadcast from a haunted house. A twelfth-century building which gives off the sounds of muffled footfalls has been chosen, and the ghost-hunting paraphernalia is to be rigged up outside the wine cellar, this part of the business being broadcast in the National programme from 8 to 8.20 p.m.

The actual manifestations, if any, will be heard between 11.45 and midnight. Mr. Harry Price, the psychical expert, will be there, accompanied by Mr. F. H. Grisewood, the announcer, who will comment on the proceedings.

I hope this broadcast will justify the high cost of land-lines.

"FOUNDATIONS OF MUSIC." A picture just received from India, showing members of a tribe in the Western Ghats enjoying their first broadcast concert.

The King's Broadcast

DESPITE certain announcements, it was hardly to be expected that King Edward would broadcast on the day of the Royal funeral, though I understand that officials were standing by at Broadcasting House in case His Majesty should decide to use the microphone at short notice.

That the King will broadcast to Britain and the Empire in the very near future there is no doubt, but the date has not been decided upon.

A Broadcasting Pioneer

In a very real sense the King is one of the pioneers of broadcasting, for he was "on the air" before the B.B.C. came into being. This was on October 7th, 1922, when the then Prince of Wales addressed the Boy Scouts' Rally from his study at York House.

At the Albert Hall

But it is not only in the quiet, intimate form of broadcast talk from a studio that His Majesty excels; frequently his broadcast utterances have been made in the presence of large audiences, perhaps the most notable occasion being that on which, as Prince, he spoke Laurence Binyon's great lines "For the Fallen" at a British Legion Festival in the Albert Hall.

Humming Sounds

IN case the B.B.C. omits to issue a warning to listeners not to rush out and have humbucking coils fitted to their speakers, I think I ought to mention that a novelty broadcast in the next few days will feature a pair of humming birds. These little creatures rise above the ordinary 50-cycle note, but people afflicted with tone-deafness might easily imagine that some funny business is going on in the mains supply.

Free Drinks

Of course, you can drag a humming bird to the microphone but you can't make him hum, but the B.B.C.'s Zoo Man, who is introducing these little friends of his during a Children's Hour, is confident that the trick will be done with the aid of a bottle and suitable liquid.

Animal and bird broadcasts have been singularly unsuccessful so far. Either the creatures are smitten with mike fright or they fail to recognise the importance of the occasion.

A Nervous Parrot

It was mike fright that troubled a parrot the other evening in an "In Town To-Night" programme. The producer took the creature for a walk up Portland Place to calm its nerves. The treatment was only partially successful, and, anyway, they missed the broadcast.

Mr. Lloyd George

A REAL Welsh rarebit is promised for Saturday, February 29th, when the Rt. Hon. David Lloyd George, O.M., M.P., will, look you, give a broadcast talk in honour of St. David's Day. Mr. Lloyd George's challenging and silvery tones will be the prelude to an all-Welsh concert.

On the same day there is a Welsh item, in the Empire programmes, at which Bach lovers may take offence, though none is intended. Miss Mansel Thomas will sing a song not yet published, entitled "Gyda'r Bore Bach."

PRINCIPAL BROADCASTING STATIONS OF EUROPE

Arranged in Order of Frequency and Wavelength

(This list is included in the first issue of each month. Stations with an aerial power of 50 kW. and above in heavy type)

Station.	kc/s.	Tuning Positions.	Metres.	kW.
Kaunas (Lithuania)	155		1935	7
Brazov (Romania)	160		1875	150
Kootwijk (Holland) (*Relays Hilversum*) (10 *kW.* till 2.40 p.m.)	160		1875	100
Lahti (Finland)	166		1807	40
Moscow, No. 1, RW1 (Komintern) (U.S.S.R.)	174		1724	500
Paris (Radio Paris) (France)	182		1648	80
Istanbul (Turkey)	187.5		1600	5
Berlin (Deutschlandsender Zeesen) (Germany)	191		1571	60
Droitwich	200		1500	150
Minsk, RW10 (U.S.S.R.)	208		1442	35
Reykjavik (Iceland)	208		1442	16
Motala (Sweden). (*Relays Stockholm*)	216		1389	150
Novosibirsk, RW76 (U.S.S.R.)	217.5		1379	100
Warsaw, No. 1 (Raszyn) (Poland)	224		1339	120
Luxembourg	230		1304	150
Ankara (Turkey)	230		1304	7
Kharkov, RW20 (U.S.S.R.)	232		1293	20
Kalundborg (Denmark)	238		1261	60
Leningrad, RW53 (Kolpino) (U.S.S.R.)	245		1224	100
Tashkent, RW11 (U.S.S.R.)	256.4		1170	25
Oslo (Norway)	260		1153.8	60
Moscow, No. 2, RW49 (Stchelkovo) (U.S.S.R.)	271		1107	100
Tiflis, RW7 (U.S.S.R.)	280		1071.4	35
Finmark (Norway)	355		845.1	10
Rostov-on-Don, RW12 (U.S.S.R.)	355		845.1	20
Budapest, No. 2 (Hungary)	359.5		834.5	20
Sverdlovsk, RW5 (U.S.S.R.)	375		800	50
Banska-Bystrica (Czechoslovakia)	392		765	30
Geneva (Switzerland). (*Relays Sottens*)	401		748	1.3
Moscow, No. 3 (RCZ) (U.S.S.R.)	401		748	100
Voroneje, RW25 (U.S.S.R.)	413.5		726	10
Oulu (Finland)	431		696	1.2
Ufa, RW22 (U.S.S.R.)	436		688	10
Tartu (Estonia)	517		580	0.5
Hamar (Norway). (*Relays Oslo*)	519		578	0.7
Innsbruck (Austria). (*Relays Vienna*)	519		578	1
Ljubljana (Yugoslavia)	527		569.3	5
Viipuri (Finland)	527		569.3	10
Bolzano (Italy)	536		559.7	1
Wilno (Poland)	536		559.7	16
Budapest, No. 1 (Hungary)	546		549.5	120
Beromünster (Switzerland)	556		539.6	100
Athlone (Irish Free State)	565		531	60
Palermo (Italy)	565		531	4
Stuttgart (Mühlacker) (Germany)	574		522.6	100
Grenoble, P.T.T. (France)	583		514.6	15
Riga (Latvia)	583		514.6	15
Vienna (Bisamberg) (Austria)	592		506.8	100
Rabat (Radio Maroc) (Morocco)	601		499.2	25
Sundsvall (Sweden). (*Relays Stockholm*)	601		499.2	10
Florence (Italy). (*Relays Milan*)	610		491.8	20
Cairo (Abu Zabal) (Egypt)	620		483.9	20
Brussels, No. 1 (Belgium). (*French Programme*)	620		483.9	15
Lisbon (Bacarena) (Portugal)	629		476.9	20
Tröndelag (Norway)	629		476.9	20
Prague, No. 1 (Czechoslovakia)	638		470.2	120
Lyons, P.T.T. (La Doua Tramoyes) (France)	648		463	90
Cologne (Langenberg) (Germany)	658		455.9	100
North Regional (Slaithwaite)	668		449.1	50
Sottens (Radio Suisse Romande) (Switzerland)	677		443.1	25
Belgrade (Yugoslavia)	686		437.3	2.5
Paris, P.T.T. (Palaiseau Villebon) (France)	695		431.7	120
Stockholm (Sweden)	704		426.1	55
Rome, No. 1 (Italy)	713		420.8	50
Kiev, RW9 (U.S.S.R.)	722		415.5	36
Tallinn (Esthonia)	731		410.4	20
Madrid, EAJ2 (Radio España) (Spain)	731		410.4	3
Seville (Spain)	731		410.4	5.5
Munich (Germany)	740		405.4	100
Marseilles, P.T.T. (Realtor) (France)	749		400.5	90
Katowice (Poland)	758		395.8	12
Scottish Regional (Falkirk)	767		391.1	50
Stalino (U.S.S.R.)	776		386.6	10
Toulouse, P.T.T. (Muret) (France)	776		386.6	120
Leipzig (Germany)	785		382.2	120
Barcelona, EAJ1 (Spain)	795		377.4	7.5
Lwow (Poland)	795		377.4	16
West Regional (Washford Cross)	804		373.1	50
Milan (Italy)	814		368.6	50
Bucharest (Romania)	823		364.5	12
Moscow, No. 4, RW39 (Stalina) (U.S.S.R.)	832		360.6	100
Berlin (Funkstunde Tegel) (Germany)	841		356.7	100
Bergen (Norway)	850		352.9	1
Sofia (Bulgaria)	850		352.9	50
Valencia (Spain)	850		352.9	3
Simferopol, RW52 (U.S.S.R.)	859		349.2	10
Strasbourg, P.T.T. (France)	859		349.2	100
Poznan (Poland)	868		345.6	16
London Regional (Brookmans Park)	877		342.1	50
Graz (Austria). (*Relays Vienna*)	886		338.6	7
Helsinki (Finland)	895		335.2	10
Hamburg (Germany)	904		331.9	100
Toulouse (Radio Toulouse) (France)	913		328.6	60
Brno (Czechoslovakia)	922		325.4	32
Brussels, No. 2 (Belgium). (*Flemish Prog'mme*)	932		321.9	15
Algiers, P.T.T. (Radio Alger) (Algeria)	941		318.8	12
Göteborg (Sweden). (*Relays Stockholm*)	941		318.8	10
Breslau (Germany)	950		315.8	100
Paris (Poste Parisien) (France)	959		312.8	60
Odessa (U.S.S.R.)	968		309.9	10
Belfast	977		307.1	1
Genoa (Italy). (*Relays Milan*)	986		304.3	10
Torun (Poland)	986		304.3	24
Hilversum (Holland). (15 *kW.* till 4.40 p.m.)	995		301.5	60
Bratislava (Czechoslovakia)	1004		298.8	13.5
Midland Regional (Droitwich)	1013		296.2	50
Chernigov (U.S.S.R.)	1013		296.2	5
Barcelona, EAJ15 (Radio Asociación) (Spain)	1022		293.5	3
Cracow (Poland)	1022		293.5	2
Heilsberg (Königsberg Ermland) (Germany)	1031		291	100
Parede (Radio Club Português) (Portugal)	1031		291	5
Leningrad, No. 2, RW70 (U.S.S.R.)	1040		288.5	10
Rennes-Bretagne, P.T.T. (Thourie) (France)	1040		288.5	120
Scottish National (Falkirk)	1050		285.7	50
Bari (Italy)	1059		283.3	20
Paris (Radio Cité) (France)	1068		280.9	0.8
Tiraspol, RW57 (U.S.S.R.)	1068		280.9	4
Bordeaux, P.T.T. (Lafayette) (France)	1077		278.6	50
Zagreb (Yugoslavia)	1086		276.2	0.7
Falun (Sweden)	1086		276.2	2
Madrid, EAJ7 (Union Radio) (Spain)	1095		274	10
Madona (Latvia)	1104		271.7	50
Naples (Italy). (*Relays Rome*)	1104		271.7	1.5
Moravska-Ostrava (Czechoslovakia)	1113		269.5	11.2
Fécamp (Radio Normandie) (France)	1113		269.5	5
Alexandria (Egypt)	1122		267.4	0.25
Newcastle	1122		267.4	1
Nyiregyhaza (Hungary)	1122		267.4	6.2
Hörby (Sweden). (*Relays Stockholm*)	1131		265.3	10
Turin, No. 1 (Italy). (*Relays Milan*)	1140		263.2	7
London National (Brookmans Park)	1149		261.1	20
North National (Slaithwaite)	1149		261.1	20
West National (Washford Cross)	1149		261.1	20
Kosice (Czechoslovakia). (*Relays Prague*)	1158		259.1	2.6
Monte Ceneri (Switzerland)	1167		257.1	15
Copenhagen (Denmark). (*Relays Kalundborg*)	1176		255.1	10
Kharkov, No. 2, RW4 (U.S.S.R.)	1185		253.2	10
Nice (La Brague) (France)	1185		253.2	60
Frankfurt (Germany)	1195		251	25
Prague, No. 2 (Czechoslovakia)	1204		249.2	5
Lille, P.T.T. (Camphin) (France)	1213		247.3	60
Trieste (Italy)	1222		245.5	10
Gleiwitz (Germany). (*Relays Breslau*)	1231		243.7	5
Cork (Irish Free State). (*Relays Athlone*)	1240		241.9	1
Swedish Relay Stations	1240		241.9	1
Juan-les-Pins (Radio Côte d'Azur) (France)	1249		240.2	0.8
Kuldiga (Latvia)	1258		238.5	10
Rome, No. 3 (Italy)	1258		238.5	1
San Sebastian (Spain)	1258		238.5	1
Nürnberg (Germany). (*Relays Munich.*)	1267		236.8	2
Christiansand and Stavanger (Norway)	1276		235.1	0.5
Dresden (Germany). (*Relays Leipzig*)	1285		233.5	0.25
Aberdeen	1285		233.5	1
Austrian Relay Stations	1294		231.8	0.5
Danzig. (*Relays Königsberg*)	1303		230.2	0.5
Swedish Relay Stations	1312		228.7	1.25
Magyarovar (Hungary)	1321		227.1	1.25
German Relay Stations	1330		225.6	2
Montpellier, P.T.T. (France)	1339		224	0.8
Lodz (Poland)	1339		224	1.7
Dublin (Irish Free State). (*Relays Athlone*)	1348		222.6	0.5
Milan, No. 2 (Italy). (*Relays Rome*)	1357		221.1	4
Turin, No. 2 (Italy). (*Relays Rome*)	1357		221.1	0.2
Basle and Berne (Switzerland)	1375		218.2	0.5
Warsaw, No. 2 (Poland)	1384		216.8	2
Lyons (Radio Lyons) (France)	1393		215.4	25
Tampere (Finland)	1420		211.3	0.7
International Common Wave	1492		209.9	0.5
Miskolc (Hungary)	1438		208.6	1.25
Paris (Eiffel Tower) (France)	1456		206	20
Pecs (Hungary)	1465		204.8	1.25
Antwerp and Courtrai (Belgium)	1465		204.8	0.1
Bournemouth	1474		203.5	1
Plymouth	1474		203.5	0.3
International Common Wave	1492		201.1	0.5
International Common Wave	1500		200	0.25
Liepàja (Latvia)	1737		173	0.1

World SHORT-WAVE STATIONS OF THE WORLD

Arranged in Order of Wavelength and Frequency

(N.B.—Times of Transmission given in parentheses are approximate only and represent G.M.T.)

Metres.	kc/s.	Call Sign.	Station.	Tuning Positions.
84.67	3,543	CR7AA	Mozambique (E. Africa). (*Mon., Thurs., Sat.*, 18.30 *to* 20.30.)	
75.0	4,000	CT2AJ	Ponta Delgada (Azores). (*Wed., Sat.*, 22.00 *to* 24.00.)	
70.2	4,273	RV15	Kharbarovsk (U.S.S.R.). (*Daily* 06.00 *to* 14.00.)	
67.11	4,470	YDB	Sourabaya (Java). (*Daily* 03.30 *to* 06.30)	
58.31	5,145	OK1MPT	Prague (Czechoslovakia). (*Experimental*)	
51.28	5,850	YV5RMO	Maracaibo (Venezuela). (*Daily*, 22.00 *to* 02.00.)	
50.60	5,930	HJ4ABE	Medellin (Colombia). (*Daily*, 16.30 *to* 18.30, *Sun., Tues., Thurs.*, 23.30 *to* 03.00 *also.*)	
50.26	5,969	HVJ	Vatican City. (*Daily* 19.00 *to* 19.15, *Sun.* 10.00 *also.*)	
50.16	5,980	HIX	Santa Domingo (W. Indies). (*Daily*, 12.00 *Sun.* 00.38 *also.*)	
50.00	6,000	XEBT	Mexico City (Mexico). (*Daily* 00.00 *to* 09.00.)	
50.00	6,000	RW59	Moscow (U.S.S.R.). (*Relays No.* 1 *Stn.*) (*Daily* 20.00 *to* 23.00.)	
49.95	6,005	VE9DN	Montreal (Canada). (*Daily* 04.30 *to* 05.00)	
49.95	6,005	HJ3ABH	Bogotà (Colombia)	
49.92	6,010	COCO	Havana (Cuba). (*Daily* 21.00 *to* 23.00, 01.00 *to* 03.00, *Sun.* 04.30 *to* 06.30 *also.*)	
49.85	6,018	ZHI	Singapore (Malaya). (*Mon., Wed., Thurs.* 23.00 *to* 01.30, *Sun.* 03.40 *to* 05.10.)	
49.83	6,020	DJC	Zeesen (Germany). (*Daily* 22.30 *to* 03.30, 17.00 *to* 21.30.)	
49.75	6,030	HP5B	Panama City (Central America). (*Daily* 17.00 *to* 18.00, 01.00 *to* 03.30.)	
49.75	6,030	VE9CA	Calgary (Canada). (*Thurs.* 14.00 *to* 07.00, *Sun.* 17.00 *to* 05.00.)	
49.67	6,040	W1XAL	Boston, Mass. (U.S.A.). (*Sun.* 22.00 *to* 24.00, *Wed., Fri.* 00.30 *to* 01.45.)	
49.67	6,040	W4XB	Miami, Fla. (U.S.A.) *Daily* 17.00 *to* 19.30, 22.30 *to* 05.00.)	
49.67	6,040	PRA8	Pernambuco (Brazil). (*Daily* 20.00 *to* 00.30.)	
49.59	6,050	GSA	Empire Broadcasting	
49.5	6,060	W8XAL	Cincinnati, Ohio (U.S.A.). (*Daily* 12.00 *to* 01.00, 04.00 *to* 06.00.)	
49.5	6,060	W3XAU	Philadelphia, Pa. (U.S.A.). (*Relays WCAU.*) (*Daily* 01.00 *to* 04.00.)	
49.5	6,060	OXY	Skamlebaek (Denmark). (*Relays Kalundborg.*) (*Daily* 18.00 *to* 24.00, *Sun.* 16.00 *also.*)	
49.42	6,070	OER2	Vienna Experimental. (*Daily* 14.00 *to* 22.00.)	
49.4	6,072	CT1AA	Lisbon (Portugal). (*Tues., Thurs., Sat.* 21.30 *to* 24.00.)	
49.35	6,079	DJM	Zeesen (Germany)	
49.33	6,080	W9XAA	Chicago, Ill. (U.S.A.). (*Relays WCLF.*) (*Sun.* 19.00 *to* 20.30.)	
49.33	6,080	CP5	La Paz (Bolivia). (*Daily* 00.45 *to* 02.15)	
49.31	6,083	VQ7LO	Nairobi (Kenya Colony). (*Daily* 16.00 *to* 19.00, *Sat. to* 20.00, *Mon., Wed., Fri.* 10.45 *to* 11.15 *also, Tues.* 08.00 *to* 09.00 *also, Thurs.* 13.00 *to* 14.00 *also, Sun.* 17.45 to 19.00 *also.*)	
49.3	6,085	2RO	Rome (Italy). (*Mon., Wed., Fri.* 23.00 *to* 00.30.)	
49.26	6,090	VE9BJ	St. John (N.B.). (*Daily* 00.00 *to* 01.30)...	
49.26	6,090	CRCX	Bowmanville, Ont. (Canada). (*Mon., Tues., Wed.* 20.00 *to* 05.00, *Thurs., Fri., Sat.* 12.00 *to* 05.00, *Sun.* 18.00 *to* 02.00.)	
49.2	6,097	ZTJ	Johannesburg (S. Africa). (*Daily ex. Sun.* 04.30 *to* 05.30, 08.30 *to* 12.00, 14.00 *to* 20.00 (*Sat. to* 21.45), *Sun.* 13.00 *to* 15.15, 17.30 *to* 20.00.)	
49.18	6,100	W3XAL	Bound Brook, N.Y. (U.S.A.). (*RelaysWJZ.*) (*Mon., Wed., Sat.* 22.00 *to* 23.00, *Sat.* 05.00 *to* 06.00 *also.*)	
49.18	6,100	W9XF	Chicago, Ill. (U.S.A.). (*Daily ex. Mon., Wed., Sun.* 21.00 *to* 07.00.)	
49.1	6,110	GSL	Empire Broadcasting	
49.1	6,110	VUC	Calcutta (India). (*Daily* 07.06 *to* 08.06 *irregular* 13.06 *to* 16.36, *Sat. from* 12.36, *Sun.* 04.36 *to* 07.36, *irregular* 12.36 *to* 03.36.)	
49.08	6,112	YV2RC	Caracas (Venezuela). (*Daily ex. Sun.* 15.30 *to* 17.30, 21.00 *to* 03.00, *Sun.* 14.30 *to* 15.30.)	
49.02	6,120	YDA	Bandoeng (Java). (*Daily* 10.30 *to* 15.00)	
49.02	6,120	W2XE	Wayne, N.J. (U.S.A.). (*Relays WABC.*) (*Daily* 03.00 *to* 04.00.)	
48.92	6,130	ZGE	Kuala Lumpur (Malaya). (*Sun., Tues., Fri.* 11.40 *to* 13.40.)	
48.92	6,132	COCD	Havana (Cuba) (*Daily* 23.00 *to* 05.00.) ..	
48.86	6,140	W8XK	Pittsburg, Pa. (U.S.A.). (*Relays KDKA.*) (*Daily* 21.30 *to* 06.00.)	
48.78	6,150	CSL	Lisbon (Portugal). (*Daily* 11.00 *to* 12.30, 18.00 *to* 22.00.)	
48.78	6,150	YV3RC	Caracas (Venezuela). (*Daily* 20.30 *to* 01.30.)	
48.78	6,150	CJRO	Winnipeg (Canada). (*Daily* 00.00 *to* 05.00, *Sat.* 21.00 *to* 06.00 *also, Sun.* 22.00 *to* 03.30.)	
48.4	6,198	CT1GO	Parede (Portugal). (*Daily ex. Tues.* 00.20 *to* 01.30, *Sun.* 16.30 *to* 18.00 *also.*)	
47.50	6,316	HIZ	Santo Domingo (W. Indies). (*Daily* 21.40 *to* 22.40, *Sun.* 16.00 *to* 17.30 *also.*)	
47.05	6,375	YV4RC	Caracas (Venezuela). (*Daily* 21.30 *to* 03.30.)	
46.69	6,425	W3XL	Bound Brook, N.J. (U.S.A.). (*Experimental*)	
46.52	6,447	HJ1ABB	Barranquilla (Colombia). *Daily* 21.30 *to* 03.30.)	
46.21	6,490	HJ5ABD	Cali (Colombia). (*Daily* 00.00 *to* 03.00)...	
46.0	6,520	YV6RV	Valencia (Venezuela). (*Daily* 17.00 *to* 18.00, 23.00 *to* 03.00.)	
45.31	6,620	PRADO	Riobamba (Ecuador). (*Fri.* 02.00 *to* 03.40)	
45.0	6,667	HC2RL	Guayaquil (Ecuador). (*Sun.* 22.45 *to* 12.45, *Wed.* 02.15 *to* 04.15.)	
42.86 to 41.10	7,000 to 7,300	.....	Band of wavelengths alloted to amateur transmitters.	
42.02	7,140	HJ4ABB	Manizales (Colombia)	
41.8	7,177	CR6AA	Lobito (Angola). (*Wed., Sat.* 19.30 *to* 21.30.)	
39.95	7,510	JVP	Tokio (Japan). (*Tues., Fri.*, 19.00 *to* 20.00)	
39.37	7,620	ETA	Addis Ababa (Abyssinia)	
38.48	7,797	HBP	Radio Nations, Prangins (Switzerland). (*Sat.* 22.30 *to* 23.15.)	
37.33	8,035	CNR	Rabat (Morocco). (*Sun.* 20.00 *to* 22.30)...	
36.5	8,214	HCJB	Quito (Ecuador). (*Daily ex. Sun., Mon.* 00.45 *to* 04.45, *Sun.* 21.45 *to* 04.15.)	
34.29	8,750	ZCK	Hong Kong (China). (*Daily* 10.00 *to* 14.00.)	
32.88	9,125	HAT4	Budapest (Hungary). (*Sat.* 23.00 *to* 24.00)	
31.8	9,428	COCH	Havana (Cuba. (*Daily* 16.00 *to* 17.00, 22.00 *to* 23.00, 01.00 *to* 02.00.)	
31.56	9,500	PRF5	Rio de Janeiro (Brazil). (*Daily* 22.30 *to* 23.15.)	
31.55	9,510	GSB	Empire Broadcasting	
31.54	9,518	VK3ME	Melbourne (Australia). (*Wed.* 10.00 *to* 11.30, *Sat.* 10.00 *to* 12.00.)	
31.48	9,530	LKJ1	Jelöy (Norway). (*Relays Oslo.*) (*Daily* 10.00 *to* 13.00.)	
31.48	9,530	W2XAF	Schenectady, N.Y. (U.S.A.). (*Relays WGY.*) (*Daily* 23.30 *to* 04.00, *Sat.* 19.00 *to* 22.00 *also.*)	
31.45	9,540	DJN	Zeesen (Germany). (*Daily* 08.45 *to* 12.15, 13.00 *to* 16.30, 22.15 *to* 03.30.)	
31.38	9,560	DJA	Zeesen (Germany). (*Daily* 13.00 *to* 16.30, 22.15 *to* 02.00.)	
31.36	9,565	VUB	Bombay (India). (*Sun.* 13.30 *to* 15.30, *Wed., Thurs., Sat.* 16.30 *to* 17.30, *irregular Mon.*)	
31.35	9,570	W1XK	Millis, Mass. (U.S.A.). (*Relays WBZ.*) (*Daily* 12.00 *to* 06.00.)	
31.32	9,580	GSC	Empire Broadcasting	
31.32	9,580	VK3LR	Lyndhurst (Australia). (*Daily ex. Sun.* 08.15 *to* 12.30.)	
31.28	9,590	W3XAU	Philadelphia, Pa. (U.S.A.). (*Relays WCAU.*) (*Daily* 17.00 *to* 24.00.)	
31.28	9,590	VK2ME	Sydney (Australia). (*Sun.* 06.00 *to* 08.00, 10.00 *to* 14.00, 14.30 *to* 16.30.)	
31.27	9,595	HBL	Radio Nations, Prangins (Switzerland). (*Sat.* 22.30 *to* 23.15.)	
31.13	9,635	2RO	Rome (Italy). (*Tues., Thurs., Sat.* 00.45 *to* 02.15.)	
31.09	9,650	CT1AA	Lisbon (Portugal)	
31.01	9,675	DJI	Zeesen (Germany)	
31.0	9,677	CT1CT	Lisbon (Portugal). (*Thurs.* 21.00 *to* 23.00, *Sun.* 12.00 *to* 14.00.)	
30.43	9,860	EAQ	Madrid (Spain). (*Daily* 22.15 *to* 00.30, *Sat.* 18.00 *to* 20.00 *also.*)	
29.24	10,260	PMN	Bandoeng (Java). (*Sun.*, 12.00 *to* 15.00) ...	
29.04	10,330	ORK	Ruysselede (Belgium). (*Daily* 18.30 *to* 20.30.)	
28.01	10,710	JVM	Tokio (Japan). (*Tues., Fri.*, 19.00 *to* 20.00)	
27.93	10,740	JVM	Tokio (Japan). (*Tues., Fri.* 19.00 *to* 20.00.)	
25.65	11,695	YB3RC	Caracas (Venezuela)	
25.6	11,720	FYA	Paris, Radio Coloniale (France). (*Colonial Stn. E-W.*) (*Daily* 00.00 *to* 03.00, 04.00 *to* 06.00.)	
25.6	11,720	CJRX	Winnipeg (Canada). (*Daily* 00.00 *to* 05.00, *Sat.* 21.00 *to* 06.00 *also, Sun.* 22.00 *to* 03.30 *also.*)	
25.57	11,730	PH1	Huizen (Holland). (*Daily ex. Tues., Wed.* 13.00 *to* 15.30, *Sun., Sat. to* 16.30.)	
25.53	11,750	GSD	Empire Broadcasting	
25.49	11,770	DJD	Zeesen (Germany). (*Daily* 17.00 *to* 21.30)	
25.45	11,790	W1XAL	Boston, Mass. (U.S.A.). (*Daily* 23.00 *to* 00.30.)	
25.40	11,810	2RO	Rome (Italy). (*Mon., Wed., Fri.* 23.00)...	
25.36	11,830	W2XE	Wayne, N.J. (U.S.A.). (*Relays WABC.*) (*Daily* 20.00 *to* 03.00.)	
25.29	11,860	GSE	Empire Broadcasting	
25.27	11,870	W8XK	Pittsburg, Pa. (U.S.A.). (*Relays KDKA.*) (*Daily* 21.30 *to* 03.00.)	
25.23	11,880	FYA	Paris, Radio Coloniale (France). (*Colonial Stn. N-S.*) (*Daily* 16.15 *to* 19.15, 20.00 *to* 23.00.)	
25.09	11,955	ETA	Addis Ababa (Abyssinia)	
25.0	12,000	RW59	Moscow (U.S.S.R.). (*Relays No.* 2 *Stn.*) (*Sun.* 03.00 *to* 04.00, 11.00 *to* 12.00, 15.00 *to* 16.00.)	
24.83	12,082	CT1CT	Lisbon (Portugal). (*Sun.* 14.00 *to* 16.00, *Thurs.* 20.00 *to* 21.00.)	
24.52	12,235	TFJ	Reykjavik (Iceland). (*Sun.* 18.40 *to* 19.00).	
24.2	12,396	CT1GO	Parede (Portugal). (*Sun.* 15.00 *to* 16.30, *Tues., Thurs., Fri.* 18.00 *to* 19.15.)	
23.39	12,830	CNR	Rabat (Morocco). (*Sun.* 12.30 *to* 14.00)...	
22.94	13.075	VPD	Suva (Fiji). (*Daily ex. Sun.* 05.30 *to* 03.60)	
22.00	13,635	SPW	Warsaw (Poland). (*Daily* 16.30 *to* 17.30.)	
21.42 to 20.84	14,005 to 14,395	.....	Band of wavelengths allotted to amateur transmitters.	
20.55	14,600	JVH	Nasaki (Japan). (*Tues., Fri.*, 19.00 *to* 20.00.)	
19.84	15,123	HVJ	Vatican City. (*Daily* 10.00, 15.30 *to* 15.45)	
19.82	15,140	GSF	Empire Broadcasting	
19.74	15,200	DJB	Zeesen (Germany). (*Daily* 08.45 *to* 12.15)	
19.72	15,210	W8XK	Pittsburg, Pa. (U.S.A.). (*Relays KDKA.*) (*Daily* 13.00 *to* 21.15.)	
19.71	15,220	PCJ	Eindhoven (Holland). (*Experimental*) ...	
19.68	15,243	FYA	Paris, Radio Coloniale (France). (*Colonial Stn. E.W.*) (*Daily* 12.00 *to* 16.00.)	
19.67	15,250	W1XAL	Boston, Mass. (U.S.A.). (*Daily* 15.50 *to* 18.30.)	
19.66	15,260	GSI	Empire Broadcasting	
19.64	15,270	W2XE	Wayne, N.J. (U.S.A.). (*Relays WABC.*) (*Daily* 18.00 *to* 20.00.)	
19.63	15,280	DJQ	Zeesen (Germany). (*Daily* 04.30 *to* 06.00)	
19.6	15,300	CP7	La Paz (Bolivia)	
19.56	15,330	W2XAD	Schenectady, N.Y. (U.S.A.). (*Daily* 19.30 *to* 20.30.)	
19.52	15,370	HAS3	Budapest (Hungary). (*Sun.* 13.00 *to* 14.00.)	
17.33	17,310	W3XL	Bound Brook, N.J. (U.S.A.) (*Daily* 16.00 *to* 22.00.)	
16.89	17,760	DJE	Zeesen (Germany). (*Daily* 13.00 *to* 16.30)	
16.89	17,760	W2XE	Wayne, N.J. (U.S.A.). (*Relays WABC.*) (*Daily* 16.00 *to* 18.00.)	
16.87	17,780	W3XAL	Bound Brook, N.J. (U.S.A.). (*Relays WJZ.*) (*Daily except Sun.* 14.00 *to* 15.00, *Tues. Thurs., Fri.* 20.00 *to* 21.00 *also.*)	
16.86	17,790	GSG	Empire Broadcasting	
16.42	18,270	ETA	Addis Ababa (Abyssinia)	
15.93	18,830	PLE	Bandoeng (Java). (*Tues., Thurs., Sat.* 15.00 *to* 15.30.)	
13.97	21,470	GSH	Empire Broadcasting	
13.94	21,520	W2XE	Wayne, N.J. (U.S.A.). (*Relays WABC.*) (*Daily* 12.30 *to* 16.00.)	
13.93	21,530	GSJ	Empire Broadcasting	
13.92	21,540	W8XK	Pittsburg, Pa. (U.S.A.). (*Daily* 12.00 *to* 14.00.)	

Recent Inventions

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each

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

AMPLIFIERS

TO prevent distortion due to valve curvature, particularly in "push-pull" or class B amplifiers, the input voltage is kept within the predetermined limits of straight-line response by the application of an automatic biasing or control voltage to one of the stages which precede the amplifier.

H. F. Elliott. No. 2010014.

o o o o

"AUTOMATIC" TUNING

INSTEAD of tuning a receiver manually, it is possible to arrange a series of push-button switches so that by depressing one or other of them the tuning-condenser is automatically rotated into a position which brings in a desired station. Such a receiver calls for high precision in assembly if it is to give satisfactory performance under present conditions.

The inventor accordingly provides means whereby if the switch leaves the circuits slightly off-tune, they are automatically "pulled" into accurate resonance. As shown in the figure, the main tuning-condensers C, C1, C2, are set for a desired station by depressing a selected push-button switch (not shown), and the three associated fine-tuning condensers VC, are subsequently readjusted, automatically, so as to compensate for any degree of mistuning that may be present.

This result is secured by arranging that for any particular setting of the tuned input circuit 1, the two circuits 2, 3, which feed the push-pull detector V_2, V_3, are tuned one a little above and the other a little below that frequency. Then if the original tuning is not accurately in step with the signal, either V_2 will pass more current than V_3, or vice versa. A corresponding current will pass through the output coil W, which is mounted in a magnetic field, so that there is a resultant torque on it. This torque is then applied to a common control spindle so as to rotate the Vernier condensers VC into full resonance. The output valve is shown at P.

H. Jackson. Application date February 24th, 1934. *No.* 437442.

o o o o

SCANNING-DISCS

IN constructing mechanical scanning-discs, as used in television, considerable difficulty arises in accurately shaping and locating the small apertures through which the light must pass, particularly when the apertures in question are other than circular.

To overcome this difficulty the disc is made of two separate discs of transparent material, each coated with opaque paint. On one of them radial transparent slots are formed by removing the paint by means of a dividing-machine, as used in engraving. The second disc is similarly treated so as to form a circular or, if desired, a spiral slot of transparency. The two discs are then mounted with the painted surfaces face to face and sealed off to prevent the entry of dust. The result gives a series of clear-cut apertures, each substantially rectangular in outline.

Electrical Research Products Inc. Convention date (U.S.A.) May 24th, 1933. *No.* 437656.

o o o o

VALVE GENERATORS

IN crystal-controlled oscillators it is usual, when changing wavelengths, to replace one crystal unit by another tuned to the new frequency. In order to simplify matters, one crystal is permanently connected between the plate and the adjacent grid of a two-grid valve, whilst a second crystal is similarly connected between the two grids. Both crystals have different fundamental frequencies, and one or other "takes charge" as the plate or grid is given a predominating voltage.

De Witt. R. Goddard (assignor to Radio Corporation of America). No. 1999656.

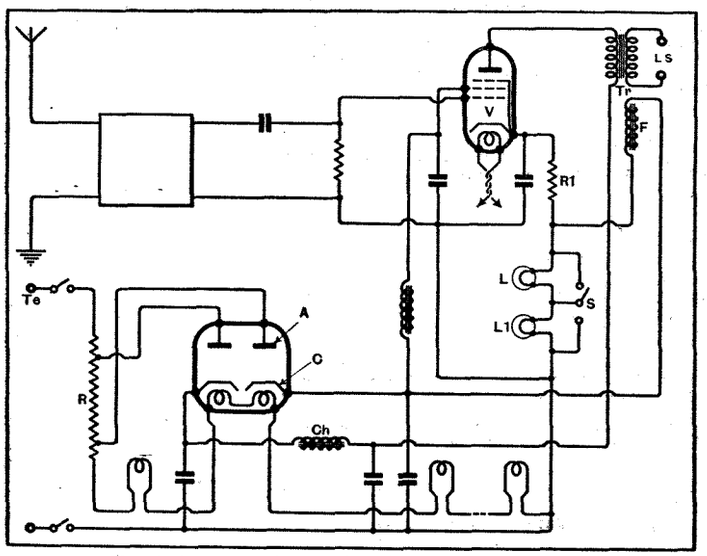
o o o o

ILLUMINATED TUNING-DIALS

IN receivers where the heating filaments of the valves are arranged in series across the mains it is usual to insert the lamp used to light up the tuning-dial also in series with the filaments. This may, however, shorten the life of the lamp, owing to the excess current taken by it when the set is switched on, and before the heaters have had time to warm up and acquire their normal resistance.

As a remedy it is now proposed to insert the dial lamp in series with the plate circuit of the last amplifier, and to use the resistance drop across the lamp as a part of the free grid-bias. When the set is of the universal type, the lighting up of the dial lamp also serves as an indication that the set has been correctly "poled" to DC mains. "Flicker" in the dial lamp similarly gives a rough indication of the presence of distortion caused by over-running the valves.

As shown, one or other of the two dial lamps L, L1 is brought into circuit by the wave-change switch S. The output circuit of the amplifier V can be traced from the mains terminal Te, through part of the resistance R to the anode A of the rectifier valve; then from the cathode C of that valve through a choke Ch and the primary of the output transformer Tr to the anode and through the amplifier V to the cathode resistance R1; then to the lamps L, L1 and back to the neutral line. The lamps may be run in parallel with the current feeding the field-coil F of the loud speaker.



Circuit incorporating tuning-dial lighting scheme.

E. K. Cole, Ltd. Convention date (Sweden) April 26th, 1934. No. 437569.

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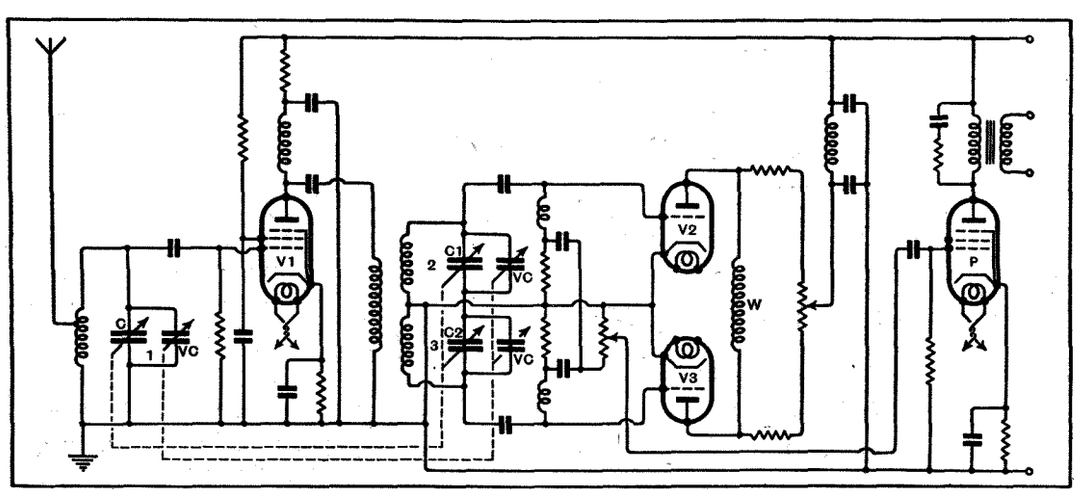
FREQUENCY MODULATION

FREQUENCY modulation is often effected by applying the signal to a movable capacity-electrode in the main frequency-determining circuit. When the microphone is situated at a distance from the transmitter, this involves the conversion of the sound first into electrical impulses, which are fed along the line, and are then reconverted into mechanical impulses to vibrate the diaphragm or similar condenser plate.

In order to avoid the use of any moving parts, the signals, according to the invention, are applied to vary the resistance of a valve, which is shunted across one of the tuning-components of the main oscillatory circuit. It is shown by analysis that if the valve resistance is properly chosen, the variations necessary to produce frequency modulation do not affect the amplitude of the oscillations.

C. Fichandler. No. 2000584.



Automatic tuning circuit for a press-button station-selecting receiver.

The Wireless World

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25th Year of Publication

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CONTENTS

EDITORIAL COMMENT

Programme Distribution

Readers' Views Invited

WHAT would be the reaction of the public if the B.B.C. decided to modify their present policy on the lines recently suggested by a contributor and looked upon all their stations as alternatives to the listener's local station?

The B.B.C., it has been suggested, is still thinking of listeners in terms of crystal sets or simple valve sets and assuming that their reception is restricted to the local transmitter and the long-wave Daventry station. If a new point of view were adopted and listeners were regarded by the B.B.C. as within the service area of all or most of their transmitters, then we believe their whole outlook on the problem would be changed, to the benefit of listeners generally.

Any modern set, unless designed for local reception only (and there are comparatively few of these), is capable of reception of many foreign stations and is equally able to receive some half-dozen at least of the B.B.C. stations well, in spite of their low power relatively to many foreign transmitters.

Should the B.B.C. plan programme distribution regarding all their stations as alternatives to the local and so do justice to the capabilities of the modern set, or should they continue the present scheme, under which they appear to regard any receiver as restricted in its repertoire to the local and long-wave stations?

A correspondent, in a letter published in this issue, draws attention particularly to the transmission of a news bulletin by stations simultaneously. If an alternative programme were available at the same time, it would satisfy the needs of those who have already read the news in their evening papers.

The views of some readers in different parts of the country on this subject would be welcomed, with reports on what B.B.C. stations are regularly receivable at good enough strength and quality to compare with the local transmitter when an alternative programme is desired.

Such reports would, we believe, indicate that with, perhaps, some increase in station power the majority of our transmitters could be well received almost all over the country.

Television Sound

Plea for Continuous Transmissions

IT has recently been announced that the Post Office has perfected, and is now ready to lay, high-definition telephone cables, such as would be suitable, not only for high quality speech, but also to carry television signals. This at once suggests that it will now be possible to connect the television transmitters at the Alexandra Palace with the B.B.C. studios at Broadcasting House.

It is understood that at first television will be broadcast for not more than three hours a day, and we would like to put forward the suggestion that some programme, preferably originating in the B.B.C. studios, should be put on to the short-wave sound transmitter when this transmitter is not wanted as an adjunct to the television transmissions.

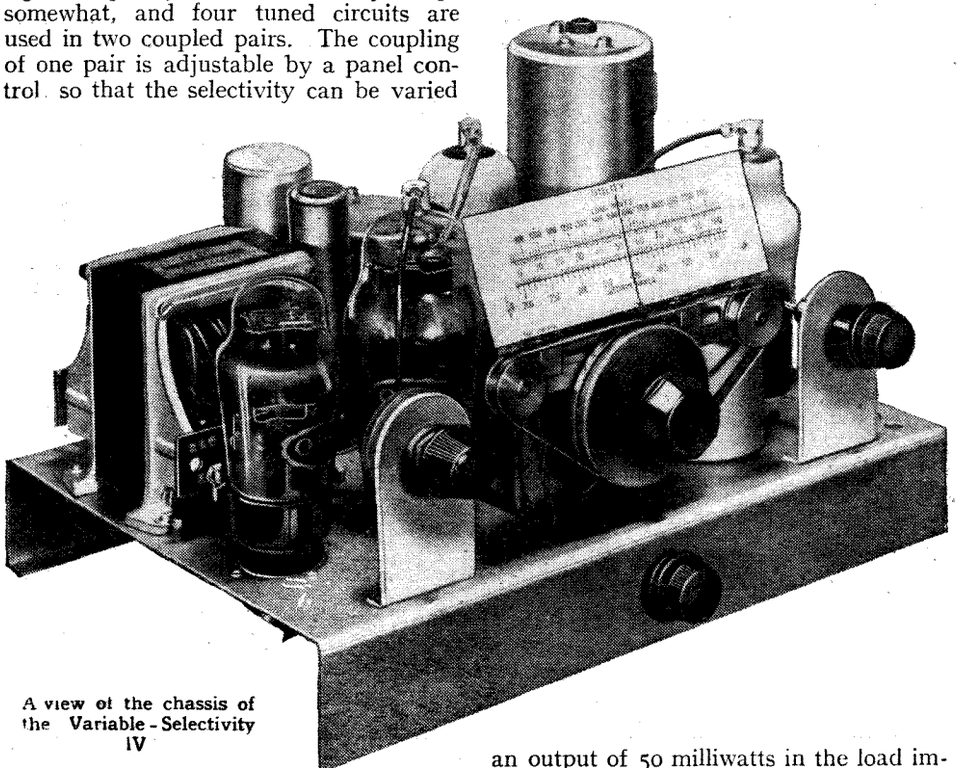
Considering the outstanding improvement in quality which is possible on the ultra-short wave transmitter, it would seem more than unfortunate if the fullest use were not made of this wavelength which, being already allotted for television purposes, could be used continuously as an auxiliary high quality sound transmitter.

Developing a Modern Quality

FROM VARIABLE-SELECTIVITY IV TO QA SUPER

HIGH-quality reproduction demands meticulous attention to detail throughout the receiving equipment. Not merely the LF and detector circuits can introduce distortion in a serious degree, but also the IF amplifier and even the AVC system. The design of a receiver for a minimum of all kinds of distortion is described in detail in this article.

A SHORT while ago a receiver was described in *The Wireless World*, under the title of the Variable-Selectivity IV[1], which has proved extraordinarily popular because of its low cost and outstanding performance. It is a three-valve superheterodyne consisting of a triode-hexode frequency-changer, a single IF stage operating at 465 kc/s, and a duo-diode-output pentode which provides delayed automatic volume control as well as acting as a detector and output valve. Owing to the adoption of a fairly high intermediate frequency, a single tuned circuit operating at signal frequency provides adequate protection against second channel or image interference. The adjacent channel selectivity is obtained chiefly in the IF amplifier, although the signal-frequency circuit naturally helps somewhat, and four tuned circuits are used in two coupled pairs. The coupling of one pair is adjustable by a panel control so that the selectivity can be varied at will, and the highest standard of reproduction consistent with the prevailing interference conditions obtained.



A view of the chassis of the Variable-Selectivity IV

[1] *The Wireless World*, November 1st and November 8th, 1935.

Practical tests showed the receiver to have a very satisfactory performance indeed, the sensitivity, selectivity and quality being exceptionally fine for a set of this class. The results of aural tests are confirmed by measurement, which shows the set to have a maximum sensitivity of 100 μV, an overall modulation frequency response substantially flat from 30 c/s to 10,000 c/s, and a degree of selectivity such that an interfering station on an adjacent channel would have to be at least fifty times as strong as the wanted one to give the same output. It may be as well at this point to remind readers that the sensitivity of a receiver is expressed by the RMS carrier input which, modulated 30 per cent. at 400 c/s, it is necessary to inject in series with a standard artificial aerial in order to obtain an output of 50 milliwatts in the load impedance of the output stage. It follows that the figure expressing sensitivity gets smaller as the sensitivity increases, for the figure is really the input voltage necessary to obtain a certain output; thus, a set with a sensitivity of 10 μV is more sensitive than one rated at 100 μV, and not less, as one might at first suppose.

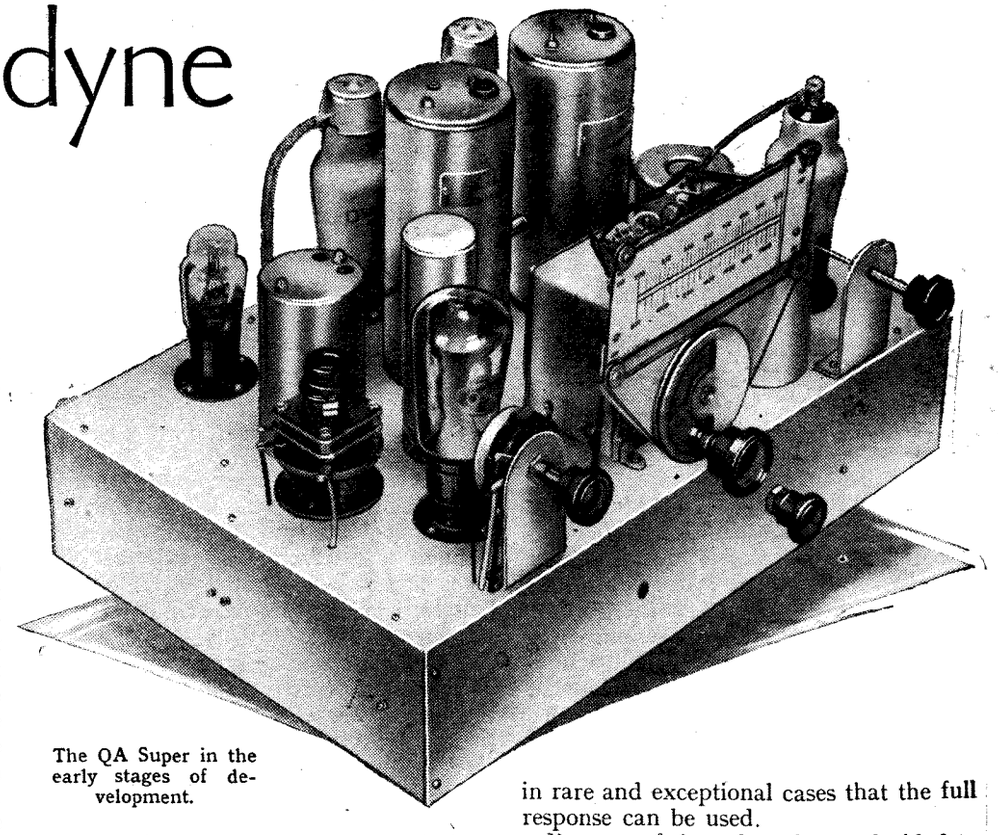
Now, although the quality of reproduction obtainable with the Variable-Selectivity IV is of a high standard, and at the present time can hardly be improved without very appreciably increasing the cost and complexity of the receiver, it would be idle to pretend that it is perfect. Perfection is the goal at which every designer aims, but it is unlikely ever to be reached. There is no doubt, however, that even to-day it is quite possible to get very close indeed to the ideal state. As far as the low-frequency circuits are concerned *The Wireless World* Push-Pull Quality Amplifier can hardly be improved upon. Its output of 4-6 watts is ample for nearly all domestic purposes, and both frequency and amplitude distortion are negligibly small. The reception which this amplifier has been accorded has been ample proof of the way in which high-quality apparatus is appreciated. The issues of *The Wireless World* containing the original constructional articles have been out of print for well over a year, and a later reprint in the issue dated February 22nd, 1935, has not been available for several months. In view of the steady demand for the constructional details, a second reprint, this time in pamphlet form, has been made, and once again full data is obtainable. Although it is almost two years since the original description appeared and it is well over two years since it was designed, the steady demand for it and the fact that it has not been found necessary or beneficial to modify in any way the original design speaks well for the performance, consistency and reliability of amplifiers built to this specification.

Feeding the Quality Amplifier

One receiver, the QA Receiver, has been designed especially for this amplifier, and the alterations necessary to several others for use with it have been described. These sets, however, do not meet all requirements, for the type of receiver necessary to give the highest standard of reproduction depends on many factors, which vary in individual cases. There is no doubt that a set of extremely high sensitivity is unnecessary, for it is rare that atmospheric conditions permit high fidelity reception of very weak stations. On the other hand, few in these days are content with purely local reception. Many readers of *The Wireless World* have suggested, therefore, that the Variable-Selectivity IV with the omission of the output valve and

Superheterodyne

By W. T. COCKING



The QA Super in the early stages of development.

the mains equipment would make an ideal receiver to precede the Push-Pull Quality Amplifier. The writer took rather the same view, but anticipated that much minor modification would be needed before the receiver could be considered wholly satisfactory for this purpose.

It was decided, therefore, to redesign the appropriate portion of the Variable-Selectivity IV and to determine, by both aural test and measurement, whether or not it would make a worthy companion to the amplifier. It may be said at once that many alterations were found to be necessary in order to obtain the highest quality with freedom from adjacent channel and image interference, and the maintenance of adequate sensitivity. The final receiver, which has been entitled the QA Super, and will be fully described in an early issue of *The Wireless World*, bears at first sight little kinship with the Variable-Selectivity IV, and it is consequently thought that it will be both entertaining and instructive to trace its development from the original small superheterodyne. In this way, the necessity for the various changes will be better appreciated and the need for close attention to the smallest details when the highest quality is demanded will be better understood.

At the outset it was decided not to aim for a frequency response perfect from the point of view of quality! Perfection would demand a response curve flat from 30 c/s to 15,000 c/s, but a receiver as good as this would be of rather limited application. When broadcasting stations are spaced by only 9,000 c/s it is only possible to reproduce frequencies higher than this when the wanted signal is so strong that by sheer power it swamps all interference. This can occur only in local reception, but even then experience shows that it is only during the daylight hours that the full frequency response can be utilised. After nightfall an annoying heterodyne whistle appears even in districts which are well within the service area of a transmitter. It seems that it is only in rare and exceptional cases that the full response can be used.

Because of these facts it was decided to aim at providing a frequency-response curve as flat as possible from 30 c/s to 8,000 c/s but cutting-off at higher frequencies in order to avoid heterodyne whistles. Experience shows that although there is some loss of quality through this restriction, it is very small, and a response of this order is usually considered to be about 90 per cent. perfect.

The relevant portions of the Variable-Selectivity IV were accordingly redesigned and an experimental model was built to the circuit of Fig. 1. A compari-

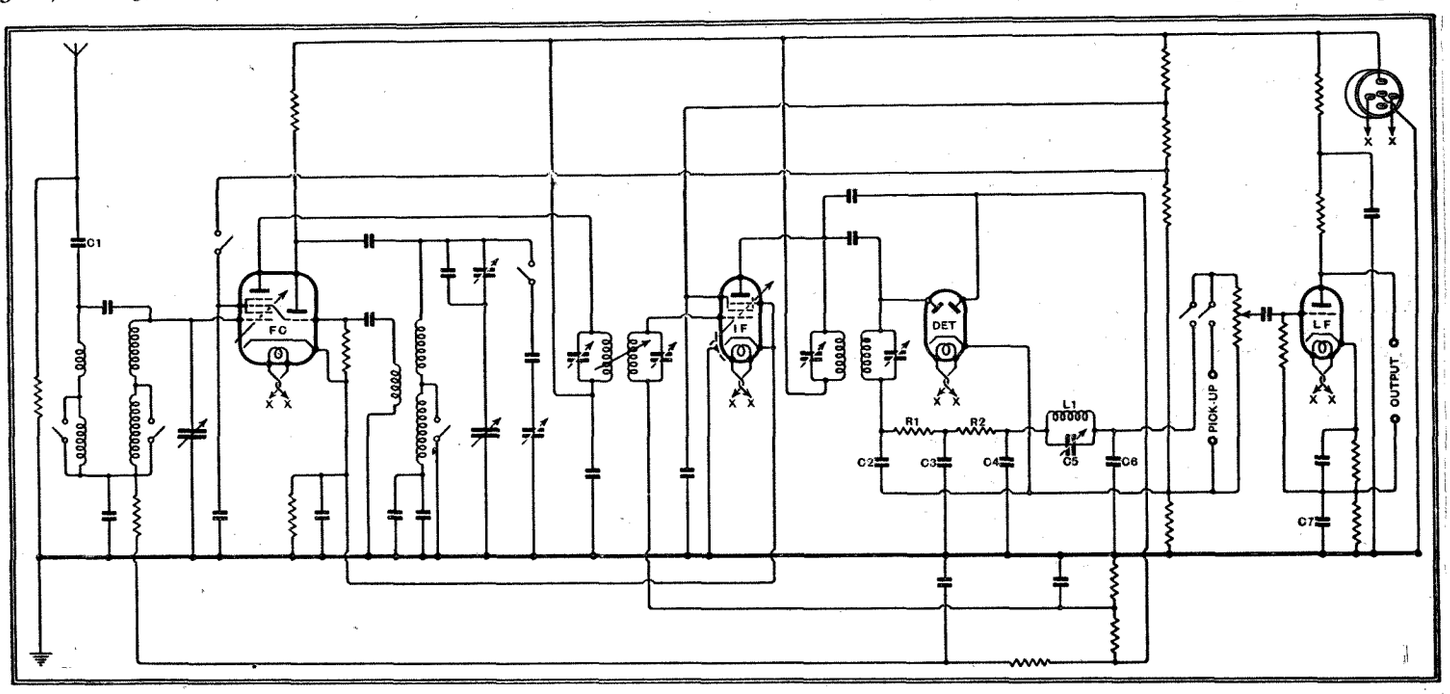


Fig. 1.—The circuit diagram of the receiver as originally tried out. The changes from the Variable-Selectivity IV are confined chiefly to the detector and LF circuits.

Developing a Modern Quality Superheterodyne—son of this diagram with that of the original set shows that the changes are quite small; in fact, before the detector the only alteration is the inclusion of C1 to permit a higher AVC voltage to be applied to the frequency-changer. The changes in the detector are first of all the use of a duo-diode instead of a multiple-purpose valve combining triode or pentode elements and, secondly, better IF filtering in the detector output circuit. Two resistances, R1 and R2, with by-pass condensers C2, C3 and C4, are used and followed by the whistle filter L1 C5 tuned to 9,000 c/s. This is followed by another by-pass condenser C6 which not only greatly increases the efficacy of the filter but gives a useful lift to the response characteristic just before the cut-off frequency.

The output of the detector feeds a triode phase-changing valve which gives no amplification but provides the LF output in the necessary form for the Push-Pull Quality Amplifier. The condenser C7 across the cathode coupling resistance provides a moderate degree of tone-correction, and its operation, together with that of the phase-reversing valve, was described in detail in a recent issue of this journal.[2] This valve requires an input of about 4 volts peak fully to load the amplifier, and as this is of the same order as that required by the output pentode of the Variable-Selectivity IV, the sensitivity of the equipment should be about the same.

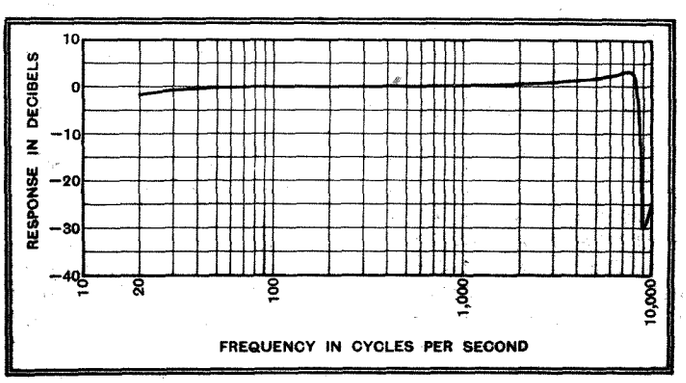


Fig. 2.—The overall frequency-response characteristic of the apparatus.

The measured overall frequency response characteristic of receiver and amplifier at "low-selectivity" is shown in Fig. 2, and is extremely good. At as low as 20 c/s the loss is only 1.6 db, and at high frequencies it rises to a maximum of +3 db. at about 8,000 c/s; at 9,000 c/s, however, it is −30 db, a change of 33 db between 8,000 c/s and 9,000 c/s. From the quality point of view this receiver was obviously satisfactory, for tests of linearity showed this also to be fairly good. Measurement showed the sensitivity to be good, varying from 60 μV to 170 μV on the medium waveband, but the second-channel ratio was certainly lower than is desirable in high-quality apparatus, varying from 50:1 to about 500:1 (Fig. 3).

[2] *The Wireless World*, February 7th, 1936.

The second-channel ratio necessary for the avoidance of interference naturally depends on the ratio of the field strengths of the wanted and unwanted stations. On the medium waveband second-channel interference can only be caused by fairly low power morse transmitters on wavelengths below 200 metres owing to the fairly high intermediate frequency of 465 kc/s. It was known that interference did not prove troublesome with the Variable-Selectivity IV, but it was thought that the protection against second-channel interference might be inadequate in view of the higher standard of reproduction and greater volume obtainable.

The First Model on Test

Tests were accordingly carried out to determine whether or not this was the case, for although one can predict the performance of a receiver fairly well from an inspection of its measured characteristics, it is easy to overlook minor points and a listening test is always advisable. The sensitivity was adequate for good reception of all the stronger Continental stations, and the quality was of a high order, although traces of amplitude distortion were present. The adjacent channel selectivity was not high, of course, but it was sufficient to enable most stations to be received free from interference. It seemed just adequate, but the reservation was made that it would be nice to have it a little greater in order to provide a bigger factor of safety. This applied also to the sensitivity, for although the amplification was adequate with a good aerial no reduction could be tolerated if good distant reception were to be maintained, nor would the set prove satisfactory for foreign listening in cases where only a small aerial could be used.

During the tests a number of whistles were found on the medium waveband and were all traced to the large input obtained from the London Regional transmitter. The simplest and cheapest remedy was found to lie in the use of a wavetrap tuned to this station, and this had also the merit of lightening the load on the AVC system and so reducing any risk of distortion due to overloading in local reception. It proved an effective cure for the whistles and removed every one completely.

Traces of second-channel interference now became evident. They were quite small and only occurred at two or three points in the tuning range. Under the conditions of test the interference could not be called severe and was not really of great importance. It was felt, however, that as in other districts it might be much worse, and that as the measured second-channel rejection was undoubtedly on the low side, some improvement was required.

The points on which an improved performance was felt to be advisable all lay in the pre-detector circuits, and the higher standard of performance was deemed necessary only because of the high fidelity and volume given by the equipment. At lower volume some of the interference would not be heard because it would be below the level of audibility. There is no point, however, in providing a large output stage and being unable to make use of the full output because a trace of interference then creeps in, and it was decided to make an attempt to improve the performance.

The sensitivity and adjacent channel selectivity being just adequate, it was felt that an improvement in the second-channel rejection was the most important, and means of doing this were considered. The easiest way was to add another signal-frequency tuned circuit. This would have complicated the waveband switching and the ganging, however, and would have reduced the sensitivity by at least 50 per cent.; as it would give also only a very small increase in adjacent channel selectivity it was not seriously considered. The alternative was the use of an image suppression circuit[3] and various types were tried. Much work had to be carried out before a satisfactory method was found, for most image rejectors are easier to apply to a pair of coupled tuned circuits than to a single tuned circuit coupled to an aerial.

The cathode-coil rejection circuit was found most satisfactory, but attempts to apply it to the signal-frequency circuit of Fig. 1 were disappointing. Ample rejection at any one frequency could be obtained (second-channel ratios of over 10,000:1 were found), but the performance could not be maintained over the waveband. Indeed, the image rejector actually reduced the second-channel ratio

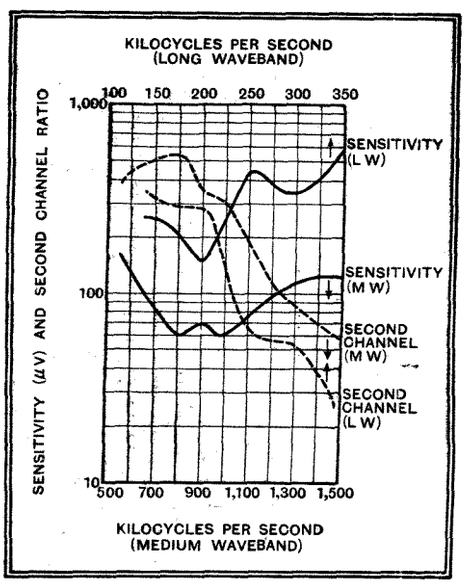


Fig. 3.—The sensitivity and second channel ratio for both medium and long wavebands are shown here.

[3] *The Wireless World*, January 17, 1936.

Developing a Modern Quality Superheterodyne—at one end of the band while increasing it at the other.

It was at length found that this effect was caused by the coupling between the tuned circuit and the aerial circuit. This was modified and the image rejector now operated properly, giving a point of maximum rejection towards each end of the waveband and maintaining high rejection throughout. Indeed, over much of the tuning range the second-channel ratio was too high to measure!

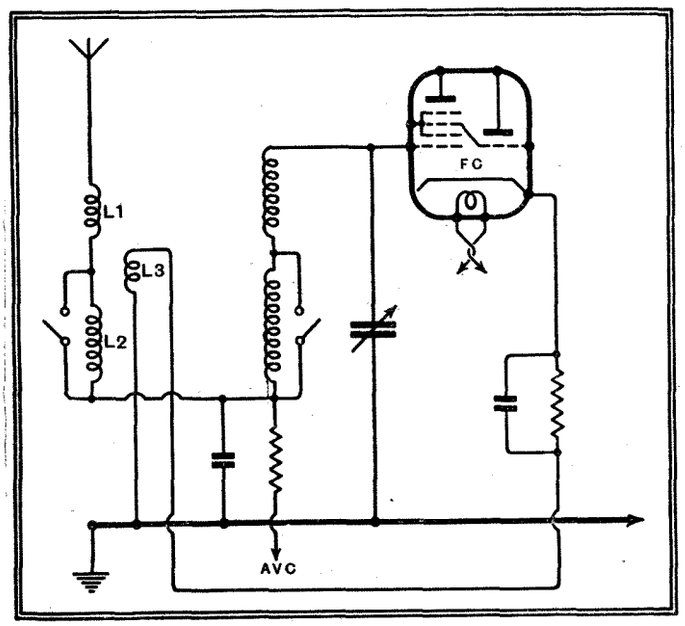


Fig. 4.—The modified signal-frequency system embodying a cathode-coil image rejector.

The input circuit then took the form shown in Fig. 4. It can be seen that the only changes from Fig. 1 were the omission of the "top-end" coupling capacity and the provision of the cathode-coil L3 coupled to L1 and L2. Actually, L3 was a single turn of wire quite loosely coupled to the aerial coils, and for maximum image rejection its spacing was quite critical.

An Extra Stage of Amplification

This proved a satisfactory solution to the problem of second-channel interference, but, unfortunately, the necessity for using a looser aerial coupling reduced the sensitivity. As the sensitivity was originally only just adequate this could not be tolerated, and it was decided that it would be necessary to add another stage of amplification. There were three places in which another valve could be added—in the signal-frequency circuits, in the IF amplifier, or in the LF amplifier. Taking these in order, an HF stage would necessitate an extra signal-frequency tuned circuit and the image rejector would no longer be necessary. The extra circuit would mean extra waveband switching and more difficult ganging. Ample gain could be secured with little risk of instability, but the extra amplification might easily cause the frequency-changer to be overloaded when the set was tuned to a frequency fairly close to that of a local station, and this would cause distortion, cross-modulation and whistles. In general, the gain of an HF stage in a superheterodyne must be kept quite low. The signal/noise ratio, however, would be improved, for the noise generated in an HF amplifier is about one-quarter of that developed in a frequency-changer. This was not felt to be of any importance in this case, however, for there was no desire to make the sensitivity high enough for the self-generated noise in the set to become of sufficient intensity to need serious consideration.

Now in the IF amplifier the addition of an extra stage would give quite high gain, and as it would carry with it an extra pair of coupled circuits it would greatly increase the adjacent channel selectivity, which was felt to be desirable. It would, of course, help AVC, but no more than an HF stage would do. The only objections were that it would increase the risk of instability and make trimming slightly more difficult. It was anticipated, however, that a gain of 30 times could be obtained without difficulty, and practical tests showed it easily possible for the amplification to be 100 times with perfect stability.

Additional amplification could be obtained in the LF circuits without complicating the trimming or ganging in any way, but it would lead to the detector being operated at rather a small input, and it would considerably increase any risk of motor-boating effects. This method was at first sight particularly attractive, for it would have been possible to obtain the additional gain from the phase-reversing valve by altering its input circuit. This would have necessitated the whole of the detector circuit being unearthed, however, and experience has shown that it is then very difficult to filter the detector output properly, with the result that there is a greater risk of instability due to IF feed-back, more likelihood of whistles due to feed-back of harmonics of the intermediate frequency, and a possibility of distortion caused by an LF valve being loaded by IF potentials.

After carefully considering these possibilities and weighing the advantages and disadvantages of each, it was decided that the IF amplifier was undoubtedly the correct place for an additional valve. Not only could the requisite gain be secured easily with such a stage, but the adjacent channel selectivity would be increased and AVC improved. The circuit diagram then took the form of Fig. 1, but with an extra IF stage, and the image rejector of Fig. 4. Additional screening and decoupling naturally proved necessary to maintain stability, and in fact the receiver was entirely rebuilt. The receiver was from the start perfectly stable and had a sensitivity of about 1 μV! It was, in fact, difficult to measure the sensitivity, since it was of the same order as the noise level. This is always the case when the sensitivity is better than some 10 μV., for the inherent noise in a *tuned circuit* is about 1 μV to 4 μV, and the noise introduced by the first valve is of the same order. To obtain minimum noise with a sensitivity better than 10 μV it would be necessary to use an HF stage before the frequency-changer.

AVC and Amplitude Distortion

Excessive gain is no disadvantage, however, for it can always be reduced, and it is as well to have some amplification in hand. An examination of the operating conditions showed a tendency for the frequency-changer to pass grid current in spite of its being operated with the maker's recommended value for the cathode bias resistance. An increase in the bias resistance completely eliminated this tendency, reduced the gain to a more reasonable figure, and improved the efficiency and sharpened the tuning of the signal-frequency tuned circuit. The gain was still high, but an increase in the bias resistance of the first IF valve brought it down to the desired level, and gave a maximum sensitivity of about 20 μV. The gain of the second IF stage was kept as high as possible in order to prevent overloading on strong signals.

Extended tests now showed the receiver to have ample sensitivity, selectivity, and second-channel rejection, and to be free from whistles. The one point in which the set failed to give complete satisfaction lay in the AVC system. The usual delayed diode arrangement was employed and was satisfactory from the point of view of reducing fading, but failed in that it produced a noticeable degree of amplitude distortion. This distortion, which was mentioned earlier, could hardly have been detected in less perfect equipment, which accounts for the widespread use of the method, but it readily showed up in this set when listening to any but weak signals. When tested by listening to the reproduction of a constant frequency note modulating the standard signal generator the distortion showed up whenever the modulation depth exceeded 50 per cent., and proved serious with signal inputs as low as 1,000 μV.

Careful investigation showed the distortion to arise from two different causes. The first lay in the inability of the AVC system to keep the output of the second IF valve at a low enough figure to avoid slight overloading on strong signals, while the second is inherent in delayed diode AVC. With

Developing a Modern Quality Superheterodyne—this system the primary of the last IF transformer is more highly damped when the AVC diode is rectifying than when it is not. Now any change in the damping of this circuit must necessarily alter the gain of the IF valve, and hence the detector input. Whether or not the AVC diode rectifies depends on its IF input, and unless the delay voltage be very small indeed it must inevitably pass from one condition to the other during modulation. With a large input it will rectify the whole time when modulation is shallow and also on the peaks of deep modulation, but in the troughs of deep modulation it will cease to rectify, and the damping on the tuned circuit will change.

Determining AVC Requirements

These effects resulted in serious distortion, as the curves of Fig. 5 show. In taking these curves the input to the aerial was set at the figures indicated, and with 30 per cent. modulation at 400 c/s the LF volume control was set to give the same output, represented on the arbitrary output scale of voltage by 53. The modulation depth was then varied, and the output plotted against it. Ideally, the resulting curve should be a straight line, and it can be seen that in all cases it is straight up to 30 per cent. modulation. The deviations up to 50 per cent. are unimportant, but only in the case of a small input (100 μV) is the curve reasonably straight up to 80 per cent.—the normal upper limit of modulation.

Simple non-delayed AVC was then tried, the bias voltage being derived from the output of the detector. This gave better results from the quality viewpoint, but was not perfect, because the control

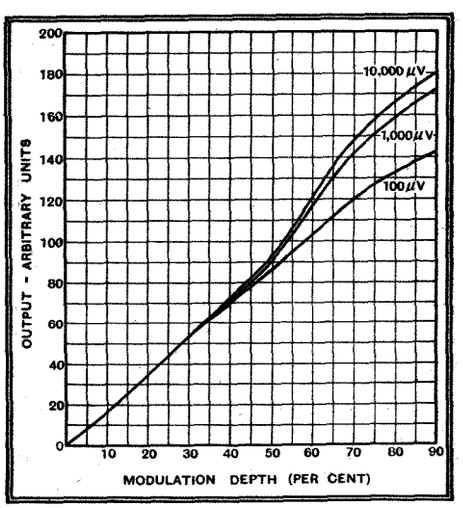


Fig. 5.—The non-linearity caused by IF overloading and by the AVC system is clearly brought out by these curves.

still permitted some overloading of the second IF valve on very strong signals, and the AVC filter necessarily made the AC load impedance of the detector appreciably less than the DC load. Moreover, the absence of delay reduced the sensitivity of the receiver seriously, and full volume could only be secured from the strongest of Continental transmitters.

The operating conditions were then critically examined with a view to determining the requirements for a perfect AVC system. It was found that to obtain full output under all conditions the detector input should be of the order of 10 volts. This would permit the output stage to be fully loaded even on stations having a comparatively shallow maximum modulation depth. This input represented a current through the diode load resistance of the order of 30 μA, and this figure was taken as the minimum input to be obtained on all worth-while stations.

The maximum input for the avoidance of distortion in the second IF valve was then determined, and for 90 per cent. modulation it was found that the current through the diode load should not exceed 60 μA, although if modulation depths greater than 70 per cent. were considered unimportant the current could be as high as 100 μA. The next step was to determine the bias needed by the two controlled valves to keep the detector operating under these conditions, and it was found to be as much as 27 volts when receiving Droitwich. The detector current was 60 μA, and, as the load resistance of the detector was 0.25 megohm, the voltage across it was 15 volts only. Obviously, amplified AVC was necessary.

Amplified AVC

Two basic methods of obtaining amplified AVC are available. One is to use delayed diode AVC fed by an extra IF stage reserved for it alone. This prevents the distortion, because a valve is interposed between the AVC diode and the signal-tuned circuits. Several difficulties arise in practice, however, for the extra IF gain may cause instability, and the very high IF voltages at the AVC diode may cause the appearance of whistles due to feed-back of IF harmonics. Moreover, when the detector input is large it is easy to overload the AVC amplifier so that grid current flows, and then distortion will occur again.

The alternative method is to amplify the DC output of the detector. There are several ways of doing this, but all require a source of steady potential negative with respect to the earth line of the receiver. This is usually obtained by inserting a resistance between negative HT and the earth line, but in this case it was found that the maximum voltage available was very limited. A further difficulty lies in preventing feed-back effects, for it requires very extensive decoupling to prevent motor-boating when amplified AVC is used.

At this stage it was seen that the ideal arrangement would be to provide an entirely separate HT supply unit for the AVC valve. An adequate voltage could then easily be secured, and no feed-back problems would arise. Incidentally, the scheme is not as expensive as it sounds, for the current required is no more than 5 mA, and there is a considerable saving on decoupling components.

This arrangement was accordingly tried, and found so satisfactory that it was unhesitatingly adopted. When correctly adjusted, the detector input varied no more than 1.3-1 for a signal input variation of 15,000-1, and the desired conditions were more than fulfilled. Listening tests now showed the receiver to be distortionless for modulation depths up to 80 per cent. As the curve of Fig. 6 shows, complete freedom from distortion is not secured, but the degree is too small to be audible until the modulation depth exceeds 80 per cent.

The Final Model

At this stage it was felt that finality had been reached, for the original sensitivity and selectivity were retained unimpaired, while the quality was well nigh perfect, and the control of AVC was greatly improved. It is in this form, therefore, that the receiver will appear in an early issue of *The Wireless World*, when the complete circuit diagram will be

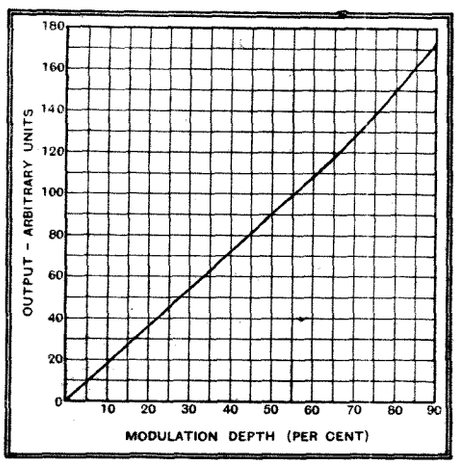


Fig. 6.—The degree of linearity obtained in the modified equipment.

given. As explained in this article, the set is a true successor to the Variable-Selectivity IV, and, with the exception of the additional IF stage, the changes are only the essential ones necessary when it is to feed such a good amplifier as the Push-Pull Quality Amplifier. Many constructors would doubtless have been fully satisfied with it without the extra valve and improved AVC system, but the set is intended for more than local reception, and the additional stage provides an ample reserve. Moreover, it is, in the writer's view, true economy, for when the sensitivity is only just adequate for good results, the slightest deterioration in a valve seriously affects the performance, and valve renewals must be frequent if the set is to be maintained in good condition. If the set be more sensitive than is necessary, however, quite a large deterioration in the valves can be permitted before the performance is noticeably affected; the intervals between replacements, at any rate in the case of the pre-detector valves, may easily be doubled.

STANDARDISATION

A Matter for Compromise

By "CATHODE RAY"

THE idea of standardisation is hateful to those people who consider it to be typical of the whole debased tendency of this deplorable modern age. They contrast it with the individual work of the old craftsmen, who are now (alas!) giving place to soulless mass-production engineers. Even in other realms the multiplication of identical articles can be abhorrent; consider, for example, the feminine demand for "exclusive creations." It would be a dull world if everyone wore exactly the same clothes. Standardisation is very regrettable in some ways, it must be admitted, and yet perhaps if it were not for the efficiency and cheapness of modern methods there would be fewer people with leisure to enjoy individual art. The well-balanced person desires neither to live like a robot nor to return to the "Glory" (but discomfort) "that was Greece." One's enjoyment of the Old Masters is not one whit enhanced by discovering that the new electric heater plug won't fit the pre-standardisation socket. There is nothing inconsistent in making use of standardised equipment where it helps life to run more smoothly, while yet displaying strongly individual tastes.

For and Against

I have devoted the whole of a long paragraph to this conflict of ideas, in order to temper the enthusiasm which the tremendous merits of standardisation in the field of radio are liable to arouse. When the arguments for radio standardisation are put forward, one feels that there is nothing left but to go right ahead and get on with it. On the other hand, when the "cons" are marshalled, they are so formidable as to make the prospect appear almost hopeless. The fact is that standardisation is excellent or execrable, according to where and how it is applied.

We are apt to blame past ages for muddles such as $5\frac{1}{2}$ yards equalling one rod, pole or perch; or even for the fact of more than a dozen different electricity supply voltages within the borders of these small islands. Now we have—and some people actually use—the Metric System; and the Grid is slowly, but we trust surely, bringing everything to 230 volts 50 cycles. Radio is modern and systematic, with things like decibels all beautifully worked out. One would expect it to be free from duplication and confusion, if anything were. But already a legacy of tiresome non-standardisation has accumulated. Valve types are far too numerous, and they overlap; while hermits in the Middle Ages would almost certainly have made a more rational job of naming them. One cannot plug in a pick-up or extension speaker with any confident hope of it matching the input or output of the set.

The success of a certain make of motor car was due in the first place not so much to its exceptional beauty or outstanding performance as to standardisation, which made it possible for parts to be obtained quickly and cheaply all over the world. In a highly technical field like radio it would be most helpful if new accessories or replacement parts could be asked for without detailed knowledge being required in order to avoid getting something unsuitable.

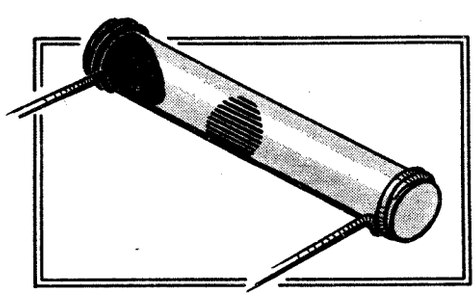
And the Expense

How much irritation is caused when wander plugs or other connections refuse to fit, when the right size of battery for the old set cannot be obtained because it was a very special sort, and when the volume control cannot be made to go on the panel because it is designed for a different thickness!

But how much more expensive things are when the manufacturer has to stock fifty types and sizes of a component instead of five, and when these in turn call for a multiplicity of minor parts!

And how confusing it is when some people work in frequencies and some in wavelengths, some in "slopes," and some in mutual conductances, some in "*m*" and some in "Q"!

If every designer worked out his specifications without relation to what others were doing things would be appalling. So why not standardise more fully still, so that, for example, when substituting a



The best example of international standardisation: perhaps the colour code for identifying resistor values has been so widely adopted because it cannot possibly offend national susceptibilities.

new type of variable condenser one could rely upon using the same fixing holes and knob; or, having built up a receiver with miscellaneous parts, one would not be confronted with knobs standing off from the panel to widely varying extents?

The benefit to the manufacturer and trader of more complete standardisation would be even greater. Why, then, is there not more of it?

In an industry with so many interested concerns it is essential for standardisation to be well considered, otherwise standards might soon be found unsuitable and discarded and we should then be no better off than before. On the other hand, they must not be so well considered that by the time a standard specification has been drawn up the subject of it has become obsolete. That actually happened with ebonite panels.

Then there is the question of who or what is going to do the standardisation. It is almost as serious a problem as that of deciding who was to bell the cat. It should be an organisation large enough in its scope to embrace all interested in the products concerned; and, preferably, international. But the more comprehensive the body, the less likely is it to have a live and practical experience of the matters with which it deals. While some highbrow committee is taking its leisurely course, the industry has to get on with its job and cannot wait a year or two for a report.

Cramping Individual Effort

Another difficulty is that, if the work of standardisation is to be comprehensive, all the manufacturers must lay all their cards on the table; and some of them may quite understandably be reluctant to disclose plans in advance.

Then there is always—in this country and in America at least—a natural resentment at interference with individual liberties. That may sometimes be little removed from pigheadedness; but standardisation should certainly not have the effect of cramping individual effort or new development. And one can hardly blame a manufacturer who says to himself: "All these other fellows are putting out the standard type; right! I'm going to do something a bit better so as to collar the market!"

That is where the standardisers have to show good judgment in confining their attention to matters which do not restrict healthy competition. Take resistors: the colour code is truly international, benefits all and hurts nobody—a good example of standardisation. Some other matters—standard values, ratings, tests and mountings—may be accepted with perhaps a certain amount of dispute. But it would clearly be imprudent to try to exercise a rigid control of all dimensions or materials of construction.

If it is true that the British excel at compromise, we should be in the forefront in standardisation.

Valves for Short Waves

BELOW a certain limit of wavelength it is physically impossible to use valves of ordinary type, and even at wavelengths considerably above this limit there is a distinct advantage in using special patterns. How these valves differ from those designed to operate at normal wavelengths is explained in this article.

Why Special Types are Needed

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

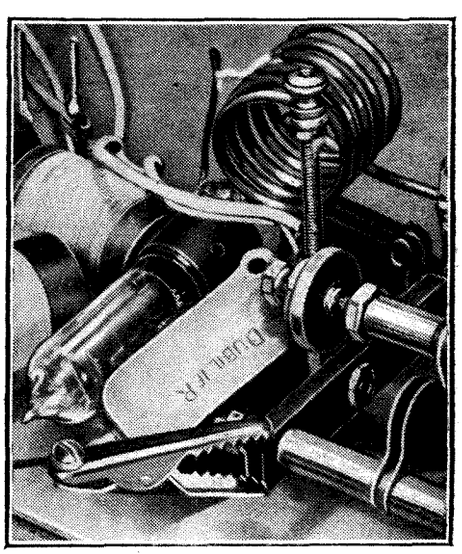
FROM 150 to 15,000 metres nobody thinks of varying the choice of valves to suit the wavelength; while "all-wave" sets make one lot of valves cover everything down to 15 metres. But try taking the next decimal step to 1.5 metres!

It is just possible to make some ordinary types of triode valve "go down" to 1.5 or 2 metres as oscillators, by taking special care about it. It may even be possible, but not very comfortable, to use such valves in simple receivers down to 3, or perhaps 2 metres. The tetrode or pentode valve of normal design can only with difficulty be persuaded to give the slightest trace of amplification below 10 or 12 metres. More elaborate valves, such as frequency-changers, are not beyond criticism at longer wavelengths still. Even where a standard valve performs quite well at, say, 5 metres, a specially selected type of valve is likely to do considerably better.

Why?

There are a number of ways in which valves of ordinary design increasingly withdraw from useful business as the wavelength becomes shorter. The chief of these concerns the associated tuning circuit. This (to run over familiar ground once more) is made up of inductance L and capacity C, which between them decide the wavelength λ to which the circuit responds, according to the famous old formula $\lambda = 1885\sqrt{LC}$ where L is in microhenrys (μH) and C in microfarads (μF). In ordinary (that is to say, medium- and long-wave) practice, L and C are considered to reside chiefly in the tuning coil and condenser respectively. It is true that one often has to take account of "stray" capacity and perhaps inductance due to the wiring and to the electrodes of the valve, but these are generally subsidiary in effect.

To fit circuits for shorter waves, L and C must be appropriately reduced; and so in short-wave sets we have coils with fewer turns of wire, and condensers with fewer or smaller plates. But obviously if these quantities are progressively reduced, whereas the valve is retained unaltered, the proportion of L and C residing within the valve must grow from a small and almost negligible one to a condition of equality, then of predominance, until finally the valve's inductance and capacity alone are greater than are needed for the wavelength.



The Hivac "Midget" valves have proved to be well suited for work at ultra-short wavelengths.

Valve Capacity

Take some actual figures. To tune to 400 metres one may conveniently use an inductance of 150 μH and a capacity of 0.0003 μF, or 300 $\mu\mu$F. Thinking in $\mu\mu$F, for μF will become clumsy in a minute or two, the L/C ratio is 150/300, or 0.5. Of the 300 $\mu\mu$F the valve contributes perhaps 10 at most; only about 3 per cent. of the whole. Now drop to 40 metres. To preserve the same L/C ratio—for if it is greatly reduced the impedance of the circuit becomes too low, and self-oscillation (if required) impossible—the tuning circuit must comprise 15 μH and 30 $\mu\mu$F, so that now the valve capacity is 33 per cent. of the whole. Taking another drop to 4 metres, on the same assumption the valve capacity is more than three times as great as the whole tuning capacity. Which, like certain steps in Euclid, is absurd.

To get out of this impasse we must sacrifice L/C ratio and obtain the short wavelength by disproportionate reduction in L. The tuning capacity can hardly be got below 20 $\mu\mu$F, allowing for wiring, self-capacity of coil, and a mere trace for tuning control. The inductance must then be only 0.225 μH. By this time the inductance of the valve is quite an appreciable part, and, unless the length of leads is reduced almost to nil, there is very little change out of our allowance of 0.225 μH with which to provide the tuning coil itself. The absolute limit is reached when *all* the L and C exist in the valve and its irreducible minimum of external connections; and this, of course, varies with the type of valve, but for ordinary receiving valves is in the region of 1 metre. In practice it is impossible actually to reach this limit, for a valve provides quite a lot of capacity but very little inductance; in other words, the L/C ratio is so low that it is impossible to set up any useful HF voltage across it.

A Graham-Farish short-wave SG valve. The base is of low-loss material, and inter-electrode capacity is reduced by leading out the grid connection to the top cap.

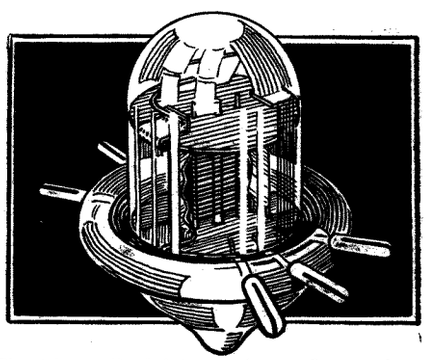
This restriction could be at least partly offset if it were possible to make a considerable reduction in the HF resistance, or losses. Unfortunately, it is difficult to prevent the loss resistance from being actually greater than usual, because, instead of the capacity being concentrated in a tuning condenser where the dielectric (insulating material between the plates) can be confined chiefly to air, which causes negligible loss, a considerable proportion is made up of miscellaneous items such as the capacity between valve pins, with comparatively high-loss bakelite dielectric. Hence the practice of valve decapping indulged in by short-wave enthusiasts.

Somewhere around the wavelengths where these difficulties appear in acute form we run into another trouble. The normal action of a valve depends on a time-table which allows nothing, or next to nothing, for the journey made by the electrons across the small internal gap between filament and anode. Now, while the electrons shoot across this small fraction of an inch at a pace which makes a

Valves for Short Waves—

high-velocity bullet seem like a fatigued snail in comparison, it must be remembered that at a wavelength of 3 metres a complete up-and-down cycle of oscillation is all over in 1/100,000,000th of a second. This certainly does not leave any time for dawdling on the way. Actually, it is found that the electrons arrive at the anode late by an appreciable fraction of this period, and at still shorter wavelengths may not turn up until the right moment for assisting the oscillation to keep going has passed. So the oscillations fail to go. Even at a wave as long as 22 metres it has been shown that this effect is equivalent to shunting the tuned circuit with a resistance, lowering its efficiency.

For the very shortest waves (usually called micro-waves, as an escape from some such dreadful term as ultra-ultra-short

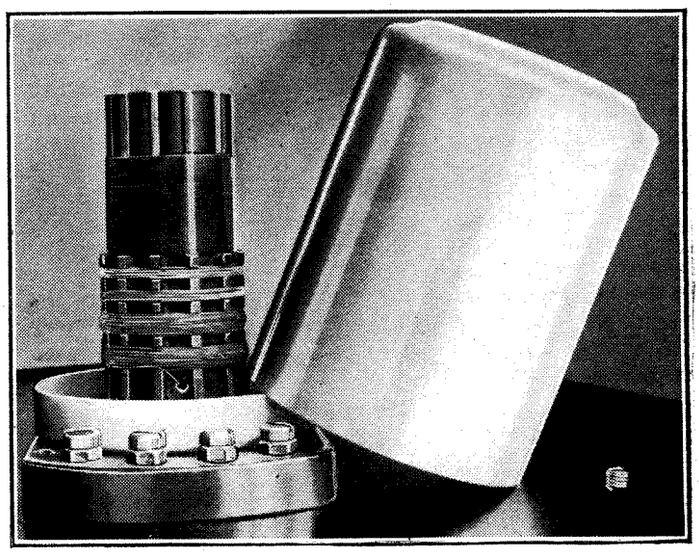


The "Acorn" miniature valve, as first produced for operation on ultra-short wavelengths.

waves) below one metre, special types of valves—magnetrons—are used which work entirely differently from the common sort, and, in fact, actually depend for their existence on the time lag that is the cause of the others' downfall. "One man's meat . . ., etc.," again. This leads to rather amusing results; for example, the tuning is done by varying the HT volts instead of a condenser. But it is not a type of valve which has any great appeal for the amateur as yet, so we pass on.

The straightforward way of arriving at a valve more suitable for short waves is to look at a standard model through the wrong end of a telescope, and produce a reduced scale model. Suppose every linear dimension is reduced to a half. Then the distances between the electrodes, and hence the time taken by electrons in crossing them, are halved. That is one good thing. But when the plates of a condenser are spaced by half the distance, the capacity is doubled, which seems to be not so good. In this case, however, the *area* of the plates is reduced to a quarter; so, taking both these factors into account, the inter-electrode capacities are halved. Good again.

The inductances are reduced in still better proportion. And the smaller clearances make up for the reduced cathode area in maintaining the valve characteristics at a high level. The only drawback (apart from the nimble-fingeredness required in manufacture) is that the power-handling capacity is lowered. But except for transmitting nobody need worry about that. Another point is that with the generally miniature components that are appropriate for ultra-short waves, tiny valves lend themselves to the construction of very neat portable equipment.



The tiny coil on the right is appropriate for use in conjunction with an "Acorn" valve for tuning to a wavelength of 0.8 metres. The comparison with a normal broadcast coil is interesting.

For these reasons the Hivac "Midget" valves have obvious advantages. They are available in three varieties of triode of high, medium, and low impedance ("XD," "XL," and "XP" respectively), a screen-grid tetrode ("XGS"), and an output pentode ("XY").

Figures showing how the inter-electrode capacities compare with those of full-size types are seen in the table of comparisons on this page.

By going the whole hog in valve diminution some remarkable results have been achieved, such as "straight" reception at 0.4 metres, and a several-fold HF amplification per stage at 1 metre!

The valves responsible for this performance are described, for reasons obvious on inspection, as "Acorns"; and besides being small compared with normal types they are laid out rather differently in order not to throw away in the leads and mountings any advantages obtained in the valves proper. Two varieties are obtainable, a triode and a HF pentode, both indirectly heated. Being of American origin,

COMPARATIVE INTER-ELECTRODE CAPACITIES
Hivac "Midget" and Standard Types

Valve.	Capacities, $\mu\mu$F.				
	Grid to Filament.	Grid to Anode.	Anode to Filament.	Grid to Other Electrodes.	Anode to Other Electrodes.
XL	1.4	2.7	1.6	4.1	4.3
XD	1.3	2.7	1.5	4.0	4.2
Full-size battery triode ..	6.3	4.3	5.3	10.5	9.5
	Grid to Filament.	**Grid to Screen.**	**Anode to Screen.**		
XSG	1.7	2.4	2.7	4.0	2.7
Full-size battery tetrode ..	7.6	2.0	6.6	8.5	6.6

CHARACTERISTICS OF "ACORN" AND STANDARD TYPES OF AMERICAN VALVES COMPARED

	RCA-76 Conventional Triode.	RCA-955 "Acorn" Triode.
Heater voltage	6.3	6.3 volts
Heater current	0.30	0.15 amps.
Anode voltage	180	180 volts
Grid voltage	−9.8	−5.0 volts
Anode current	3.2	4.5 milliamps.
Amplification factor	13.8	25
Anode resistance	11,200	12,500 ohms
Mutual conductance ("slope") ..	1.2	2.0 milliamps. per volt
Grid-cathode capacity	3.5	1.0 $\mu\mu$F.
Anode-cathode „	2.5	0.6 $\mu\mu$F.
Grid-anode „	2.8	1.4 $\mu\mu$F.

	RCA-6C6 Conventional Pentode.	RCA-954 "Acorn" Pentode
Heater voltage	6.3	6.3 volts
Heater current	0.30	0.15 amps.
Anode voltage	250	250 volts
Screen voltage	100	100 volts
Grid voltage	−3	−3 volts
Anode current	2.1	2.0 milliamps.
Amplification factor	1,840	2,100
Anode resistance	1.5	1.5 megohms
Mutual conductance	1.225	1.4 milliamps. per volt
Grid-cathode capacity	5.0	3.0 $\mu\mu$F.
Anode-cathode „	6.5	3.0 $\mu\mu$F.
Grid-anode „	0.010	0.005 $\mu\mu$F.

Valves for Short Waves—

the heaters are for 6.3 volts (a 6-volt accumulator will do) and 0.15 amp. The characteristics, judged merely for ordinary valves, are remarkably good; but especially so in view of the conservative characteristics of most American types. In fact, as the table on the preceding page shows, they excel the full-size valves.

One of the most decisive points of superiority is not listed above. The equivalent shunt resistance due to the electronic time lag, according to measurements that have been published, is fourteen times as great in the case of the 954 "Acorn," and the loss therefore correspondingly smaller.

It is rather amusing to consider the size of coil suitable for tuning to 0.8 metre, as shown in the accompanying illustration, where it is compared with an ordinary broadcast receiver type.

"Acorn" valves are now obtainable in this country, but only for bona-fide amateur or experimental use.

It must not be forgotten that the original object of the superhet was to dodge the difficulty of short waves by "converting" them to longer ones. But having made full use of this expedient there is always the irreducible minimum of the input portion of the frequency-changer, which *must* function at the original wavelength, and also the oscillator, whose wavelength must be very near.

The X41 valve (triode-hexode) is especially suited for operation as a short-wave frequency-changer.

It is just that nearness, which must never degenerate into actual identity, that is part of the difficulty. When two circuits are tuned to very nearly the same wavelength the slightest coupling between them produces a tendency for the circuits to "pull" one another, shifting the wavelengths. This is a most undesirable tendency in a short-wave superhet, because a very small change of this sort produces a very large proportional change in the intermediate frequency. As both of these tuned circuits—input and oscillator—are connected to the same frequency-changer valve, it is difficult to avoid a trace of capacity between the two. The coupling *via* such capacity increases in proportion as the wavelength is reduced. An important point to consider in a short-wave frequency-changer valve, then, is smallness of capacity between oscillator and input control grid.

Next, for reasons given earlier, there is increasing difficulty in obtaining self-oscillation as the wavelength is shortened. So the oscillator section of the valve should have a maximum of mutual conductance and a minimum of HF loss.

Thirdly, the wavelength of the oscillator at any setting of the tuner should be very stable. It should not, for example, change as the bias on the control grid varies during the process of AVC, or fading would have the effect of mistuning the required programme. Nor should it be subject to drift as the valve slowly warms up, or a station tuned in at the start will gradually be lost.

Although it is not impossible to use the heptode type of frequency-changer down to fairly short waves—13 metres or thereabouts—the limitations just set forth are not negligible. The oscillator section being formed by two of the grids in the electron stream, one is not so free to design it for maximum "oscillability." And for the same reason it is difficult to reduce the capacity to the remainder of the electrodes as much as one would like.

The triode-pentode is undoubtedly the best for short waves, according to the above criteria. The two sections, being as much separate as they possibly can be within one bulb, are freer from interactions than any other type, and the triode characteristics can be made to measure. It is unfortunate, therefore, that it is just when these merits are of outstanding advantage—at the shortest waves—that difficulty is experienced in arranging the mixing of oscillator and signal waves. One proposed solution is that described by W. T. Cocking in *The Wireless World* (March 8th, 1935), in which two heptodes are used in push-pull. To avoid the necessity for two valves the triode-hexode, exemplified by the Osram X41, has been introduced, which is designed to combine the merits of the separate oscillator section in the triode-pentode with those of the electronic mixing principle of the heptode. The capacity between sections is not quite as small as in the triode-pentode, but the interaction is much less than in the heptode, and it can therefore be used effectually at a shorter wavelength. Unfortunately, a battery valve of this type requires a higher HT current than the heptodes for equal conversion gain. Since the HT consumption is of such importance the triode-hexode is not so likely to be favoured for battery receivers.

DISTANT RECEPTION NOTES

Should the Long-wave Band be Abolished?

LYONS DOUA is now operating with an output power of 90 kilowatts, just six times that of the old transmitter. The original Lyons station was so well heard in this country that it came through well even in summer-time, and I have several times recorded it during daylight hours. The new transmitter is providing excellent reception, as might be expected, and listeners should make a note of it. It is to be found immediately below Prague.

Some time ago I mentioned that the 150-kilowatt Brasov appeared to be causing little or no interference with Hilversum 1, which is rated at 100 kilowatts, after 2.40 p.m., and shares the same wavelength of 1,875 metres. I hear from several correspondents living in the West Country that Brasov, now in full operation, interferes so seriously in their localities with Hilversum 1 that the programmes of the Dutch station have ceased to have any entertainment value. I understand, too, that in some parts of Holland severe interference is experienced. The position is a difficult one, for under the Lucerne Plan the 1,875-metre wavelength belongs exclusively to Brasov. The wavelength assigned to Hilversum (then known as Huizen) at the Lucerne Conference was 1,345 metres, which it should have shared with Kharkov No. 1. The whole of the long-wave portion of the Lucerne Plan was upset by the refusal of the Dutch station to give up the 1,875-metre wavelength, to which it was felt that it had established a claim, and by the fact that Luxembourg declined point-blank to be relegated to the lower part of the medium-wave band or to incur the big reduction in output power that would have followed compulsorily had it agreed to do so. The long-wave band is now hopelessly overcrowded, and, as none of the countries concerned appear to be willing to make any concession, I am afraid that the jamming and heterodyning of one station by another must continue.

It has been suggested that the best thing that could happen to European broadcasting would be the complete abolition of the long-wave band. The arguments advanced are pretty strong. Many of the big long-wave transmitters produce powerful third, fourth, fifth, sixth, seventh, and even eighth harmonics, which are responsible for heterodynes on the medium-wave band, already chock-a-block with its own stations.

Luxembourg Effect

Next, there is that unpleasant phenomenon originally known as the Luxembourg effect: when a powerful long-wave station and a medium-wave station are more or less in a straight line with the receiving aerial, the long-wave transmission is apt to appear as a strong background to the signals of the medium-wave station. This effect is now produced by many other long-wavers of a high-power class, in addition to Luxembourg, and it is undoubtedly amongst the major nuisances experienced in wireless reception.

Parede, which was burnt out by a big fire last year, has now been rebuilt, and is once more at work on the 291-metre wavelength, which it shares with Heilsberg. Since Parede's power is only 5 kilowatts and that of Heilsberg is 100, the Portuguese station is not likely to be logged by long-distance enthusiasts in this country, except at times when the big German is silent.

A station well worth the attention of those who don't mind consuming the midnight watt is LRI of Buenos Aires, which works on 280.4 metres. This station has a 50-kilowatt plant, and it is most likely to be heard on nights when U.S.A. stations are not too good.

D. EXER.

Current Topics

COAT POCKET TRANSMITTER. Mr. O. B. Hanson, Chief Engineer of the N.B.C., inspects the 0.2 watt micro-wave transmitter now used for outside broadcasts. Note the "acorn" valve on the table.

EVENTS OF THE WEEK IN BRIEF REVIEW

World's Smallest Transmitter ?

TWO years' research by the American N.B.C. in the micro-wave field has produced a "coat pocket transmitter" which "O.B." officials can carry in the palm of the hand. Ranges up to 4 miles can be obtained, according to Mr. O. B. Hanson, Chief Engineer of the N.B.C.

Under test is a still smaller transmitter than the present one, which is approximately a three-inch cube with two 10in. rods as antenna. An acorn-type valve is used, and the power is 0.2 of a watt. Current is obtained from a small 90-volt battery unit weighing less than 4 lb. The transmitter itself weighs less than 1 lb.

Zworykin Exhibit at Science Museum

THE Science Museum, South Kensington, has acquired from Dr. Vladimar Zworykin a specimen of his ten-stage electron multiplier, and this is now on view.

African Radio Survey: Amateur Help ?

CAPTAIN R. F. DURRANT, who is in charge of the British Civil Aviation Wireless Department at Heliopolis, Cairo, is starting on a wireless survey flight from Cairo to Khartoum and on to Kano and thence to Lagos, West Africa.

"British East Africa," he writes, "looks a difficult problem from the wireless point of view. You might put a note to this effect in the journal, as there are bound to be 'fans' somewhere on the route, and, after all, the commercial world to-day learnt most of its lessons from the amateur."

Wireless in Will

AN unusual legacy is that of £300 under the will of Miss Gordon, of Elgin, for the upkeep of wireless sets in a local convalescent home.

Energy from the Sun

"SANCTIONLESS sunshine" is now being enjoyed in Milan, according to a correspondent, who reports that an engineer there has evolved a sun dynamo with the help of several hundreds of photo-electric cells. Enough energy is obtained to drive a small motor.

Dead Man's Election Speech

A DEAD man's voice may have played a large part in holding Louisiana State for the Democratic Party, according to our Washington correspondent. It was Huey Long's voice, taken from a recording made shortly before the Senator was assassinated last summer, that was broadcast over the local stations the other evening—a typical speech of the "Kingfish" interspersed with his campaign song, "Every man a king."

NEXT WEEK

Special Issue: RADIO INSTRUMENTS

A Review of All Types of Measuring Instruments, with special articles on their use in receiver design and testing.

Range of French Television

THE range of the 8-metre television transmissions from the Eiffel Tower is the subject of interesting notes in our contemporary, *L'Antenne*. Within a radius of ½ to 1 mile from the Tower reception is "very difficult," and, with an inside aerial, "impossible." Reception is "relatively easy" in a zone of from 12 to 20 miles around the capital.

The best long-distance report is from M. Ferry (F8US), a well-known amateur, who picks up television with a reaction detector at Haravillers, Seine-et-Oise, 25 miles from Paris.

"Selectivity of Tuned Circuits"

IN the above article, published in our issue of January 31st, the formula in line 24, p. 101, was incorrectly printed. The root sign should cover the whole of the denominator.

Radio on Everest Expedition

MR. WINDHAM, wireless operator of the Mount Everest Expedition, left London on Friday last to join the party at Darjeeling.

He will take charge of the short-wave transmitting and receiving sets operating over a range of ten miles for relaying messages from the summit to the Indian radio stations.

Climbers will carry portable radio equipment and will establish the transmitter on Camp 5 at an altitude of 25,700 feet—easily the highest radio station in the world.

Short Waves from Garmisch

WINTER Olympic Games commentaries from Garmish are being given daily from 12.15 to 12.45 a.m. on DJC, the 49.8-metre station which American commentators are using for broadcasts to their national networks. The games conclude on Sunday next.

Doorstep Tactics

HOUSE-TO-HOUSE collection of radio licence fees has been inaugurated in the Seine Department of France. From January 1st to the 23rd, 1936, the sum of 3,364,600 francs was obtained as compared with 1,960,615 francs for the corresponding period last year.

Short or Ultra-short ?

A CLASH between American and British points of view in regard to radio nomenclature looms ahead in view of the assertion of engineers of the U.S. Federal Communications Commission that it is wrong to use the term "ultra-short waves" to describe the extremely high frequencies. The term is a misnomer, they insist, and the official regulations of the F.C.C. do not recognise it at all as applied to frequencies above 30,000 kilocycles (10 metres). The appropriate term, they assert, is "very high frequencies" for all waves of 10 metres and under.

Rule 186 of the official F.C.C. regulations divides the spectrum into the following classifications: low frequencies, 10-100 kc/s; medium frequencies, 100-550 kc/s; broadcast frequencies, 550-1,500; medium-high frequencies, 1,500-6,000; high frequencies, 6,000-30,000; very high frequencies, above 30,000 kc/s.

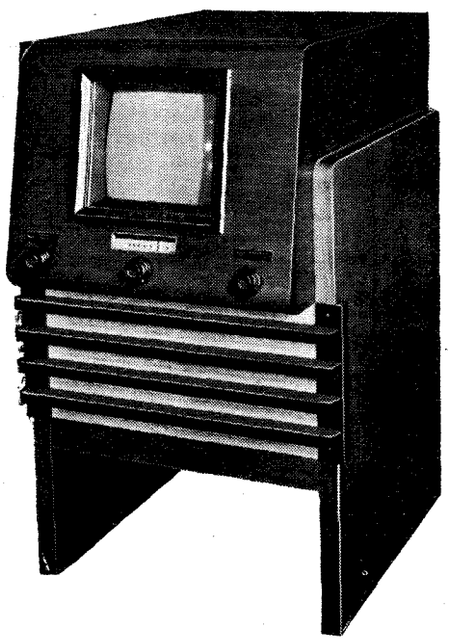
Science Museum and *The Wireless World*

THE Librarian of the Science Museum, South Kensington, is searching for the first nine volumes of *The Wireless World* and also Volumes I and II of the *Marconigraph*. Any reader who possesses all or any of these volumes, either bound or unbound, would be doing a national service by presenting them to the Museum. Offers should be addressed to the Officer in Charge of the Radio Department, Mr. G. R. M. Garratt, the Science Museum, London, S.W.7.

Mr. L. A. Sweny

MR. L. A. SWENY has resigned his appointment as Officer-in-Charge of the Signals Department (Civil Aviation), Air Ministry, to become technical representative of the Aircraft Department of Marconi's Wireless Telegraph Co.

Television Receiver for High Definition



Description of a Design by the Telefunken Company

By H. O. ROOSENSTEIN

A service of high-definition television broadcasting is already operating in Germany. In this article an outline is given of the Telefunken receiver. It is an ultra-short wave superheterodyne with a single HF stage and frequency-changer, but two IF amplifiers—one for sound and one for vision.

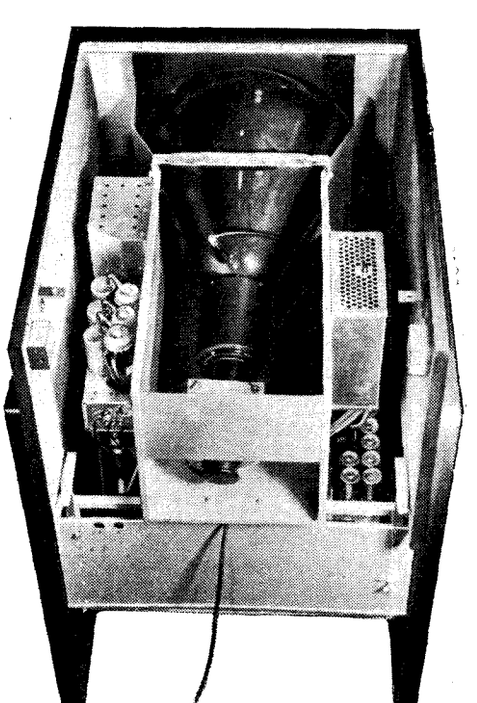
THE installation of the television transmitter at Witzleben and the regular broadcasting of television programmes have given a fresh and very satisfactory impetus to the development of television receiving sets in Germany, and the design of the Telefunken equipment illustrated on this page is particularly worthy of study.

This set is intended to receive television transmissions of 180 lines as broadcast by the German Post Office, and is designed for tuning to all transmitters of the projected wavelength range. It is arranged for connection to any mains supply of 220 or 110 volts AC, and uses a short aerial for receiving the image and sound. A length of 2 metres is in most cases sufficient for the aerial. A front panel, which is inclined against a vertical plane at an angle of 12°, permits inspection of the image from a standing or sitting position. Whilst the panel of the set is comparatively small, the image has the dimensions of 19 × 22 cms., and the diameter of the cathode-ray tube is 35 cms. To protect the user of the set against any possible explosion of the tube a sheet of Securite glass is provided which covers the screen of the tube. Today such explosions are very rare, the technique of the glass manufacturers having greatly improved. Nevertheless, such a sheet is in any case necessary to prevent the bulb from being knocked.

In the lower half of the set an opening is provided for the loud speaker, which is covered by a piece of tightly stretched linen, and at the sides of this opening several knobs are mounted which are also covered by the linen. By adjusting these knobs in the factory the position and size of the image is adjusted once and for all. The complete chassis can be pulled out at the back of the apparatus for repairs, and is then resting on the dropped flap at the back of the set. In this position the entire bottom part of the set is easily accessible, and can be tested while the set is actually in operation.

To explain the circuit and working of the set a diagram of connections is shown in Fig. 1. In this figure A represents the aerial, which is used for the reception of both the sound and image. As shown in the illustration, the high frequencies are amplified in a first amplifier to obtain a level which is sufficiently greater than the noise level in the subsequent mixing valve. The mixing stage comprises a triode-hexode valve, and directly feeds both intermediate-frequency amplifiers for the sound and image waves. The tuning system comprises, besides the oscillator circuit, two further highly damped circuits, viz., the aerial circuit and the intermediate circuit. The inductances used in these circuits are of the sliding variometer type and are actuated by a control knob in the centre of the front panel. The range of frequencies extends from 35-50 mc/s and covers all projected German television transmitters. According to the projected range of frequencies a frequency difference of 1.8 mc/s is usually provided between the image and sound frequencies of each transmitter, so that if a common oscillator is used in super-heterodyne receivers the same frequency difference is also maintained between the image and sound frequencies of the intermediate frequency stages. The intermediate vision and sound amplifiers can therefore be tuned in the factory to frequencies which vary from one another by this difference, so that if the oscillator is tuned to the loudest reception of sound the vision intermediate frequency is at the same time also adjusted so that it can pass through its own amplifier.

As Fig. 1 shows, the sound intermediate frequency is fed from the mixing stage to an amplifier which will be further discussed below. We will consider first the vision intermediate-frequency amplifier, which comprises two amplifying stages and one power stage. In the cathode circuit of one of the intermediate-frequency stages a resistance W1 shunted by a condenser is provided by which the amplification may be adjusted as usual by means of a double knob on the right-hand side of the front panel. The Wehnelt electrode of the cathode-ray tube is fed from the output of the image amplifier. Here also a resistance W2 shunted by a condenser is provided in the cathode circuit for adjusting the biasing voltage. The necessary current is fed to the resistance W2 by a resistance R1. In adjusting W2 the image can be made more or less contrasting, and by altering W1 the brightness may be adjusted. Fig. 2a shows the resonance curve of the vision IF amplifier, and it will be seen that the width of the band is approximately 1,400 kc/s, so that the



In this view of the receiver the cathode-ray tube can clearly be seen with the vision IF amplifier on the left.

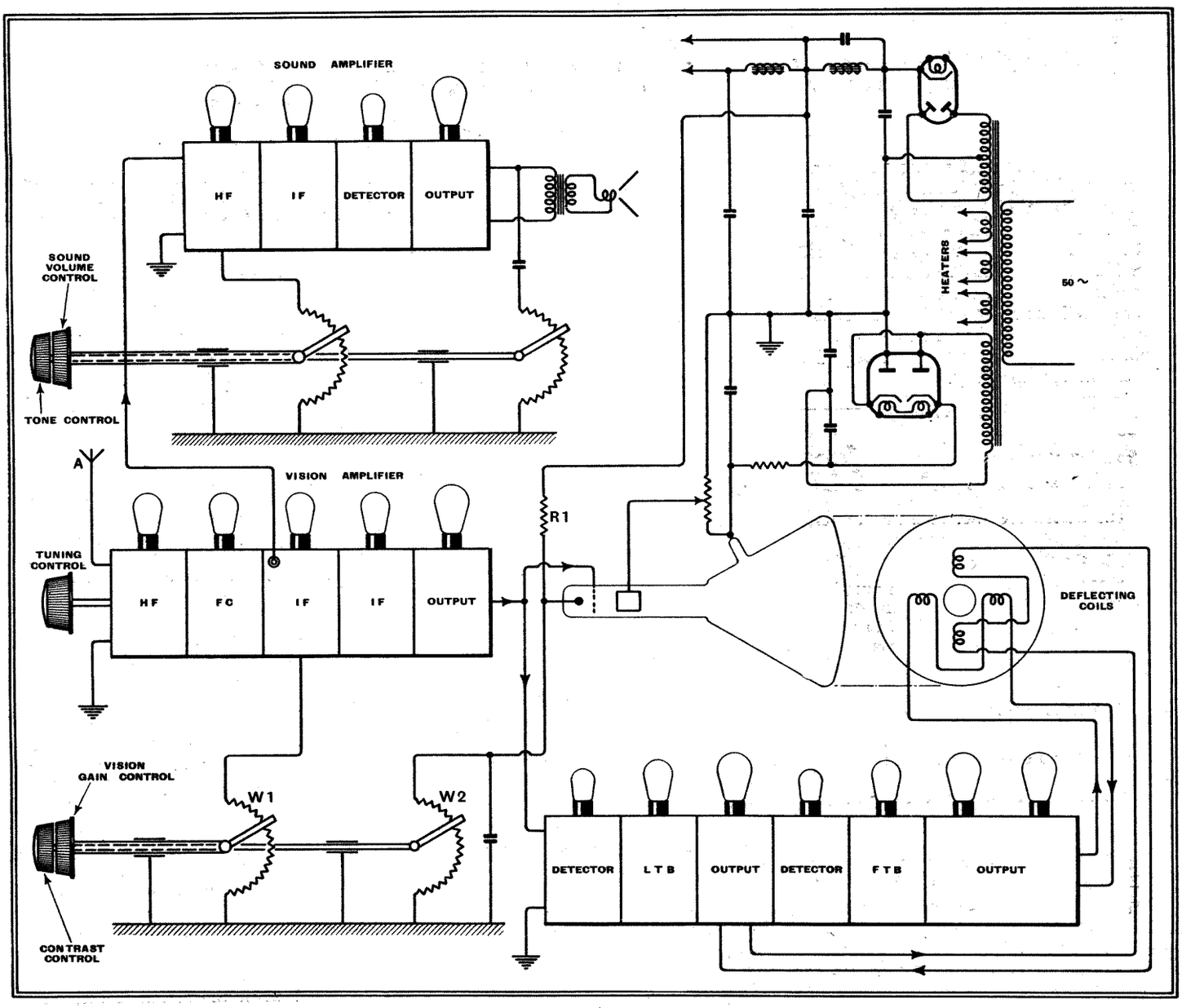


Fig. 1.—A diagrammatical representation of the receiving equipment; the letters LTB and FTB refer respectively to the line time-base and the frame time-base.

width of the transmitted band is sufficiently broad to include both side bands of the vision signal. With this band-width the amplification of each stage is set at approximately 15, which has been accomplished by constructing the intermediate-frequency circuits and the band filters with very small capacities.

The Time-base Equipment

The sound amplifier has a band-width of approximately 30 kc/s, as will be seen from the resonance curve shown in Fig. 2b. With this it is possible to obtain very good reproduction of sound. For the same purpose an electrodynamic loud speaker of high quality is also built in the set.

To deflect the electron rays in the tube, a deflecting device is used to which, as shown in Fig. 1, the transmitted signals are fed from the output of the vision amplifier. It rectifies the vision signals and

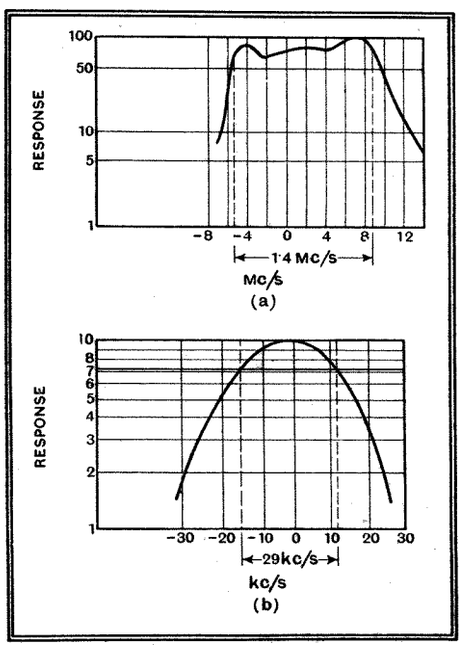


Fig. 2.—The resonance curve of the vision IF amplifier is shown at (a) and that of the sound amplifier at (b).

then separates the image modulation from the frame and line synchronising impulses. After filtering, the latter are fed to the power stage, which furnishes the current for deflecting the electron beam by means of the line-deflecting coil. From the power valve for the line deflection the frame impulses are filtered by means of an electrical filter, and are fed after several transformations to a power stage, which effects the deflection in the vertical direction. The power stage is of the push-pull type, so that the current fed by the HT supply unit is as free as possible from the 25 c/s frame component. Feed-back to other apparatus connected to the same supply is thus avoided.

The mains equipment comprises a single mains transformer, which is connected to two rectifying valves. One rectifier supplies the anode voltage for the cathode-ray tube, and for this purpose special rectifying valves are used which operate in the voltage-doubler circuit. With this circuit only one winding delivering 1,800 volts on the transformer is necessary to obtain an output of 5,000 volts, so that insulation difficulties are reduced. The anode

Television Receiver for High Definition—

voltage for all other valves of the television set is supplied by a second rectifier, which also uses only one rectifier valve. Special devices to keep the voltage constant are not used, as experiments have shown that the circuit is sufficiently independent of alterations of the voltage and operates without any disturbance even if considerable variations in the voltage occur. The transformer which feeds the set is so arranged that its magnetic leakage field does not affect the deflection of the electron rays in the cathode-ray tube. To render this arrangement more effective, the circuit is so chosen that the magnetic field is as low as possible with regard to its extent and intensity.

The device described above comprises, besides the cathode-ray tube, thirteen valves and five rectifying valves or diodes. Gas-filled valves are not used, as their life and constancy, up to the present, seems uncertain. Besides the high-voltage amplifying valves, which, as explained above, are of special types, all the other valves are normal types already used in wireless sets.

This description shows how far the construction of television receiving sets has been perfected. It can be said with certainty that if the transmitting system used to-day were replaced by an improved one, the accumulated experience would not be wasted but would form the basis for new development.

Letters to the Editor

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

B.B.C. Control

MR. MOSCROP has raised the question of balance and control in broadcasting. In this connection I should like to put forward the suggestion that the control engineer, however skilled he may be at his job, cannot always do it properly unless he is in a position from where he can see the conductor. Sudden changes in volume level occurring after a held chord the length of which depends entirely on the conductor's rendering, provide a case in point. Since the controller can do so much to destroy or maintain the conductor's ideas, surely he should attend rehearsals, and in the case of the B.B.C.'s own orchestras, he might be permanently attached, becoming, in fact, a member of the orchestra.

With reference to the Concert Hall organ, I should like to point out that the statements that the organ had been built especially for broadcasting referred to the voicing of the stops, i.e., the tone colours provided. I should imagine that it would be rather difficult to make a stop sounding like a tuba but giving very much less volume. With a controller who has some knowledge of the organ, and who has heard the programme rehearsed, such difficulties should disappear.

R. H. TANNER.

London, S.E.21.

I SHOULD like to support your correspondent, Mr. Moscrop, in what he says regarding the balance of certain of the B.B.C. transmissions. Whether the cause is bad placing or bass cut off there is no doubt that not only the Theatre Orchestra and Henry Hall's Band, but also the Wireless Military Band would be greatly improved by a stronger and deeper bass. The B.B.C. might learn much from Germany in the matter of bass in dance bands. In the case of the Theatre Orchestra and "Variety" not only is there a lack of bass, but there appears far too much echo in the top.

Jack Payne's Band has been dealt with in an appalling way since he left the B.B.C. I noticed he did complain about the acoustics of the studios. The reply given appears to have been that the B.B.C. knew better than he did.

It would be interesting to hear other people's views on the transmissions of the regular B.B.C. bands and orchestras.

The B.B.C. must naturally be anxious to deliver the goods and might possibly take some action if it were clear that there was any general dissatisfaction.

Retford, Notts. P. B. C. BEASLEY.

A New Battery

WE have observed in your article by Mr. R. W. Hallows, M.A., entitled "Novel Accumulator Construction," which appeared on page 67 of your issue of January 17th, 1936, several references to the Fuller dry secondary cell, and would like to point out that the use of the word "Fuller" in this connection is incorrect and misleading, "Fuller" being our registered Trade Mark No. 528031.

Furthermore, we have no connection whatsoever with the persons or firm mentioned in this article.

We shall be very much obliged indeed if you will draw your readers' attention to this fact to avoid any possibility of misunderstanding.

For Fuller Accumulator Co. (1926), Ltd.,
R. M. BLOMFIELD, Secretary.

Chadwell Heath.

[The author of the article referred to this battery as the Fuller battery, as this is the name of the inventor, Mr. L. W. Fuller, of Block Batteries, Ltd. The letter which we publish above will serve to avoid any confusion of the name with the Fuller Accumulator Co., Ltd.—ED.]

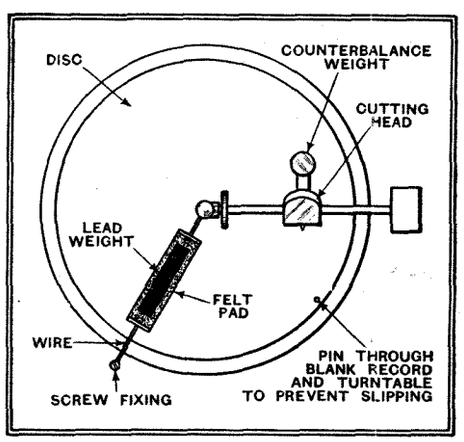
Home Recording

IT is with great interest that I read the letters with regard to home recording. It is only within the last two or three months that I have anything approaching success with recording, but now I can say that, if I take enough trouble, I am almost certain to get excellent results. In fact some of my piano recordings seem better than many commercial discs, and if recorded from wireless sound almost exactly the same as the original programme, and that on a high fidelity radiogram. On some of the records there is so little scratch that there is no need for any high frequency cut off. The only thing one cannot quite guarantee is the background scratch—some cutting needles seem to give practically none, others quite a seashore effect.

I am using a rewound Ekco cutting head and tracker (rewound to 15 ohms to match the output transformer of two PPS/400 in push-pull). You will see that this gives about 12 watts output—I found 5 watts barely sufficient if recording is to be on a level with commercial recording—all very loud passages were blurred. I am using the cellulose aluminium records made by Parmeko, of Leicester, and these have the advantage that if one has recorded something badly they can be resurfaced by pouring on the record a quantity of amyl acetate, sufficient to give a really smooth surface. These when dry will be found to be as good as new discs. They can be cut about four times in this manner before the surface breaks and shows the aluminium. The Ekco cutting head weighs about 6 oz., and I think the best cutting weight is 3 oz.; the extra weight has to be balanced by fixing an arm to the back of the cutting head, weighted so as to give the right pressure.

I am using a Paillard motor rewound so that it takes about twice its original wattage, and I find there is such little pitch variation that if it were not for needle scratch one would not be aware that a record is being played. For readers who have Ekco recorders and would like to try the Parmeko discs I give a diagram of my turntable.

As there is a considerable amount of swarf



Details of recording arrangement.

produced when the record is being cut, it is necessary to arrange a pad to sweep it up, otherwise it will tend to lift the cutting head off the record. This I have arranged as shown.

If one is fortunate enough to have a Rothermel Piezo pick-up H.M.V. loud steel needles can be used, but I feel it is advisable to use fibre needles if one wants the records to last for many years. The surface of the records can be hardened with acetic acid, or what I find better still, a product called "Alladinite," which is used to renovate old records.

G. P. DENNY.

Sussex.

Hill and Dale Recording

ON the subject of home recording, I am surprised that no correspondent has mentioned the possibility of the vertical (hill and dale) cutting of records.

Some time ago temporary records of performance were required, and they were produced by this system.

A balanced armature pick-up was adapted for vertical cutting by mounting it at right angles to the normal. The recording head was traversed by a screw geared to the main spindle, the slides being of the kind used in typewriters—a V slide rolling on steel balls, with a steel wire and suspended weight to prevent backlash.

Tracking was arranged to start from the

inside of the blank, an input of about 2 watts was used and the turntable was weighted with a ¼in. lead disc to increase the inertia of the system.

The blank was a thick disc of celluloid, which cuts excellently and is hard enough to permit playing back about a dozen times. The pickup needed alteration to work from this vertical cutting, but the results justified the alteration.

At first the discs were prepared for a second recording by skimming in the lathe. Later, two cast-iron discs were used. These were ground and lapped flat and in use were heated in oil to about 110 C. The record was then inserted between the discs, pressed, and allowed to cool. The result was a disc slightly increased on dia. but with a mirror finish, and perfectly flat.

The system outlined can be recommended, especially where permanent records are not required. A crystal pickup could be used both for recording and play-back with considerable improvement in quality. The track for vertical cutting can be of U shape and large low-frequency excursions will not damage adjacent grooves. For reproducing, a sapphire gives the best results.

One final point: good quality clear celluloid must be used for the recording discs or trouble will be experienced both in recording and reproducing. "H. H. J."

Stourbridge.

Burghead Wavelength

WITH regard to the question of the Burghead wavelength, the whole thing seems to me to depend on whether the B.B.C. intends to close down the "Little Nationals" or not.

If they do not, then the best thing to do, so far as I can see, is to put Burghead on 285.7 m., at present used by Scottish National, and to synchronise the latter with the other Nationals on 261.1 m.; but if, on the other hand, they do intend to close them down, then Burghead would obviously work on 261.1 m., the North-East Regional using 267.4 m. in either case.

Oxford. R. G. UPTON.

Transmissions

I READ with considerable interest in your issue of January 10th the remarks of your contributor H. C. H. under the heading "At the Transmitting End." He comments on the bad quality and excessive surface noise during a gramophone record programme. I have recently noticed this faulty transmission myself on many occasions.

The most noticeable instances were programmes of dance music and miscellaneous records. Programmes of more serious music were of the usual quality transmitted.

I wrote to the B.B.C. about the quality of transmissions in question, asking them if any alterations were being made in the usual record transmission system, or if they were experimenting with a view to improving the general quality. Their reply was as follows:

"On one or two occasions recently the gramophone programmes from certain equipment in this building have been characterised by greater top note response, and consequently more prominent surface noise than is usual. The equipment concerned has been receiving attention."

I have no doubt many other of your readers noticed the difference in quality, and they may be interested in the B.B.C.'s explanation of it.

Considerable prominence has lately been given to home recording processes in your columns; may we now have an article on designing special apparatus with tone correction circuits to get the best possible quality from home-made and commercial records?

Warrington. H. W. DAVIES.

Alternative to News Programme

I WAS very interested to read an article on the subject of alternative programmes in your issue of January 20th, and this brought to mind a point which has puzzled me for years now. It may seem trivial to most people, but the instance I have in mind is the simultaneous broadcast from all the stations of the B.B.C. of the first News Bulletin at 6 o'clock. This, consisting as it does of the news, sporting news, racing, stock market reports, and fat-stock prices, generally runs until about 6.25, when we may then be regaled with a gramophone record until the evening programme commences at 6.30.

I may now add that I am one of those fortunate people who arrive home just after 6 o'clock, too late to hear the end of the dance music broadcast, and I must wait until 6.30 for the next music. I am not in any way casting any doubts on the importance of the News, but there must be many to whom a programme of light music at this time as an alternative to the News would be very welcome.

This half-hour is practically the only period in the day during which there is no alternative programme broadcast, and I think that it is reasonable to suppose that the B.B.C.'s potential audience at this time is somewhere approaching the "peak" total. Why, therefore, cannot the B.B.C. afford listeners an alternative? Nothing elaborate would be necessary, indeed a few gramophone records would do admirably, and I am sure would be gratefully received by those listeners who, like myself, are not interested in hearing practically word for word news which is in the evening paper.

Hounslow. L. J. FRYER.

NEW MARCONIPHONE SETS

Two Table Models and a Radiogramophone Employing "Straight" Circuits

THE chassis which forms the basis of these new receivers has many points of technical interest. The circuit comprises a screen-grid HF amplifier, triode detector, and high efficiency output pentode. Uniformity of efficiency and selectivity on the medium and long wavebands has been achieved by the employment of Litz wire in the long-wave aerial tuning coil; and a wavetrap, which may be cut out by the use of an alternative aerial tapping, ensures freedom from Droitwich interference under all conditions. Fixed reaction with a special circuit to give uniform efficiency over both wavebands is provided, and the combined volume and sensitivity control takes the form of a variable bias resistance in the HF stage.

Other interesting details of the chassis include the complete screening of the detector stage in a "Radio-metal" can, and a large translucent tuning scale with a divided circular light pointer.

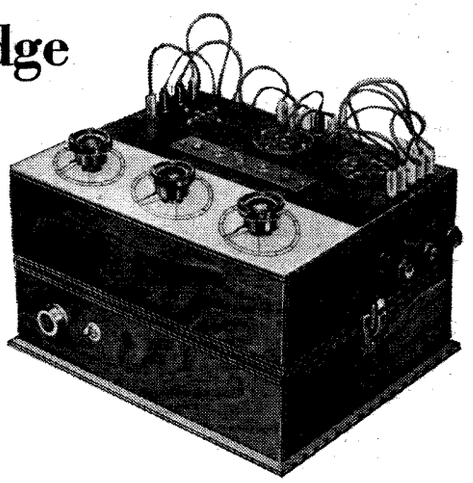
Models 238 and 237, both at eight guineas, are table receivers, the former in walnut and the latter in blue leatherette with chromium fittings. The Model 245A at 16 guineas, which employs the same chassis, is a radiogramophone housed in a figured walnut cabinet measuring 34 × 16½ × 14 in.

In Next Week's Issue:—

Valve Testing Bridge

For Rapid Measurement of Mutual Conductance

ALTHOUGH the valve is so widely used in modern receiving equipment, few have any means of testing specimens with any degree of accuracy. A simple and inexpensive valve bridge is consequently of great value to the serious experimenter and service engineer alike. The bridge to be described in next week's issue of *The Wireless World* enables the mutual conductance of any valve to be measured with rapidity and certainty. The range covers values of 0.01 mA/V. to 10.0 mA/V., so that all valves from variable-mu types at a high grid bias to high efficiency output pentodes can be tested.



List of Parts.

1 Valve holder, 5-pin (without terminals) **Clix Chassis Mounting Type V1**
1 Valve holder, 7-pin (without terminals) **Clix Chassis Mounting Type V2**
1 Valve holder, 9-pin (without terminals) **Clix Chassis Mounting Type V2**
2 Fixed condensers, 4 mfds. 500 volts DC test **Dubilier BS**
1 Fixed condenser, 0.1 mfd. tubular **Dubilier 4513**
1 Resistance, 50,000 ohms ½ watt **Bulgin HW23**
1 Resistance, 2,000 ohms ½ watt **Bulgin HW5**
1 Potentiometer, wire wound, non-taper, 1,000 ohms **Reliance S/W10**
1 Potentiometer, wire wound, non-taper, 10,000 ohms **S/W11**
1 Potentiometer, wire wound, non-taper, 100,000 ohms **Reliance S/W12**
3 Knobs **Bulgin K12**
11 Ebonite shrouded terminals, input +, input −, phones +, phones −, grid +, grid −, LT +, LT −, HT +, HT +1, HT − **Belling-Lee "B"**
17 Wander plugs **Eelex**
5 Sockets **Eelex**
Wood, systofler, wire, screws, etc.

Listener

Outstanding I

NELSON KEYS IN REVUE. An informal picture taken during a revue rehearsal in Broadcasting House. Nelson Keys is at the mike with Hermione Gingold, Joan Carr and Sylvia Leslie. Mark Lubbock (in shirtsleeves) is the conductor. "February Revue for 1936" is featured on Tuesday next. (Nat. 10.20).

THE appearance of the Revue Chorus in the B.B.C. studios next Sunday suggests nothing more than an oversight in the Programmes Department; but when, in addition to this, there comes the welcome inclusion of Mr. George Robey, we may be forgiven for asking whether the B.B.C. is anticipating the Ullswater Report.

The Revue Chorus, it is true, will not be heard in revue, but in selections from "Madame Butterfly," "Carmen," and "Faust" at 9.30 (Nat.); and Mr. George Robey, casting aside the motley, will give a talk in "The Spice of Life" series (Reg., 9). But everyone will agree that the B.B.C. is beginning to sail very near the wind.

◈ ◈ ◈

FEATURING THE PIANO

OF special interest among the new dance bands is that of Dave Frost, which will broadcast in the National programme on Thursday next, February 20th. This is a small combination of nine instruments led by Dave Frost himself at the piano. The policy of the band, which has appeared at the Café de Paris, the Café Anglais and the Ritz, is to feature the piano part, the band being built round Dave Frost and his instruments, with music arranged accordingly. The combination consists of two trumpets, three saxophones, two violins, double bass and piano. Gerry Fitzgerald and Betty Warren are the vocalists.

◈ ◈ ◈

CONDUCTOR-PIANIST

THIS week's musical visitor from abroad is the famous Hungarian composer and pianist, Ernst von Dohnanyi, who conducts the Sunday Orchestral Concert (Reg., 9.20), which includes his own "Minutes Symphoniques." On Tuesday, February 18th, he will give a pianoforte recital comprising his own Rhapsody in C and a Mozart Sonata in A (Nat., 9).

◈ ◈ ◈

FEMALE BARITONE

ALTHOUGH we realise that female sopranos have to earn their living, it will be refreshing on Thursday to tune in Marjorie Stedeford, the Australian girl with the "baritone voice." She is to be heard with Reginald Foresythe at the piano in their first "team" broadcast.

If listeners like the combination, it may become a regular "turn."

◈ ◈ ◈

WINTER SPORTS

TO-MORROW evening (Saturday) comes one of those "O.B.'s" which quicken the circulation and provoke general restlessness. This will be the running commentary on the semi-finals of the Ice Hockey contest in the Olympic Winter Sports at Garmisch, Bavaria. This sport is one of the fastest on earth, as the B.B.C. commentator on these occasions is only too keenly aware. An ice-hockey commentary is considered as second only to a boxing commentary for sheer difficulty in holding the pace.

◈ ◈ ◈

"YE GOODE OLDE DAYES" AGAIN

THIS week's backward glance—no week passes without one—dwells on the London of fifty years ago. "Remembrance of Things Past," to be broadcast on Thursday at 9 (Nat.), is the work of Mr. Moray McLaren, of the B.B.C. Talks Department, who conceived the idea of approaching Londoners in all walks of life who remember the "good old days" of half a century back.

Well-known people will *not* appear, but there will be representative types. For example, a grand specimen of the late Victorian cab driver has been discovered driving a taxi. One of his remarks will be that he much preferred the smell of the horses to the poisonous petrol fumes of the present day. There will be other characters—all, I understand, very definitely in favour of the "good old days."

◈ ◈ ◈

MUSICAL PARODIES IN BALLAD COMEDY

A FUGUE on the theme of pickled onions figures in a promising little comedy, "The Doctor's Day," which is to be broadcast on Thursday (Nat., 8) and Friday (Reg.). The author of this ballad-comedy is Walter Pitchford, and the story deals with the trials of an inexperienced young Irish doctor who finds himself in charge of a country practice for a day. The numbers parody various styles of music, of which the fugue is only one. If we switch off before the end we may miss a good deal, because it is in the last four words that Denis O'Neil, as "Dr. O'D," gives the unexpected explanation of the play.

◈ ◈ ◈

HILAIRE BELLOC

IT is a pity that Hilaire Belloc himself is not coming to the studio on Sunday at 6.45 (Nat.) to read his "imaginary biography" on "The Man Who Recognised the Royal Family at Varennes." No genuine Bellocian will miss this item.

TEDDY PETERSEN'S BAND will be relayed from the Wivex Restaurant, Copenhagen, by Kalundborg at 10.30 on Sunday.

Guide for the Week

oadcasts at Home and Abroad

THE BLOCKFLÖTE will be heard in "Shepherd's Hour," a Hamburg programme at 6.45 on Thursday.

VISITING A RUSSIAN CRÈCHE

"COME with us by tram and have a look," say the Moscow broadcasting authorities in announcing an English transmission this evening (Friday) at 9, in which the microphone will be taken to a model nursery for the children of workers in the First Moscow State Ball-Bearing Plant. The transmission is on 1,724 and 50 metres.

SALOMÉ

WAGNER has a big share of to-night's operatic broadcasts, and, oddly enough, "Lohengrin" has been chosen by two stations, Prague at 6.5 and Warsaw at 7.10. Frankfurt (relayed by Stuttgart) offers "The Flying Dutchman" at 11 o'clock with commentaries in various languages. The Hamburg Station Orchestra, Choir and soloists are taking part.

Perhaps the most notable opera of the week, however, is Richard Strauss' "Salomé," which Brussels No. 2 is relaying at 8 o'clock on Sunday from the Royal Flemish Opera, Antwerp. This opera is generally considered to be the composer's operatic masterpiece.

Its production in 1905 was hailed as the most important event in the history of German opera since Wagner. Albert Coates had the distinction of conducting the second performance of "Salomé," which commenced only fifteen minutes later than the première—at Dresden.

Frankfurt handles opera in a novel manner this week by bisecting Mussorgsky's "Boris Godunov." Part I forms the 7.10 transmission on Monday, and Part II will be radiated at the same hour on Tuesday.

BRITISH DRAMA ABROAD

PEOPLE without "the gift of tongues" miss many interesting dramatic items on the Continent. This week there are no fewer than four dramatic items abroad of outstanding British interest. To-night, at 7.10, Stockholm broadcasts a translation of Merton Hodge's "The Wind and the Rain," now in its third year on the London stage. Bernard Shaw's "Arms and the Man" is in the Monte Ceneri programme at 7 to-morrow. On Monday, at 7.10, we find the Deutschlandsender staging a play, by Rothe, around the life of Mary, Queen of Scots. Then, on Thursday at 7.10, Frankfurt offers "Col. Lawrence—Revolt in the Desert"— a play by Dr. Paul Laven.

GUARDS IN UNIFORM

THE band of the Danish Royal Guards is broadcasting (in uniform, says the advance programme) from the Concert Hall of the Copenhagen Radio House at 2.25 on Sunday, and will be heard on Kalundborg. Another promising Danish item that day is "Lilac Time," from Kalundborg at 7.

["His Master's Voice" photo.

THE LENER QUARTER, of international fame, broadcasts a Schubert and Kodaly programme on the National wavelengths on Sunday at 5.30. Left to right: J. Lener (violin); I. Hartman ('cello); J. Smilovitz (violin); S. Roth (violin).

CARNIVAL

A SEASON of high carnival opens in Germany on Wednesday, February 19th, and continues until Shrove Tuesday, February 25th. Munich ushers in the festivities on Wednesday with "Fasching," revealing the spirit of the occasion in a manner which can be appreciated by listeners everywhere.

THE AUDITOR.

HIGHLIGHTS OF THE WEEK

FRIDAY, FEBRUARY 14th.

Nat., 8, Kentucky Minstrels. 9, Viola Recital by William Primrose.
Reg., 8.15, Hunting Programme. 9, Comic Opera.
Abroad.
Radio Paris, 8.45, Comic Opera: "Jeanne, Jeannette and Jeanneton" (Lacôme).

SATURDAY, FEBRUARY 15th.

Nat., 7, Saturday Magazine. 8.30, Music Hall. ¶Henry Hall's Hour.
Reg., 9.15, Ice Hockey Commentary (from Garmisch).
Abroad.
Brussels II, 8, Operetta: "The Gypsy Princess" (Kalman).

SUNDAY, FEBRUARY 16th.

Nat., Eugene Pini and His Tango Orchestra. 5.30, The Lener Quartet. 9.30, Light Concert by B.B.C. Revue Chorus and Theatre Orchestra.
Reg., Medvedeff's Balalaika Orchestra. 9.20, Dohnanyi conducts Sunday Orchestral Concert.
Abroad.
Strasbourg, 8.10, "Echoes of Salzburg"—a Mozart Concert.

MONDAY, FEBRUARY 17th.

Nat., 8.15, Play: "The High Road" (Frederick Lonsdale). ¶The Lyra Quartet.
Reg., 8.15, Variety Programme. ¶B.B.C. Military Band.
Abroad.
Leipzig, 7.10, Winter Relief Fund Concert from the Alberthalle.

TUESDAY, FEBRUARY 18th.

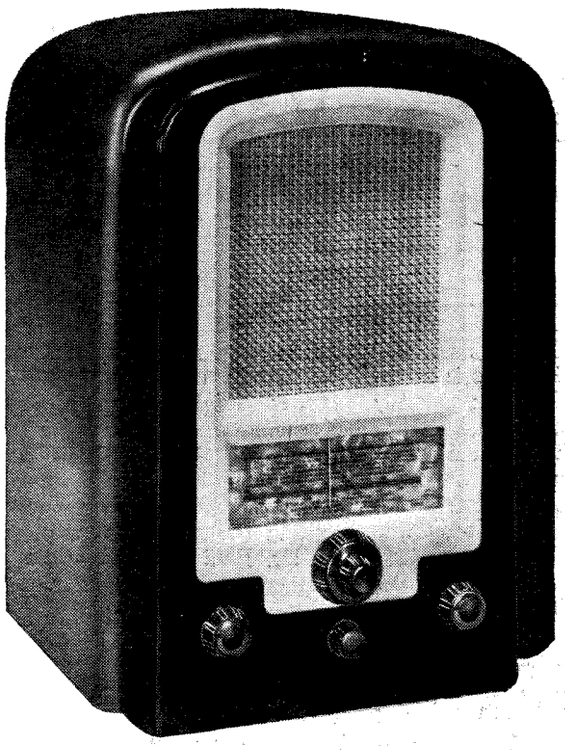
Nat., 8, Victorian Melodies. ¶Pianoforte Recital by Ernst Dohnanyi. ¶"Conquest of the Air"—I.
Reg., "Music from the Movies." 8, "The High Road." ¶Fred Hartley and His Novelty Quintet.
Abroad.
Hamburg and Munich, 7.10, Opera: "The Masked Ball," (Verdi).

WEDNESDAY, FEBRUARY 19th.

Nat., B.B.C. Dance Orchestra. 8.30, B.B.C. Symphony Concert. ¶Jack Jackson and His Band.
Reg., 8.15, "Meet Mickie Mouse." ¶B.B.C. Theatre Orchestra.
Abroad.
Strasbourg, 8.30, Gala Subscription Concert from the Palais des Fêtes.

THURSDAY, FEBRUARY 20th.

Nat., 8, Ballad Comedy: "The Doctor's Day" (Pitchford). ¶"Remembrance of Things Past."
Reg., 7.20, Sir Thomas Beecham conducts Hallé Concert. ¶B.B.C. Dance Orchestra.
Abroad.
Berlin (Funkstunde), 8, "Collegium lusticum"—introduction to the art of Being Happy (Cabaret programme).



Ferranti All-

GOOD ALL-ROUND PERFORMANCE ON THREE WAVEBANDS

FEATURES.—*Type.*—*Table model superheterodyne for AC mains.*** **Wave Ranges.** — *(1) 19-51 metres. (2) 200-550 metres. (3) 900-2,000 metres.* **Circuit.**—***Heptode frequency changer—var. mu pentode IF amplifier—double-diode-pentode second detector and output valve. Full-wave valve rectifier.*** **Controls.**— *(1) Tuning (two-speed). (2) Volume and on-off switch. (3) Tone. (4) Waverange.* **Price.**—*£13 18s.* **Makers.**—*Ferranti, Ltd.*

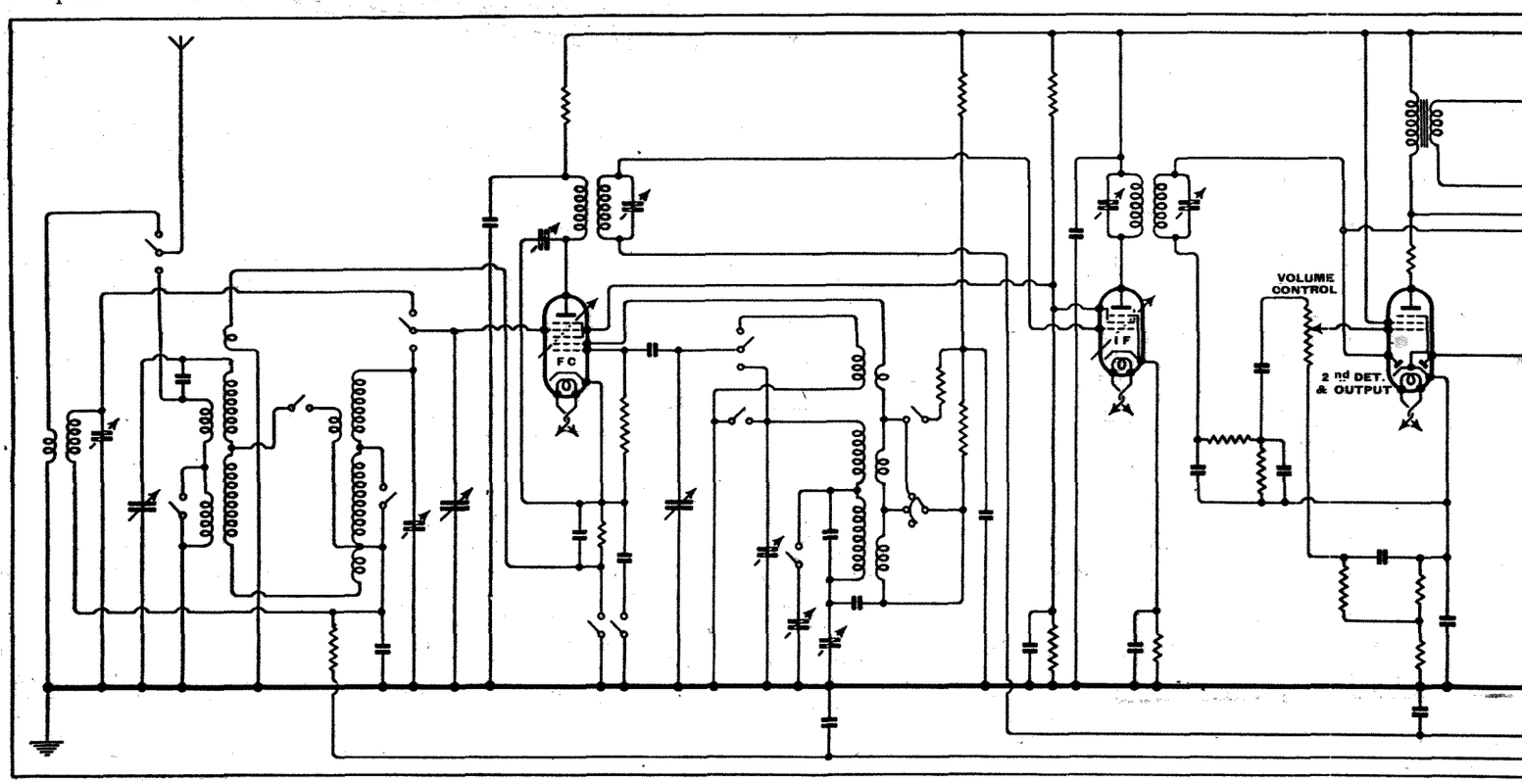
EXCLUDING the rectifier there are only three stages in this receiver; but two of these valves are of the multiple type, and as the circuit is arranged on the superheterodyne principle it is reasonable to assume that the maximum range and selectivity have been extracted.

That this assumption is justified will be apparent after an hour or two's experience with the set. The performance on the medium and long wavebands is, in fact, quite equal to that of the majority of four-valve superheterodynes in which a separate second detector of the duo-diode-triode type confers the advantage of an additional stage of LF amplification. Even in daylight the medium waveband is productive of quite a lively performance from the Continental transmissions, and the good selectivity and bright quality of reproduction contribute their share to the creation of an immediately favourable impression.

Reception is perfectly clear of interference outside one channel on either side of the Brookman's Park transmitters when using the set in Central London, and on the long waves the Deutschlandsender is a station which can be listened to at any time with a negligible degree of interference from the sidebands of Droitwich and Radio-Paris. With the exception of one second channel whistle, which under the conditions of the test occurred at about 460 metres, the medium and long wavebands were completely free from this type of interference.

It is, however, in the performance on the short waveband that interest will be principally centred, as the introduction of this feature is a new departure in Ferranti receivers. Apart from the closer attention which must be paid to tuning there is nothing in the behaviour of the set to indicate that one is not on the medium or long waverange, for there is no increase in the background noise, and there are nearly as many transmissions of first-rate quality and volume on the short waveband as on the other ranges. It would appear that the designers have hit upon exactly

Complete circuit diagram. A band-pass filter is used in the aerial coupling for medium and long waves and a single circuit on short waves.



Wave Superhet

the right degree of sensitivity for short-wave reception, for it is possible to receive long-distance transmissions only when the conditions are such that the transmissions are of definite programme value. Even with the volume control at maximum the set is quite incapable of producing a noisy background; yet the sensitivity is such that we were able to enjoy excellent programmes from Schenectady and Pittsburgh during the period of the tests.

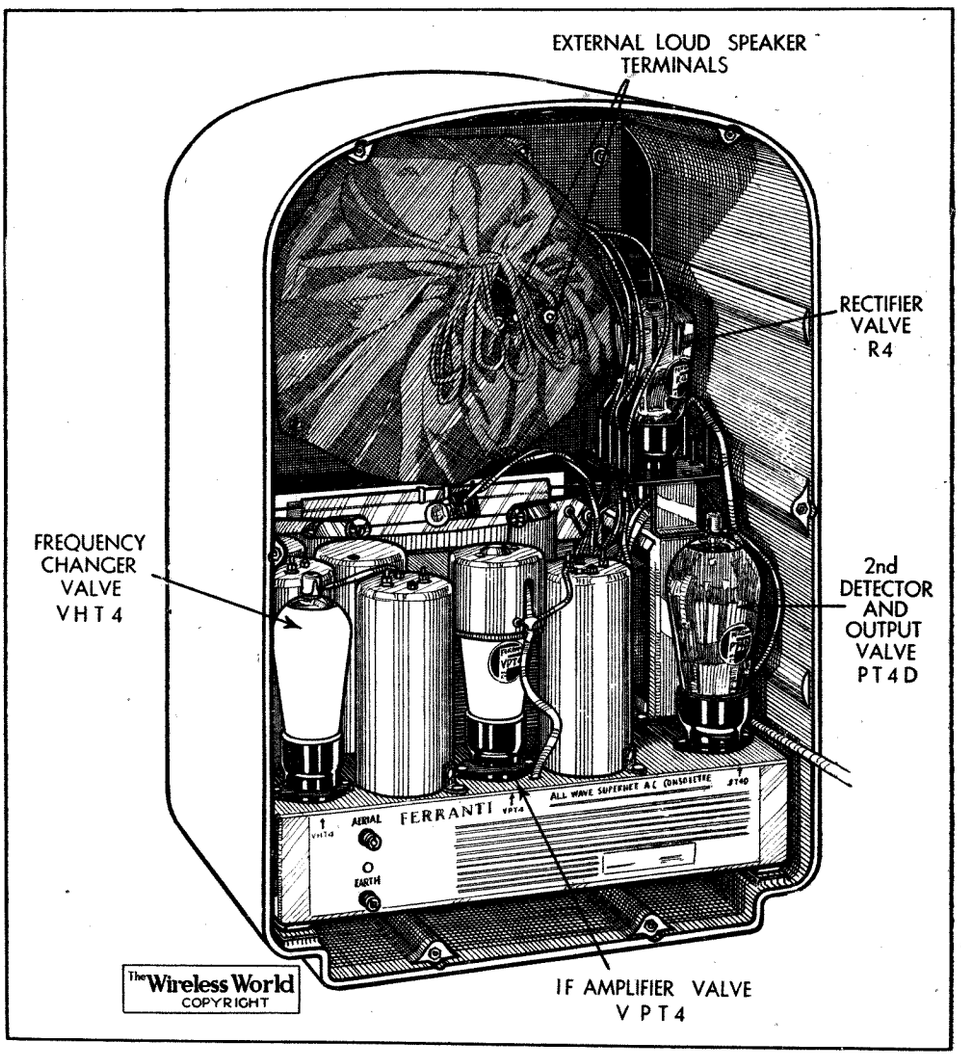
It seems a pity that the makers did not extend the short waverange down to 16 metres in order to receive Bound Brook which generally gives a good programme, but there is sufficient material to be found in the rest of the range for this point to be overlooked.

Alternative Tuning Points

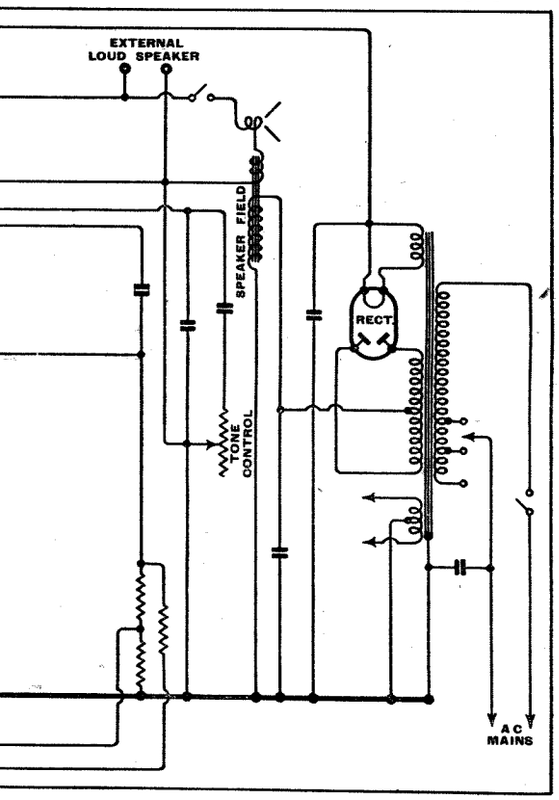
With only a single tuned circuit preceding the frequency changer it was not surprising to find double tuning points on each station. These are quite close together, and sometimes it is possible to avoid interference by using the alternative setting on some transmissions.

The two-speed dial gives just the right ratios for the short and normal wavebands. As far as the tuning condenser itself is concerned there is no backlash, but some slight inertia in the movement of the scale pointer was noticed. This was not sufficient to give rise to inaccuracy in reading the scale. The well-known Ferranti indicating dial, in which subsidiary pointers show the settings of the volume tone and wave-range controls, is once again a welcome feature of the receiver.

In view of the fact that short-wave reception will be a new experience for many purchasers of this set, it is gratifying to find that a large section of the instruction leaflet has been devoted to a very clear exposition of the behaviour and the propagation of short waves and their reflection from the various ionised layers of the atmosphere. This useful information is finally summarised in the form of a table showing which wavelengths are most likely to provide interesting listening at different times of the day and at different seasons of the year.



A compact chassis layout is obtained by mounting the power rectifier immediately above the mains transformer.



CLUB NEWS

Modern Component Design

The robust simplicity of modern components was stressed in a lecture given recently before the Ilford and District Radio Society by Mr. H. T. Stott, of Messrs. A. F. Bulgin and Co., Ltd. A demonstration on the Bulgin AC/DC Four Range Five receiver revealed an excellent performance on the short waves, W 8 XK on 19.78 metres being heard at fair volume on the speaker at 10 p.m. Hon. Sec., Mr. C. E. Largen, 44, Trelawney Road, Barkingside, Ilford.

Voigt Speaker Demonstration

Mr. P. A. G. Voigt is demonstrating the Voigt speaker before the Croydon Radio Society at 8 p.m. on Tuesday next, February 18th, at St. Peter's Hall, Ledbury Road, South Croydon. An invitation is extended to all *Wireless World* readers to attend the meeting. Hon. Sec., Mr. E. L. Cumbers, 14, Campden Road, S. Croydon.

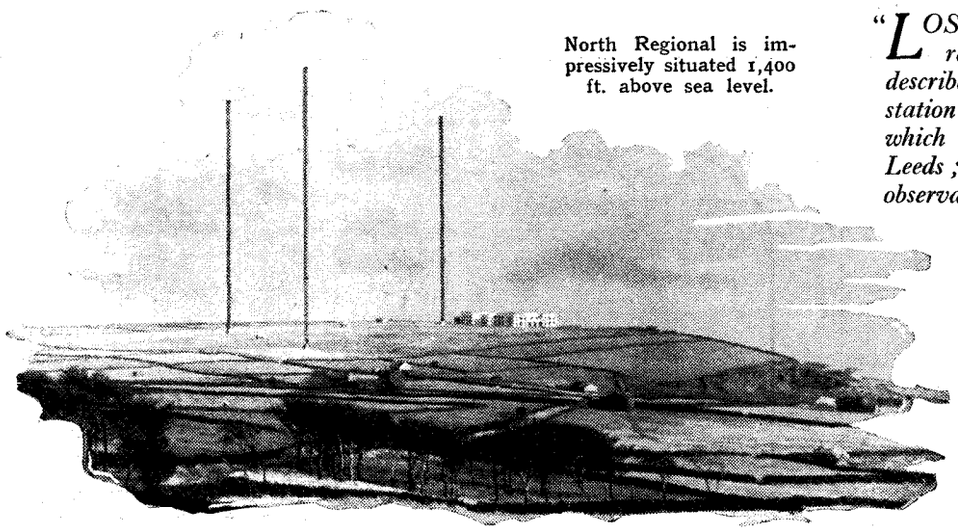
Amateur Measurements

Measuring instruments available to the amateur were dealt with by Mr. J. E. Emerson, B.Sc., in a recent lecture before the Golders Green and Hendon Radio Society. The lecturer gave special attention to apparatus which the amateur could construct himself. All correspondence relating to the Society should be addressed to Lt.-Col. H. Ashley Scarlett, 60, Pattison Road, N.W.2.

Short Waves in N. Devon

Those interested in short-wave radio in N. Devon are invited to get in touch with Mr. E. K. Jensen, secretary of the Bideford and District Short-Wave Society, 5, Furzebeam Terrace, East-the-Water, Bideford. Meetings are held fortnightly on Mondays at the Red House Café, The Quay, Bideford.

Does Broadcasting Serve



North Regional is impressively situated 1,400 ft. above sea level.

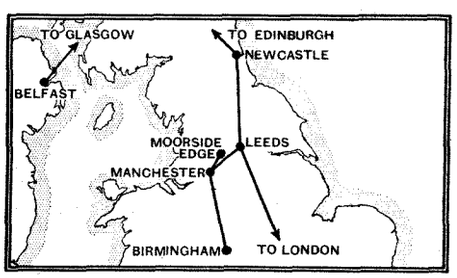
"LOST opportunities" is the theme-song of Mr. Baily's review of B.B.C. activities in Yorkshire. He describes his visits to the bleakly situated North Regional station and also to the converted Quaker meeting-house which now forms the Corporation's headquarters in Leeds; and, in regard to the latter, makes trenchant observations on "the oddest piece of mis-designing I have ever come across."

XI.—Moorside Edge and Leeds

By LESLIE BAILY

THE B.B.C.'s conduct at Leeds—if I may start with true Yorkshire bluntness—is an instance of spoiling the ship for a ha'porth of tar.

Casual visitors to Yorkshire's Broadcasting House in that city may come away impressed by the huge main studio, so bold and spacious and modern, and by the cosy modernity of the talks studio, and by the excellent technical equipment: the six-channel dramatic control panel, the control room with its line-testing gear and



Land line map showing how Manchester has become the engineering "focus" of the North, being linked to London via Birmingham.

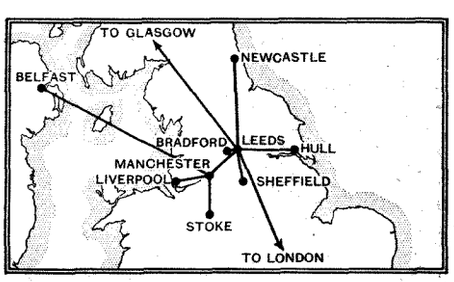
other modern gadgets. But let us scratch below the surface.

Let us first clearly understand the place of Leeds in the North Region. Last week we were at Manchester, the Region's headquarters. Proceeding to Moorside Edge, I motored through miles and miles of cobbled Lancashire streets, changing suddenly to open moorland, with a stiff climb up to the bleak plateau on which the North Regional station is perched, 1,400 feet high, so that the 500 ft. masts carry the aerials up to nearly 2,000 feet above sea level. These are the highest aerials in this country, I think, and certainly in the most impressive situation for a wireless station, whether you see it in summer, when the eye can rove over miles of rugged moorland, or in winter when the aerials are hidden in scudding clouds and when, in fact, you may find the place snowed-up.

Bedsteads are included in the equipment of this station, so that a snow-marooned staff may at least be comfortable. Engineer-in-Charge Wheeler told me that his staff numbers 30, and there is a B.B.C. bus to and from their homes (most live at Huddersfield, five miles away).

Since the famous adventure a few years back when an engineer climbed, in darkness and a 90 m.p.h. gale, up one of the masts to free a broken aerial halyard, floodlights have been fitted outside; but, considering the severity of the weather here, breakdowns are remarkably rare, thanks to robust construction and to precautions such as heating the aerials to prevent ice-coating overnight.

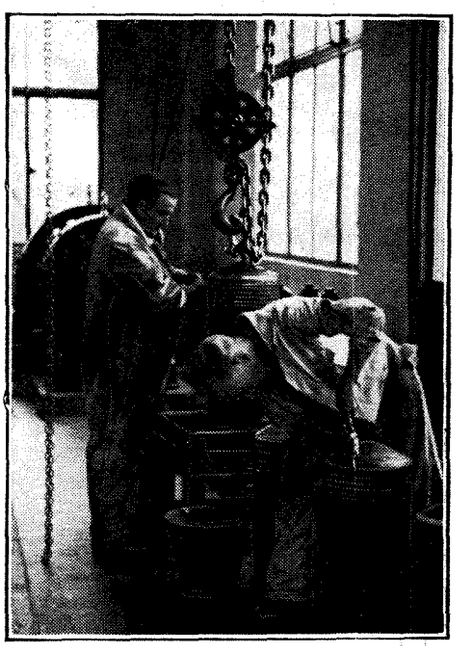
When the station was built in 1930 underground lines were laid between here and Manchester control room, through which pass all programmes broadcast from Moorside Edge, whether National or from the Northern studios at Manchester,



Before Manchester "took over." Leeds was then the only link between London and the B.B.C. stations in the North.

Leeds or Newcastle. Thus, Manchester control room is what I might call the engineering "focus" of the North (see map in first column).

I remember the time when Leeds held this responsible position, acting as the one and only link between London and all stations in the North of England and Scotland. To watch the "S.B." switchboard at Leeds then was to witness a busy scene—even a hectic one, for all the switching was done manually, by plug and jack!



All in the day's work—decarbonising Diesel engine pistons at Moorside Edge.

Nowadays all is comparatively quiet at Leeds control room, and only four engineers are kept there permanently.

Leeds, however, was in 1933 given a brand new Broadcasting House. Until then there had been only one small, unventilated, and dreadfully "dead" studio. Now a Quaker meeting-house was purchased, gutted, and amazingly transformed internally from a sombre place of worship to control rooms, offices and studios designed by a local architect, John Proctor, who made such a grand job of them that he was rewarded with a similar B.B.C. contract at Bristol. Externally

Britain ? A REGIONAL TOUR OF INVESTIGATION

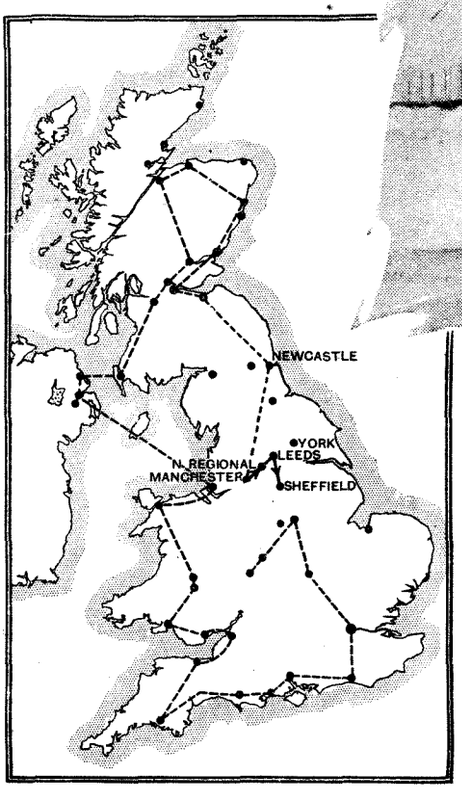
the building has not been altered; its grim and smoke-grimed Victorian appearance gives no hint of the chromium-plated modernity within.

Here, at last, the B.B.C. found itself in possession of a studio capable of accommodating the brass bands and the choirs for which the County of Broad Acres is justly famed. But there's a deal more to Yorkshire than Broad Acres, and far more opportunities for programme-building than bands and choirs. No county has greater broadcasting possibilities, not only because of Yorkshire's immense acreage and population, but because none holds such a variety of interests. Cities like Leeds, Bradford, Doncaster and Sheffield remind us of its industrial importance, yet it is a great agricultural county and has a long and busy coastline; the Minsters at York and Beverley, and the ruined monasteries and castles in the Yorkshire dales are monuments to the White Rose's eventful history, while the Yorkshireman himself is renowned the world over for the depth of his character and the individuality of his traditions. And what is the B.B.C. machinery for exploiting this promising situation?—a Broadcasting House with two studios and a resident staff of one programme organiser!

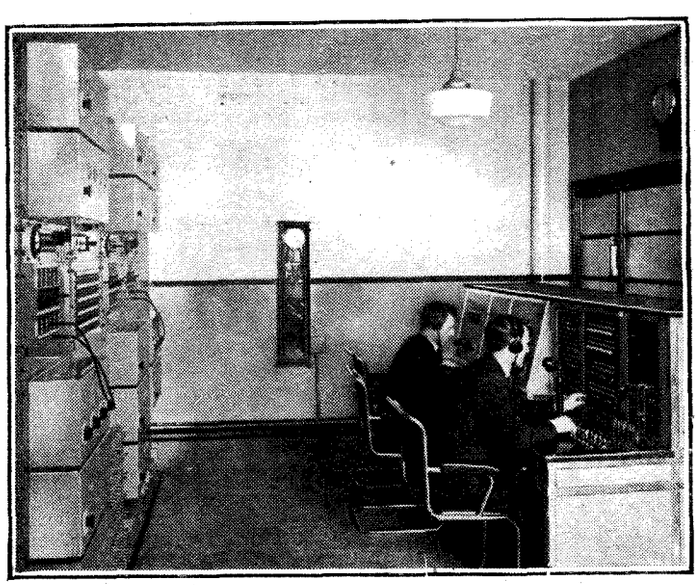
No Drama Studio

This provision of a gigantic band studio and a tiny talks studio is the oddest piece of mis-designing I have come across. It entirely overlooks the needs of small broadcasting units, such as violin and piano for which the talks studio is too small, the band studio too lofty and "echo-y." It amazingly overlooks radio drama. There is a D.C. panel, but no drama studio! True, a waiting room has been pressed into service for drama, but it is far from suitable. There is no effects studio. This is in a county full of opportunities for drama and feature programmes.

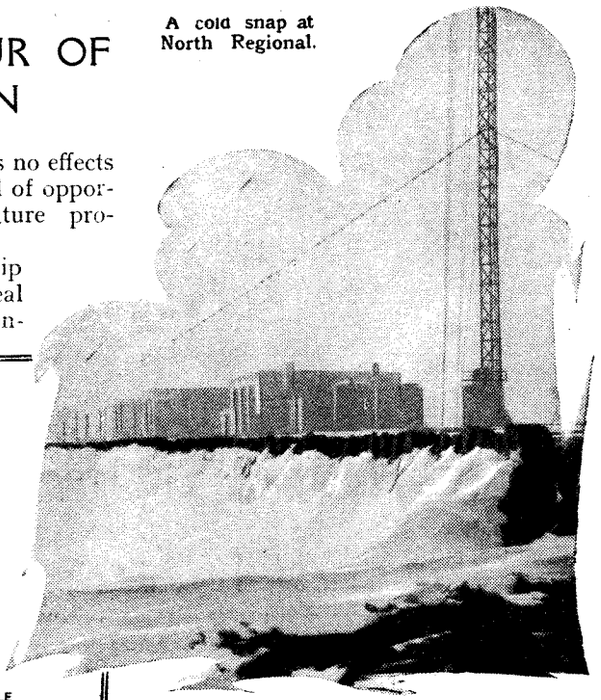
The resident "staff" is Philip Fox, one of the B.B.C.'s real "old-timers." He was originally appointed Station Director at Leeds in 1924.



The programme chiefs from Manchester make regular visits to Leeds for auditions and productions, but what I said in my despatch from Newcastle applies equally here: that this system of itinerant programme organisers dissipates energy and does not permit persistent concentration on the job of exploiting local opportunities. I would estimate that to cover Yorkshire properly Mr. Fox needs a couple of assistants, while the Leeds premises, for the sake of mere efficiency, ought to have at least two extra studios.



The Leeds control room is now less active than formerly, when it formed the only link between North and South.



A cold snap at North Regional.

Perhaps, now that more money is being spent on provincial broadcasting, there is a chance of this being done. As Alfred Dunning, one of the North's leading radio critics, said recently in the "Yorkshire Post," such increased finance need not be spent necessarily on programmes. "Much of the money," he said, "would be better used in the enlargement of staffs to deal, as they cannot adequately do at present, with the radio resources of their areas. In the North, for example, there is only one dramatic producer—and even he is expected to combine studio variety production with 'straight' plays."

And also, I might add, to run about between Manchester, Newcastle and Leeds.

Big Changes

When Philip Fox and I got together there was, of course, a deal of gossiping. We went over the old times, rather wistfully . . . the old times when Leeds had a transmitter of its own and a good deal of independence, when Fox had a permanent assistant, and they ran regular local features like the 2LS Children's Hour, the organiser of which was a certain "Uncle Max," who has since found (as Max Kester) fields of Variety to conquer in London. In those early days Fox had an allowance of £20 per week to cover everything, and he now recalled to me how, when I wrote the first 2LS Birthday Programme (1925), he was allowed "as a special favour" to pay me the princely fee of seven guineas.

Nowadays the Children's Hour is centralised at Manchester, as is so much else of North Regional administration. In most respects this is, I think, justified. In fact, the organisation of the North of England into one Region has proved advantageous both from a technical point of view and in regard to programmes, which strike a higher standard than was ever

Does Broadcasting Serve Britain?—

attempted in the good-bad old days. Some of the features sent from Yorkshire up to those aerials on Moorside Edge merit the highest praise, but that does not alter my contention that the B.B.C.'s work in Yorkshire *could* be a great deal more thorough, given the necessary machinery.

From Leeds I travelled on to Sheffield, another of these great cities which once had stations of their own. Sheffield, in fact, had the very first relay station in the country (1923). The choice of Leeds as the North Region's Yorkshire sub-centre, rather than Sheffield, has been a sore point here, for Sheffield can point to a small population advantage over Leeds (which, on the other hand, claims to be the chief administrative centre of Yorkshire). A studio is, in fact, still retained at Sheffield, on the site of the old 6FL transmitter, but it is only suitable for talks and is used, so I am told by the B.B.C., only about a dozen times a year. It saves Sheffield speakers the trouble of going to Leeds.

The B.B.C. has so far resisted claims for larger studios in Sheffield, but it may be that the recent extension of the North Region to cover Lincolnshire may strengthen the case for studio extensions at Sheffield—as we shall see next week.

Real life features are popular in the North. Here is a miner taking part in a pit broadcast.

Next Tour: *East Anglia and Brookmans Park.*

Random Radiations

By "DIALLIST"

The Short Wave Question

MORE letters reach me from readers in answer to the question "Are the short waves worth while?" which I asked in these columns a week or two ago. Some hold strongly that they *are;* others are equally emphatic—perhaps even more so—that they are not. The chief counts in the indictment against the short waves are that transmissions made upon them are liable to fade, that distortion is not infrequent, and that, except in the case of "local" stations at ranges of a thousand miles or less, no such thing as a reliable service is to be expected. There is no denying the truth of all of these accusations. Luckily, though, short-wave transmissions don't *always* fade any more than they are *always* distorted or *always* unreliable. Except at times when conditions are bad there is usually something which I should call worth listening to on one band or another of the short waves. The question is rather how far is the listener prepared to make allowances for a certain amount of crankiness in view of the fact that short-wave transmissions do enable him to hear broadcasts—and some of them particularly interesting broadcasts—from the ends of the earth?

Worth Thinking About

One correspondent, who writes from Houghton-le-Spring, warns manufacturers against painting too rosy a picture of short-wave reception for the man in the street. Nothing, he says, is worse than to lead a listener to believe that he has only to turn over a switch and twiddle a tuning knob in order to be able to hear stations from China to Peru whenever he feels so minded. There's something in this undoubtedly, but people nowadays are accustomed to take such claims with a grain of salt.

My correspondent suggests that in their handbooks, makers of all-wave and short-wave sets should say something about the uncertainties of the short waves. With this I agree, though I am not quite at one with him when he contends that raising expectations over high may in time kill interest in short-wave reception. Some time ago preposterous claims were often made about the numbers of medium and long-wave stations that certain sets could receive. The numbers were far in excess of the individual channels in use in Europe! Yet this seems to have done no harm.

The Same View

To my mind the right and proper way of regarding the all-wave receiver or the short-wave adaptor for the receiver designed to deal with the medium and long waves is this. You can't obtain from any distant station quite the same quality that you can from a local. Therefore, if your set is for the medium and long waves only you will use it far more for local reception than for anything else. At the same time you know from experience that remarkably good reproduction is possible from many European stations, and that these often—though not always—transmit attractive programmes. Hence you find it convenient, useful, and a source of real pleasure to possess a receiving set which will enable you to reach out when you feel so inclined on the medium and long waves. The addition of a short-wave range vastly enlarges the scope of the receiving set and makes it possible to range much farther afield. There's plenty of interest in short-wave reception, though the average listener will probably indulge in it occasionally rather than as a regular thing.

Near the Peak?

THE signs are that we are gradually nearing the saturation point in the matter of wireless receiving sets. In other words, the curve showing the increase in the number of licensed listeners has now reached a distinct "upper bend," and is tending to flatten off. Of course, an absolute saturation point can never be reached, for the population of the country is always growing, and you have only to move about the country by train, bus or car to be struck by the huge numbers of new homes that are springing up here, there, and everywhere. At present the total number of homes in this country is a little over eleven millions. The total number of wireless licences at the end of last year was 7,415,000. The increase for December, 1935, was 46,108, against 119,565 for December, 1934, and 101,722 for December, 1933. Figures for January are not available as I write, but it is expected that they will show much less than half the increase that occurred during the corresponding month last year. The total number of licensed listeners is likely to rise slowly to the neighbourhood of eight millions, and to remain more or less stationary at that figure.

What's the Reason?

It is perhaps rather surprising that though there are now nearly seven and a half million homes containing licensed wireless sets, there are between three and a half million and four million homes without them. Probably "piracy" accounts for a pretty considerable number, but the total is still large. Most of the homes without wireless sets are also without electric light. This means that battery sets must be used, and though this kind of receiver can be cheap enough to buy in the first instance, its running costs are very much higher than those of mains apparatus. This is, I think, one of the chief reasons for the slowing down of the rate of increase in licences. Were it possible to run an efficient battery set for a few pence a week there would be far fewer homes in this country without wireless.

The Radio Industry

A CATALOGUE describing the new Ferranti all-wave receivers has just been issued by Ferranti, Ltd., Moston, Manchester.

◇ ◇ ◇

Complete sets of HT, LT, and, where necessary, grid-bias batteries, are now being marketed for various well-known receivers by Exide and Drydex. The "battery packs," as they are called, are clearly labelled with the names of the sets for which they are suitable.

◇ ◇ ◇

A leaflet describing Lissen Matched Dipole Aerials for all-wave receivers is available from Lissen, Ltd., 113-117, Charing Cross Road, London, W.C.2.

◇ ◇ ◇

A catalogue dealing with various components and accessories as well as with complete sets of parts for various *Wireless World* receivers has just been issued by Chas. F. Ward, 46, Farringdon Street, London, E.C.4. *The Wireless World* Quality Amplifier in completed form is also listed.

◇ ◇ ◇

On Messrs. Joseph Sankey's stand (No. B707) at the British Industries Fair, the exhibits of wireless interest will comprise Stalloy and Lohys transformer and choke laminations, as well as loud-speaker parts.

◇ ◇ ◇

A catalogue describing measuring instruments of various kinds is issued by Nivex Instrument and Gauge Co., Exmouth House, 3-11, Pine Street, London, E.C.1.

BROADCAST BREVITIES

By Our Special Correspondent

B.B.C. in the Press Gallery

I LEARN on good authority that the B.B.C. confidently awaits permission to send a permanent representative to the Press Gallery at the House of Commons. He would either deliver "running commentaries" during important debates, or save up his material for eye-witness accounts in the broadcast news bulletins.

Scope for John Watt ?

The direct broadcasting of debates is extremely unlikely. I think, however, that Mr. John Watt would add still further to the gaiety of nations if he could take the wandering mike around the Parliamentary lobbies. The task would be easier than trying to coax pleasantries out of first-night audiences; the only difficulty would be in making the M.P.s queue up for turns at the microphone.

Truth About Stagshaw

MR. GUILFORD, B.B.C. director at Newcastle, takes me to task for mentioning Mr. Stanelli in the same breath as Stagshaw, where the new North Regional station is to be situated. It appears that "Stagshaw" really is at Stagshaw, and that Hexham is a good five or six miles away. Let it be Stagshaw, then.

Incidentally, the Bachelor Parties are being described at the microphone as "Stag Parties" once more, so everyone should be happy again.

King Boris and the Flag

RUSHING hither and thither prefaced the visit to Broadcasting House of King Boris of Bulgaria ten days ago. The invitation had been extended, half-jocularly, to a member of His Majesty's suite just prior to the King's departure for the Continent, and it was not thought that there was time for a royal trip to Portland Place.

King Boris, however, leaped at the proposal and was spinning B.B.C.-wards in a high-speed saloon car almost before Mr. Chilman, who looks after these matters, had had time to send out for a Bulgarian flag.

In the Control Room

The King was escorted round the Concert Hall, the Control Room and the Listening Rooms by Mr. Cecil Graves. It was in the Control Room that most time was spent, for His Majesty seemed fascinated by this direct link between the hub of London and the European ether.

Throughout the visit the Bulgarian flag fluttered on the roof. Mr. Chilman can get the flag of any country on earth at short notice. He knows where you can hire them by the hour, day, week or month.

Ugly Duckling into Swan

THE prestige of Tatsfield has gone up tremendously in the last few months, due to the skilful handling of such American features as "Five Hours Back" and the Raymond Swing talks. It is no secret that the Tatsfield receiving station used to be something of a poor relation or ugly duckling among B.B.C. departments, probably because it so often had to enlist the help of the Post Office beam service in staging transatlantic relays.

Things are different to-day.

"Diversity Reception"

Mr. H. V. Griffiths, engineer-in-chief, would tell you that recent successes are largely due to the use of "diversity reception," whereby a number of receivers are used with a common output. Actually three function at the present time, and they rely, for the most part, on W2XAD (19.56 metres), W3XAL (16.87 metres), and W8XK (19.72 metres). Very often all three transmitters are relaying the same programme, and when this is the case the three receivers are able to give an almost fade-free rendering.

W2XAF is sometimes found the best in the evenings after 9 o'clock.

Big Ben All Day ?

A DECIDED "No" is the official answer to last week's proposal that the chimes of Big Ben should be radiated every quarter of an hour throughout the day on a special wavelength so as to "have the Empire's most impressive clock striking and chiming always."

Proposals of this kind (this one appeared in the Correspondence columns of *The Times*) invariably come from people whose ardour slightly outweighs their awareness of the practical difficulties involved. And yet such people are the salt of the earth.

Orchestra on the Run

IN addition to the visit to Leicester on March 11th, the B.B.C. Symphony Orchestra will travel to Glasgow for a concert on April 11th before proceeding on its Continental tour, which, incidentally, will last less than a week.

Orchestral musicians must be hardened to this sort of thing, but I confess that their high-speed itinerary rather takes my breath away.

Prestissimo

They will be performing in Paris on April 21st, and the next evening will be heard at Zurich. Then, with one day to themselves—for travelling, not as a "breather"—they will be broadcasting from Vienna on April 24th, and find themselves in the Budapest studio on the 25th. If they can still give a good account of themselves in the City of "Night Falls," they must be models of imperturbability, and this is not a quality that one looks for in a sensitive musician.

SIX PROGRAMMES are available to guests at the Waldorf-Astoria Hotel, New York, which claims to have the biggest internal radio relay system in the world. All-wave receivers, with a special antenna system, "comb the globe" for the choicest radio fare. A large radio staff is maintained for the purpose.

Transporting the Instruments

The business of transporting the instruments from one capital to another in this mad, wild rush must be a formidable one.

Can it be that Dr. Boult and his orchestra fear that British broadcasting would languish if denied their presence for more than five days?

Television Tram ?

THE B.B.C.'s television bus service to the Alexandra Palace is to run in two sections. There will be a magnificent door-to-door equipage, probably complete with mobile dressing room, for taking aged and infirm artists from headquarters to Mr. Cock's stately pleasure dome; and there will also be, so I understand, a shuttle service of small B.B.C. buses between Wood Green Underground station and the Palace gates for the youthful and nimble.

Trams cover this short route, and it has even been suggested that the B.B.C. should charter a tram of its own.

Angry Gardener

BURST into my office last week an enraged amateur gardener. Had been listening eagerly to Mr. T. Hay's Gardening Talk on Good Flowers for 1936. Mr. Hay started to give names of recommended varieties, but was cut short by the clock. Was just able to exclaim, "Sorry, but you'll find the remainder in 'The Listener.'" E.A.G. bought "Listener," but talk cut short there, too, though he found reams of reading matter that never had been broadcast. Small consolation, considering holes already dug in garden for new varieties.

A sordid tale, and the only moral seems to be that variety is the spice of life.

Henry Hall's Contralto

HENRY HALL has a good nose for genuine talent, so we may expect great things of Vivienne Brooks, the convent-educated contralto, still in her 'teens, who is to join the B.B.C. Dance Orchestra as vocalist on March 16th next. Smokes thirty cigarettes a day and adores tea.

Recent Inventions

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each

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

AIRCRAFT WIRELESS

AN aeroplane is automatically steered along a predetermined course by two overlapping radio beams, each modulated by a distinctive note frequency. The rectified notes are utilised to throw over a steering-switch to one side or another, according to the direction in which the craft yaws away from the course. The control is effected by means of two cup-shaped members, each mounted on a reed resonant to the note frequency.

Owing to the different air-resistance of the concave and convex surfaces of the cup-shaped members, the reed that vibrates more strongly under the influence of the received note frequency sets up a torque which closes the control contact on the side necessary to maintain the aeroplane on its predetermined course. A course can be followed which is off the zone of equi-signal strength formed by the overlapping radio-beams, and an automatic correction can be made for wind drift.

T. E. Brockstead (assignor to Washington Institute of Technology). No. 2003240. *(U.S.A.)*

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MAINS-SUPPLY UNITS

CURRENT from the mains is stepped up to a frequency in the neighbourhood of 15,000 cycles per second, and in this form is used as the anode and filament supply to a wireless set. This allows the selectivity of the associated circuits to be sharpened without giving rise to self-oscillation. The set functions to some extent as a super-regenerator.

F. A. Parsons. No. 2005237. *(U.S.A.)*

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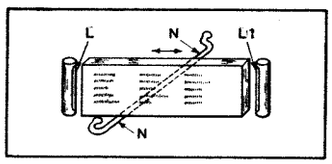
TUNING-DIALS

GROUPS of station names are printed on the rear surface of a panel of glass by etching or sand-blasting. The panel is illuminated by two lamps L, L1 placed at each end, so that the rays of light travel inside the glass, being kept there by internal reflection except at the frosted lettering, which accordingly stands out against a dark background.



A novel tuning scale.

At the back of the panel is a movable Neon glow-tube N which is controlled by the tuning-knob so as to light up the particular station being received in red light. The Neon tube is screened by a moving band (not shown) provided with slots at intervals which allow the red light to fall on to the name of the selected station. The tube is moved over to the different groups of stations by the operation of the wave-band switch.

N. V. Philip's Gloeilampenfabrieken. Convention date (Germany) July 21st, 1934. *No.* 438010.

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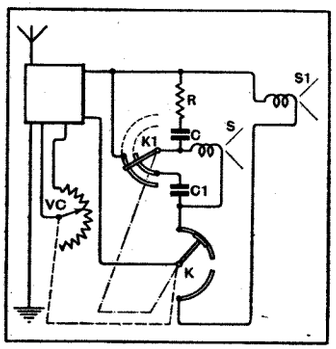
DUAL LOUD SPEAKERS

A SMALL-DIAPHRAGM speaker, working with the so-called piston effect, gives very satisfactory results on sounds of



Method of loud speaker connection.

low intensity, but for a greater volume of sound a larger diaphragm is necessary to avoid distortion. A wireless receiver is accordingly provided with two loud speakers, one of which is automatically changed over for the other as the volume control on the set is moved from low to high.

As shown in the drawing, the speaker S is a small-diaphragm speaker, whilst S1 is suitable for handling a greater volume of sound. The hand volume-control VC is ganged to a switch K so that the speaker S is automatically cut out in favour of the speaker S1 at a certain point. The switch arm is arranged to make a gradual change-over, with an intervening period during which both speakers are in operation.

When both speakers are used together, a second ganged switch K1 is arranged to bring into circuit a tone-control filter R, C for the speaker S, so as to emphasise the high frequencies. Simultaneously a shunt condenser C1, which for solo working attenuates these frequencies, is open-circuited.

E. K. Cole, Ltd. (communicated by Aga Baltic Radio). Application date June 25th, 1935. *No.* 438014.

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CATHODE-RAY TUBES

THE various electrodes of a cathode-ray tube, which must be accurately aligned and at the same time insulated from each other, are, according to the invention, arranged in two groups. One consists of the accelerating and focussing electrode, the Wehnelt cylinder, and the cathode, all of which are operated at a high negative potential. The other consists of the anode, which is usually earthed, and the two deflecting electrodes which carry comparatively low voltages.

The groups are separated by at least two, and preferably three, distance-pieces of steatite, and the whole assembly is maintained firmly in position by the pressure of two resilient arms which extend forward and press against the outer sides of the far end of the tube.

The General Electric Co., Ltd.; L. C. Jesty; and G. W. Seager. Application date August 17th, 1934. *No.* 437624.

ONE way of varying the intensity of the spot on the fluorescent screen is to apply the signal voltage to a control grid situated near the Wehnelt cylinder of the cathode-ray tube. In practice, however, it is found that in addition to varying its intensity the applied voltage displaces the spot from its proper position on the screen, thus producing distortion of the picture.

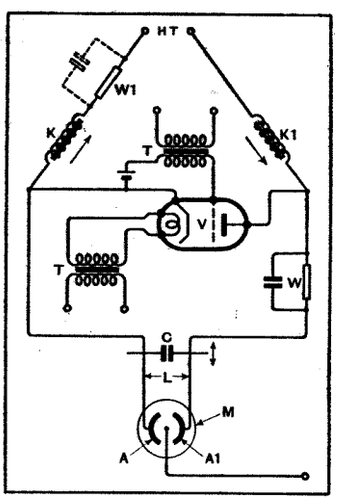
This is probably due to the fact that the cathode is not situated in correct line with the axis of the Wehnelt cylinder and the anode, so that the electrons are subjected to a certain amount of lateral pull. In order to overcome this defect all the electrodes are correctly centred in position by fitting them with short glass rods which, in turn, are fused on to two glass supporting-rods sealed into the pinch of the tube.

E. Hudec. Convention date (Germany) April 8th, 1933. *No.* 438117.

o o o o

SHORT-WAVE MODULATORS

MICROPHONE currents are applied at T to the grid of a modulating valve V which is shunted across the two halves A, A1 of a split-anode magnetron. The high-frequency currents in the output circuit L, C are thus modu-



Circuit for modulation at high frequencies.

lated in push-pull across the anodes. Since the voltage supply for both the valves V, M is taken from a common HT source, and since it is necessary to keep the anode of the modulating-valve V more positive than its cathode, a voltage-dropping resistance W is inserted in the lead to the anode A1 of the magnetron, so as to keep the same DC voltage on both the split-anodes; or the required adjustment is made by inserting a resistance W1 as shown in dotted lines.

The signal voltage applied at T alters the impedance of the valve V. This sets up corresponding voltages across the chokes K, K1 and are so applied in push-pull to the magnetron oscillator.

Telefunken Ges. für drahtlose Telegraphie m.b.h. Convention date (Germany) August 21st, 1934. *No.* 438018.

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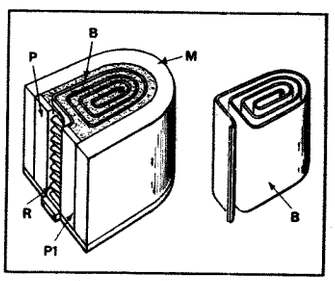
MICROPHONES

A HIGH-FIDELITY microphone comprises a "ribbon" diaphragm R, set between the poles P, P1 of a permanent magnet M, and backed by a chamber which contains a labyrinth of passages formed as shown separately at B.



A new microphone.

This long passage-way is packed with felt or other damping-material, which forms a mechanical "impedance" load upon the ribbon diaphragm. The ribbon responds to the velocity component of the sound wave, as well as to its varying pressure. The microphone as a whole is sufficiently small to be suspended from the lapel of a coat.

Marconi's Wireless Telegraph Co., Ltd. (assignees of H. F. Olsen). Convention date (U.S.A.) November 21st, 1933. *No.* 438090.

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LIGHT VALVES

BEFORE modulating a ray of light in a Kerr cell, the ray is first passed through a prism of doubly refracting material, such as Iceland Spar, which splits it into two oppositely polarised rays, one of which is then suppressed by total internal reflection.

According to the invention, the refracting prism is preferably made in the form of a cylinder cut out from pieces of the natural crystal. These are first cemented together by Canada balsam, and trimmed up into cylindrical form. The pieces are next separated by dissolving the cement, and are carefully polished. They are then reassembled with aluminium foil "spacers" so as to leave a number of air-films at which the suppression of the unwanted ray takes place.

P. V. Reveley and Baird Television, Ltd. Application date August 28th, 1934. *No.* 437988.

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CONTENTS

EDITORIAL COMMENT

Radio Measurement

Importance of Quantitative Analysis

THE present issue is principally devoted to the subject of instruments for radio measurement and their applications.

It is hardly possible to over-stress the importance, in any serious wireless work, of knowing the nature of the quantities involved and being able to measure those quantities as they occur in various parts of the receiver circuit.

Those whose business it may be to design sets, to build them or to service them, all require to have this knowledge in varying degrees, and it is when this basic information is lacking or there is not skill enough to make these measurements, that trouble begins.

For the designer the necessity for this understanding of the nature of the quantities met with and the ability to measure them is obvious. In the case of the builder of sets, although he may be successful so long as everything goes right, he may land himself in hours of unnecessary work if he is not equipped with the knowledge which will enable him to put his finger quickly on any error made inadvertently during assembly, or caused through some defective component part. Those whose constant task it is to service receivers can muddle along "by hit and miss" methods and aided by past experience as to what defects are most likely to occur, but servicing on these lines seldom gives satisfaction to the owner of the set or to the serviceman, who probably wastes hours on jobs which, with a little more knowledge and the aid of instruments, would be promptly and satisfactorily despatched.

When we look back on the history of wireless from the receiver point of view we find that for once it is not fair to put all the blame on the "workman," because until comparatively recently the workman's "tools" have been inadequate or costly beyond his means. To-day that difficulty has been very largely removed, for there is now a wide variety of measuring and testing instruments available for almost every conceivable requirement and at prices which are by no means excessive.

To-day there is little excuse for dabbling in the dark, when for a small outlay in cash, coupled with a little effort in acquiring the necessary knowledge, receivers, even of the most complicated types, can be examined bit by bit and faults diagnosed and corrected with certainty.

The value of this issue to our readers will, we feel, be fully recognised. In addition to the inclusion of special articles we include a fully representative review of the wide choice of measuring and testing apparatus now available.

Spreading Electricity

Birmingham's Example

WE feel that the occasion should not be allowed to pass without expressing our keen appreciation of the progressive policy indicated in a recent move by the Birmingham Corporation Electricity Supply Department.

The Department is now prepared to connect its mains to houses not hitherto supplied, and to provide one power point for use with a wireless set at the low quarterly minimum charge of 5*s*. and a small charge for connecting.

Not only is this low initial installation charge an important concession, but it is also an official intimation that the Department, unlike less progressive suppliers, has not made the error of regarding wireless as a lighting load.

Analysing a Modern Receiver

HOW THE WHEELS GO ROUND IN THE VARIABLE-SELECTIVITY IV

IT is always interesting to know exactly what is happening in every part of a receiver, and it is not difficult to find out in most circuits with the aid of quite simple testing equipment. It is especially important when a receiver is not functioning, for a comparison of what is happening with what should happen usually leads to the cause of the trouble in a few minutes. It is common knowledge that current and voltage tests are a very necessary part of all testing, but it is not always realised that there is a right and a wrong way of making them, and, of course, the readings must be properly interpreted if they are to be of any value.

It is proposed, therefore, to describe in detail what should happen in every circuit of a typical modern receiver, and to show how tests may be applied to prove that events are really as described. The Variable-Selectivity IV has been selected to form an example, not only because it is representative of modern technique, but also because it is an extremely popular set. The complete circuit diagram is shown in Fig. 1, and it is proposed first of all to deal with the purely direct current aspects. Taking the receiver first of all with no applied signal, and for the time being, taking for granted that the mains equipment supplies and maintains a potential of 200 volts across C24, it is easy to see that the current flowing in any circuit is dependent only on the total resistance of that circuit. This resistance includes not only the actual resistances employed, but, in addition, the resistances of other components and of the valves themselves. The valve resistance, moreover, is not a constant, but depends on the voltages applied to all the electrodes.

Fig. 2 shows the circuits of the output valve, which is a duo-diode-output pentode—three valves in one. The purely pentode circuits are shown as heavy lines, the detector circuits as light lines, and the purely AVC connections dotted. The cathode of the valve emits electrons which are collected by the positive anode and space charge grid and constitute the current taken by the valve. This current flows from cathode to the positive electrodes in the valve, and thus from the negative of the HT supply to the positive.

Starting at the negative HT terminal in Fig. 2, therefore, the total current taken by the pentode (the cathode current) flows to the valve through R12 and R11. The current divides in the valve and a portion of it appears in the space-charge grid circuit, whence it flows straight to positive HT. The major portion of the current, however, appears in the anode circuit and flows to HT through R10 and the primary of the output transformer. As will be seen later, the control grid takes no current.

The Output Pentode

Now the anode current is the current which flows from anode to positive HT and the screen (or space-charge grid) current is that which flows from the space-charge grid to positive HT. The cathode current, however, is the current which flows from negative HT to cathode, and assuming that the other electrodes draw no current it is equal to the sum of the screen and anode currents. These currents can readily be measured by connecting a milliammeter in series with the various circuits, as shown at X, Y and Z, for the screen, anode and cathode currents respectively. In this case they should be 6.75 mA., 26 mA., and 32.75 mA.

The presence of the correct currents is prima facie evidence that everything is in order, but it is not proof, for they depend upon the voltage, and it is possible that normal currents might be obtained even with low anode and screen voltages if the grid bias also happened to be abnormally low. Now, care must always be exercised in the measurement of voltage, for the presence of the voltmeter changes the voltage in the circuit in some degree. With high-quality voltmeters of high internal resistance, this effect is usually small, but it can only be ignored when the resistance of the meter is high compared with the circuit across which it is connected.

The true voltages on the valve are those existing between its electrodes. The true anode voltage can be measured with a voltmeter joined between anode and

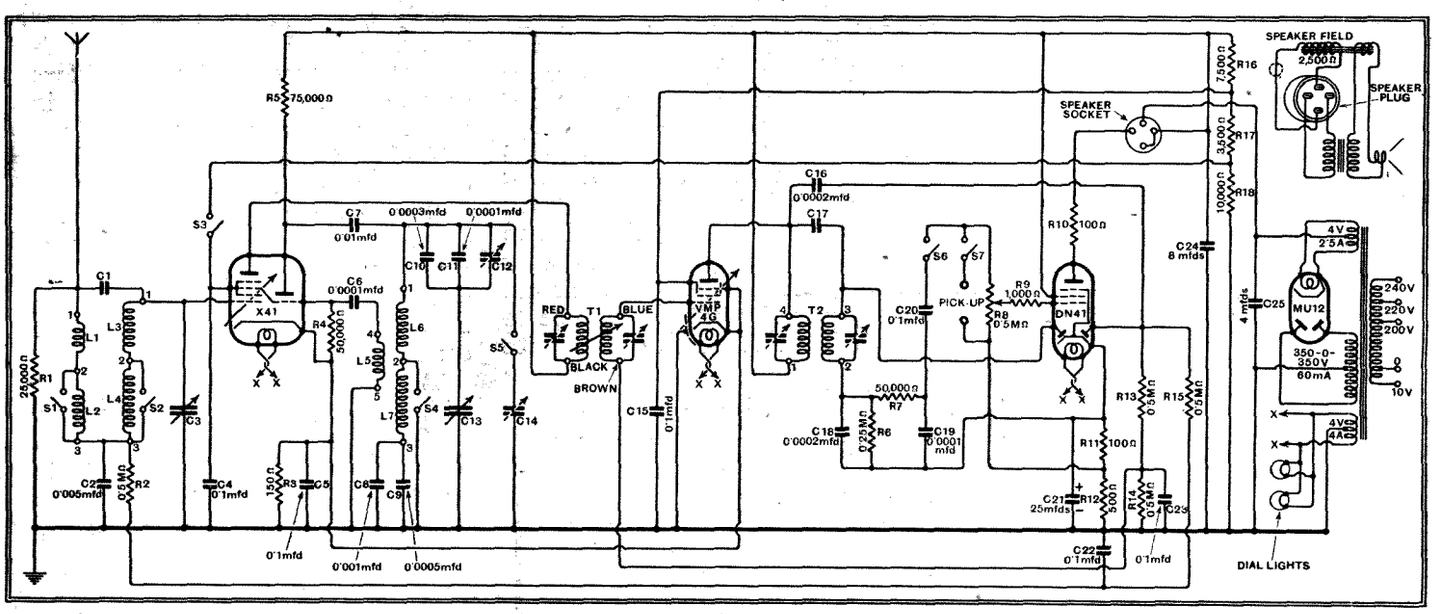
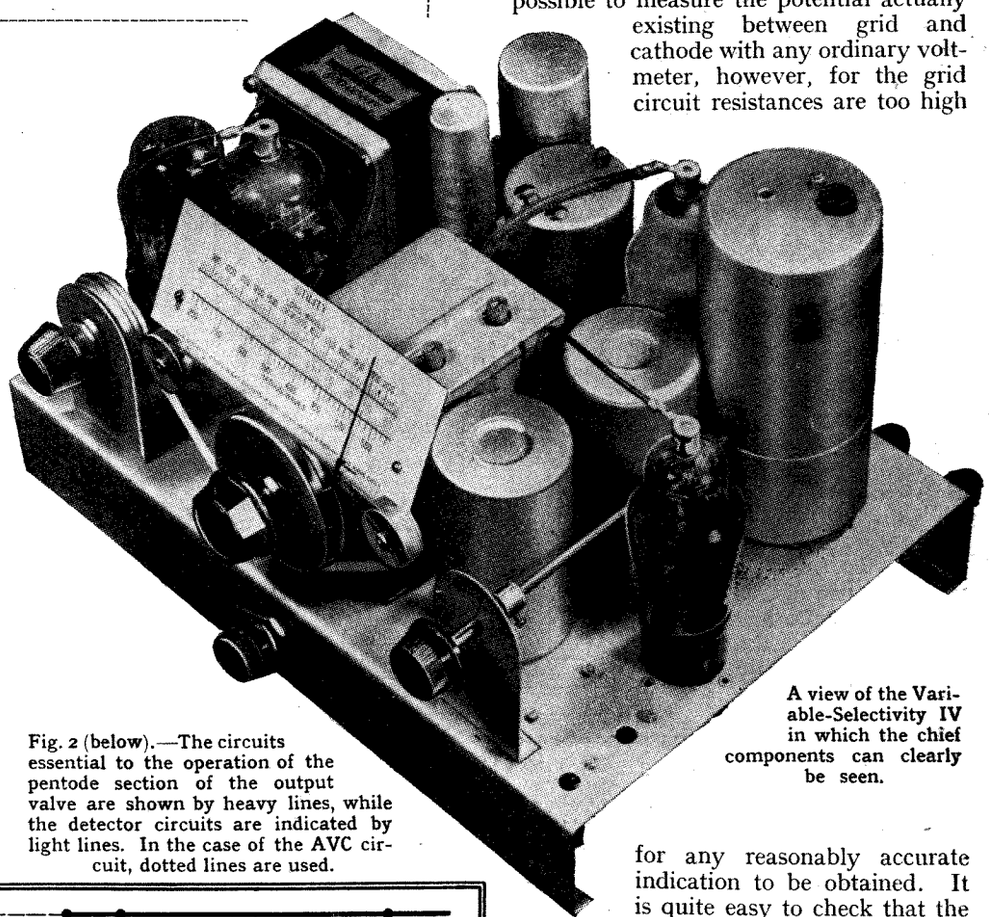


Fig. 1.—The complete circuit diagram of the Variable-Selectivity IV. The current through the speaker field can be measured by inserting a milliammeter at the point indicated by a dotted ring.

THE voltage and current distribution in modern receivers is not always clearly understood. In this article it is shown how it may be investigated with quite simple measuring apparatus. The receiver chosen as an example is one which, as far as the direct current circuits are concerned, is typical of practice.

cathode (B and C, Fig. 2) and the screen voltage by connecting the meter between screen and cathode (A and C). The anode voltage is less than the screen voltage, because of the resistance R10 and the resistance of the primary of the output transformer. In this case, a voltmeter between anode and cathode will read 160 volts, but there is 185 volts between screen and cathode. It is easy to see that 25 volts is lost between A and B; from Ohm's Law (current (mA.) = 1,000 × volts/Resistance (Ω)) the resistance between A and B must be 960 ohms, and as R10 is 100 ohms, the transformer primary must be of 860 ohms resistance. This can be checked by connecting an ohmmeter, with set switched off, between A and B; it should read about 960 ohms.

Now, in the cathode circuit, a voltmeter connected between C and E will read 20 volts, the cathode potential above negative HT. The cathode current is 32.75 mA., so that the resistance should be 610 ohms; the values of R11 and R12 actually total 600 ohms. This agreement is very good when it is remembered that the resistances may vary as much as ±15 per cent., and no correction has been made for the loading of the voltmeter. In this case, the voltage drop across R12 serves no useful purpose as far as the pentode is concerned, and the voltage (16.375 volts) across it has no effect on its operation. The potential across R11, however, of 3.275 volts is actually the grid bias of the pentode, for the grid is returned to the point D through R9 and R8. It is not possible to measure the potential actually existing between grid and cathode with any ordinary voltmeter, however, for the grid circuit resistances are too high for any reasonably accurate indication to be obtained. It is quite easy to check that the bias voltage developed across the bias resistance R11 is reaching the grid of the valve by connecting a milliammeter in the anode circuit at Y and then connecting the grid directly to its source of bias—that is, short-circuiting the points DF. There should be no change of anode current.



A view of the Variable-Selectivity IV in which the chief components can clearly be seen.

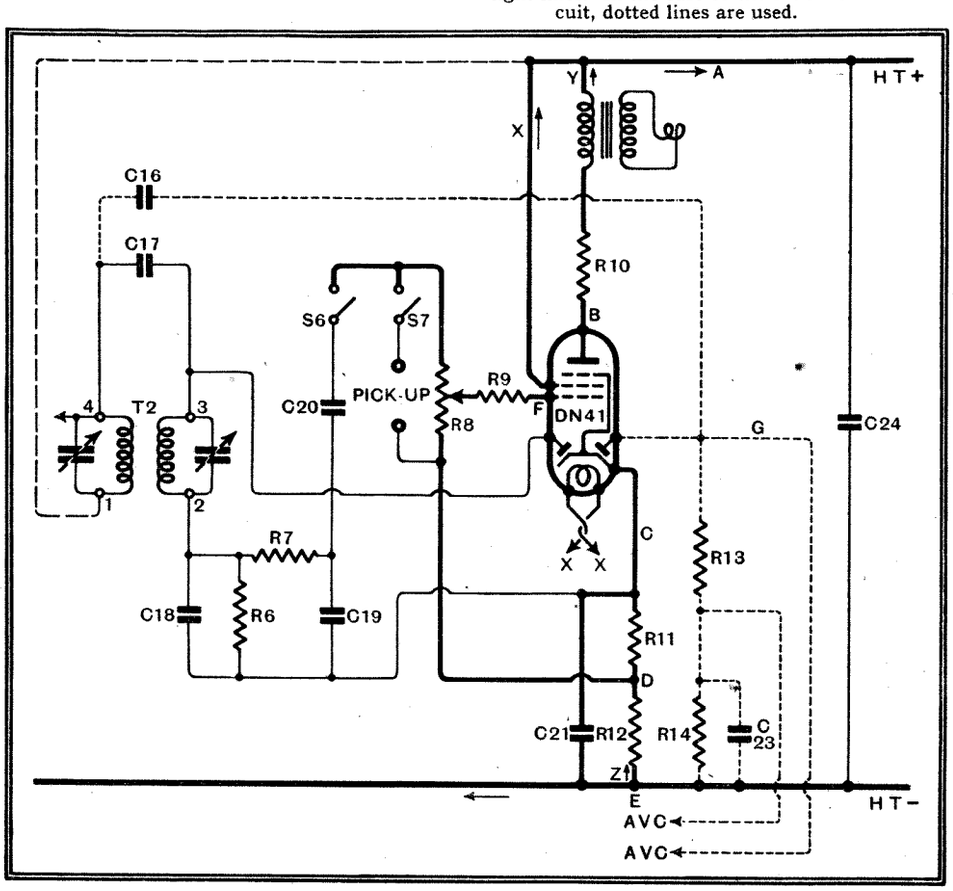


Fig. 2 (below).—The circuits essential to the operation of the pentode section of the output valve are shown by heavy lines, while the detector circuits are indicated by light lines. In the case of the AVC circuit, dotted lines are used.

The Detector

It must be realised that any marked difference from the correct figures that is obtained must be due to a defect, and from the particular differences which are noted it is usually a simple matter to locate the cause. Small variations are to be expected, however, for no two components and valves are exactly alike. While dealing with the question of voltages, it may be as well to remark that the voltage figures published in the constructional article dealing with this receiver are all measured from negative HT (chassis), since this is often more convenient than measuring the true anode and screen voltages. These true voltages are equal to figures headed "anode volts" and "screen volts" if the cathode voltage of the particular valve is deducted from the latter.

Turning now to the detector circuits,

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current and voltage tests are of little use, for no voltage is applied from the HT supply, and a sensitive microammeter would be necessary to detect the small current flowing through R6 as the result of the rectification of a signal. This applies also to the AVC circuits, for although there should be a potential of 20 volts between G and C, it cannot be measured with an ordinary voltmeter on account of the high values of R13 and R14. Certain tests are applicable, however, and will be dealt with later.

Turning now to the IF stage, the anode is fed from positive HT through the primary of the transformer T2, but as the resistance of this winding is quite low the voltage at the point A is practically the same as that at B. The anode current of 6.85 mA. passes through this winding. Now the screen requires a much lower potential than the anode, so that it is fed from a tapping on a voltage divider which is connected across the HT supply. The grid bias is obtained by the voltage drop across the cathode resistance R3. The matter is complicated by the fact that the currents consumed by the frequency-changer enter into it. In so far as they affect the present matter, they are marked on the diagram of Fig. 3.

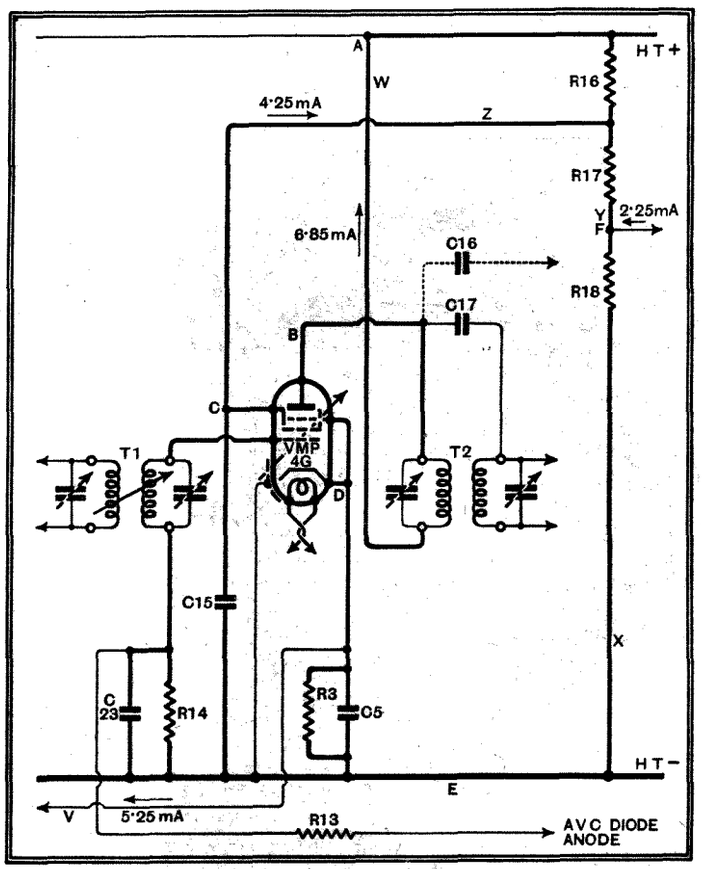

Fig. 3.—The heavy lines show the main circuits of the IF valve.

The screen grid of the IF valve passes a current of 4.25 mA., as can be seen by including a milliammeter at Z. The current through R16 is thus this current plus that flowing through R17, a total of 13.5 mA. A voltmeter across A and E registers 205 volts, but connected between C and E it shows 100 volts; the drop across R16 is thus 105 volts and its resistance should be $105 \times 1{,}000/13.5 = 7{,}474$ ohms. As the rated value of R16 is 7,500 ohms, the agreement is remarkably close.

The anode current of the VMP4G can be measured by connecting a meter at the point W, not in the more convenient anode lead to the valve, since this would be likely to cause instability and this would in turn cause a change in the anode current. The total current consumed by the frequency-changer can be read on a meter joined in the cathode lead of this valve (V); it is 5.25 mA. The current through R3 is the sum of the screen and anode currents of the IF valve plus the current taken by the frequency-changer, or $6.85 + 4.25 + 5.25 = 16.35$ mA. The bias can be read on a voltmeter joined to D and E and is 2.45 volts; R3 should thus be $2.45 \times 1{,}000/16.35 = 149.8$ ohms, which is negligibly different from the nominal value of 150 ohms.

The grid of this valve receives its bias through the secondary of T1 and R14, but the measurement of the bias directly between grid and cathode is just as impossible with ordinary equipment as in the case of the pentode. The connection of the grid directly to E, however, should in the absence of a signal cause no change in the anode current if all is well.

The frequency-changer can be dealt with in exactly the same way as the other valves, but is slightly more complex because of the oscillator section. The X41 is really two valves in one, and it is best to deal with the oscillator first, since its operating conditions affect the currents passed in the hexode section. The converse is not necessarily true, however. The oscillator anode current can be read on a milliammeter connected at X in Fig. 4, and it depends not only on the applied voltages but also on the amplitude

The Voltage Divider

A voltmeter connected between F and E indicates a potential of 70 volts between these points; as R18 has a resistance of 10,000 ohms there should be a current of 7 mA. through this resistance, and this can be checked by connecting a milliammeter in series with it at X. When the voltmeter is connected across C E, however, it reads 100 volts; there is consequently 30 volts dropped across R17, and the current through this resistance should equal the sum of the current through R18 and the current drawn off at the point F, or 9.25 mA. This current can be measured by inserting a milliammeter at the point Y. The value of R18 can be evaluated from this data and is obviously $30 \times 1{,}000/9.25 = 3{,}254$ ohms; this resistance is assigned a value of 3,500 ohms and the calculation shows it to be somewhat lower, but well within the usual tolerance.

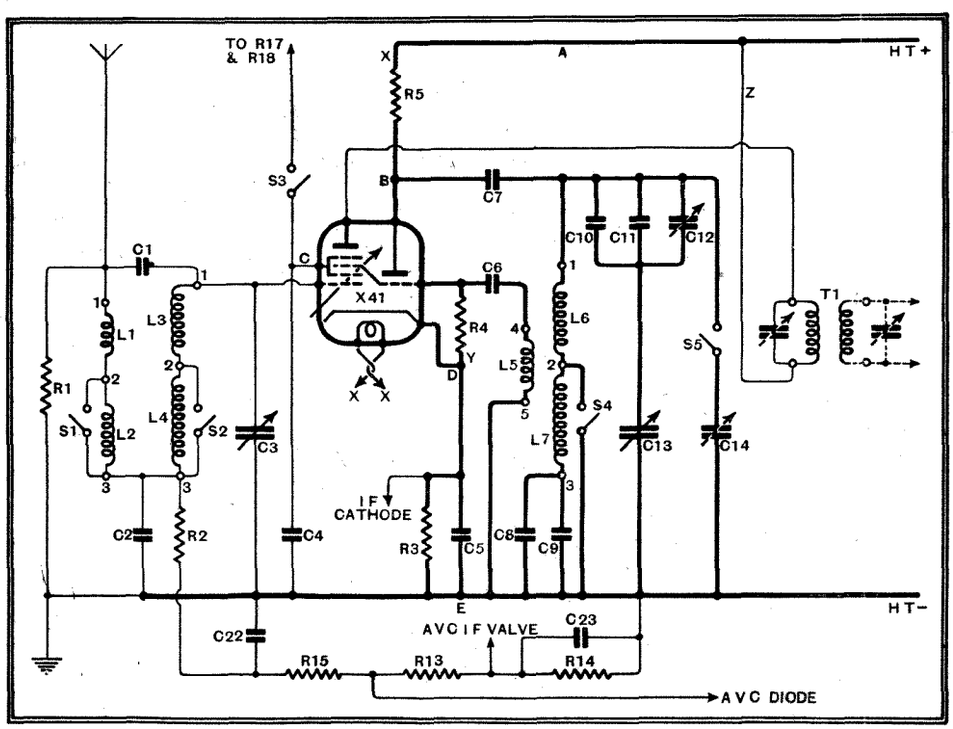

Fig. 4.—The circuits of the hexode section of the frequency-changer are shown by light lines, while those of the triode oscillator are indicated by heavy lines.

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of oscillation. It is likely to vary somewhat over the tuning range, therefore. When the valve is oscillating correctly the current should be about 1.7 mA., but if the valve be prevented from oscillating by short-circuiting terminals 4 and 5 of L5, the current will rise. If it does not, then the valve is not oscillating.

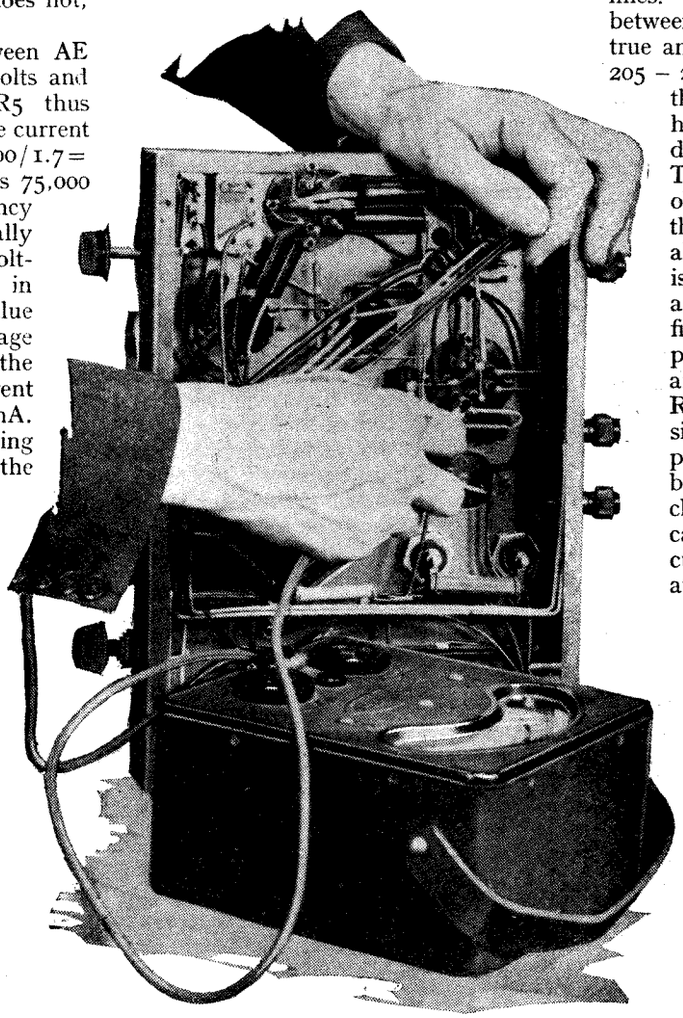
Measurements of voltage between AE and BE show respectively 205 volts and 40 volts. The drop across R5 thus appears to be 165 volts, and as the current is 1.7 mA., R5 should be $165 \times 1{,}000/1.7 = 97{,}000$ ohms. Its actual value is 75,000 ohms, however, and the discrepancy seems rather large. It is actually due to the resistance of the voltmeter which becomes important in this circuit because of the high value of R5. Actually, the anode voltage is greater than 40 volts with the meter absent and the current through R5 is greater than 1.7 mA. with the meter present. Assuming R5 to be really 75,000 ohms, the true anode voltage is easily calculated and is $205 - 74{,}000 \times 0.0017 = 77.5$ volts. To be quite exact the grid bias of 2.45 volts developed across R3 should be subtracted.

The Oscillator

The change of anode current between the oscillating and non-oscillating conditions forms a reliable test when there is any doubt that the valve is oscillating. The amount of the change, however, is no reliable guide to the amplitude of oscillation, and the efficiency of the frequency-changer depends very largely upon this. Fortunately, it is possible to measure the amplitude with reasonable accuracy by quite simple means, although a fairly sensitive milliammeter is needed. The HF potentials developed on the grid of the oscillator are rectified in the grid circuit by the normal action of a diode detector, and a steady current consequently flows through R4 in such a direction that the voltage set up across R4 by the passage of the current holds the grid at a potential negative with respect to the cathode.

The magnitude of this current is very nearly proportional to the amplitude of oscillation, and is approximately equal to the amplitude in volts divided by 1.2 times the resistance of the grid leak (multiplied by 1,000 for current in mA.). The X41 requires an amplitude of 12 volts, and as the leak resistance is 50,000 ohms the current through it should be $12 \times 1{,}000/1.2 \times 50{,}000 = 0.2$ mA.

This can easily be read on a meter giving a full-scale deflection for 1 mA., inserted at the point Y of Fig. 4, but is difficult to read accurately with a less sensitive instrument. If the receiver is tuned over the waveband with this meter in circuit it will be found that the current falls somewhat at the high wavelength end of the band. This is because of the change in the L/C ratio in the oscillator tuned circuit. On the long waveband the current is only about 60 per cent. of that on the medium, because the same reaction coil is used for both wavebands. The X41 is not at all critical as to the oscillator voltage, however, and quite wide variations from the optimum of 12 volts are permissible without any important effect on the efficiency. It should be noted that these grid current variations of the oscillator are reflected in the anode current—a fall in grid current corresponding to a rise in anode current.



Measuring screen-voltage of the IF valve.

Resistance Measurements between points in Ohms.

1 & 3 of Aerial Loading Coil ..	MW	1.5
	LW	22.5
1 & 3 of Aerial Tuning Coil ..	MW	4.7
	LW	24.0
1 & 2 of Oscillator Coil		2.6
1 & 3 of Oscillator Coil		6.0
4 & 5 of Oscillator Coil	MW & LW	1.4
Primary of T1 (red & black) ..		2.5
Secondary of T1 (blue & brown) ..		2.8
Primary of T2 (1 & 4)		5.1
Secondary of T2 (2 & 3)		5.1
Mains Transformer Primary		
0—10		1.4
0—200		34.0
200—220		4.2
220—240		4.5
High Voltage Secondary.		
C.T. to Outer 1		360.0
C.T. to Outer 2		490.0

The circuits of the hexode section of this valve are shown in Fig. 4 by the light lines. The anode voltage measured between A and E is 205 volts, but the true anode potential between A and D is $205 - 2.45 = 202.55$ volts on account of the drop across R3. The difference, however, is negligible, as is also the drop in the transformer primary T1. The screen potential of 70 volts is obtained from the voltage divider at the junction of R17 and R18, as already described. The control grid is returned to the earth line through a complex network comprising at first L3 and L4. There are then two paths, one through L2, L1, and R1, and the other through R2, R15, R13, and R14. In the absence of a signal, the grid should be at chassis potential, and this can be checked by short-circuiting the grid to the chassis and noting whether this causes any change in the anode current read by a meter connected at Z.

All these tests apply when there is no signal. When a signal which is strong enough to operate the AVC system is present, the conditions differ considerably and the distribution of voltage and currents is changed. When AVC is operating, the anode of the AVC diode becomes negative with respect to the earth line, and this potential is communicated through a resistance-capacity network to the control grids of the X41 and VMP4G valves. It is unnecessary to enter here into the precise arrangements of this distribution, for it cannot be checked with any ordinary meter on account of the high resistance of the circuits.

On tuning in a strong signal, however, the grids of the controlled valves receive an increased negative bias, and as a result their anode and screen currents fall. In the case of the X41, however, the change is much less than in the VMP4G, and as the oscillator anode current may rise slightly the total cathode current of the X41 may change very little. In any case, however, the total current through R3 falls and also the voltage drop across it. Because the screen currents fall, the voltage drop across R16 and R17 falls, and the screen potentials rise; owing to this rise in voltage there is a slight increase in the current through R18. The total current consumption of the receiver falls somewhat, however, and the HT voltage consequently rises, with the result that the output pentode will pass a slightly higher current and the voltage drops across the resistances in its cathode circuit will increase. The importance of checking a receiver without a signal will thus be

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appreciated, for it is easy to see that very misleading results may be secured if the set is tuned to a signal. It should, of course, be understood that some of the current and voltage changes which actually occur are of negligible importance and may be barely detectable by meter. The only important changes in current are those occurring in the valves controlled by the AVC system.

By totalling the figures already given, the total current consumption of the set can be computed; it is—

X41	Hexode anode current ..	1.3
	Hexode screen current ..	2.25
	Oscillator anode current	1.7
VMP4G	Anode current	6.85
	Screen ,, ...	4.25
DN41	Anode ,, ...	26.0
	Screen ,, ...	6.75
Voltage Divider	,, ...	7
		56.10.

The total current can be measured by inserting a milliammeter in series with the speaker field at the point marked with a dotted circle in Fig. 1. The measured current is found to be 56.5 mA.; the difference of 0.4 mA. may well be the leakage current of the electrolytic condenser C24, but is, in any case, unimportant, since it is so small. It often occurs that the discrepancy is greater, and quite a large difference can be assigned to errors in the meter and errors in reading it.

The HT voltage of the receiver is measured across C24, and is 205 volts, as already found, and the output of the rectifier can be measured across C25; it is 350 volts. The difference of 145 volts represents the drop across the speaker field, and as the current is 56.5 mA. the resistance of the winding is 2,563 ohms—good agreement with the rated value of 2,500 ohms.

There are, of course, many other tests which can be applied when a defect occurs in a receiver, but many of them do not show up so well just what is happening in the various circuits. For fault finding, resistance tests are often as useful as voltage and current readings, and in some cases they are better. It would not, however, be interesting to describe such tests in detail, since they consist merely of checking the resistance between various points in the circuit with an ohmmeter. A table is appended, however, giving the chief values of resistance between various points, all readings being taken with the set switched off.

Below 100 Metres

Notes from a Listener's Log Book

IN an article "Recent Solar Activity" in Ralph Strangers *Science Review* (February, 1936, p. 118), "H.N." writes "The chief feature of recent solar activity has been the great stream of sunspots that crossed the sun's disc from November 26th to December 9th in solar latitude 25 deg. south. The central meridian passage was December 2nd, when it could easily be seen without a telescope on suitably screening the eyes with a heavily tinted piece of glass. . . . It may be noted that no obvious disturbance in the earth's magnetic field took place on or about December 2nd when the group of spots was most nearly in line with the earth. Indeed, the magnetic traces recorded at Abinger, Surrey, of declination, horizontal force and vertical force showed little disturbance throughout December, although there was general unsteadiness from December 14th to 16th and December 25th to 28th."

It is these latter dates in which we are interested, and, looking backwards through our observations, we find that on Sunday, December 15th, ultra-short wave conditions were particularly good round about sunset. W3AIR, W2AOG and W2HFS were noted as very strong signals on 10 metre 'phone, but later in the evening dx conditions were very poor; at 2100 GMT, JNM Tokio was telling London that both GOZ and GNX were ZAN (I can receive Absolutely Nothing), and complete silence, except for LSI Buenos Aires (the London-Buenos Aires route being always the last affected), reigned below 40 metres at this time. This was the afternoon on which all the W3's were coming in! Conditions were similar on December 14th and 16th, and the poor night conditions extended to December 20th.

On December 25th and 26th ultra-short conditions were again very good during the late afternoon and round about sunset, but favoured the longer waves in the late evening and night, because whilst comparison had been R9 + and Merit 4 + to 5 at 10.35 p.m. on December 23rd, on December 26th it was noted that even the U.S. commercial station WIH-WIZ, etc., on 44 metres were weak at 8 p.m.

These two sets of days have also another point in common—the extraordinary strength of PHI on 25.57 metres during the afternoons, and G5JW Wimbledon obtained R3/4 signals from G6DH Clacton during the afternoon of December 28th on 10 metres.

Evidently these particular magnetic storms were associated with a condition of extremely high levels of ionisation during daylight, coupled with an equally low level of night-time ionisation, and one is inclined to attribute the daytime activity to Region "G," the third region, which is obscured by the E and F regions when these are normally ionised.

An alternative explanation, however, and one which is possibly more in accordance with the facts, suggests itself. This is the theory put forward, I believe, by Dr. Watson Watt, that on these occasions the ultra-short wave propagation takes place *via* the Intense E region. Since the effect disappears rapidly after nightfall, it is conceivable that ultra-violet light is the ionising agent, and the E layer, being situated in a region of relatively high gas pressure, rapidly recombines. (Free electrons recombining with ions.) The "G" layer, being in a region of comparatively low gas pressure, because of its much greater height, would not recombine so quickly.

On January 2nd, W2XAF had again reached an excellent signal (at 9.20 p.m.). The above "G" or Intense "E" region variety of ultra-short wave propagation is sometimes called type "B." The normal type "A," which occurs during a general increase in "E" and "F" layer intensity is typified by conditions on January 4th and 5th, when all waves from 8 metres upwards were good.

Before progressing to our fortnightly review of daily conditions, one must mention another 5-metre report by G2MV. This time he reports the reception of the 4th harmonic of RIM Tashkent on 4.92 metres, at 8.33 a.m. on Thursday, February 6th. Tashkent, which is situated in Turkestan, some 4,000 miles from London, was calling Amsterdam and not Moskva (Moscow) on this occasion.

We may note here with interest that Germany has just notified three new frequencies for use by the Zeesen transmitters. They are DJT, 25,850 kc/s, 11.61 metres; DJU, 25,950 kc/s, 11.56 metres; DJV, 29,450 kc/s, 11.33 metres.

Turning now to daily conditions for the period under review, it was interesting to log W4AH on 10 metre 'phone on the loud speaker at 7 p.m. on January 30th, saying "Please reply on C.W. First noise is very bad here." W1AHJ was also a good signal at this time, nearly two hours after sunset.

Later in the evening really good programme-value signals were obtained from W3XAL on 16.87 metres and W2XAD on 19.56 metres, and at 8.15 p.m. W3XAL was relaying an orchestra (name missed) playing Handel's Firework Music, the orchestra being conducted by Sir Hamilton Harty.

Conditions were similar on January 31st, though perhaps not quite so good, and at 8 p.m. W3XAL in the 17-metre band and W2XAD, W2XE and W8XK in the 19-metre band, were all good, W3XAL being just a little ahead, and later W2XAF 31.48 metres was almost a local station signal at 10.45.

W2XEM, W2CBO, W9XAZ and W9BHT were all good signals between 9 and 11 metres at 5 p.m. on Saturday, February 1st, and at 5.30 p.m. G5BY was heard calling "Test dx" on 5 metre C.W. A S. American newcomer is HJU Buenaventura, Colombia, on 33.11 metres, schedule 1-4 a.m., Tuesdays, Thursdays, Saturdays, well heard early February 5th working W2XAF.

The short-wave relay W2XE of the Columbia Broadcasting System was heard at quite good strength "signing off" on 19.64 metres at 8 p.m. on Thursday, February 6th, immediately before changing wave to 25.36 metres, which change was accomplished by 8.04 p.m., and slightly better signals were noted on this wave.

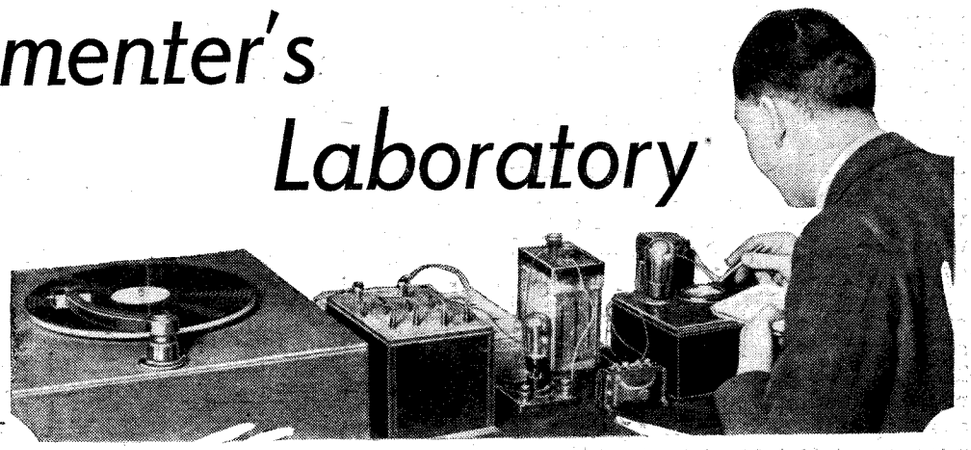
Some of the U.S. amateur 'phones on 20 metres, in particular W2BST, were giving rather better signals than U.S. broadcasters in the 19-metre band at 10.30 p.m. on February 7th, although W8XK and W1XAL, Boston, on 25.45 metres were good signals in the 25-metre band, W2XE on 25.36 metres being weaker than either. W1XAL was unfortunately suffering badly at times from interference from the Brazilian telegraph transmitter PPH, which was occupying far too large a slice of the short-wave spectrum (about 60-100 kc/s). W2XAF was again an almost local station signal at 11 p.m.

At 2 p.m. on Saturday afternoon, February 8th, W8XK was heard closing down on 19.72 metres, a fair signal, and from the announcement one gathered that this channel is not used on Sundays.

Conditions on 10 metres seemed to be rather worse on Sunday, February 9th, but the half-wave of Moscow on 12.5 metres was fair at mid-day. ETHACOMBER

The Experimenter's Laboratory

MINIMUM ESSENTIAL APPARATUS AND ITS USE IN SIMPLE MEASUREMENTS



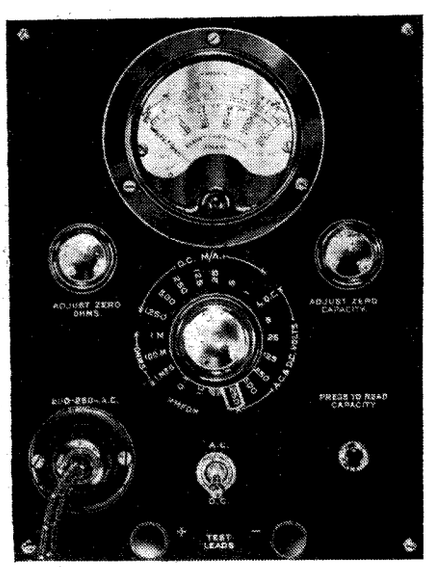
Measuring the response of an intervalve transformer with the aid of standard frequency records.

FOR the majority of tests associated with components and receivers a vast amount of useful information is to be gleaned with the aid of a few well-chosen instruments. These may well form a nucleus for the development of a really well-equipped radio laboratory.

THERE is little doubt that if one were sufficiently well endowed with this world's goods it would be possible to commission a consulting radio engineer to furnish a complete radio laboratory, just as one can go into any of the big stores and buy a carpenter's kit of tools before taking up the hobby of spoiling good wood. The majority of us, however, will be content either from necessity or knowledge of our own shortcomings, to start with a saw, a hammer, and a screwdriver, and to leave the purchase of morticing chisels, a brace and expanding bits until we begin to feel the inadequacy of some of our joints and of the red-hot kitchen poker as a method of drilling holes.

To begin with a thorough grounding in routine AC and DC measurements is essential. The necessity for checking resistances, voltages and currents—either direct or at supply frequencies—is constantly cropping up even in the most advanced research work, and most experienced workers will agree that the instrument which they would miss most is the multi-range test meter. Basically this consists of a sensitive milli- or micro-ammeter with a series of shunts, an internal battery and an oxide rectifier controlled by switches so that the range of the instrument can be instantly adapted to the measurement of any of the fundamental electrical quantities.

If funds are short and there is access to a good Wheatstone bridge for accurately measuring the resistance of shunts, the construction of such an instrument might well be considered, and those who are interested will find details in the issue of this journal for July 19th, 1935. If this course is adopted the meter itself could be made detachable and its range chosen so that it could be used also in a valve voltmeter—of which more later. However, it is possible to visualise occasions when the meter will be required in two places at once, and as there are many excellent commercial universal test meters at reasonable prices the wisest plan will probably be to make the acquisition of one of these instruments the first step towards the establishment of the embryo laboratory.



A typical universal test meter for routine DC and AC measurements.

The Valve Voltmeter

Having safely taken care of DC and supply tests we are in a position to explore the field of radio- and audio-frequency measurements, and here the key instrument is the valve voltmeter. In the majority of DC and power circuit measurements the load imposed by the measuring instrument could be easily allowed for and in many cases entirely ignored, but in radio- and audio-frequency work voltage measurements must be made without taking power from the circuit to actuate the indicating meter. Thus we find that the best instrument for all measurements of this character is the valve voltmeter. The load imposed by this instrument is the high grid-to-filament impedance of the valve, and its effect on the circuit can be neglected in the simple type of tests and experiments with which we are concerned in this article.

One of the principal attractions of this type of meter is that it can be calibrated at low frequencies, using the mains as a source of alternating current for the purpose, if desired. A properly designed valve voltmeter calibrated at 50 cycles will hold its calibration over the whole of the audio-frequency range, and over the medium- and long-wave broadcast wavebands as well. The simplest type of valve voltmeter is that shown in Fig. 1. In essence it is an anode bend detector in which the change of anode current is a measure of the alternating voltage applied to grid and filament. A sensitive meter, having a range from approximately 0 to 250 microamps, is required. Meters of this type are of delicate construction and generally of high price, but recently a number of miniature panel-mounting meters with the required sensitivity have made their appearance at reasonable cost. In the particular circuit shown a potentiometer

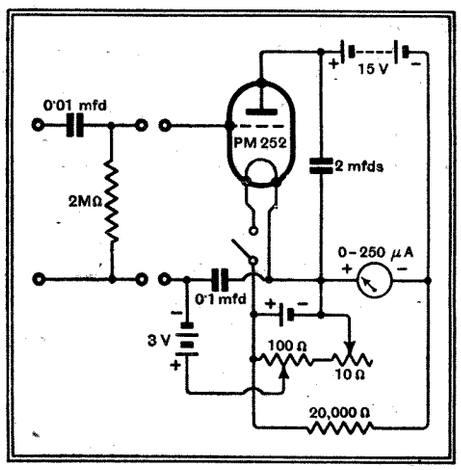


Fig. 1.—Circuit of a simple wave voltmeter for HF and LF measurements. The grid condenser and leak is for use in circuits carrying DC as well as AC.

The Experimenter's Laboratory—

is arranged to balance out the residual anode current so that the meter reading starts from true zero. The range of this valve voltmeter is about 1 volt RMS. This may be exceeded where a slight increase in the load of the circuit is unimportant, but for radio-frequency measurements on tuned circuits the voltage to be measured must not exceed the value at which the peaks cause grid current to flow in the valve.

The disadvantage of limited input is overcome by adopting a circuit of the self-biasing type as shown in Fig. 2. This voltmeter has a range up to approximately 10 volt RMS, and has the further advantage that a more robust meter with a range of 0 to 1 milliamp. may be employed. On the other hand, there is some discrepancy between the calibration of audio- and radio-frequencies, but it is quite a suitable instrument to use for tests where comparative readings and not absolute values are required.

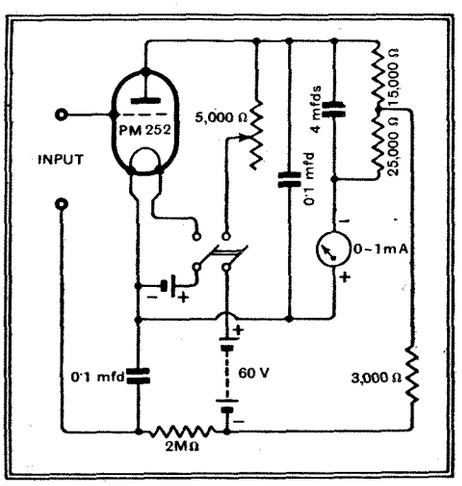


Fig. 2.—Self-biasing type of valve voltmeter permitting an increased range of input.

Fortunately a large amount of useful information can be obtained with a valve voltmeter without knowing the exact calibration of the scale in volts. Sooner or later, however, absolute values will be required, and in this connection it should be noted here that the Colebrook type of valve voltmeter shown in Fig. 1 can be accurately calibrated by a DC method which was described in the issue of this journal for October 14th, 1931. To begin with, however, either type can be given an accurate calibration in decibels which will be quite adequate for many of the more important fundamental measurements. This is a scale of relative values, and it saves much time and arithmetic when plotting the audio-frequency response curves of picks-ups, LF transformers, etc.

To make the decibel calibration a special potentiometer will have to be wound. Suggested values in ohms for the tapping points are given in Fig. 3. A range of 0 to −14 db. has been provided, as this is the most one can read conveniently on a square law valve voltmeter with a reasonably open scale.

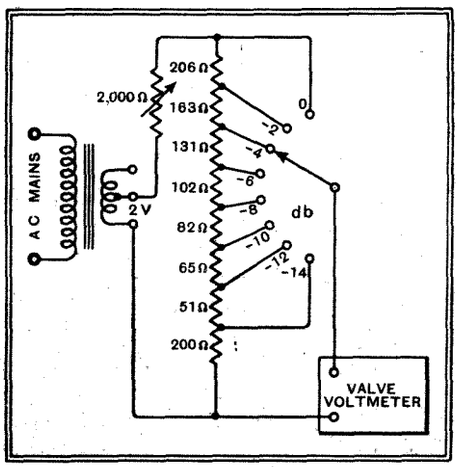


Fig. 3.—Method of calibrating a valve voltmeter with a decibel scale.

Assuming that the 0 to 1 volt type is to be calibrated, the centre-tapped filament winding of a mains transformer can conveniently be used as a source of AC. The potentiometer should be connected across half the winding, and a variable resistance of about 2,000 ohms should be connected in series with the decibel potentiometer to bring the reading of 0 db. down to full scale deflection, i.e., about 1 volt RMS. The potentiometer switch is then moved down a stud at a time, and the readings corresponding to successive 2 db. drops marked on a paper scale attached to the glass cover of the meter. No special care is necessary in winding the calibrating potentiometer non-inductively, as any inductance it may have can be ignored at 50 cycles.

Ohms With a Foot Rule

If access is not obtainable to a Wheatstone bridge for measuring the resistances it will be sufficient to make each element proportional in length of wire to the figures given. No. 40 S.W.G. Eureka wire is convenient as it has a resistance of approximately 1 ohm per inch. If the valve voltmeter with the 10-volt range is chosen the increase of calibrating voltage can be made up by connecting other filament windings of the transformer in series, care being taken, of course, to connect them in the right sense.

A valve voltmeter so calibrated can be used to take the output characteristic of a gramophone pick-up. Standard frequency records will be required for this, and they will make a useful source of audio-frequencies until such time as a beat oscillator can be acquired.

Using the calibrated pick-up and standard frequency records as a source, it will now be possible to take the curve of an intervalve LF transformer. This should always be measured in conjunction with the valve with which it will be used in the circuit, and Fig. 4 shows the schematic layout of the apparatus. The output from the pick-up is reduced by means of a potentiometer, and a change-over switch is associated with the valve voltmeter in order that the input may be monitored at each frequency.

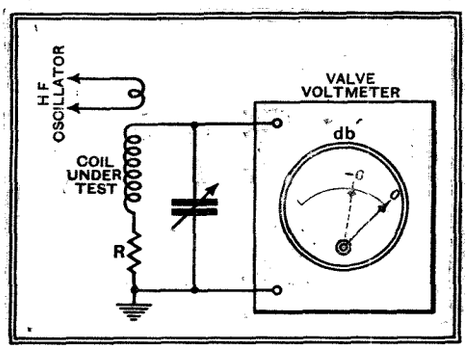


Fig. 5.—Measuring the HF resistance of a tuning coil with a valve voltmeter calibrated in decibels.

This is necessary as the pick-up characteristic varies slightly with each needle that is used. After a preliminary test to see that the potentiometer is adjusted so that the input and output readings fall within the scale of the valve voltmeter throughout the range of frequencies on the record, the potentiometer must be left untouched throughout the calibration. The difference in the input and output tabulated readings will then give the curve of the transformer and valve combination.

If the decibel potentiometer used in calibrating the valve voltmeter is employed in making up the attenuator for the pick-up output it will be possible to raise the input at high frequencies where the transformer may possibly show a serious cut-off. The increase in decibels on the potentiometer must be deducted from the output reading before plotting the curve.

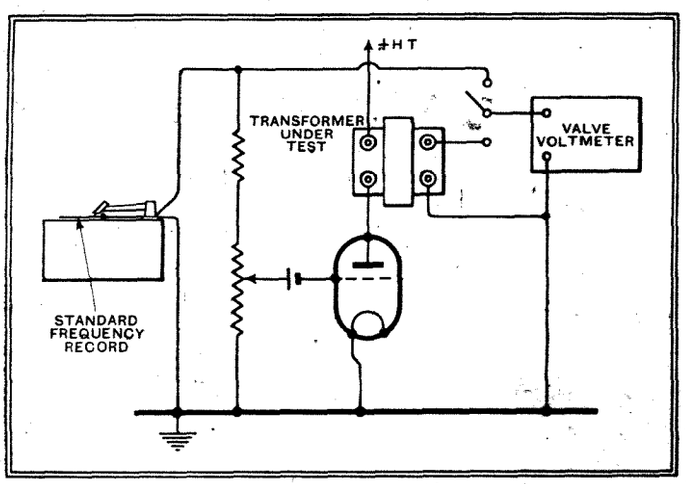


Fig. 4.—Schematic diagram of apparatus for taking the characteristic of an intervalve transformer.

Another possible application of a valve voltmeter with a decibel scale is in the

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measurement of the HF resistance of tuning coils. The coil under test is tuned with a low-loss variable condenser, and is coupled to an HF oscillator or wavemeter as shown in Fig. 5. The coupling is reduced until 0 db. is read on the valve voltmeter. A resistance R is then

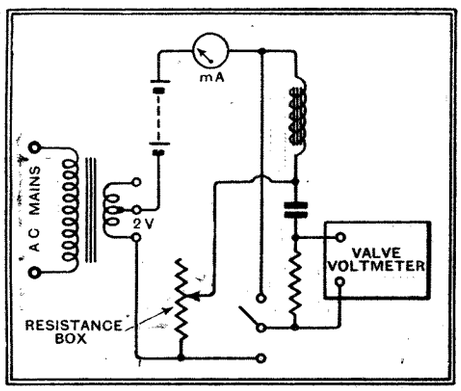
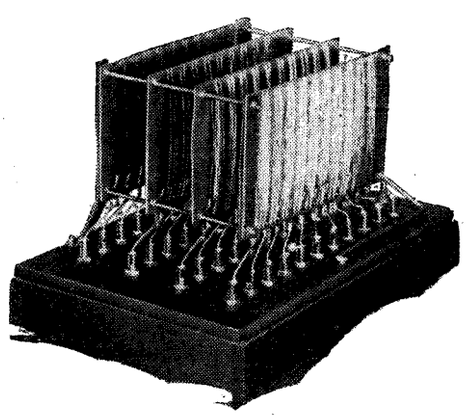


Fig. 6.—Simplified method of measuring the inductance of a choke carrying direct current.

inserted, and its value adjusted until, with other conditions remaining unchanged, the valve voltmeter reading falls to −6 db. This is equivalent to halving the volts across the tuned circuit, and the value of R will then be equal to the HF resistance of the coil. Special straight wire resistances fitting into a low capacity clip holder must be used in this test, and a number of these will be required with resistances increasing in small steps. It may not be possible to obtain an exact reduction of −6 db. by this method, but the test will be sufficient to indicate the relative merits of a number of tuning coils which may be under consideration.

Inductance of Chokes

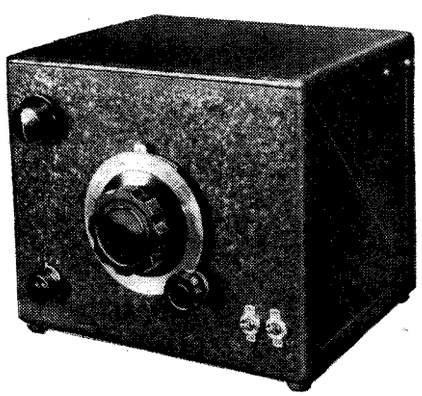
There are many measurements which may be made with a valve voltmeter which are based on equality of readings and do not depend on the calibration of the scale in any way. In other words, the valve voltmeter is used merely as an indicator. The measurement of LF choke inductance is a case in point. We may want to know the inductance with DC flowing in the circuit, and if so the



Decade resistance box with non-inductively wound elements in units, tens, hundreds and thousands of ohms.

arrangement shown in Fig. 6 is one method which may be employed. Once again the filament winding on a mains transformer can be used to send AC with a superimposed DC current from a battery in series through a variable resistance and the choke to be measured. The valve voltmeter must be preceded by a grid condenser and leak to eliminate the voltage drop due to the DC current, and a change-over switch is arranged to connect the voltmeter alternately across the resistance and the choke. The resistance is adjusted until equal readings are obtained at both positions of the switch. The inductance of the choke is then calculated from the formula $L=\frac{R}{2\pi f}=\frac{R}{314}$ for 50-cycle AC.

This is the simplest of the many so-called substitution methods of measuring choke inductance, and it assumes not only that the DC resistance of the choke is negligible, but that the inductance with only a few milliamperes of DC current will be required. Suitable modifications of this method for other cases will be found in an article in this journal dated August 26th, 1931. For the resistance a variable wire-wound volume control can be calibrated, and will give results of sufficient accuracy for finding the right order of inductance of an unknown choke, but for accurate work a decade resistance box

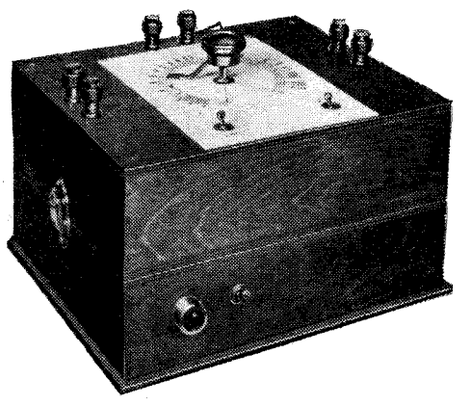


An essential item of every experimenter's laboratory should be a modulated test oscillator for ganging receivers.

will be required. This useful piece of apparatus can be constructed by winding the sections on flat cards of paxolin or other insulating material. Each section is wound in two halves with the direction of winding opposed. This form of construction gives a very low value of residual inductance, and can be used for the majority of audio-frequency measurements. At the same time a commercially designed decade resistance compensated for both inductance and capacity, and guaranteed for radio as well as audio-frequencies, may be regarded as a good investment for future requirements.

The tests so far mentioned have not involved any specialised pieces of apparatus, but have been made with the temporary assembly of a number of general purpose units. Where it is found that a certain type of measurement is being made with increasing frequency, much time will be saved if a skeleton baseboard is made up with spaces reserved for meters, resistances, etc., so that they can be dropped into place and wired up with the minimum delay.

For readers who are primarily interested in the design and construction of high-performance receivers a modulated oscillator for ganging will be an important

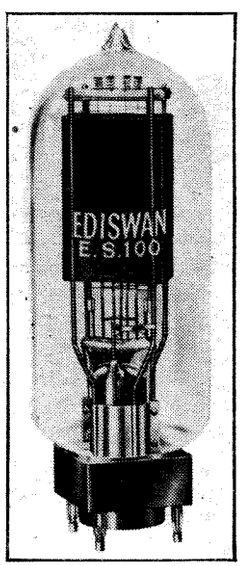


The routine checking of resistance and condenser values is simplified if a bridge is used.

item of the laboratory equipment, and will no doubt be followed later by a calibrated standard signal generator. However, this may be looking rather too far ahead, and in the meantime the construction of a capacity and resistance bridge for rapidly checking these important quantities may be regarded as a task of greater urgency. Constructional details for such an instrument were given as recently as December 20th, 1935, and to bring things right up to date attention is drawn to the valve-testing bridge described elsewhere in this issue.

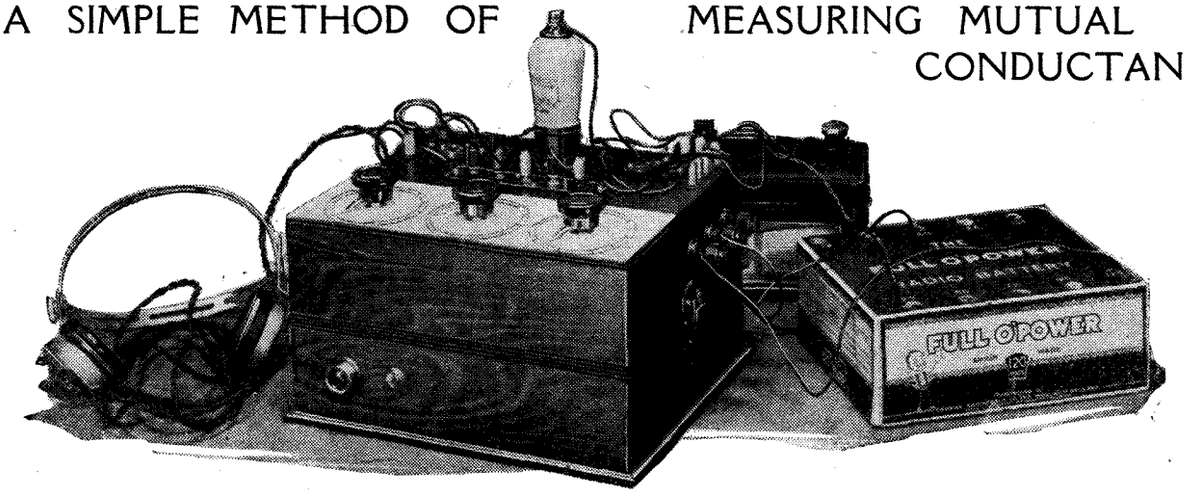
NEW EDISWAN OUTPUT VALVE

A NEW valve designed to give a large output is being produced by the Edison Swan Electric Co., Ltd.; it is the ES100. It has a filament rated for 6 volts at 3 amperes, and in normal operation it should be AC heated; if a DC filament supply be used, however, the anode return leads should be joined to the positive filament terminal. The internal AC resistance is 1,750 ohms, and the optimum load impedance is some 7,000 ohms. With its rated anode potential of 1,000 volts, the anode dissipation is 100 watts and the valve can deliver an output of 30 watts. It has a special 4-pin base and is priced at 10 guineas.



Valve Testing Bridge

A SIMPLE METHOD OF MEASURING MUTUAL CONDUCTANCE



A SIMPLE method of measuring valve constants has been a long-felt want. The construction of inexpensive gear for the measurement of mutual conductance is described in detail in this article, and it enables all types of valves other than diodes to be tested.

THE measurement of valve constants normally demands quite elaborate apparatus, and this is especially the case when a high degree of accuracy is required. It is because of this that the usual valve-tester operates merely as an emission tester combined with a very rough check on mutual conductance. The required voltages are applied to the valve and the anode current noted; the grid bias is then increased by a known amount and the new value of anode current recorded. The change in anode current divided by the change in grid voltage gives a figure representing mutual conductance, while the values of anode current themselves give an indication of the state of emission.

The results are only of value if it is known what the figures should be for the particular valve under test. The change of grid bias, for instance, used in estimating mutual conductance must necessarily be too large for the valve constants to be the same at both voltages, for it must never be forgotten that the so-called valve constants are not constant. They depend upon the construction of the valve, it is true, but also to a very large degree upon the voltages applied to the valve. With a triode the amplification factor (μ) usually varies very little with the operating condition, but the anode AC resistance (Ra) varies enormously. The ratio μ/Ra, which is called the mutual conductance (g) naturally varies also.

The AC Bridge Method

The most accurate method of measuring the constants is by means of a suitable AC bridge, and all three constants can be measured directly. The apparatus becomes quite expensive, however, when it is required to determine all three with accuracy over the wide ranges of values encountered in practice. The AC resistance of modern valves ranges from 500 ohms for an output triode to 10 megohms or more for an HF pentode at a high grid bias, while the amplification factor may be as low as 2.0 or as high as 10,000. Mutual conductance covers an equally wide range, from 0.001 mA/V to 10.0 mA/V.

Were we concerned only with triodes of ordinary design, it would be as easy to measure one constant as another, but when

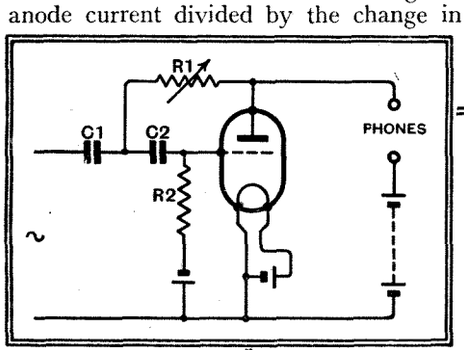


Fig. 1.—The basic circuit of the mutual conductance bridge.

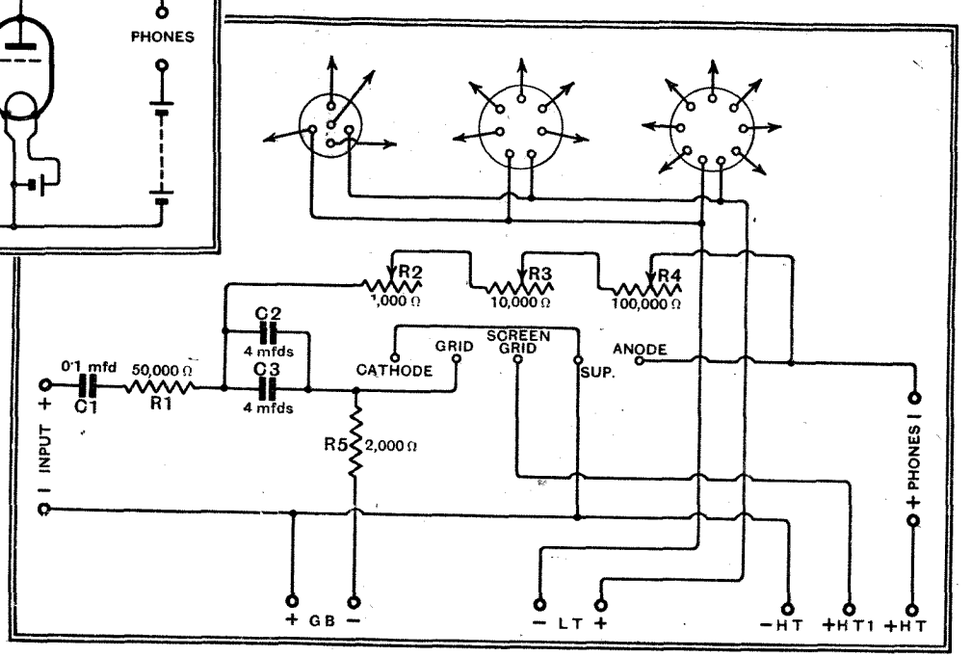


Fig. 2.—The complete circuit of the apparatus. Flex leads terminating in wander plugs are fitted to the valve-holders to enable any valve to be accommodated.

Valve Testing Bridge—

extreme values are encountered this is not always the case. In general, it is easier to measure mutual conductance than either of the other constants, and the AC resistance is the most troublesome. The most valuable single constant is mutual conductance, for it reveals more about the condition of a valve than either amplification factor or AC resistance alone.

Mutual Conductance

There are several methods of measuring mutual conductance, and the simplest, from the point of view of calibrating the apparatus, is that shown in Fig. 1. The condenser C1 serves merely to prevent the HT supply being short-circuited through the source of alternating current, and ideally the combination of C2 and R2, which are included merely to isolate the grid of the valve from the HT supply, would cause no attenuation and no phase shift. Given these conditions, the input voltage is applied to the grid of the valve directly and to the anode through R1. Owing to the reversal of phase which takes place in the valve, two voltages of opposing phase appear in the anode circuit, and when they are exactly equal in magnitude no sound can be heard in the telephones. The magnitude of the voltage which comes *via* the valve depends upon the mutual conductance and the magnitude of the opposing voltage upon the value of R1.

In practice the value of R1 is varied until silence is obtained in the telephones, and it can be shown that the mutual conductance in milliamperes per volt is equal to 1,000/R1 where R1 is in ohms. In order to measure mutual conductance over the range of 10.0 mA/V to 0.01 mA/V, therefore, R1 must be variable from 100 ohms to 100,000 ohms.

The condenser C2 and resistance R2 will introduce an error if they cause the voltage actually applied to the grid of the valve to be appreciably less than that fed to R1. The error can be made negligibly small, however, by assigning large enough values to these components. Of greater importance is the phase shift which they introduce. When the grid and anode voltages are not in exactly the same phase, no silent point can be found when adjusting R1 for balance, but only a minimum. This makes the adjustment difficult and liable to error. Minimum phase change and the best balance are secured by using large values for C2 and R2, so that the requirement is the same as for avoiding attenuation; it is, however, much more severe.

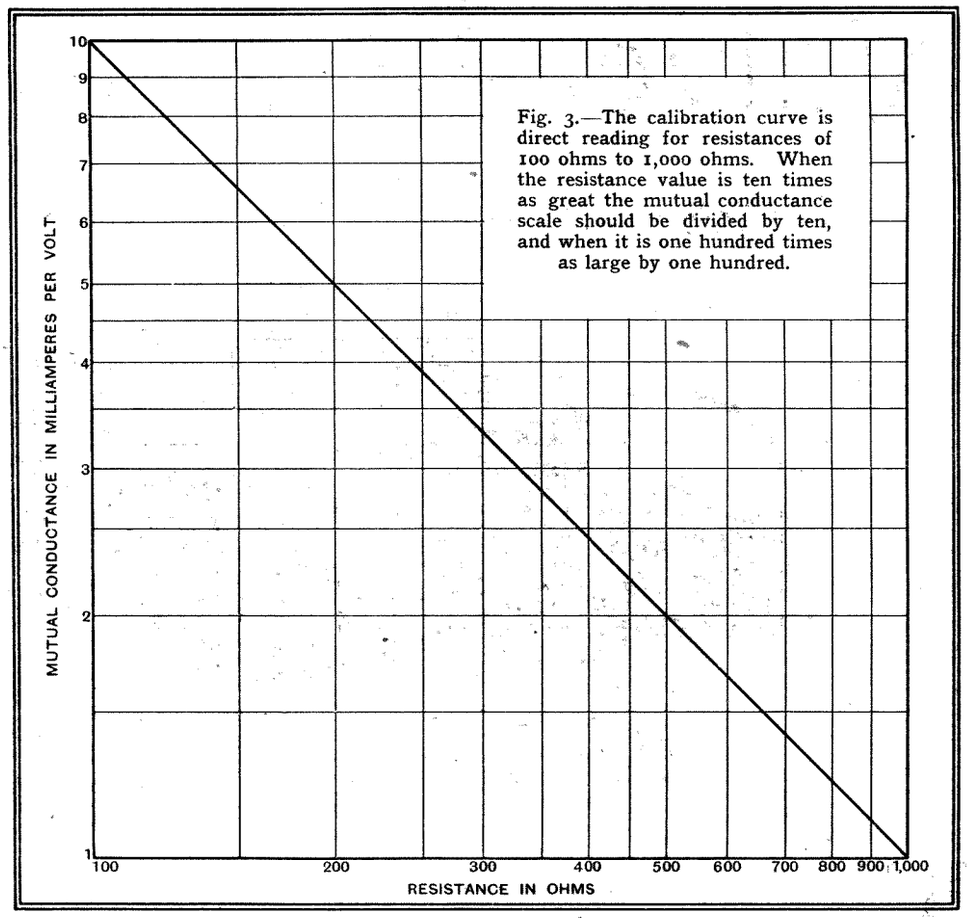
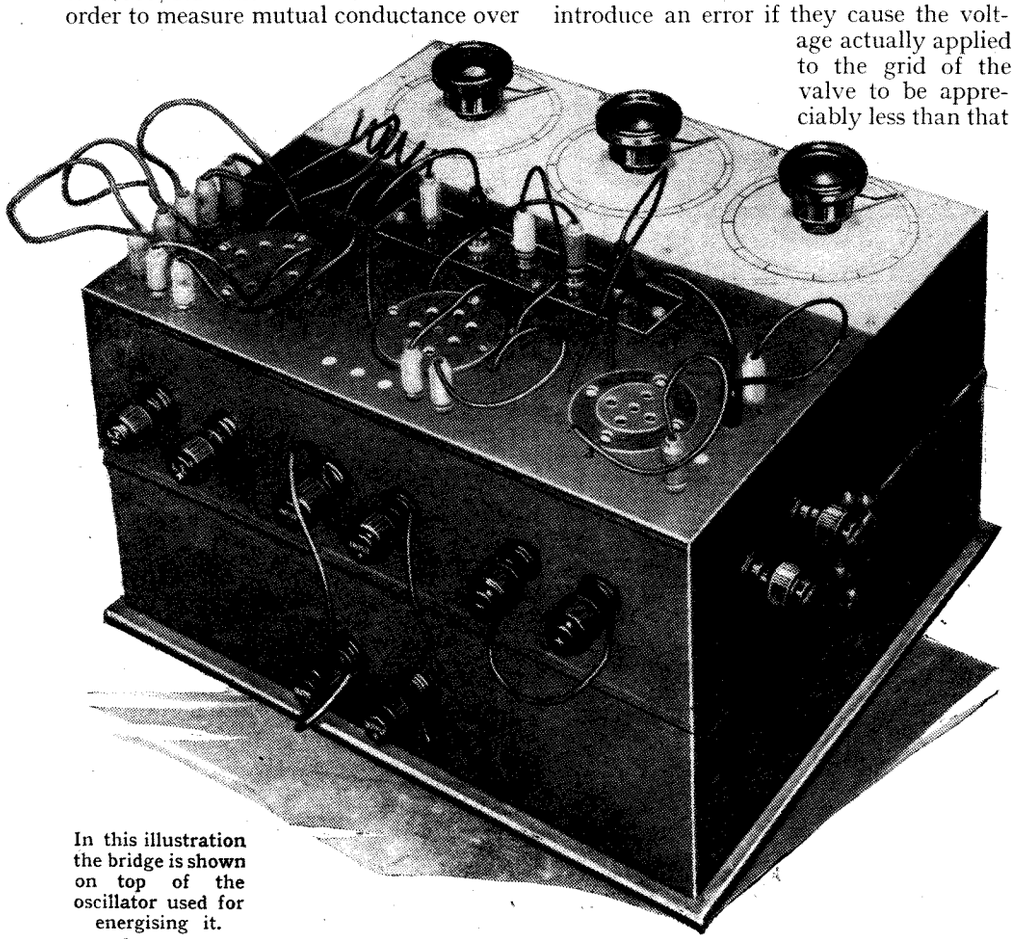


Fig. 3.—The calibration curve is direct reading for resistances of 100 ohms to 1,000 ohms. When the resistance value is ten times as great the mutual conductance scale should be divided by ten, and when it is one hundred times as large by one hundred.



In this illustration the bridge is shown on top of the oscillator used for energising it.

The Practical Arrangement

At first sight it would seem that one could use for these components the values customarily employed in a resistance-coupled amplifier. It is, however, often required to take measurements of valves operating with zero grid bias, for the makers' figures for mutual conductance are usually quoted for this condition. The valve may then pass grid current, and if there is a resistance in the grid circuit the bias will no longer be zero but slightly negative. In order to make the discrepancy negligible it is necessary to make R2 quite low, and a value of 2,000 ohms has been found satisfactory. With this low value of resistance it is necessary to give C2 a capacity of 8 mfds. to maintain the phase change at a satisfactorily low degree.

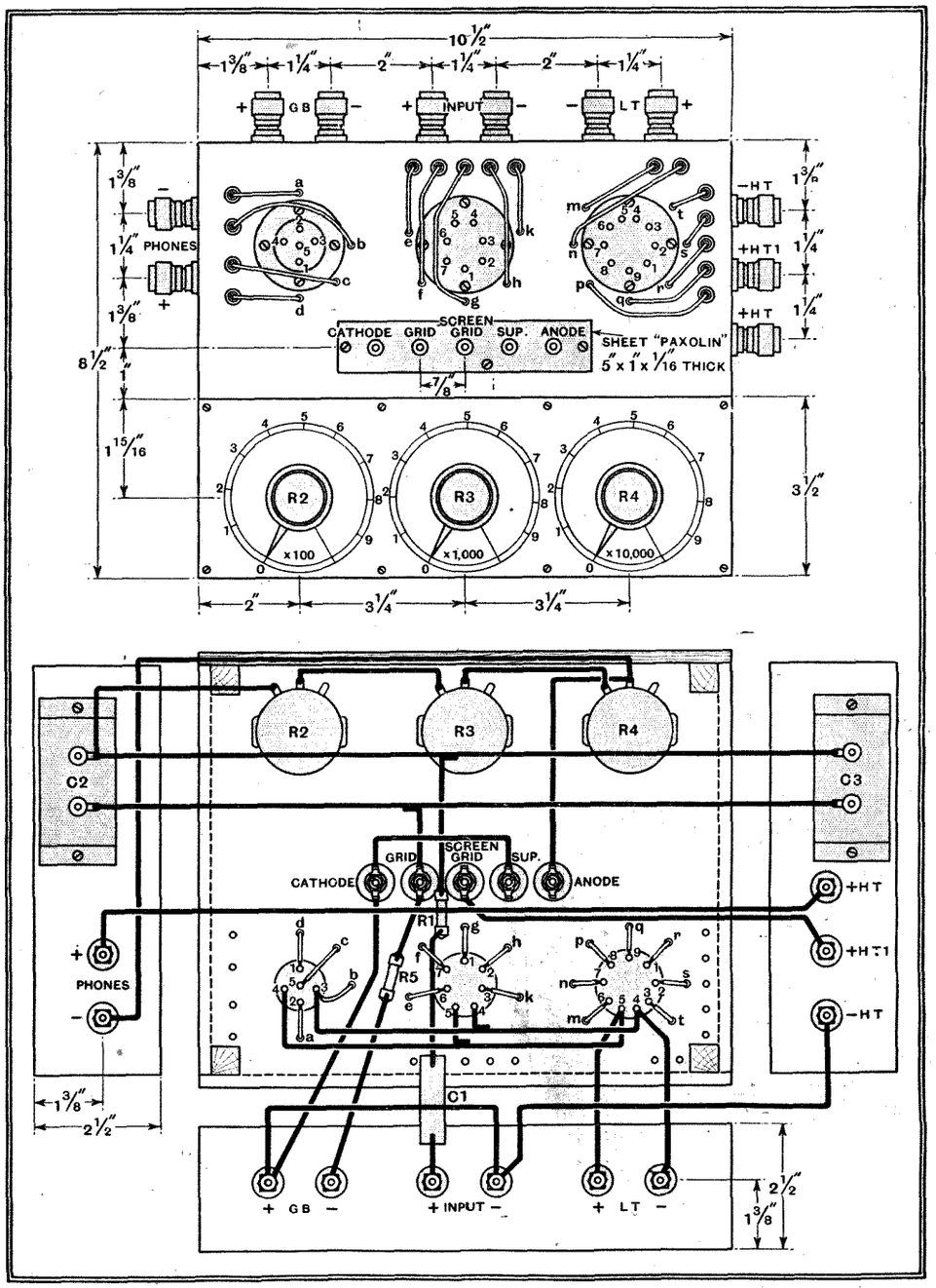
Using these values a very good balance is secured over the wide range of 0.1-10.0 mA/V; although complete silence is not secured, the balance point is very sharp

Valve Testing Bridge—

and definite. For lower values of mutual conductance the balance deteriorates somewhat, but is reasonably accurate down to 0.01 mA/V.

Since the mutual conductance is proportional to the reciprocal of resistance, the scale cannot satisfactorily be made direct reading. In order to obtain a reasonably open scale it would be necessary to have a tapered resistance with an extraordinarily high degree of taper—probably too great to manufacture. The scale is consequently calibrated in resistance values, and to obtain the mutual conductance it is necessary either to work out the reciprocal or refer to the conversion curve given in Fig. 3 of this article.

The photographs and drawings clearly show the construction of the gear which is designed to work with the oscillator, which was described in *The Wireless World* for December 20th, 1935, for a Resistance and Capacity Bridge. The complete circuit diagram appears in Fig. 2, and it will be seen that three variable resistances are employed for balancing. This is done in order that a high degree of accuracy may be obtained over a wide range. The resistance R2 has a maximum value of 1,000 ohms, R3 10,000 ohms, and R4 100,000 ohms.



These drawings show the full constructional details of the bridge together with the wiring.

For mutual conductances higher than 1 mA/V only the 1,000 ohms resistance R2 should be used, R3 and R4 being set at zero. The 10,000 ohms resistance R3 should be employed for mutual conductances between 1 mA/V and 0.1 mA/V, while the third resistance R4 is for values down to 0.01 mA/V. Whichever resistance is being used, the other two must be set at zero. It is, of course, possible to employ the three resistances in the manner of a decade box, setting the high values only at tenths of the maximum values. This is somewhat more troublesome, but is slightly more accurate at high values of resistance.

Three valve holders are embodied in order to accommodate all standard types of valves. The filament sockets are all wired in parallel and connected to the LT terminals. For battery valves a 2-volt accumulator should be joined to these, but for AC valves either a 4-volt accumulator or the 4-volt winding of a mains transformer. The remaining sockets of the valve holders cannot be permanently wired, for the connections required depend upon the particular valve to be tested. A flex lead terminating in a wander plug is therefore attached to each socket, and a row of five sockets is provided for them. When not in use the plugs are kept tidy by being placed in holes drilled in the wooden panel. Only a few of the plugs are in use at any one time.

Using the Bridge

For directly heated valves the filament plug is inserted in the cathode socket, but for indirectly heated types the cathode plug is used and the filament plug left free. Whichever valve sockets they may be, the grid, screen grid, suppressor grid, and anode must always be joined to the appropriate sockets in the centre by the flex leads. If the valve has a top cap or side terminal this must be joined to the appropriate socket by a separate lead terminating in a plug. Any other pins of normal valves need not be connected, for metallising and diode anodes can be left free.

Terminals are provided for the grid bias and HT batteries. For normal tests when the results will be compared with the valve makers' figures the grid bias terminals will be short-circuited, and for triodes 100 volts HT should be used. Actually the anode potential should be

List of Parts.

1 Valve holder, 5-pin (without terminals) **Clix Chassis Mounting Type V1**
1 Valve holder, 7-pin (without terminals) **Clix Chassis Mounting Type V2**
1 Valve holder, 9-pin (without terminals) **Clix Chassis Mounting Type V2**
2 Fixed condensers, 4 mfds. 500 volts DC test **C2, C3** **Dubilier B5**
1 Fixed condenser, 0.1 mfd. tubular, **C1** **Dubilier 4513**
1 Resistance, 50,000 ohms ½ watt **R1** **Bulgin HW23**
1 Resistance, 2,000 ohms ½ watt **R5** **Bulgin HW5**
1 Potentiometer, wire wound, non-taper, 1,000 ohms, **R2** **Reliance S/W10**
1 Potentiometer, wire wound, non-taper, 10,000 ohms, **R3** **S/W11**
1 Potentiometer, wire wound, non-taper, 100,000 ohms, **R4** **Reliance S/W12**
3 Knobs **Bulgin K12**
11 Ebonite shrouded terminals, input +, input −, phones +, phones −, grid +, grid −, LT +, LT −, HT +, HT +1, HT − **Belling-Lee "B"**
17 Wander plugs **Eelex**
5 Sockets **Eelex**
Wood, systoflex, wire, screws, etc.

Valve Testing Bridge—

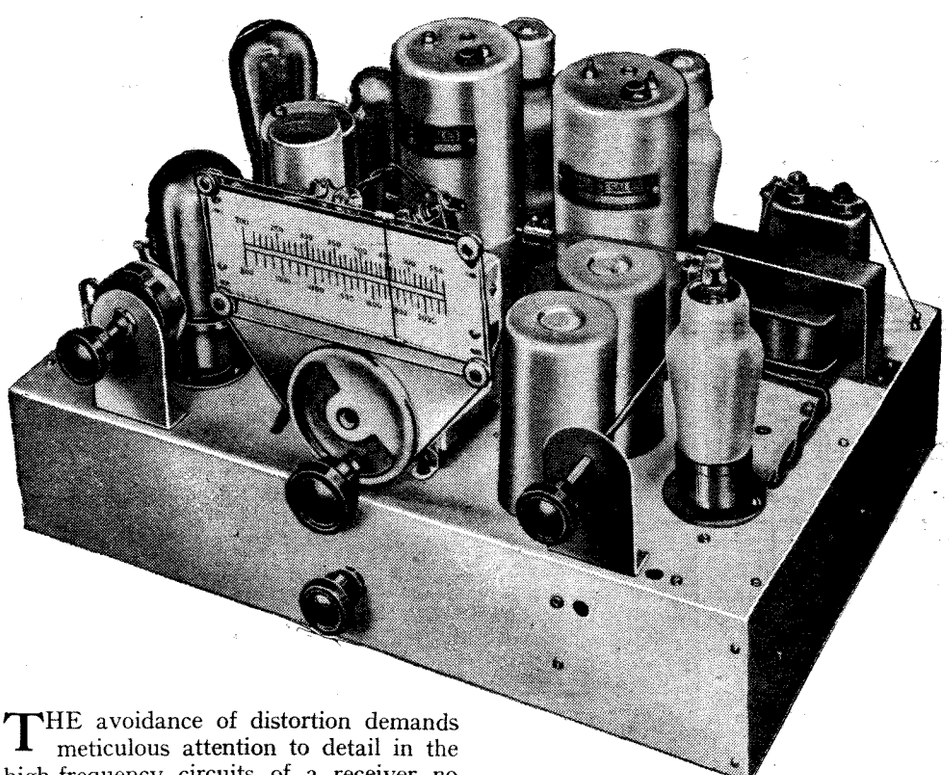
100 volts, and it will be less than the battery voltage by the drop in the telephones. Strictly speaking, therefore, the battery voltage should be adjusted so that the voltage measured between the cathode and anode sockets on the panel is 100 volts with the valve in place and operative. When power valves are being measured the current may be quite large and the voltage drop across a pair of phones will be high. In order to avoid this and to protect the phones it is best to use an output transformer with a low primary resistance. Alternatively, the phones can be shunted by a choke of low DC resistance; the inductance need not be high, for 2H or 3H is sufficient. Measurements of anode current can, of course, be made by connecting a suitable milliammeter in the positive lead to the high-tension battery.

Little more need be said about the uses of the instrument or the method of connecting it up for different valves, for these are obvious. The question of calibration must receive attention, however, and this is easily done with the aid of the resistance bridge already referred to. A sheet of white paper, or, better, ivorine, should be fastened to the panel to receive the scale, and the two extreme ends of the three resistances used for balancing joined to the resistance bridge. Set R3 and R4 to zero and the resistance bridge to 100 ohms. Adjust R2 for silence, and mark off the scale for 100 ohms. Then set the bridge to 200 ohms, and repeat. As many intervening values as are required can be marked off, and when this resistance has been done, R3 can be tackled. Here both R2 and R4 must be at zero and this is calibrated in 1,000-ohm steps with suitable intermediate steps. Lastly, R4 is calibrated in 10,000-ohm steps with R2 and R3 at zero. The process is quite easy, which is fortunate, for it is not possible to rely on variable resistances being sufficiently consistent for a printed scale to be used.

In Next Week's Issue

Distortionless Receiving Equipment

The QA SUPER



THE avoidance of distortion demands meticulous attention to detail in the high-frequency circuits of a receiver no less than in the LF equipment. Every endeavour has been made in designing the QA Super to produce a receiver which is a worthy companion to the Push-Pull Quality Amplifier. The set is a superheterodyne, including a frequency-changer and two IF stages with variable selectivity; diode detection is used, and a special AVC system giving an exceptionally wide range of control and maintaining the valves always under linear conditions of operation.

LIST OF PARTS.

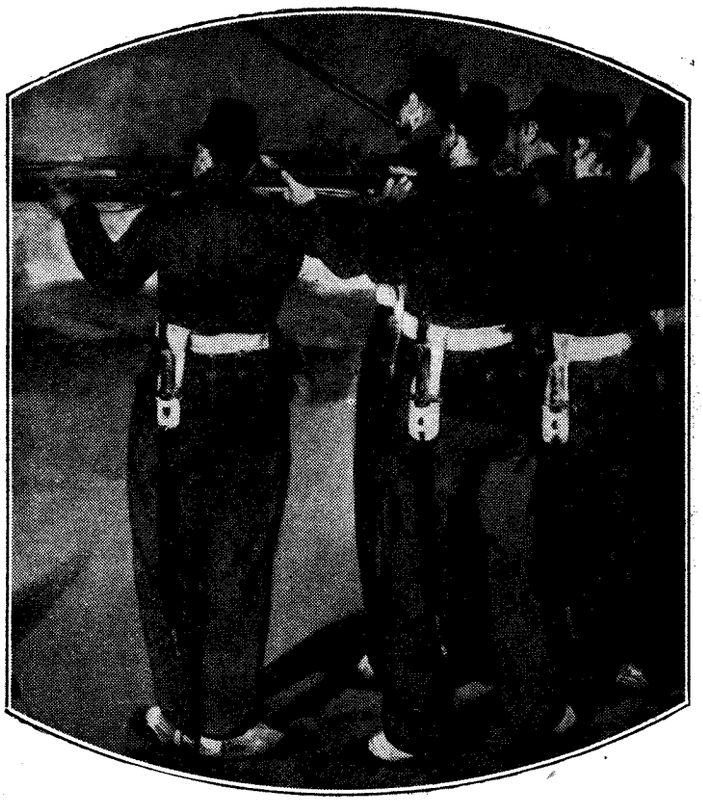
1 Two-gang condenser, 0.0005 mfd. **Polar "Midget"**
1 Dial **Polar VP Horizontal Drive** (Utility)
2 Bulbs for above, 4 volts, 0.1 amp. **Bulgin B410**
2 Reaction condensers, 0.0005 mfd. with knobs **Ormond R509**
1 Aerial Coil **Bulgin C6**
3 Aerial loading coils **Bulgin C42**
1 Oscillator coil 465 kc/s **Bulgin C59**
1 IF transformer, 465 kc/s **Bulgin C50**
2 IF transformers, variable selectivity, 465 kc/s with 6in. extension rod and adaptor for ¼in. knob **Sound Sales IF465**
2 Trimmers, 0.0003 mfd. **Sound Sales 3VC**
1 Transformer, Primary: 4 volts 50 c/s. Secondary: 175 volts 5 mA. **N. Partridge WW4**
(All-Power, Bryce, Challis, London Transformer Products, Claude Lyons, Sound Sales, Vortexion)

Fixed Condensers

5 0.0001 mfd. **Dubilier 665**
2 0.0003 mfd. **Dubilier 665**
1 0.0005 mfd. **Dubilier 665**
1 0.001 mfd. **Dubilier 670**
1 0.005 mfd. **Dubilier 670**
2 0.01 mfd. **Dubilier 670**
12 0.1 mfd. Tubular **Dubilier 4513**
1 2 mfds. 250 volts DC working **Dubilier "BB"**
(Bulgin, Polar-N.S.F., T.C.C., T.M.C.-Hydra)
1 50 mfds., Electrolytic, 12 volts DC working **Dubilier 3013**
1 8 mfds., Electrolytic **Dubilier 0281**
(Polar-N.S.F., T.C.C.)
2 8 mfds., Electrolytic, 150 volts DC working **T.C.C. "AT"**

Resistances

1 150 ohms ½ watt **Bulgin HW38**
5 500 ohms ½ watt **Bulgin HW2**
1 1,000 ohms ½ watt **Bulgin HW3**
1 2,000 ohms ½ watt **Bulgin HW5**
1 5,000 ohms ½ watt **Bulgin HW10**
3 10,000 ohms ½ watt **Bulgin HW15**
4 50,000 ohms ½ watt **Bulgin HW23**
1 75,000 ohms ½ watt **Bulgin HW24**
1 100,000 ohms ½ watt **Bulgin HW25**
2 500,000 ohms ½ watt **Bulgin HW31**
2 2 megohms ½ watt **Bulgin HW34**
(Ferranti)
1 2,000 ohms 1 watt **Erie**
2 20,000 ohms 1 watt **Erie**
1 5,000 ohms 2 watts **Erie**
(Amplion, Bryce, Dubilier, Ferranti, Claude Lyons, Polar-N.S.F.)
1 5,000 ohms **Bulgin PR9**
3 10-way resistance boards **Bulgin C32**
1 Tapered volume control, 0.25 megohm **Reliance SG25**
(Ferranti, Claude Lyons, Rothermel)
1 Multi-contact switch **Magnum WW7**
1 Whistle suppressor **Kinva (QA receiver type)**
1 Metal rectifier half-wave **Westinghouse H50**
3 Valve holders 5-pin (without terminals) **Clix Chassis Mounting Type V1**
3 Valve holders 7-pin **Clix Chassis Mounting Type V2**
6 Ebonite shrouded terminals, A, E, PU (2) output (2) **Belling-Lee "B"**
1 5-way cable with twin 70/36 leads and 5-pin plug **Goltone**
2 lengths screened sleeving **Goltone**
2 Screened top connectors **Bulgin P64**
1 Plug top connector **Belling-Lee 1175**
1 Pair bevel gears, equal sizes 1-1 ratio ⅞in. dia. × 26 teeth **Meccano Type 30**
1 Knob **Bulgin K12**
3 Knobs **Bulgin K14**
Chassis, complete with brackets and screens **B.T.S.**
Miscellaneous:— **Scientific Supply Stores**
1 oz. No. 16 and 4 ozs. No. 20 tinned copper wire, 9 lengths systoflex, 2 lengths brass studding 4BA 1¼in. long, etc. Screws:—4 6BA brass screws 1in. long; 8 6BA brass screws ½in. long; 65 6BA brass screws ¼in. long; 4 4BA brass screws ½in. long; 85 6BA brass nuts and washers; 12 4BA brass nuts and washers.
Valves:—
2 VMP4G metallised, 1 D41 non-metallised, 1 MH4 non-metallised, 1 MHL4 plain or metallised, 1 X41 metallised. **Osram or Marconi**



[By permission of the Tate Gallery.

DEATH OF AN EMPEROR.—Manet's famous fragment (from a larger canvas) showing the firing party at the execution of the Emperor Maximilian, whose court-martial and death are the subject of Philip Guedalla's radio play on Monday and Tuesday.

Listeners' Gu

Outstanding Broadcasts at

ROYALTY in distress was ever a rich theme for the dramatist: the greater the royal fall, the greater the drama. This week's radio play contains the tragic ingredient in full measure, for it concerns the ill-fated Archduke Maximilian of Austria, who in 1867 was persuaded by Napoleon III to establish a royalist régime in Mexico with French support. The Archduke, his head filled with visions of Imperial glory, set out with his wife for the New World, but disillusionment followed quickly. The French troops were withdrawn from Mexico, and Maximilian was left to his fate. Deserted by all but a few followers, he was arrested, condemned, and shot.

It is with the final stages of this melancholy story that Philip Guedalla has concerned himself in "Court-Martial of an Emperor," to be broadcast on Monday (Nat., 8.40) and Tuesday (Reg., 8). Malcolm Keen will play the part of Maximilian.

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LARRY ADLER

LARRY ADLER, the mouth organ virtuoso, has obtained the permission of the composer to play Kreisler's "Liebesfreud" in his microphone concert on Sunday next (Reg. 6.45) with Stanford Robinson and the Theatre Orchestra. Larry doubted whether the playing of such a piece on the mouth organ would be overstepping the bounds of musical propriety, but when he met Kreisler in person at the Birmingham Town Hall the great man was friendly. "Do you mind your great works being massacred on the mouth organ?" asked Larry. "But why not?" smilingly queried Kreisler. "After all, have they not been played on the saxophone, even on a zither?"

Other items in this intriguing concert will be "Caprice Viennois," De Falla's "Fire Dance," and, as a popular number, a new arrangement of "Stardust," composed by Hoagy Carmichael.

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ONLY ONE BRANSBY WILLIAMS

MANY people would rather hear the same sketches repeated by Bransby Williams than a repertory of new ones by the average elocutionist. Bransby comes to the Regional microphone at 8 on Thursday to give such favourite monologues as "Devil May Care," "'Is Pipe," and "The Caretaker."

MASTERS OF THE BOW

MUSICIANS will stay indoors on Wednesday evening next for the rare treat of hearing Lionel Tertis (viola) and Adolf Busch (violin) playing together in Mozart's "Symphonie Concertante" for violin, viola, and orchestra. This is the main item in the B.B.C.'s Queen's Hall Symphony Concert at 8.30, with Sir Henry Wood as conductor. The concert also includes Arnold Bax's "Overture, Elegy and Rondo," and Sibelius' First Symphony.

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MUSIC, BUT NO POLITICS

A THIRTY-YEAR-OLD Russian who has been called the "Composer Laureate" of the Soviet State is represented in the Sunday Orchestral Concert (Reg., 9.20). He is Dmitri Shostakovitch, whose Symphony No. 3 will be conducted by Nikolai Malko. The music of Shostakovitch is looked upon as an expression of political faith, and the composer is fond of quoting Lenin, who said that "Music is a means of unifying broad masses of people." The B.B.C. anxiously points out, however, that his work must be judged on its musical merits and not for any political or economical theories it may contain.

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"THE STUDENT PRINCE"

WITHOUT doubt, the week's most tuneful programme will be Romberg's ever-popular operetta, "The Student Prince," which has been adapted for broadcasting by Mark Lubbock and Peter Cresswell. "The Student Prince" will be heard at 8.30 on Thursday (Nat.).

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DRAMATISED SCRIPTURE

"ST. PAUL," the thirty-minute radio play by Geoffrey Dearmer which is being broadcast at 5.30 on Sunday (Nat.) was originally written for performance in Liverpool Cathedral in 1929. Chief events in the play are St. Paul's conversion, his determination to admit Gentiles into the Church, and his martyrdom under Nero. In a printed version of the play Mr. Dearmer has quoted a formidable list of authorities to guarantee the accuracy of his interpretation. The play will be produced by Robin Whitworth.

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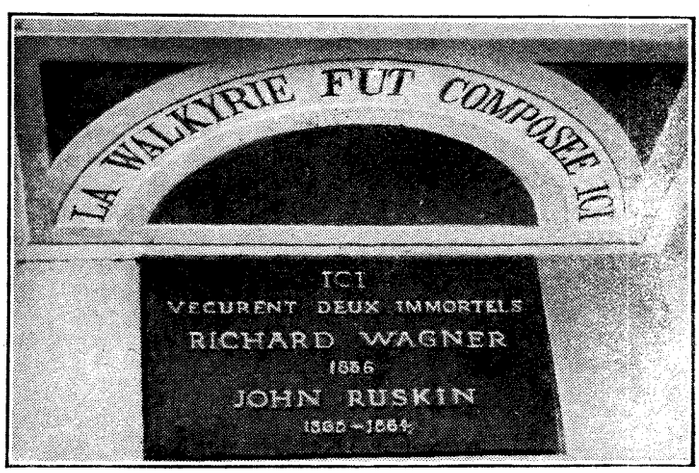
PANCAKES—AND WHY

SHROVE TUESDAY is not only noted for tossing the pancake, but for a number of other queer practices which will be illustrated in a programme which Felix Felton is producing on the National wavelengths at 9 on Tuesday. The Effects Department will be busy, no doubt, for the strange customs to be depicted will include playing ball games through the streets, taking eggs to the school for the master's pancakes, and throwing broken crockery at cottage doors.



"VALKYRIE."—This interesting tablet adorns a house "for sale" at Mornex, in the Zone Franche. Extracts from Wagner's "Valkyrie" will be heard in the Brussels II programme at 11.15 p.m. on Sunday.

ide for the Week

Home and Abroad

HIGHLIGHTS OF THE WEEK

FRIDAY, FEBRUARY 21st.

Nat., 8, Songs from the Shows. 10.20, B.B.C. Concert of Contemporary Music.
Reg., 9, "The Doctor's Day."
Abroad.
Rome, 7.35, Operetta: "Le Roi de Chez Maxim" (Costa).

SATURDAY, FEBRUARY 22nd.

Nat., 2.50, Rugby International, Scotland *v.* Ireland. 8.30, Savoy Hill Memories.
Reg., 8.30, "Boris Godounov," relayed from Sadler's Wells.
Abroad.
Paris, P.T.T., 8.30, Cabaret and Revue.

SUNDAY, FEBRUARY 23rd.

Nat., Mantovani and his Tipica Orchestra. ¶"St. Paul," by Geoffrey Dearmer. 9, Hastings Municipal Orchestra.
Reg., B.B.C. Military Band. 6.15, Lewis Carroll Nonsense Songs. ¶Sunday Orchestral Concert, conducted by Nikolai Malko.
Abroad.
Munich, 10, Visits to four Carnival Balls.

MONDAY, FEBRUARY 24th.

Nat., Carroll Gibbons' Band. 8.40, "Court-Martial of an Emperor," (radio play).
Reg., B.B.C. Organ Recital. 8.30, "The Table Under the Tree."
Abroad.
Brussels II, 8, Symphony Concert.

TUESDAY, FEBRUARY 25th.

Nat., 8, Florence Oldham in Variety. 9, "Shrove Tuesday"—feature programme. ¶"Conquest of the Air, II."
Reg., B.B.C. Dance Orchestra. 8, "Court-Martial of an Emperor."
Abroad.
Leipzig, 7.10, Operetta: "Die Fledermaus" (Johann Strauss).

WEDNESDAY, FEBRUARY 26th.

Nat., B.B.C. Dance Orchestra. 8.30, B.B.C. Symphony Concert. Conductor: Sir Henry Wood.
Reg., 8.15, Old Ballad Concert—VI. ¶Serge Krish Septet. ¶Roy Fox and his Band.
Abroad.
Frankfurt, 7.45, Bach-Handel Concert, with Organ, Harpsichord and Orchestra.

THURSDAY, FEBRUARY 27th.

Nat., Alfredo Campoli Trio. 8.30, "The Student Prince" (Romberg). ¶Casani Club Orchestra.
Reg., Bransby Williams. 8.15, Royal Philharmonic Concert. Conductor: Sir Thomas Beecham.
Abroad.
Kalundborg, 7, Schubert Concert from the Oddfellows' Hall.

CARNIVAL.—A pictorial soufflé of the fare which we may expect from German, French and other Continental stations on Monday and Tuesday, when all Europe will be making merry.

THE CARNIVAL SPIRIT

CARNIVAL, not unconnected with Shrove Tuesday and the beginning of the Lenten season, dominates the Continental programmes on Monday and Tuesday next. Munich offers a carnival gala programme on Tuesday at 7.10, which will probably typify the spirit of conviviality throughout Europe. Both on Monday and Tuesday the German stations will be giving relays of actual festivities as well as carnivals from the studios; Kalundborg at 9 on Tuesday offers "Carnival Frolics," and there will be similar jollities in France.

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MODERN ITALIAN OPERA

THE fact that Respighi, the great Italian operatic conductor, is lying seriously ill gives poignant interest to the broadcasting of his most recent, and perhaps most beautiful work, "La campana sommersa," from Rome on Saturday evening at 7.35. Respighi's music is probably better known in this country than that of any other living Italian. It is modern, but strikingly free from eccentricity.

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"TOSCA" ON 120 kW.

NOW that Strasbourg is using 120 kilowatts the relay of "Tosca" (Puccini) and "Cavalleria rusticana" (Mascagni) from the Opera-Comique, Paris, at 8.15 tomorrow should be well worth tuning in. At 8.10 on the same evening Wagner's "Flying Dutchman" is being offered by Breslau. Another Wagner item on Sunday comes from Brussels No. 2, viz., selections from the "Valkyrie" from 11.15 until midnight. Earlier on Sunday evening Brussels No. 1 relays Saint-Saëns' great biblical opera, "Samson and Delilah," from the Brussels Opera House at 8. Mozart enthusiasts should certainly not miss two miniature comic operas, 'L'Oca del Cairo" and "Lo sposo deluso," which Leipzig and other German stations are relaying from Saarbrücken at 7.10. These miniatures, though seldom heard, are rich examples of Mozart's inimitable melody and elegance.

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NATIONAL MUSIC

BROADCASTING seems to be reviving the cult of National and folk music. This week I have picked out at least seven outstanding examples. Tonight Moscow gives Russian folk songs at 7; Hamburg at 7.10, Scandinavian music; and Warsaw at 8.50, Polish dances and songs. Then, to-morrow, the Deutschlandsender gives songs and dances by a children's choir at 5 p.m., and at 7.10 Konigsberg relays a Rhineland carnival in which will be heard the Dietrich Schrammel Ensemble. Brussels No. 1 takes us to Russia for music and song at 9.15 on Monday, and Kalundborg at 9 on Tuesday brings Danish folk music from Aarhus.

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VERDUN

FRANCE never forgets the triumph and tragedy of the Battle of Verdun, and to-night Radio-Paris radiates a programme of commemoration.

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TITLES

FOR titles we must "hand it" to Germany. On Monday at 7.10 Munich offers a "grotesque" musical comedy entitled, "The Magic of the Voice," or "The Victory of Innocence and Broadcasting over Foolishness and Pride." Another good German title has been chosen for Cologne's offering at 7.10 on Thursday, "Girls in the World are Worse than Bad Money."

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BRIGHTER SUNDAYS IN DENMARK

AN effort to prevent the "disgusted snapping of switches," apparently a general practice in Danish homes on Sunday evenings, is to be made by the Danish programme director, who is bringing Louis Preil's dance band to the microphone to lighten the Sabbath programmes after 7 o'clock.

So Kalundborg promises to be yet another bright alternative to B.B.C. fare, for though, I hear, some of the conventional decorum of the day is to be preserved by means of readings and Mozart recitals, these are to be sandwiched between the hot-dance sessions.

THE AUDITOR.

MEASURING INSTRUMENTS

A Review of Suitable Equipment for Home and Laboratory Use

IN an article published nearly a year ago under the title of "Testing Without Equipment," the resourceful author showed his readers how to set about the task of finding a fault in a receiver without the aid of any measuring instruments whatever. One could not fail to admire the ingenuity with which substitutes were devised, or even to admit that those gifted with the detective instinct and with well-developed powers of deduction may perform wonders, but even with the best of luck one is sure, sooner or later, to come to a full stop. In any case, only the most elementary testing can be done without meters, and the lack of them is, at the best, always responsible for a waste of time.

Voltmeters

Of the various instruments that are used in testing and locating faults, the voltmeter is, by common consent, the most useful. So far as the modern mains set is concerned the indications given by a milliammeter are perhaps more informative, but its use involves the breaking of connections in order that the meter can be inserted in series with the circuit under test. A voltmeter, on the other hand, is always connected in shunt and so is obviously easier to use.

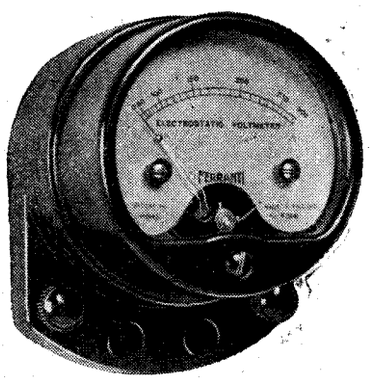
Cheap moving-iron voltmeters, it must be admitted, have a distinctly limited field of usefulness. Their accuracy is questionable, and, worse still, most of them impose a fairly heavy load on the circuit under test, with the result that the voltage measured is not that existing under normal conditions. However, they have their uses; applied with common sense and a knowledge of their shortcomings, valuable information can be obtained.

For serious testing purposes, moving-coil instruments are employed for DC work, and, with the addition of a metal rectifier, for AC and signal-frequency measurements. The advantage of these rectifying instruments is that, within wide limits, they are independent of frequency. Where supply frequency AC voltages only are to be measured, moving-iron instruments of suitable design are generally preferred.

As a general rule for wireless testing purposes, high resistance is extremely desirable, but for basic reasons inherent in the design of all instruments, this desirable feature involves extra cost.

In the Weston series of 2-in. panel-mounting DC voltmeters, there is an unusually wide choice of ranges; those in most common use cost £1 14s. The standard resistances are 200 or 500 ohms per volt. Thermal meters for high-frequency measurements are also made.

In the Ferranti series of DC moving-coil voltmeters, all requirements are catered for. Both flush-mounting and projecting patterns are made, and the price is from £1 15s. upwards according to scale readings. Three-range voltmeters, either in portable form or for flush mounting, will usually be preferred for general testing, as their use shows a considerable economy over separate meters of the same scope. Ferranti moving-iron meters reading both AC and DC are made in one,



The Ferranti electrostatic voltmeter consumes no current, and so is suitable for measurements in high-resistance circuits.

two, and three ranges; these are not expensive instruments; they cost from 25s. upwards, but are not, of course, comparable with the cheap watch-type meters. For the higher voltages resistance is 210 ohms per volt. Metal-rectifier AC instruments work on frequencies from 20-20,000 c/s and have a resistance of 1,000 or 2,000 ohms per volt.

As is well known, the electrostatic meter, which reads either AC or DC, consumes no current whatsoever, and so does not affect the circuit to which it is connected except by adding a small amount of capacity. In the standard Ferranti electrostatic range the readings vary from 50-300 volts to 1,000-3,500 volts; most of these cost £3 5s. There is a special model reading from 30-150 volts at £6 10s.

The Salford Electrical Instrument Co. produce 2½in., 3in., and 3¼in. moving-coil voltmeters for DC and moving-iron instruments for AC, as well as a series of rectifier-type meters for measuring AC of supply or audio frequencies. The exceptionally wide range of instruments made by this firm is completed by a series of thermal radio-frequency meters.

Although they are perhaps more useful for specialised purposes than for general testing the Bulgin miniature moving-iron instruments should be mentioned, if only because the data published with respect to them is so complete that it is easy to determine their suitability for any special purpose. The same firm also make conventional moving-coil and AC-DC moving-iron instruments in useful ranges.

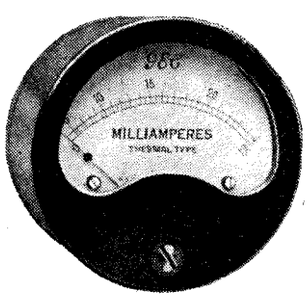
Inexpensive moving-iron instruments of the watch-type are made by Sifam Electrical Instrument Co., which also produce a series of low-priced magnetic-controlled polarised meters accurate to 5 per cent. The Sifam moving-coil meters, with a resistance of 200 ohms per volt, average about 30s. in price, while moving-iron instruments for AC or DC work cost from 21s. to 25s.

Inexpensive watch-type moving-iron voltmeters with one or two ranges are made by Goltone, Telsen Electrical, and Nivex, etc.

Milliammeters

For ordinary testing work the moving-coil milliammeter is always used, and, in view of the fact that the currents flowing in the various circuits of a wireless receiver differ so greatly, multi-range instruments are generally favoured. As in the case of voltmeters, metal rectifiers are often fitted in order that AC or audio-frequency currents can be read, and thermal meters are employed for radio-frequency work. All makers of voltmeters detailed in the preceding section also produce current-measuring instruments with similar features and at approximately the same price, so far as normal ranges are concerned.

The Salford Electrical Instrument Co.'s milliammeters are, of course, made in the same sizes as the voltmeters, and among other current-measuring instruments there is an 0-25 microammeter; a new production which aroused considerable in-

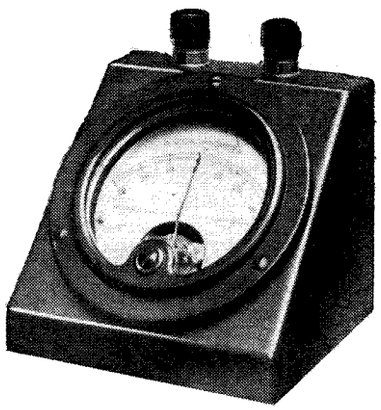


The Salford thermal milliammeter, for HF measurements.

terest at the recent exhibition of the Physical Society.

In addition to milliammeters, there are several Weston galvanometers and microammeters suitable for wireless purposes; the former are specially useful for bridge work. Ferranti also makes microammeters, while the 0-1 milliammeter made by this firm is widely used as a basis for home-assembled test sets or for simple valve voltmeters.

Modern Types and Their Applications



Weston centre-zero galvanometer, for bridge work.

Multi-range Instruments

As compared with separate meters for each purpose, the multi-range test set scores heavily on the grounds of economy and in saving of space. On the debit side all that can be urged against it is some inevitable loss of legibility of the scale, and the fact that it does not permit of simultaneous observation of what is taking place in two or more circuits.

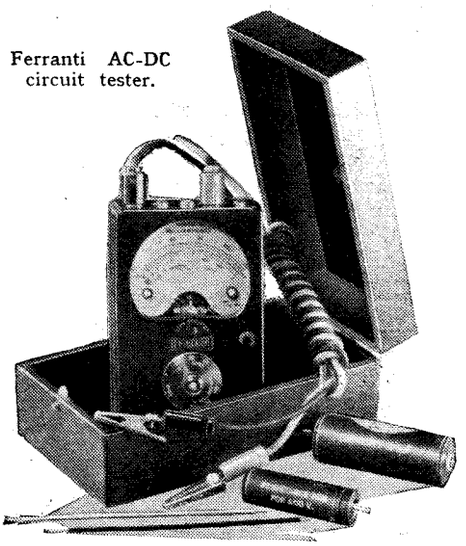
Essentially, a combination test set is nothing more than a milliammeter and a number of series resistors, parallel shunts

Radiolab "All-purpose" tester, with separate resistance scale.

and other "frills" such as metal rectifiers for AC work, and perhaps a battery for resistance measurements, together with provision for making the appropriate circuit changes for the work in hand. But this bald statement of essentials hardly does justice to the great amount of ingenuity that has been displayed in making these instruments convenient, safe, and in every way practicable for their purpose; it is no exaggeration to say that the combination meter is now the most popular "tool" among both professional wireless men and serious amateurs.

A deservedly popular instrument is the Avometer, which has been standardised by many set manufacturers for service purposes. In its most ambitious form (the "Universal" model) there are 10 voltage ranges and 8 current ranges for either AC or DC, together with 4 resistance ranges. The usefulness of the instrument is greatly enhanced by its long scale, while the selector switching system is convenient and as fool-proof as it could possibly be. This model costs £12 12s., while the standard Avometer, similar in essentials except for the fact that it does not read AC, costs £8 8s. Finally, there is a "junior" instrument, the Avominor, with plug-and-socket selector and a 2½-in. meter, costing only 40s. Ranges are: 3 current, 4 resistance, 3 voltage. (An AC-DC model costs £5.)

Everett Edgcumbe's Radiolab All-purpose Tester is distinctly low in price, considering its versatility and high resistance (1,000 ohms per volt). In addition to 4 voltage and 4 current ranges there is a separate scale for resistance measure-



Ferranti AC-DC circuit tester.

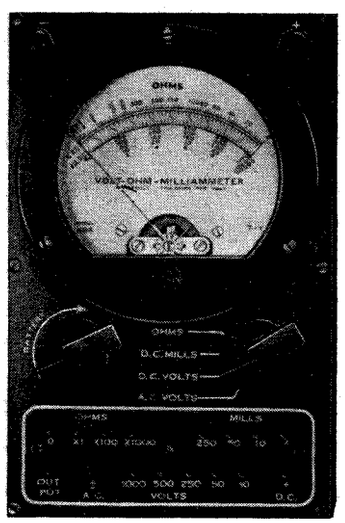
ments, which makes for greater legibility. The standard instrument costs £5 5s., and 4 capacity scales (0.01 mfd. to 10 mfds.) are supplied for £1 extra.

The latest "Ferranti "AC-DC Circuit Tester No. 2" has the usual voltage (AC and DC) current and resistant ranges, and in addition provides for capacity measurements. On the voltage ranges the resistance is 2,000 ohms per volt—an exceptionally high figure, allowing measurements to be made with extreme accuracy. Among other Ferranti multi-range instruments are DC and AC test sets with two dials, one for current and the other for voltage.

Standard Telephones and Cables produce the Model 407 Set Analyser, an ambitious instrument which, in addition to measuring voltage, current and resistance, shows output power from 6½ mW to 4 W at various impedances between 600 and 20,000 ohms.

The meter unit of the Wearite test equipment (mentioned elsewhere) is obtainable separately at the price of £6 17s. 6d. It provides 7 DC and 6 AC voltage ranges, as well as 3 current and resistance scales. Capacities between 0.05 and 4 mfds. and inductances between 5 and 120 henrys may also be measured. In addition, facilities for receiver output measurements are provided. A cheaper AC-DC instrument, known as the Multimeter, has voltage, current, and resistance scales; it costs £4 5s.

The Lyons-Hickok test set, sold by

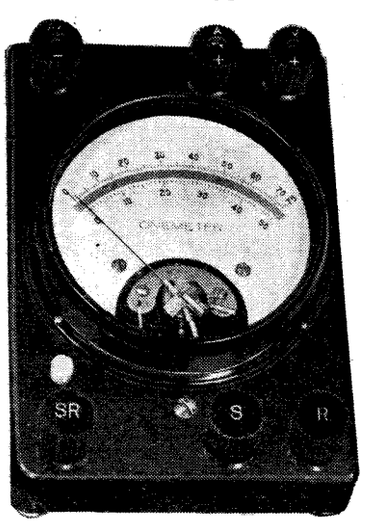


Lyons-Hickok test set.

Claude Lyons, Ltd., is in many respects unusual. Resistance on the voltage ranges (both AC and DC are provided) is 1,000 ohms per volt, and, in addition to complete current and resistance scales, there is a 5-range output meter. Selection is by means of a plug-and-socket system combined with a rotary switch. The price is £10 10s.

Leslie Dixon and Co.'s Dix-Onemeter is based on a long-scale milliammeter reading 0-2 (40 microamps. per division) to which shunts or multipliers may be connected in a particularly convenient manner. The basic instrument costs 55s.; an AC version is available.

Goltone moving-iron test sets, with two voltages and one current range, are available either as a watch-type instrument or



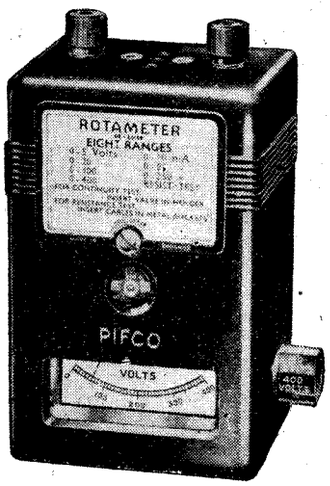
Basic unit of the Dix-Onemeter.

in a wooden case. A moving-coil model is also made.

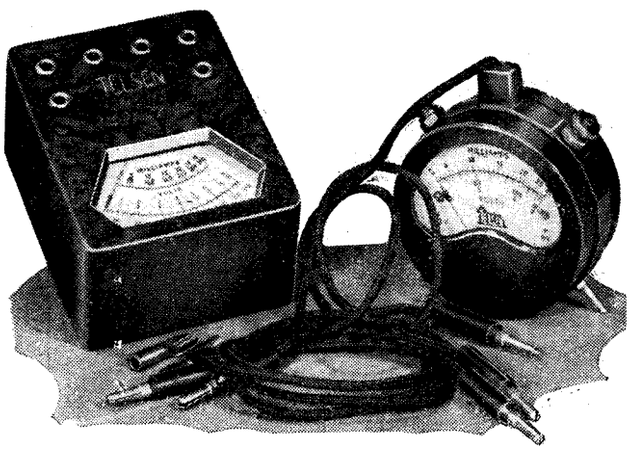
Measuring Instruments—

The Pifco Rotameter is unusual in that the scales are changed mechanically by operation of the range switch. In addition to voltage, current, and resistance ranges, provision is made for a direct valve test. The moving-coil model, with a resistance of 500 ohms per volt, costs 42s., while a similar instrument with a moving-iron meter is sold at 29s. 6d.

The Telsen Multimeter (moving-iron) measures LT volts, HT up to 240 volts, and current to 300 milliamps. In a bakelite case, it costs 12s. 6d. Watch-type meters are made by Telsen and also by the Nivex Instrument Company; the latter firm also produces a moving-coil test set, calibrated to the purchaser's choice in current, voltage, and resistance, at 39s. 6d.



Pifco Rotameter, with automatically changed scales.



Telsen Multimeter and watch-type three-range volt-milliammeter.

Output Meters

Output meters are now coming into general use, both for quantitative measurements and as an aid to alignment and other initial adjustments. For the former purpose they are used in conjunction with signal generators and oscillators described elsewhere, while for ganging and trimming they replace such crude indicators as detector anode current meters, etc.

The Ekco output meter has 6 ranges, and works with no fewer than 40 impedance values between 20 and 20,000 ohms. The indication given is substantially independent of frequency, and temporary overloads may be applied without risk of damage to the resistance networks.

In the Standard Telephones and Cables Model 402C output meter, the range of impedances is from 1.5 to 20,000 ohms in 10 steps. A cheaper model, No. 402A, is intended for comparative work such as circuit alignment, and is fitted with a moving-iron meter. There is one power output range, ±9 db. referred to 50 mW, and impedance-matching taps between 6 and 20,000 ohms are provided.

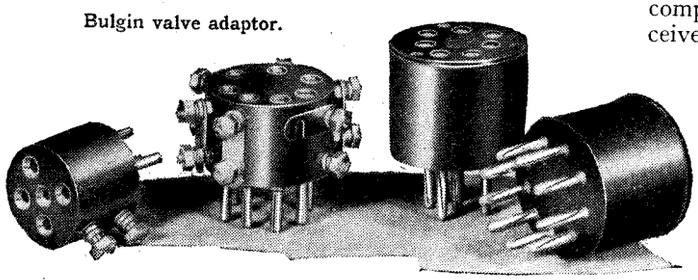
Everett Edgcumbe's Radiolab output meter has three switch-selected ranges, 0-40, 0-400, and 0-4,000 milliwatts, as well as a direct-reading decibel scale. Output impedance is fixed at 4,000 ohms.

Accessories for Testing

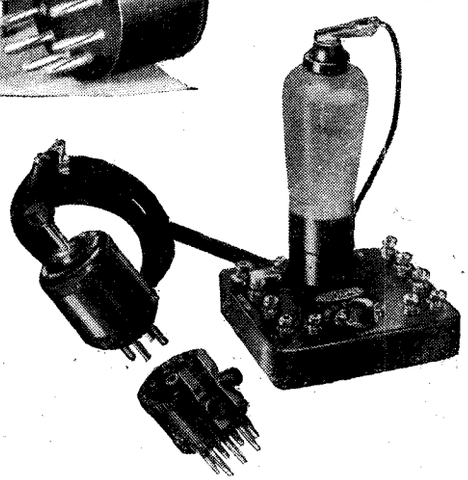
By some stretching of the imagination, almost every wireless component or accessory might be described as an aid to testing. However, space does not permit of treating any but accessories specifically produced for this purpose.

Practically every manufacturer of meters provides test prods or clips for the connection of his instruments, either included with them or as an extra. Bulgin has a specially good assortment of those small "bits and pieces" which add so greatly to the convenience with which tests may be made. The valve adaptors made by this firm are specially useful; by using the appropriate "split" or "tapped" type, access to the particular circuit under suspicion can often be obtained with a minimum of trouble. Bulgin precision resistors, guaranteed to 2½ per cent., are useful for many purposes, as are the test clips (both plain and insulated), test prods, and fuses.

Bulgin valve adaptor.

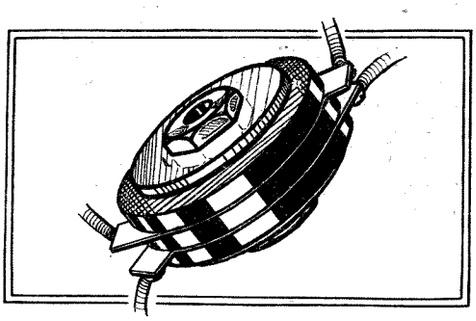


(Below) Avodapter and Avocoupler, valve testing accessories for Avometers.



Goltone manufactures a complete series of heavy-duty slider resistances, suitable for the adjustment of voltage or current; these range from 2,000 ohms downwards.

Mention should be made of the Westinghouse instrument rectifiers, so widely used for converting moving-coil meters for reading supply-frequency or audio-frequency AC voltages or currents. The units, which comprise four bridge-connected rectifiers giving full-wave rectification, are available separately in 1, 5, or 10 mA. ratings; their uses are fully described in a booklet issued by the Westinghouse Brake and Signal Company.



Westinghouse instrument rectifier.

Valve Testers

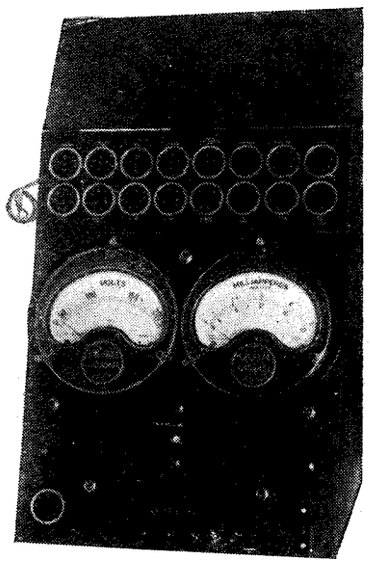
So far the apparatus dealt with might well be described as general-purpose instruments, for they are not restricted in their usefulness to any particular branch of wireless or electrical work. The single-range meters can be embodied in more elaborate test sets, as is done in the case of the multi-range instruments, and they find application also, in one form or another, in all the special apparatus evolved for development, production testing and for the servicing of receivers. The first two mentioned classes include apparatus of a laboratory nature which it is not proposed to deal with here in detail. Servicing equipment covers a very wide field and now includes a variety of test sets such as instruments for valve testing, simple bridges for resistance and inductance measurement, as well as apparatus for the complete overhaul of receivers.

A very convenient valve-testing panel is that evolved for use with the Automatic Coil Winder Co.'s Avometers. Known as the Avodapter, it consists of a valve-holder mounted on a small panel, the connections to the sockets of which can be interrupted by a switch for the insertion of a meter. A cable terminating in a plug fits into the valve socket in the set, the valve is transferred to the test panel and its voltages and currents measured under working conditions. A series of valve adaptors enables any type of valve to be tested with this unit. It costs 25s.

Another valve-testing unit designed to work in conjunction with a multi-range

Measuring Instruments—

instrument is the Radiolab Oni-Selector, made by Everett Edgcumbe and Co., Ltd. It is suitable for all types of valves fitted with standard-size pins, and enables a

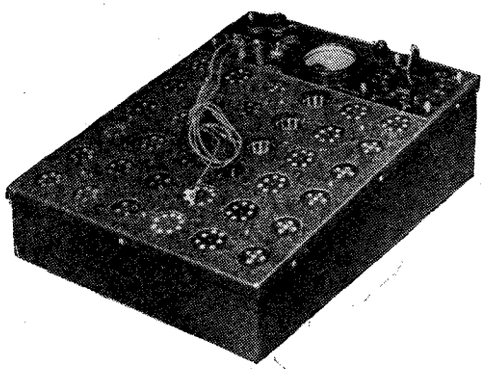


Radiolab AC operated valve testing panel.

valve to be tested by measuring the currents and voltages taken under working conditions in the set. Whilst primarily intended for use with the Radiolab All-Purpose Tester, a multi-range instrument, it can be employed with any other measuring instrument having suitable ranges, or separate meters can be used for simultaneous readings of the various currents and voltages. Complete with adaptors and leads this unit costs £3 5s.

Self-contained valve-testing units intended for use in retail establishments or wherever valves are handled in quantities and check measurements of their characteristics are needed, are also included in the Radiolab range of instruments. These provide tests of filament continuity, inter-electrode insulation, currents and voltages at electrodes, and indication of mutual conductance. The AC mains model costs £19 19s., and the battery-operated style £12 12s., but with this model mutual conductance measurements are omitted.

The Weston Selective Analyzer also provides facilities for valve testing, though this is but one of the many uses to which this versatile instrument can be put. It is a complete instrument for diagnosing the troubles in a faulty receiver, and enables AC and DC voltages, DC currents, resistance and capacity of condensers from 0.0002 mfds. to 10 mfds. to be measured with the single unit. This instrument, with valve-socket adaptors for British valves, leads and carrying case, costs £15 15s. There are several accessories available for extending its usefulness, and these include a set of adaptors for American valves as well as for those with side contacts.



Radiometers' universal type valve-testing panel, entirely AC mains operated.

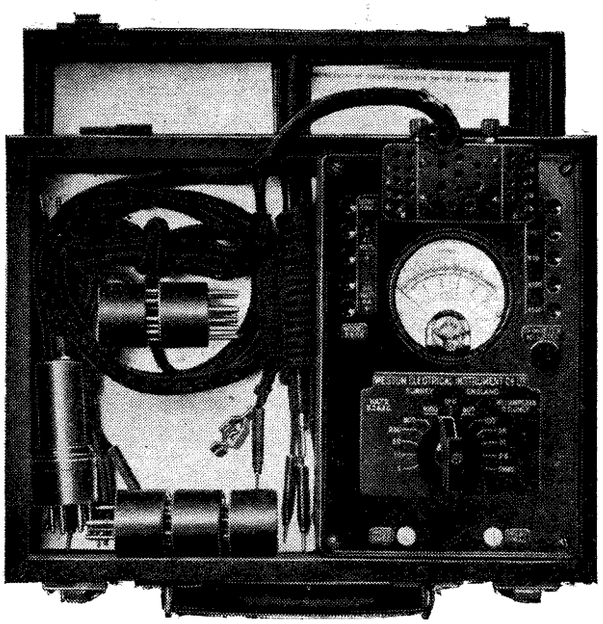
Included in the range of service instruments made by Wright and Weaire, Ltd., is a valve-testing unit costing £4 17s. 6d., which is fitted with valve-holders to take 4-, 5-, 7- or 9-pin valves, also one for those with side contacts. A self-contained mains supply unit enables the emission of a valve to be tested independently of the receiver, or by the use of adaptors, the voltages and currents applied to any valve in the set can be investigated under working conditions. For all these tests a separate meter having suitable ranges is needed, but this requirement is met by the Wearite Meter Unit, to which reference has been made already in an earlier section.

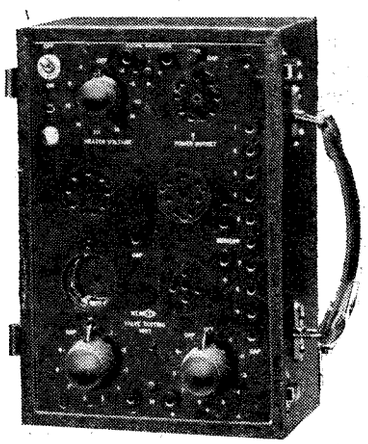
What must surely be a unique unit is the Radiometers Allvalve Tester, for it contains no fewer than thirty-six valve-holders internally wired so that any British or American valve can be tested by inserting it into the appropriate socket. The meter fitted gives readings of anode current with either a low or a high value of grid bias, and by comparing these values with a chart supplied, it is possible to judge the condition of the valve under test. It is AC operated and costs £8 8s.

The Bulgin Universal Valve Tester is also a self-contained unit for testing valves independently of the receiver. It operates from the AC mains and provides the voltages necessary for the complete analysis of a valve. Four valve-holders are fitted which, with the aid of a few adaptors, will accommodate almost every British valve other than the side contact type. It embodies a two-range milliammeter, selector switches for anode, screen and grid bias voltages, and costs £8 8s. complete.

Bulgin makes, also, a simple valve-test panel giving access to the various electrode circuits to enable voltages and currents, as supplied by the set to the valve to be measured with external meters. This costs 15s. It is fitted with a nine-pin valve socket and a nine-pin cable plug, and a series of reducing adaptors are made for use with 4-, 5- and 7-pin valves; these cost 2s. 9d. each, and similar adaptors with plug and socket parts reversed are available for the cable-plug at the same price.

The Lesdix Type S radio service Set Analyser provides facilities also for checking the condition of valves in the set when supplied with their normal working voltages, but this is only one of its many uses, for the instrument is a self-contained portable test set for servicemen's use, and with it all voltages and currents, either





(Above) The valve testing unit of the Wearite range of servicing apparatus.

(Left) Weston Selective Analyzer and adaptors for valve testing.

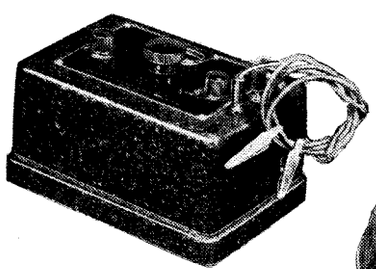
(Right) AC operated valve analyser made by Bulgin.

Measuring Instruments—
DC or AC, can be readily measured. It is housed in a stout wooden case with carrying handle, and costs £5 17s. 6d.

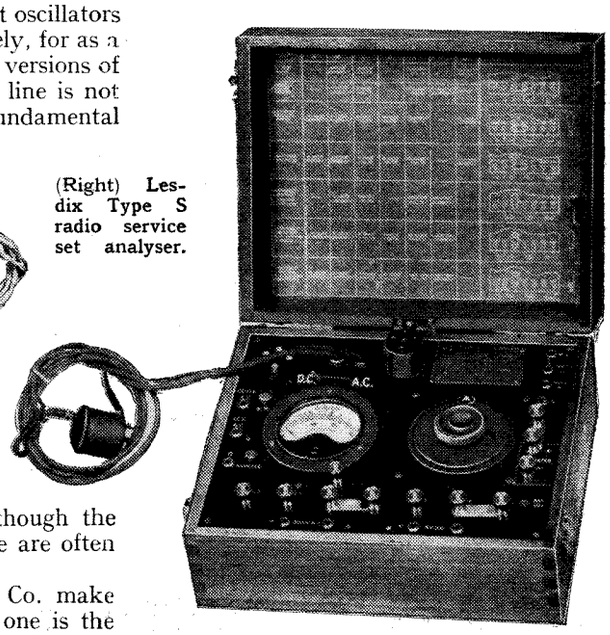
Modulated Oscillators

Whilst the instruments mentioned so far are essential aids to servicing and enable a very large percentage of the faults that arise to be traced, cases of indifferent performance are occasionally encountered, yet from voltage, current and valve tests everything appears to be normal. There may be several reasons for this, but in most cases little short of a stage by stage test will lead to the seat of the trouble.

Circuits out of alignment is one likely cause, but even this can be easily checked with an oscillator which, for preference, should provide a modulated signal. This type of testing set might be divided into two classes, viz., modulated test oscillators and signal generators respectively, for as a rule the former are inexpensive versions of the latter, though the dividing line is not very well defined, since the fundamental idea is the same in all cases, though the design, workmanship and scope are often quite different.



The new Avo Oscillator.



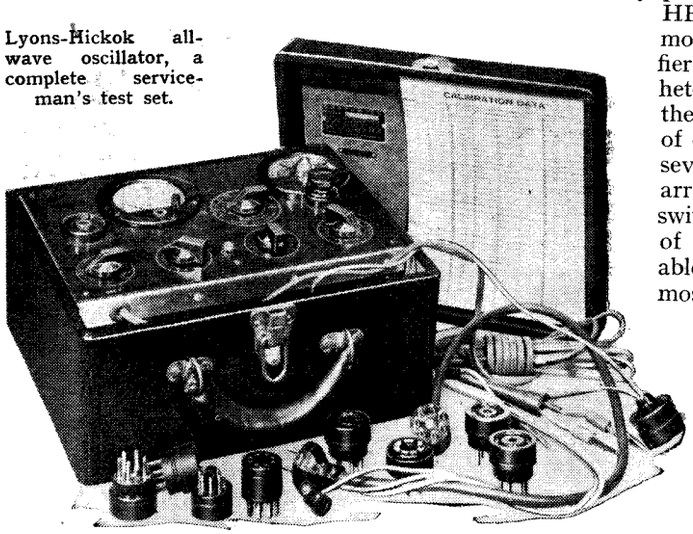
(Right) Lesdix Type S radio service set analyser.

The Automatic Coil Winder Co. make two instruments of this type; one is the new Avo Oscillator costing but £5 10s., whilst the other is a signal generator priced at £15 15s. Both are battery operated.

The Avo Oscillator provides two frequency ranges using the fundamentals; these are 100 to 280 kc/s. and 500 to 1,600 kc/s, but by using the harmonics of the higher range its usefulness can be extended to the short-wave bands. Three output sockets give a choice of signal level with, in addition, a variable control, and the unit, which measures 6 × 4 × 4in. only, forms a valuable addition to the serviceman's as well as the experimenter's kit.

The Avo Signal Generator is a higher-grade instrument attaining laboratory standard, being fitted with separate valves for the HF oscillator and for the modulator, whilst provision is made for the use of an external LF generator when required. This model is fitted with a three-position switch giving frequency bands of 100 to 300 kc/s, 500 to 1,800 kc/s, and 6 to 25 mc/s respectively, thus covering all broadcast bands, including the short waves as well as all superheterodyne intermediate frequencies. Complete screening is adopted, and special care taken to ensure frequency stability.

The Lyons-Hickok all-wave Oscillator is a fine example of the servicing equipment in general use in the U.S.A. It has an exceptionally wide frequency range having no fewer than eight bands giving a coverage of from 85 kc/s to 40 mc/s (3,500 metres to 7.5 metres) without a break. By the use of multiple electrode valves two only perform the functions of HF oscillator, 400-c/s modulator, buffer amplifier and beat frequency heterodyne LF oscillator, the latter having a range of 0 to 10,000 c/s, these several functions being arranged by means of switches. The inclusion of a continuously variable LF oscillator is a most valuable feature.

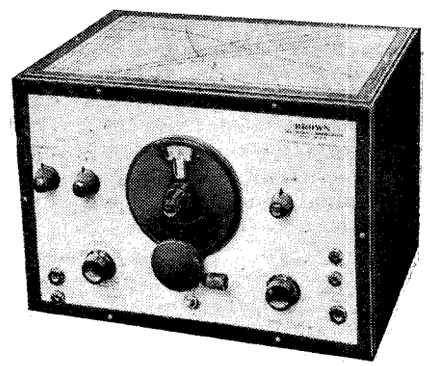


Lyons-Hickok all-wave oscillator, a complete serviceman's test set.

In addition, there is a two-range output meter, though this can be used only with American sets unless the plugs and adaptors are changed for the British valve types. The meter is also adaptable for measuring anode currents up to 10 mA.

The whole is assembled in a case measuring 11 × 9 × 6½in., and the price of this versatile test set, which is obtainable from Claude Lyons, Ltd., is £17 10s.

Quite an extensive range of inexpensive modulated oscillators and signal generators

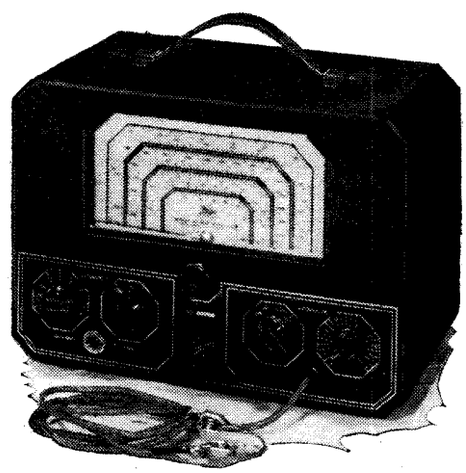


Brown all-wave modulated oscillation, Type M.2.S.

is made by Wm. F. Brown, one of the most useful for servicemen's and experimenters' use being the all-wave model Type M.2.S. This has a range of from 5 to 3,000 metres, but it is understood to be capable of extension down to 2 metres if required. Only fundamental frequencies are used, and, though costing but £14 14s., embodies many features generally associated only with the more expensive models.

The Type M.2.S. is AC mains operated, but models for AC-DC and battery supplies are available also, in addition to which, this firm makes LF oscillators and short-wave oscillators, the latter with or without internal modulation equipment, while provision is made for the use of external modulators in all models.

The inclusion of an ultra-short wave range in some of these servicing oscillators and test sets is a valuable feature, since this range will be needed in the near future when the new television transmitters come on the air. Ultra-short waves are catered for in most of the American sets, several of which are available in this country. The Lyons-Hickok, already



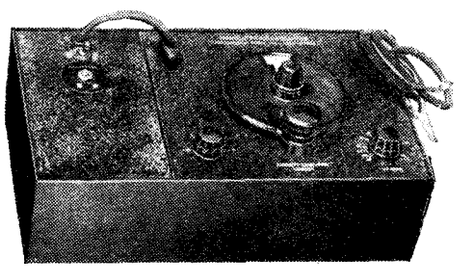
Webber Model 20 service oscillator supplied by Rothermel.

Measuring Instruments—

mentioned, is one example, whilst another is the Webber Model 20 Oscillator, marketed by Rothermel, Ltd., at £15.

An outstanding feature of this model is the large calibrated dial measuring 6½ × 3¼in., and on which seven separate frequency scales are engraved, giving direct reading of frequency from 90 kc/s to 60 mc/s (3,300 metres to 5 metres), with continuous coverage throughout. Internal modulation is provided at 400 c/s, though an unmodulated, or pure HF, output is available if required. The test set is battery operated, the whole being housed in a metal case, with carrying handle, measuring 11 × 7¾ × 6¼in.

The output from the oscillator is controllable by a wide-range attenuator and then fed through a screened lead to the set. An interesting point in connection with this model is the provision of a jack marked "cathode-ray modulator," which enables the oscillator to be used for visual alignment, or other tests, of receivers where a cathode-ray tube equipment is available.



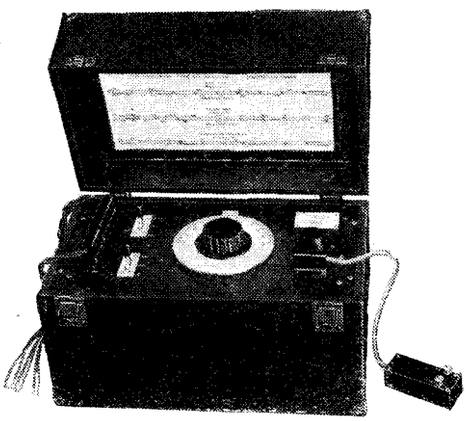
Radiolab Universal Oscillator, Type B.

Everett Edgcumbe include in their Radiolab series of testing equipment a modulated oscillator for broadcast and intermediate frequencies. A new model has been introduced by the Weston Electrical Instrument Co., known as the Super Oscillator Type 692. It covers a frequency range of 100 kc/s to 22 mc/s (3,000 metres to 13.6 metres), its price being £14 19s. 3d.

The Wearite service oscillator is still another example. This model has a 1,000 c/s modulator embodied in it, the output from which can be utilised for testing LF amplifiers, in addition to its other function of modulating the HF output.

HF oscillators of a laboratory standard, but designed for servicemen's use, or wherever a pure or modulated source of high frequency is needed for experimental purposes, are made by Muirhead and Co., Ltd. They cover the medium- and long-broadcast bands with an additional range of 100 to 135 kc/s for IF amplifiers. Models with self-contained batteries or for use with external batteries are made. Whilst not normally covering the 465-kc/s frequency band, which is finding favour in some all-wave superheterodynes, the makers can supply these oscillators with an extra range filling in the gap between the two broadcast bands for a very small additional charge. These range in price from £9 15s. to £13 15s., according to type.

The Standard Telephones and Cables Universal Test Set not only provides all facilities for investigating the failure of receivers, but serves also for initial adjustments and lining up of the circuits in every



Muirhead Type 5 modulated oscillator.

type of modern broadcast receiver. It comprises a modulated oscillator and set analyser, and covers frequency ranges of 100 to 280 kc/s and 550 to 1,500 kc/s, though it can be supplied with coils for the wide band of 110 to 15,000 kc/s if required.

Whilst it is not proposed to include in this review the more elaborate precision or laboratory apparatus, in which such firms as the Cambridge Instruments, E. K. Cole, Everett Edgcumbe, Salford Electrical Instruments, Standard Telephones, Sullivan, Tinsley, and Weston, among others, specialise, several models are available that just fall on the borderline, and might well be mentioned in passing.

The B.S.R. beat frequency LF oscillator is a case in point. This has a range of 5 to 15,000 c/s, is continuously variable, and is fitted with two frequency scales; one covers the whole range while the other has a reduced coverage of 5 to 450 c/s only, and, of course, has a much more open scale. Battery or mains models are made and they cost from £37 10s. upwards.

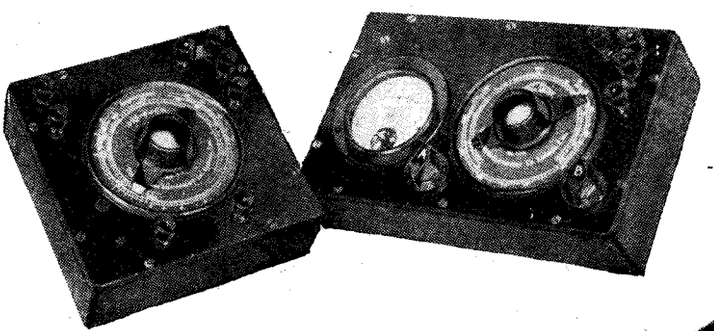
Standard Telephones make several LF oscillators, all reasonably priced, which give a number of fixed frequencies selected by switches.

There is, on the market, a host of subsidiary apparatus not possible to classify as servicemens' equipment in the true sense, though some will be found exceedingly useful in this particular field. For example, while many of the multi-range testing meters enable one to measure resistance, and some also, capacity, with few exceptions the degree of accuracy possible with these is a variable factor depending very much on the manner of use, and, to some extent, the skill of the user. As a general rule, bridges answer best for resistance, capacity and inductance measurements, being simple to operate, and, if well designed, capable of a high order of accuracy.

Resistance and Capacity Testers

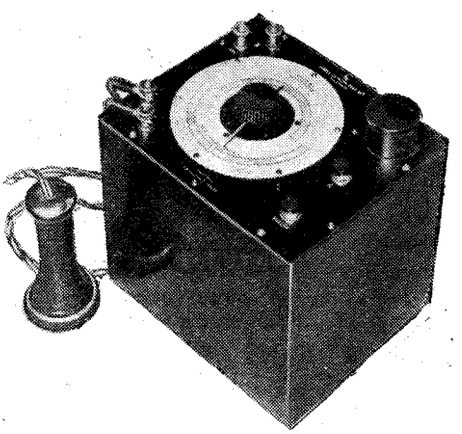
There are a few quite reasonably priced instruments of this nature now available, some excellent examples being made by The Baldwin Instrument Co. The Logohm Mark II resistance bridge is light and portable, and gives direct readings of resistance from 0.5 ohm to 40,000 ohms. Another Logohm model has a range of 0.5 ohm to 0.5 megohm, and they cost respectively £5 10s. and £8. Baldwin also makes a useful series of inductance bridges, the Micro-Henlog model being especially suitable for service, test and experimental use as its range is from 50 microhenrys to 3,200 microhenrys. Another model has a wider range, covering 20 to 20,000 microhenrys, all direct reading. Complete with a separate valve-oscillator unit for exciting the bridge, the first-mentioned costs £20 10s. Many other models, some for production tests, are included in the Baldwin series.

H. W. Sullivan has a simple capacity test set with a range of 50 m-mfds. to one microfarad, costing £5 10s., and Claude Lyons has recently introduced the Lyons-Hickok Model 47-x capacity tester which covers the wide range of 0.0001 mfd. to 20 mfd., and enables the capacity of electrolytic condensers to be measured as well.



(Left) Baldwin Mufer condenser bridge and Logohm resistance bridge.

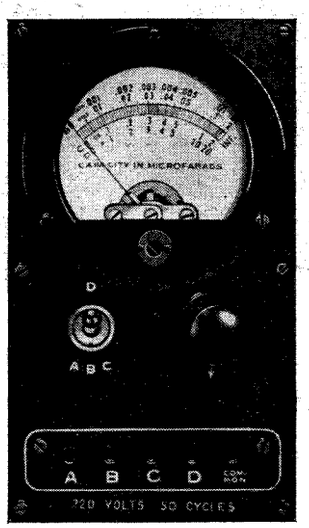
(Below) Sullivan capacity test set.



Large inductances of the order of henrys can be tested and measured with this instrument, the price of which is £8 10s., and it is operated from the AC mains.

Measuring Instruments—

An inexpensive capacity and resistance test set is made by Modern Radio Equipment. This is fitted with a large scale



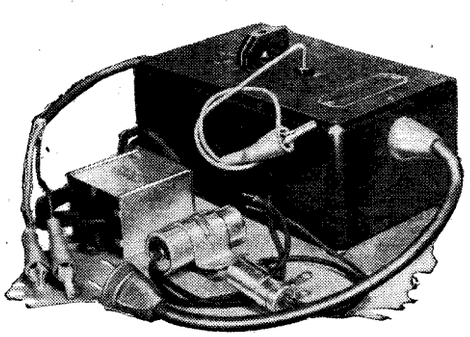
Lyons-Hickok capacity tester, Model 47-x. It can be used, also, for checking the inductances of smoothing chokes and the like.

calibrated for direct reading and with seven ranges covering 10 m-mfds. to 10 mfds., and 0.01 ohm to 10 megohms. respectively. It costs £3 17s. 6d.

Valve Voltmeters

Valve voltmeters have a multitude of uses, though, perhaps, of more value to the research worker and experimenter than to the serviceman, and quite good instruments are now obtainable at low prices. Wm. F. Brown has a wide range, one model being AC mains operated, gives reading from 0.05 volt RMS to 10 volts RMS in three ranges and costs £11. Single-range models are available from £8. The Cambridge Instrument Co. has a very wide selection of single- and multi-range types, whilst B.S.R. and E. K. Cole also include valve voltmeters in their respective series of testing equipment.

An instrument that is believed to be unique and quite in a class of its own is the Sprague Interference Analyser, which should prove invaluable to servicemen. Its function is to ascertain the particular style of suppressor needed to cure or



Sprague Interference Analyser and suppressor units marketed by Rothermel.

ameliorate electrical interference. The Analyser provides some sixteen different filter combinations covering almost every type of circuit devised for this purpose. When called upon to apply remedies in such cases it is a tedious business for the serviceman to try all the known arrangements using separate units, or combinations thereof, but with this Analyser the turn of a switch brings each into use and that which proves the most efficacious can be determined in a very short time. Knowing the style of suppressor needed, an equivalent unit can then be obtained and fitted.

This is an American appliance and is obtainable from R. A. Rothermel, Ltd., the price being £4 10s., including a full set of Sprague interference filters. Individually these cost from 1s. 9d. to 6s. each, according to type.

Random Radiations

By "DIALLIST"

Birmingham Leads the Way

THE Birmingham Corporation Electricity Supply Department has recently instituted a scheme which may have far-reaching effects within the area that it serves. The Department is prepared to make the operation of all-mains receiving sets possible in houses that are not wired for electric light. They offer to connect a house to the mains and to provide a meter for an inclusive sum of ten shillings, provided that the run is not more than sixty feet. For the wall plug itself and the indoor wiring there is a small extra charge, which will be approximately twelve shillings. And what is more, they offer to supply current at the power rate, with the proviso that five shillings shall be the minimum payment for current in any quarter. One can see in a moment how popular this scheme should be. Good though the battery set can be, it is necessarily inferior to its mains counterpart in performance and much more expensive to run, especially if mains current can be obtained at the power rate. In fact, I know quite a few people without electric light in their homes who much want to have wireless but will not do so unless and until they can run a mains set. Then there are those who are tenants with short leases or under the Rent Restriction Act. They don't see the point of having electric light installed unless the landlord will bear part of the expense—and often he won't. Such people will leap at the chance of getting on to the mains for wireless purposes at small cost.

May Others Follow!

It is very much to be hoped that other electricity supply authorities will follow Birmingham's lead. Were they to do so they would give an immense fillip to the wireless industry, for the sales of mains sets would soon show a very large increase; there would be many who would exchange battery-operated sets for mains apparatus as well as many newcomers to wireless who would hasten to purchase their first receivers.

I am especially glad to see that the Birmingham authorities offer current at the power rate for receiving sets. In some centres there has been a tendency to bind the consumer by agreement or otherwise to run his set off lighting mains. I never could see any justification for this, since we don't want light from our receiving valves and the output of our receivers is measured in watts, the watt being the unit of power. One difficulty that is not infrequently experienced by those who try to run receiving sets from power mains is that these may be much noisier than the lighting mains. This problem can in most cases be solved by the use of simple and inexpensive disturbance suppressors.

Looking to the Future

The easier it is for people to obtain mains current for the operation of wireless sets and the smaller the cost of such current, the more rapid will be the development not only of wireless but also of television in this country. At the present time the great majority of wireless sets are run from lighting circuits. If the consumer's agreement is based on the Norwich plan, or some other kind of flat rate, he gets his current pretty cheaply; but he is still better off in many places if he is able to obtain his supplies at the power rate. As matters stand, even mains users are apt to be somewhat frightened of the set containing more than four or five valves. Could they always obtain supplies at the power rate such fears would speedily vanish. "Power" current often costs much less than a penny a unit; but let us take a penny as a working basis. Even a monster set requiring 200 watts would run five hours for a penny, and the weekly cost for operating it would probably not be much in excess of sixpence. The Birmingham system might well be extended in other districts, not only to those who are without electric light, but also to those who have electric lighting circuits but not power circuits in their homes. Were it possible to install a power circuit at small cost for the operation of the wireless set we might get rid of the prejudice against the real multi-valve receiver which is so strongly in evidence in this country.

A Wonderful Set

STAYING the other day with some friends I came across a really remarkable old-stager amongst wireless sets. It was built eight years ago as a four-valve receiver, operated from 200-volt DC mains. Certain alterations have been made from time to time to bring it up to date, but the circuit is substantially the same as it was in the beginning, the only really important changes having been the substitution of a diode detector for the original grid-leak and condenser triode and of triode push-pull for single pentode output. The set still consists, as it did to begin with, of a screen-grid high-frequency valve, a detector, a first low-frequency stage, and an output stage. This veteran is even to-day able to bring in both the home stations and a large selection of foreigners with excellent volume and admirable quality. I must admit that it is used at a place on the Wiltshire Downs, where probably reception conditions are as nearly ideal as anywhere in this country. Since it lies outside any "swamp" area, there is no need for selectivity of a high order, though the field strength of several of the home stations and of most foreigners that are really worth listening to is adequate for first-rate reproduction. Is any reader the proud possessor of a yet older set that is still in use and still gives a good account of itself?

CURRENT TOPICS

EVENTS OF THE WEEK IN BRIEF REVIEW

M. MANDEL, France's "radio-minded" Post-master - General, to whom is largely due the rapid development of the regional broadcasting scheme and the campaign against radio pirates.

Vatican Broadcasting

IT is understood that the Vatican has applied to the International Broadcasting Union for membership.

Tally-ho !

THE parasite-hunting season was in full swing in France during January, with the result that M. Mandel's agents tracked no fewer than 5,969 cases of interference with broadcast reception. Some 34 persons were prosecuted.

Said Lahti

RADIO nomenclature in Finland has reached a stage at which it is difficult to accommodate one word in a single line of newsprint. A short talk on television broadcast from Lahti on February 10th was entitled "Elektrolyyttisviivaine Hyperkaukoluotaussuperkuuntelutelevisionilaite."

No Television for Westminster ?

IN the House of Commons last week Major Tryon, the P.M.G., replying to a question, said it was not yet possible to give an approximate date for the opening of the television broadcasting service, but it was expected that the service would be in operation during the coming summer. The suggestion that arrangements should be made for the service to be received in some convenient part of the Palace of Westminster was primarily a matter for the First Commissioner of Works. He understood that in 1930 the opinion of practically all of the House was strongly opposed to the installation of a wireless receiving set, and he imagined that the House would take a similar view in regard to television.

Thank You !

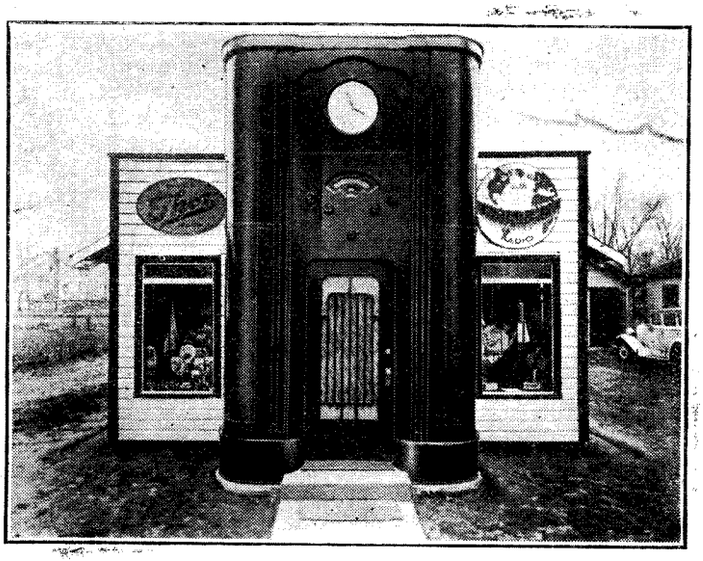
WE lift our hat to our esteemed German contemporary, *Funk alle Tage*, for the gracious reference in its issue of February 9th to "the English radio periodical, *The Wireless World*, not only the oldest but also the most reliable technical radio newspaper in the world."

New Interference Menace

"FEVER machines" are causing trouble in the American radio world, and the Federal Communications Commission feels that something should be done about it. These machines are being increasingly employed by the medical profession to stimulate artificial fever in patients — remarkable cures are recorded—but their high-frequency radiations are proving much more formidable than those emanating from ordinary electro-therapeutic apparatus.

Nearly a year ago it was discovered that certain "phantom" signals were interfering with communications in the band between 15,000 and 16,000 kilocycles, according to Commander Craven, Chief Engineer of the F.C.C. The phenomenon was examined by experts of the Naval Research Laboratory in Bellvue D.C., and just a few weeks ago they discovered that a "fever machine" in Boston was causing the trouble, not only in Washington but as far off as San Francisco. It is estimated that some 2,000 of these machines may be in use in the U.S. Other countries are likely to follow suit, so the machines may soon be producing artificial fever of a kind which their inventor never intended.

Perhaps the question will be discussed at next week's important meeting of the International Broadcasting Union in Paris.



IN AMERICA. This is how a Middle-West radio dealer ensures that there shall be no mistake as to the nature of his business. Incidentally he also sells washing machines.

Optimistic Sheffield

ACCORDING to Press reports, Sheffield's £50,000 news theatre, now building, is to be equipped with television apparatus for the programmes transmitted by the B.B.C. The Northern city is evidently hopeful that a local television station will soon be in operation.

Bessel Functions

A SPECIAL course of twelve lectures on "Bessel Functions," by Dr. N. W. McLachlan, M.I.E.E., opens on Tuesday next, February 25th, at 7.30 at the Polytechnic, Regent Street, London, W.1, the chairman at the first lecture being Prof. E. V. Appleton, M.A., D.Sc., F.R.S. The course, the fee for which is 10s. 6d., will be given each Tuesday from 7.30 to 8.30 (omitting April 7th and 14th). It will deal with the applications of Bessel functions to engineering.

Norwegian Television

HIGH - DEFINITION television is to start in Oslo within the next few months, a private company having been granted a special licence to experiment. The broadcasting authorities are not themselves interested in television—a fact which emerged when the question of television accommodation in the new Broadcasting House was discussed recently.

Danger Signal

BY tacit understanding with listeners, *Petit Parisien* now gives warning when an ensuing transmission is not intended for the ears of the young. When the announcer begins "Mesdames, Messieurs," the little ones are sent to bed; if he says "Mesdames, Mesdemoiselles, Messieurs," the children stay up for supper. According to our Paris correspondent, "Mademoiselle" is the signal that the programme will be of the "U" category—for universal audition.

German Records Dispute

GERMAN listeners may soon hear recitals on records made by the prominent gramophone firms. The Berlin Court of Appeal has upheld the judgment passed at the First Court declaring that broadcasters may make extended use of records of music but not of records of the spoken word.

There is still (writes our Berlin correspondent) a possibility of an Appeal to the Supreme Court at Leipzig, but this is considered unlikely as the gramophone companies are at present negotiating with the broadcasting organisation in an attempt to reach an amicable agreement.

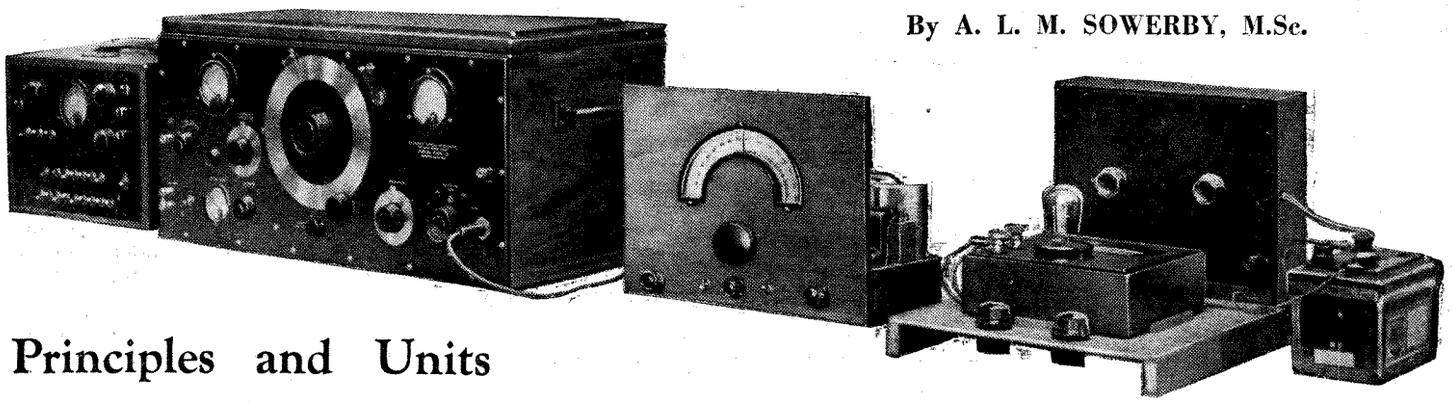
Pay Every Time

SETS, not listeners, are taxed in France. There was a reminder of this fact in the French Chamber last week when a Deputy was informed that the tax must be paid afresh every time a set changes hands, however short the period of ownership. The law is causing dissatisfaction not only among listeners but in trade circles, as it tends to curb the purchase of new sets.

Paradoxically, a French listener owning two sets, if they are kept in the same dwelling house, need only pay tax on one. But according to the regulation the two sets must not be used simultaneously—a clause much applauded by the neighbours.

Measurements on Receivers

By A. L. M. SOWERBY, M.Sc.



Principles and Units

ALTHOUGH DC and supply-frequency AC quantities in broadcast receivers are measured in standard electrical units, it has been found necessary to develop a special technique for assessing the fundamental qualities of sensitivity, selectivity, and fidelity. The systems on which these measurements are made are described in this article.

IN essence, all measurements made on a set, whether as a whole or in parts, depend on putting into it a high-frequency signal, simple or modulated, and observing the response either at the loud speaker or at some intermediate point. Both the voltage of the unmodulated carrier and the depth to which it is modulated must be known, while the response given by the set can be measured either in volts or, if checked at the loud speaker, in terms of the power being delivered by the output valve.

The testing signal is provided by a rather complex piece of apparatus known as a **signal generator**. This consists of a screened oscillator, tunable to any wavelength, in combination with an **attenuator** by the aid of which the high-frequency voltage at the output terminals of the generator can be adjusted to have any value from (usually) one volt to one microvolt. (One microvolt—μV—is one-millionth of a volt.) In addition, the signal can be modulated to any desired depth by a second oscillator adjustable to give any audio-frequency note from perhaps 30 cycles to 10,000 cycles or more. The whole is thus capable of giving a completely controllable "transmission" consisting of a carrier, of any wavelength or intensity, modulated to any desired depth with a "tuning note" of any desired pitch.

Of the various adjustments afforded by the signal-generator, all seem self-evident in their purpose except, perhaps, that for depth of modulation. A carrier with no modulation, of wave-form such as that shown at *a* in Fig. 1, consists of a high-frequency voltage of constant amplitude. It corresponds to a silent interval in a broadcast programme, during which the station is working, but sending out no music or speech. One volt of this, rectified by a detector, would give rise to no audio-frequency output at all. At the other extreme lies complete modulation, as at *b*, where the high-frequency voltage alternates in amplitude between zero and double its mean value, these alterations taking place at the audible frequency of the note being transmitted. One volt of this, rectified by a perfect detector, would give rise to one volt of audio-frequency signal. This condition, 100 per cent. modulation, represents the strongest undistorted signal that the HF current can convey from transmitter to receiver. There is no theoretical lower limit to the degree of modulation permissible, but valve-hiss accompanying the carrier, whether derived from the receiver or from the generator itself, will drown out the audible signal if this is reduced too far by cutting down the modulation depth. For purposes of measurement, one seldom need go below 10 per cent. Fig. 1 *c* shows a carrier modulated to this depth, so that the three curves show: *a*, unmodulated carrier; *b*, carrier with maximum modulation, and *c*, carrier with minimum modulation. All signals supplied by the generator will be represented either by *a* or by some modulation-depth lying between *b* and *c* as extremes.

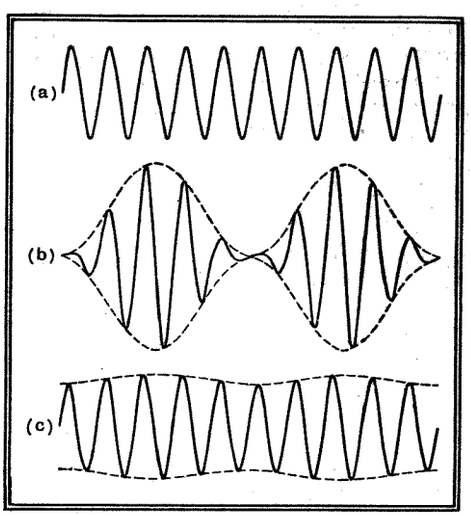


Fig. 1.—(a) HF carrier unmodulated. (b) HF carrier, of same amplitude as a, modulated at 100 per cent. (c) as b, but modulated at 10 per cent.

About the method of measuring the response of the receiver to the signal supplied there is less need to particularise; the output of the last valve, in milliwatts, can very readily be measured by means of an **output meter.** This instrument is connected in place of the speaker, can be adjusted to give a mean speech-frequency load of any reasonable value to suit the valve in whose anode circuit it is connected, and indicates directly on a scale output power from about 0.1 milliwatt to 5 watts.

HF and LF Voltages

For measurements on intermediate parts of the set a **valve voltmeter** is the most convenient instrument; it consists of a valve adjusted so as to rectify and indicating, by change in anode current, the RMS voltage applied to its grid. It will measure high or low frequencies equally well, and if properly designed has no appreciable consumption of power at its grid, so that it can be connected straight across a tuned circuit without introducing any damping. The only result of attaching it to any part of a set is to add some 10 to 15 micro-microfarads ($\mu\mu$F) of capacity between the "live" point (grid anode, etc.) and earth. Except across a tuned circuit where the addition can be compensated for by re-tuning, this capacity is practically never large enough to make any difference to the set's behaviour.

It will clearly be advantageous to make our measurements in a form which will enable us not only to compare the performance of two or three sets that may be in our possession at any one time, but to record their performance in such a way that they can be compared, on the basis of this record, with sets we may measure a year hence or with sets measured by others at other times and places. To do this it is necessary either to record the measurements in the form of a *ratio* (e.g., amplification equals "volts out" divided by "volts in") in which the units used do not

Measurements on Receivers—

matter, or, where this is not possible, to use units universally recognised. Some, like henrys and farads, are international standards for all electrical purposes. Others, however, are peculiar to wireless work, and are standardised only by a more or less general acceptance with no real authority to back them.

Basis for Comparison

Into this latter class falls the unit, if such it can be called, of **sensitivity**. It is evident that we can *compare* a number of sets by giving them all in turn the same signal (fixed carrier-voltage, fixed modulation-depth) and seeing which of them gives the greatest output. We could even express this in reproducible terms by noting that for 100 μV., modulated 50 per cent. at 400 cycles, Set A gave 100 milliwatts, Set B 1,400 milliwatts, and so on. But we might well find, if there were wide variations between sets, that one whole group of them gave no measurable output, and another group all gave outputs distorted in quality and limited in amount only by the power-handling capacities of their output valves. To class the first group all alike as "Duds," and to label all the second group "Overloaded" would be a little crude; there might be very considerable differences between members of each group.

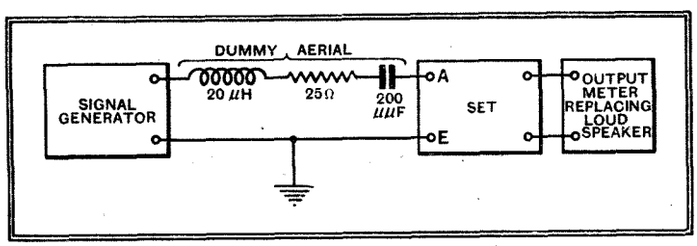


Fig. 2.—The dummy aerial, and how it is connected when making measurements on a receiver.

Since variations of output cannot be used to compare sets of widely different sensitivity, we must use variations of input. This implies that we must find what carrier-voltage, modulated to some predetermined depth, gives some arbitrarily chosen output. Two of the three variables, it is to be noticed, have to be fixed by common agreement. The accepted values of modulation depth and output to be used in measuring sensitivity are 30 per cent. and 50 milliwatts respectively, so that if we say that a set "has a sensitivity of 100 μV." we mean that on applying to it a 100-microvolt carrier, modulated to a depth of 30 per cent. (at, usually, 400 cycles) the audio-frequency output of the set is 50 milliwatts. Note that without the implied standards of modulation and output this description of the sensitivity would be so indefinite as to be almost meaningless.

It will be observed that by this method of measurement from aerial terminal to loud speaker a high post-detector gain is allowed to make up for a low pre-detector gain, and *vice versa*. The obvious justice of this supplies the reason why the measurement is made in this way and not, as might be preferable on some grounds, by taking the ratio of input carrier-voltage to HF voltage at the detector.

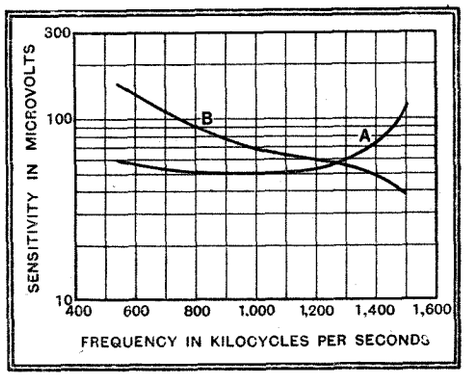


Fig. 3.—Typical sensitivity curves. A, a superhet; B, a "straight HF" set. Note that A is more sensitive at 550 kc/s, B at 1,500 kc/s.

In the choice of 50 mW. as an output there is no particular merit; it corresponds to a very small noise indeed. With 100 per cent. modulation the output would rise to some 550 mW., and at the time when the 50-milliwatt standard was laid down this was about the maximum output of any receiver. The choice of output thus implied that at the carrier-voltage specified by the sensitivity figure the output valve would be just about fully loaded at full modulation; in other words, that an input of that magnitude would just about give full loud speaker strength without danger of overload with the volume-control turned fully up. But as stations seldom peak up to full modulation, and nearly all sets are allowed to overload when they do, it is seldom that a set is so adjusted as to give no more than 50 mW. for a 30 per cent. modulated carrier. As a result, the detector deals with a smaller voltage during the test than it would in actual reception, so that it is not impossible for two sets using different types of detector to have identical sensitivity on measurement, although one may be definitely more sensitive than the other in actual reception of stations. This discrepancy, however, can be duly recorded by a supplementary measurement of each set at a different output—expressed as, say, "550 μV. for 1,500 mW.," in which statement 30 per cent. modulation is still understood.

The Artificial Aerial

Nothing has yet been said about the manner of applying the signal to the receiver. If the signal generator, which may have an impedance of only 10 ohms or so between its output terminals, is connected directly to the aerial and earth terminals of the set, the behaviour of the first tuned circuit may be very seriously upset. This circuit is so designed as to be connected to an aerial, the electrical characteristics of which may be roughly reproduced by an inductance of 20 μH., a capacity of 200μμF., and a resistance of about 25 ohms, all in series. To maintain the proper functioning of the first tuned circuit this combination, collectively called a **dummy aerial,** has to be inserted between signal generator and set as shown in Fig. 2. Since the exact values chosen may affect the voltage arriving at the grid of the first valve, the constants of the dummy aerial are always understood to have the values just given. Other values may be allotted in cases where this "average" aerial is not that with which the set is designed to work (e.g., in a car set), but in such a case details of the dummy aerial actually used must be fully stated in the record of the measurements made.

It is evident that since the characteristics of the tuned circuits in the set vary over the tuning range, the sensitivity of the set will also vary. It is consequently necessary, if the fullest information is required, to take a series of readings for a number of wavelengths covering both wave-bands. It is usual to plot the sensitivities found against frequency, giving curves like those of Fig. 3; it is not unusual to find, as there suggested, that of two sets the one more sensitive at 200 metres is the less so at 550. Note that a lower curve, or a lower figure, represents a higher sensitivity; a "twenty-microvolt set" is twice as sensitive as one labelled "forty microvolts," since it requires only half the input for the same output.

Response "Off Tune"

The measurement of the second main property of a set, its **selectivity,** is much more difficult in theory than in practice, owing to the fact that there is no recognised unit in which to express the result. The practical method adopted is to begin by adjusting signal generator and set as for a sensitivity measurement, the signal being tuned in on the set as accurately as possible. Then, leaving the set un-

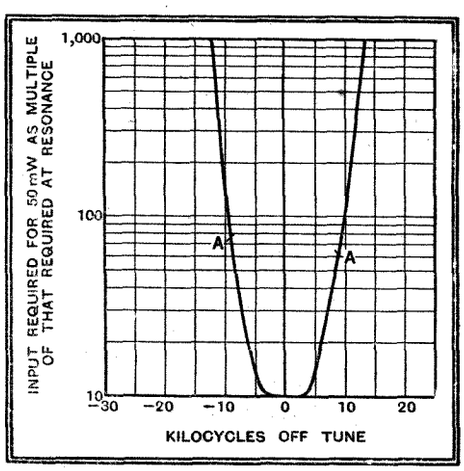


Fig. 4.—Selectivity curve: the input required to give a standard output is plotted against kilocycles off tune, producing an inverted resonance curve.

Measurements on Receivers—

touched, the signal generator is de-tuned in a series of small steps, each time bringing the output up again to its original level by increasing the input by readjustment of the attenuator. The more selective the set, the greater is the increase in input necessary to keep the output constant in spite of the slight de-tuning. Plotting the figures so obtained gives a curve like that of Fig. 4, which, it will be noticed, is *inverted* as compared with a resonance curve as usually drawn.

It tells us, for example, that at 9 kc/s from resonance (points A) the input has to be increased from 10μV. to 70μV. to keep the output constant; in other words, that at 9 kc/s off tune the sensitivity of the set is reduced to one-seventh of that at resonance. Selectivity thus appears as a *ratio of sensitivities* for a given amount of detuning. This can be expressed numerically in some such form as "Seven times down at 9 kc/s." But as resonance curves may take many different shapes, no such abbreviated description in figures can possibly convey more than a fraction of the information given by the curve. It is therefore the latter that has to be put with the record of the set's behaviour.

As is well known, the response of a set to signals slightly off tune is an indication also of its response to the outer sidebands that carry the higher notes of a transmission—in other words, of its **fidelity** in reproducing music. To measure this, we give the set a signal constant in all things save the pitch of the "tuning-note" it conveys. A set of perfect fidelity would evidently give the same output for all audio-frequencies; by measuring, over a full range of frequencies, the output actually obtained, the divergence from perfect fidelity can readily be determined.

A curve typical of many modern sets is shown in Fig. 5, which shows a slight falling-off in the bass and a more serious drop in the treble. For describing the curve, which in a perfect set would be a horizontal straight line, we have to take the ratio between the power at one frequency and that at another. Since few sets show a falling-off so high in the bass, or so low in the treble as 400 cycles, it is to the output at this frequency that the output at all others is referred. In the case shown, the output at 5,000 cycles is down to one-tenth, so that the fidelity of the set may roughly be indicated by stating that it is "ten times down at 5,000 cycles." But as in the case of selectivity, curves have all manner of shapes, and only the curve itself can convey the full information.

More often the ratio is expressed in terms of the decibel, which is the unit of power ratio. This system, rather a muddling one till one gets used to it, will be described in the concluding instalment of this article.

(To be concluded.)

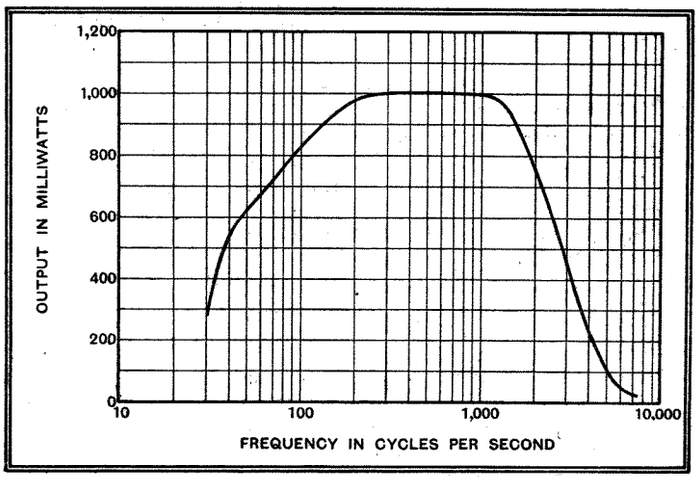


Fig. 5.—Fidelity curve, plotted as milliwatts output against frequency.

BOOK REVIEWS

Electricity in the Home.—By C. B. Brook, A.M.I.E.E. Pp. 186 and 86 illustrations. Published by the author, 10, Burwood Road, Lindley, Huddersfield. Price 2s. 6d., or 2s. 9d. post free.

IT is perhaps surprising to find how many domestic users of electricity are unable to rectify even the simplest of minor defects, such as the replacement of a melted fuse. This is, no doubt, due to the fact that electricity is regarded as something mysterious, and that any attempt to rectify a fault is fraught with danger. In "Electricity in the Home" the author effectively dispels this fallacy, and great pains are taken to show that in reality less danger attaches to the use of electricity than other domestic services. The text is couched in the simplest terms and deals with all aspects of the subject from the householder's point of view. The economic side is fully dealt with and a complete case is made out for the use of electricity—it is pointed out that a 40-watt lamp can be used for one hour for the cost of a single match! Many practical questions and their answers are interspersed throughout the book, which concludes with a very useful chapter on locating and repairing faults. Although little space is allotted to the use of "all-mains" radio receivers and radio-gramophones, the general advice in regard to other devices applies equally well here.

This practical handbook will prove a source of valuable information and reliable advice to all domestic users of electricity.

O. P.

Tuning-in Without Tears. By Frank Boyce. Pp. 139 with 75 illustrations by Con H. Lomax. Sir Isaac Pitman and Sons, Ltd., 39, Parker Street, W.C.2. Price 2s. 6d.

THE author of this book is, it appears, the service manager to one of the oldest and best-known of radio manufacturers. Knowing this, the reader might reasonably expect to trace in its pages the evidence of a permanently embittered character. But years of contact with human nature at its most exasperating have engendered only a sympathetic insight into the plain man's (and woman's) difficulties in understanding wireless.

The title is a just claim, for any tears shed over the book are of joy and not of boredom. Both text and illustrations are in the most buoyant style. But not, be it noted, at the expense of accuracy or informativeness. The author, indeed, claims that he has, with a collaborator, avoided anything to which a "classically or scientifically educated wireless engineer" could object, "unless he were also a K.C." I, personally, winced slightly at the phrase "machinery makes electricity" which one encounters near the start; but any misgivings on this account were more than neutralised before the close of the same chapter by the author's masterly treatment of the difficult subject of radiation. He goes beyond the stone-in-pond analogy to the far truer and clearer picture of bubbles being blown one inside another.

This is a book that will bring comprehension to the veriest dullard, and entertainment to the hardest-boiled expert. M.G.S.

THE RADIO INDUSTRY

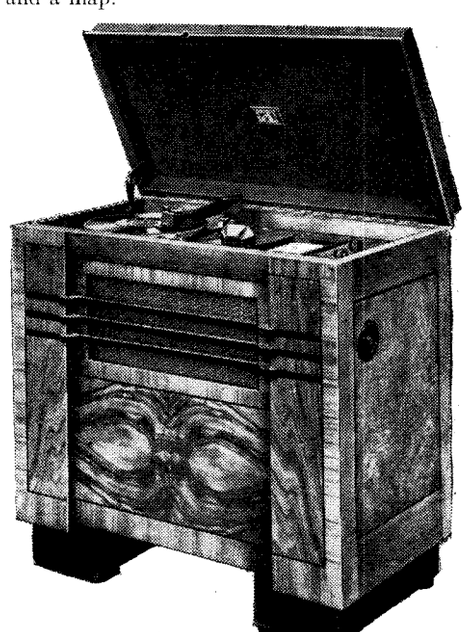
WRIGHT & WEAIRE, of 740, High Road, Tottenham, London, N.17, are making coils for the "By Request" crystal receiver. The complete set comprises four coils, wound to the published specification.

◈ ◈ ◈ ◈

Halford Radio announces a new type of chassis which is now being fitted to all models. For local-station reception a "straight" circuit is used, but for long-distance work this is converted into a superheterodyne circuit by operation of a switch.

◈ ◈ ◈ ◈

"Glorious Adventure at Home" is the title of a booklet just issued at 2d. by Philco. It contains a great deal of useful information for short-wave listeners, including lists of stations and a map.



THE LATEST H.M.V. RADIOGRAM. An entirely new five-stage superheterodyne chassis is fitted in the Model 545 recently released by the Gramophone Co., Ltd., and a special feature is made of the new "Station Selector Ray" tuning scale. The price of the radiogram is 22 guineas and a table model receiver is available at 13 guineas.

OHM'S LAW

An Explanation that Assumes NO Knowledge of Electricity or Mathematics

By "CATHODE RAY"

THE apostrophe should be noted, as it distinguishes this law from O.H.M.S. (which deals with *really* unpleasant matters, such as income tax). There is no doubt that many people who are quite enthusiastic about various aspects of radio fight shy of Ohm's Law. It seems to me that there are three reasons—apart from psychological associations with things like school-days and work—why this is so. One is that references in books usually appear something like this:—

Ohm's Law

$$I=\frac{E}{R}$$

$$R=\frac{E}{I}$$

$$E=IR$$

Whereupon the reader exclaims: "I hate (or "I can't be bothered with" or "I don't know anything about") algebra!" And that's that.

Another difficulty is that, even when it has been grasped that "I" stands for amps., etc., it is a troublesome sort of business to calculate, for example, the correct resistor to supply 15 volts bias to a valve taking 23 milliamps.

The third reason is that amps. and volts and ohms are not things that one can see or understand naturally; they are just so many uncouth words to most people.

Quite Painless

I hope, however, to be able to administer Ohm's Law in such a way that the patient (i.e., the entirely non-mathematical reader) has it inside him without any accompanying bad taste having been experienced.

In this present (or Hore-Belisha) era the idea of miles per hour is surely understood by all. What is reckoned in miles per hour? *Speed*. Good! We are getting on! Further interrogation of the kindergarten would reveal that miles measure *distance* and hours *time*. There are thus three quantities—speed, time and distance—and they are related in such a way that if any two of them are known the third can be calculated. Even the reader who prides himself on being one hundred per cent. non-mathematical would probably have to admit to having, on various occasions, carried out certain of these calculations; nay, more—to having actually done them *mentally*! Thus, if he had just done a journey of 100 miles and had taken four hours over it, he would rightly claim an average speed of 25 miles per hour; calculated by dividing 100 by 4.

What he has done mentally can be summed up for all possible journeys by writing:—

Speed (miles per hour) is Distance (miles) divided by Time (hours),

or, more compactly:—

$$\text{Speed}=\frac{\text{Distance}}{\text{Time}}$$

On another occasion he might be setting out to walk 6 miles; and, knowing that he can walk at 4 miles per hour, he is able to estimate the time it will take by dividing 6 by 4, giving $1\frac{1}{2}$ hours. In other words:—

$$\text{Time}=\frac{\text{Distance}}{\text{Speed}}$$

In the same way, knowing the average speed and the time taken, the distance covered can be arrived at:—

$$\text{Distance}=\text{Speed}\times\text{Time}.$$

Most people (even non-mathematical people) probably don't think about having to remember these three formulæ. But if they wanted to remember how to do all these three sorts of calculations there would be no need to remember three separate things; all could be done with one:—

$$\frac{\text{Distance}}{\text{Speed}\times\text{Time}}$$

Hide the thing you want with your finger, and what is left tells you how to get it.

Anybody who can understand this (and probably most of you feel intellectually insulted by now), and who feel confident in challenging the policeman who alleges infringement of a 30-m.p.h. limit on the ground of covering a measured mile in $2\frac{1}{2}$ minutes, can understand and use Ohm's Law. The one thing to remember is:—

$$\frac{\text{Volts}}{\text{Amps.}\times\text{Ohms}}$$

Proceed as directed before (hiding the thing you want, etc.), and if you are given two things you can easily find the third. But before you get busy memorising the above, I suggest that for radio purposes it would be time better spent to memorise it in this form:—

$$\frac{\text{Volts}}{\text{Milliamps.}\times\text{Thousands-of-ohms}}$$

Usually one works in milliamps., and it is discouraging to have to convert them to amps., with decimal points and things smelling strongly of mathematics, before being able to use the key.

Example: you have a 100-volt HT battery, and you want to know the milliamps. when you connect a 2,000-ohm resistor between the terminals. You hide "Milliamps.," leaving $\frac{\text{Volts}}{\text{Thousands-of-ohms}}$, or $\frac{100}{2}$ or 50. Fifty milliamps. is much too much current for an ordinary HT battery, so you now know that it is not a particularly good thing to connect a 2,000-ohm resistor between its terminals.

Having shown (I hope) that calculations by Ohm's Law are no more abstruse or difficult than calculating the average speed of a motor car, I would like to go a little further by bringing to it the aid of visualisation. One reason why it seems easier to calculate speeds and distances is that while doing it one has a mental picture of the vehicle travelling along the road; and it becomes natural to assume that the longer the road the longer the time taken to traverse it. Although it is possible to make electrical calculations with the utmost precision and ease by blindly following the rule just given, it is far more satisfactory and useful to have some mental picture of what is going on.

The Volts Drive the Amps

That lay journalists lack such a picture is evident every time they declare that so many hundred volts "passed through the body of the deceased." The electric current that lights lamps, converts gangsters into corpses, and makes sounds come out of loud speakers, is measured in amps. (short for amperes) or, if in small quantities, in milliamps., which are thousandths of an amp. It corresponds to gallons-per-minute or other convenient measures of the rate of flow of liquids.

Volts are necessary to cause milliamps. to flow, just as a certain amount of pressure or difference in level is required to persuade water to flow through a pipe or along a river bed. The more volts there are, the more milliamps.

Nature might have been so arranged that doubling the volts would cause four times the number of milliamps. Or, perhaps, the-square-root-of-two times as many or some other number. It happens that except for special things such as valves (which weren't invented in Herr Ohm's day) it always works out that doubling the volts doubles the milliamps. also. That is what Ohm concisely set down in his Law.

The amount of pressure that is required to cause one amp. or milliamp. to flow is fixed by the nature of the circuit or bit of circuit through which the flow takes place. A long thin pipe laid all round the country would take quite a lot of pressure to force

Ohm's Law—

one gallon a minute through it. So would a very short pipe if it were full of dirt. It we had a unit with which to measure resistance to the flow of water, such as the "resistwater," we might make up an Ohm's Law for water systems:

$$\text{Gallons per minute} = \frac{\text{Pounds per sq. in.}}{\text{Resistwaters}}$$

Only it wouldn't be true. Electricity is a much simpler, more law-abiding thing than water. That is why, when once people have grasped electrical laws they elucidate difficult problems in mechanics and other things by thinking of them in terms of corresponding electrical quantities. It may sound incredible, but the easiest and best way to find out exactly what will happen to a complicated system of weights and springs and levers is first to translate them all into volts and amps. and ohms. But to get back to ohms—they are, of course, the quantities of resistance to the flow of electricity. Looking at the formula for Ohm's Law one can see that, if the ohms are many and the volts are few, the amps will be very few. That is what one concludes simply by blindly following the Law. But without knowing any Law, if you are told that the resistance to the flow of electric current is great, and the pressure producing the current is small, common sense will tell you that there will not be a very copious current.

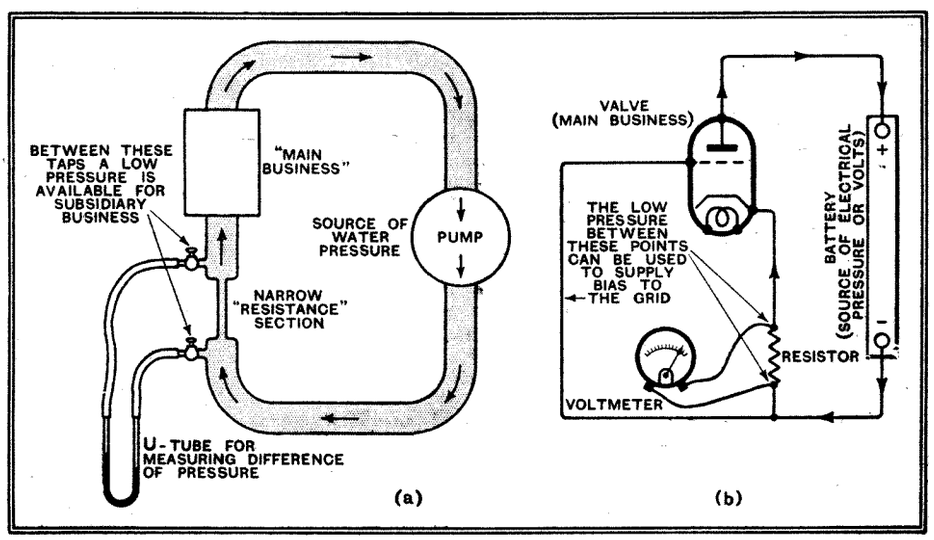


Fig. 1.—(a) Showing how it would be possible to cause a small difference of water pressure between two taps by interposing a narrow pipe in a hydraulic main supplying a high pressure to some machine or other (Main Business). Compare the corresponding electrical system found in most wireless receivers (b).

Practical Applications

Having got Ohm's Law in easily memorisable form, and some idea of what it means in ordinary everyday language, one may still be unable to make much use of it through failure to recognise occasions when it can be usefully applied. Take the example I mentioned before—calculating the right resistor for providing a valve with bias. It may seem excessively puzzling to talk about a resistor (which is a convenient chunk of ohms) *providing* volts at all, when all that has gone before suggests that ohms kill or neutralise volts, just as a choked pipe opposes water pressure. Exactly. If you wanted to appropriate a small portion of the pressure from a hydraulic main, what would you do?

To make a hole in the main would provide the whole pressure; far too much. But you could take out a section of the big pipe and replace it by a narrower one; this would offer appreciable resistance to the flow and demand a corresponding amount of pressure to overcome it. So between taps situated at each end of the resistance section this pressure would be available. Of course, it would not be available for providing a heavy flow of water; if your private by-pass pipe in which you utilised the pressure did that sort of thing the pressure would drop. In the same way a resistance placed in a circuit for obtaining a desired number of volts will maintain them only so long as it is not abused by connection to a relatively low resistance. The grid of a valve is a practically infinite resistance, taking no current; so this method is very commonly adopted in the so-called "automatic" or "free" grid bias system.

To take a definite example: suppose a resistance connected as in Fig. 1(b) would carry 23 milliamps.; in other words, the anode current. And suppose 15 volts are required as grid bias. Then (by Ohm's Law) the resistance is 15 divided by 23, or roughly 0.65 thousands-of-ohms, or 650 ohms.

Another example: you want to find the number of ohms of a resistor. You have a battery and a voltmeter scaled up to 100 volts and marked "1,000 ohms per volt." You first measure the battery voltage accurately and it turns out to be 62. You then interpose the resistor, which cuts down the reading to 18. How many ohms has the resistor?

This is solved by the application of Ohm's Law. From the information given we know that the total number of ohms in the voltmeter is 100 × 1,000, or 100,000. In the second test the pressure of 62 volts generated by the battery is applied to overcome the ohms in the voltmeter and also those in the resistor. We know that 18 are accounted for by the voltmeter. So the remaining 44 must be required for pushing the current through the resistor. The long way about it would

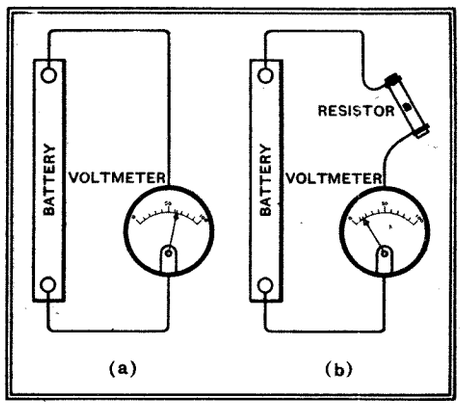
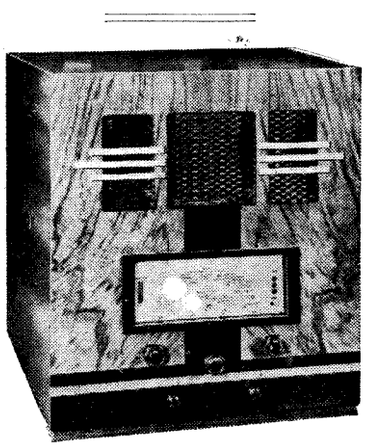


Fig. 2.—A simple method of measuring the ohms in a resistor by means of a battery and voltmeter. Two readings (a) and (b) are taken, and Ohm's Law applied to find the result.

be to calculate the current by Ohm's Law—$\frac{18}{100}$, or 0.18 milliamp.; then to use this to calculate the ohms in the resistor (because obviously the same current passes through both)—$\frac{44}{0.18}$, or 250 thousand (nearly). But it is possible to take a short cut by noticing that it is not really necessary to find out the actual number of milliamps at all. If 100 thousand ohms require 18 volts pressure to push a current through them, how many ohms will 44 volts pass the same current through? Obviously more, in the proportion of the volts: $100 \times \frac{44}{18}$ = same result as before.

All very useful. But even if one is not concerned with making actual calculations, it is helpful to have an idea of what Ohm's Law means.



NEW COLUMBIA SETS. The Model 381 illustrated above shows the system of "Spotlight Controls" which has been incorporated in a new series of receivers and radiogramophones issued by the Columbia Graphophone Co., Ltd. A column of light at the left of the dial serves as a tuning indicator and red and green "spotlight" indicators are used for long and medium waves respectively.

BROADCAST BREVITIES

BY OUR SPECIAL CORRESPONDENT

Not "High Fidelity"

MAGNIFICENT quality *can* be had from the test transmissions which, as I reported last week, are now going out daily from the ultra-short-wave aerials above Broadcasting House, but the trouble is that so many of the items selected from the National or Regional programmes are O.B.s. A few days ago I tuned in a cinema organ relay on about 7.7 metres, and the quality was decidedly mediocre, due no doubt to the land line link.

The Weak Link

If "ultra short" broadcasting develops on a large scale the Post Office will not be able to rest on its laurels when the London-Birmingham high-frequency line is completed.

We shall want co-axial cable for all musical O.B.s or, as the only alternative, shall expect the B.B.C. to abandon outside entertainment and make use of its own rich resources. (Who, by the way, will want to hear an ordinary cinema organ when Eric Maschwitz's world-beater gets going in St. George's Hall?)

Linking "B.H." with "A.P."

An undraped cable drum in Portland Place, marked "Co-axial," let the cat out of the bag last week. A high-frequency cable is now being installed between the old "30-line" television studio at 16, Portland Place and the transmitters at the Alexandra Palace. Thus artistes of special eminence will not be required to undertake the long and arduous journey to the (in estate agents' language) "Northern Heights."

No Alternative to "First News"

SEVEN days ago I was still inexperienced enough to think that I had found a question the B.B.C. could not answer. I was going to put to them the poser so admirably expressed by a correspondent in last week's "W.W." viz., Why is there no alternative to the 6 o'clock news bulletin?

Official Attitude

I went to Broadcasting House, found an official, and put the question point blank. And did he waver?

"The arrangement," he said, quite unperturbed, "will not be altered. Why should it be? You must remember that the 6 o'clock bulletin is the first to be broadcast in the day, the previous bulletin having been given at 10 on the previous night. For this reason it is felt that the transmission should go out all over the country."

Nationals Out of Reach

"But surely," I queried, "a transmission restricted to the National wavelengths — long wave as well as medium— should cover the whole of the United Kingdom? The fact that it goes out on the Regional wavelengths as well doesn't extend its range?"

"It does," parried the official. "We know of people who cannot receive Droitwich and are unable to tune down to the shorter wavelengths used by the other National transmitters. In fact, they are outside the National range."

Disappointing the Many

So far as it goes, this seems to be an adequate answer, but it raises the question whether the B.B.C. should inconvenience the majority of listeners in order to satisfy the demands of a few people who cannot, or will not, provide themselves with up-to-date receiving gear.

However, the Corporation hath spoken. "The arrangement will not be altered."

Men of Letters

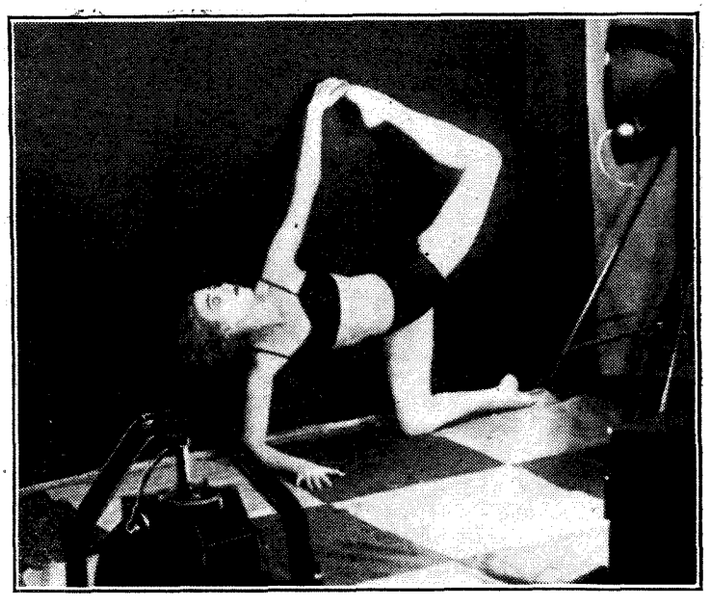
FROM the "D.G." downwards, nearly everyone of rank in Broadcasting House is now known by his initials; in fact, there is a veritable plague of capital letters, and woe betide the unlucky junior who fails instantly to recognise the S.C.C.S.B. and the A.D.P.A. or confuses the C (E) with the C.E.

The first-mentioned is, of course, the Secretary of the Central Council for School Broadcasting, and the second the Assistant Director of Programme Administration. C.E. has no religious significance but stands for Civil Engineer, while C (E), if you did not know, means Chief Engineer.

Who's Who

A few more:—D.O.T., Director of Television; D.T., Director of Talks; D.D., Director of Drama; D.V., Director of Variety; D.B.R., Director of Business Relations; P.R., Press Representative; P.R.ex., Public Relations Executive; O.E.I.D., Overseas and Engineering Information Department; E.E.O., Engineering Establishment Officer.

More next week.



SO THIS IS TELEVISION. A clever act in a Moscow television programme. High definition tests are now in daily operation.

Inquisition

WHILE Leslie Baily has been conducting his survey of the B.B.C. stations on behalf of *The Wireless World*, an official emissary from Broadcasting House has been engaged on a similar mission, and it was sheer coincidence—or lack of it?—that "never the twain did meet." Once or twice, I believe, they missed each other by inches.

A Secret Report

The official tourist was none other than Mr. Charles Siepmann, late Talks Director and now Director of Regional Relations. I hear that he has now practically completed a thorough inquiry into provincial broadcasting and is shortly to make a report to Sir John Reith. Some very interesting, and possibly drastic, changes may be suggested.

At the moment Mr. Siepmann's views are being kept a close secret at Broadcasting House.

Doings at Daventry

DAVENTRY tends to be forgotten by listeners in this country now that Droitwich shelters the National and Midland transmitters, but I hear that the construction of new buildings to house the high-power Empire transmitters is now going ahead after some delay caused by the very severe weather.

The engineers are hoping to get the transmitters installed during the summer, so test signals may be expected in the autumn or early winter.

B.B.C. Lectures?

SIR STEPHEN TALLENTS, Public Relations Officer of the B.B.C., is, I understand, planning a lecture tour for next autumn and winter, with the idea of establishing personal contact with listeners up and down the country.

One would think that the B.B.C. could win the confidence of listeners via the microphone.

Eighty-Nine Studios

BELIEVE it or not, the B.B.C. now has eighty-nine studios, of which 58 are in the provinces. The biggest group is at Birmingham (6), Edinburgh and Cardiff coming second with five each.

The thirty-one London studios are as follows:—Broadcasting House, 22; Maida Vale, 5; Alexandra Palace, 2; St. George's Hall and a disused "30-line" television studio at 16, Portland Place.

London Landmark

ONE of the most surprising Christmas cards the B.B.C. received came from a listener in New York. It consisted of his own lino-cut of Broadcasting House, and was much appreciated at headquarters, though one wonders whether the design appealed to the sender's friends in America. Is Broadcasting House now in the class of universally recognised London landmarks, like the dome of St. Paul's?

Recent Inventions

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each

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

THERMIONIC VALVES

THE characteristic curve of a valve is largely determined by the internal spacing of the electrodes. Sometimes it is desirable to be able to change, say, the amplification factor, or the mutual conductance, of the same valve when used under different circumstances such as for different kinds of experiments in a research laboratory.

To allow this to be done a single valve is fitted with a large number of rod-like electrodes, which are brought out to separate external leads. These are then grouped in such a way that the particular electrodes selected, and therefore the working characteristic of the valve, can be changed as desired by a simple switching operation.

Telefunken Ges. für drahtlose Telegraphie m.b.h. Convention date (Germany) March 2nd, 1934. No. 438181.

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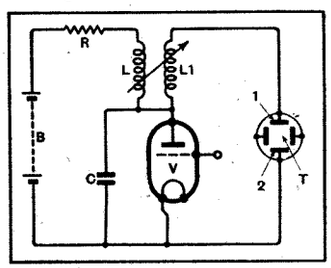
SAW-TOOTHED OSCILLATOR

A GAS-FILLED valve V applies scanning-potentials to the deflecting-electrodes 1, 2 of a cath-



Trigger circuit for cathode-ray tube.

ode-ray tube T used as a television receiver. A battery B charges up the condenser C through a resistance R, and, when the valve V is triggered by a synchronising impulse so as to discharge the condenser, a series of saw-toothed oscillations is applied to the cathode-ray tube.

In order to regulate the amplitude of these oscillations, without at the same time altering their frequency, an inductance coil L is inserted in series with the charging-circuit, and is variably coupled with a similar coil L1 in the anode circuit of the valve V. This introduces an auxiliary voltage which may either be added to or subtracted from the normal voltage of the output oscillations.

J. C. Wilson and Baird Television, Ltd. Application date August 31st, 1934. No. 438285.

o o o o

REGULATING "GAIN"

AN amplifier designed to handle, say, the picture and sound signals from talkie film, or the output from a gramophone, is arranged to expand the dynamic range of the applied signals, so as to give a greater contrast between the pianissimo and forte passages than exists in the original film or record.

A biasing voltage derived mainly from the higher-frequency notes is applied to vary the gain-ratio of the amplifying-valves so that it increases with increasing intensity of input. The control is sufficiently sluggish in action not to respond to changes in the individual audio-oscillations, but only to variations in average intensity; and detector action, such as might produce undesired harmonics, is cut out. Among other advantages the effect of needle scratch is reduced.

J. H. Hammond, Jr. No. 2008701. (U.S.A.)

o o o o

SUPERHET RECEIVERS

THE local oscillator valve of a superhet set is arranged so that it automatically produces higher voltages as it is tuned to lower frequencies, in order to offset the attenuation in transmission of the lower carrier frequencies.

In order to achieve this result the small series condenser which is inserted in series with the oscillator circuit, for tracking purposes, is back-coupled to the plate circuit through coils which, together with the condenser, are resonant to a frequency below the lowest to be received.

P. O. Farnham (Assignor to Radio Corporation of America). No. 2001695. (U.S.A.)

o o o o

PUSH-PULL AMPLIFIERS

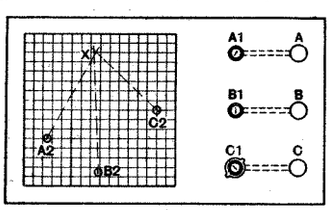
BOTH the grids of a class-B amplifier are given a fixed positive bias, which is substantially halfway to maximum plate current, so that the input voltage-swings are always on the positive side of the characteristic curve. This is stated to double the power sensitivity of the circuit. A driver stage is, of course, used to offset the effect of grid current.

C. Travis (Assignor to Radio Corporation of America). No. 2016402. (U.S.A.)

o o o o

DIRECTION-FINDING

TO track the position of a moving craft, such as an aeroplane in flight, three separate land-stations A, B, C, each fitted with rotating frame-aerials, pick up signals from the craft, and relay them



Position-finding device.

to a central station where the signals are correlated by Neon-lamp indicators A1, B1 C1, which are rotated in synchronism with the frame aerials. The luminous bearing lines so produced are maintained by a stroboscopic effect and are co-ordinated at A2, B2, C2 on a chart, so as to indicate the position X of the aeroplane as it moves along its course.

A. Bertrand and M. Parisier. Application date April 25th, 1935. No. 438852.

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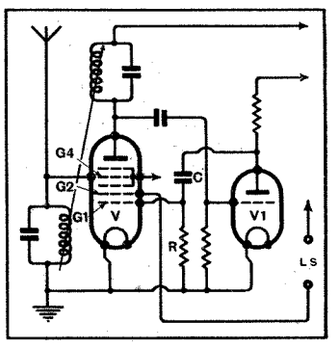
REFLEX CIRCUIT

ONE part of the electrode system of a five-grid valve is used to amplify the carrier fre-



Multi-valve reflex circuit.

quency, whilst another part serves to amplify "reflexed" low-frequency signals. Incoming signals are applied to the grid G4 of the valve V and, after amplification, are rectified by a second valve V1. The output from the latter is back-coupled through a resistance R and capacity C to the first grid G1 of the valve V, and the amplified low-frequency signals are finally fed from the output grid G2 to the loud speaker LS. The third and fifth grids are connected together and are anchored to a fixed biasing-voltage.

Marconi's Wireless Telegraph Co., Ltd.; N. M. Rust; and O. E. Keall. Application date May 28th, 1934. No. 439047.

o o o o

AUTOMATIC VOLUME CONTROL

THE usual method of controlling the gain of an amplifier in accordance with changes in input strength is to vary either the plate impedance or the amplification-factor of the valve, or both, by applying suitable biasing-potentials to one or more of the grids. This, however, also produces changes of plate-current which give rise to non-linearity and distortion.

In accordance with the invention the load impedance is varied, independently of the valve impedance, so as to secure automatic volume control, by the use of an element which has the property of instantaneously changing its resistance with change of current. A suitable substance is the silicon-carbide composition known by the name Thyrite. This is coupled to, and varies the effective load impedance of, one or more of the tuned high-frequency currents in the receiver.

Standard Telephones and Cables, Ltd. (assignees of D. H. Ring). Convention date (U.S.A.) May 26th, 1934. No. 438565.

"QUIET" TUNING

IN order to suppress interstation "noise" without having to use an extra valve for this purpose, the grids of two of the high or intermediate-frequency valves are connected through separate resistances to a tapping on the load resistance of a diode-pentode rectifier. The arrangement is such that when the slider of a manual volume-control is at its upper position, the grids of both valves are positively biased, so that the path to the loud speaker is blocked in the absence of any signal of worthwhile strength.

As signal strength increases, the voltage developed by the pentode-rectifier throws the two grids negative, and the normal supply to the loud speaker is restored. The output volume, as well as the extent of noise suppression, are both regulated by adjusting the position of the manual-control slider.

E. K. Cole, Ltd., F. A. Inskip, and A. W. Martin. Application date June 25th, 1934. No. 438670.

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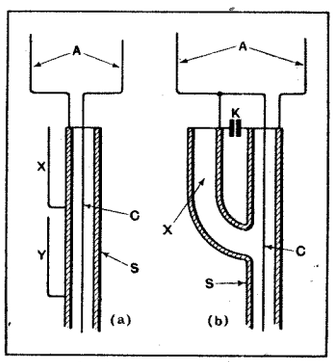
SHORT-WAVE AERIALS

IN a concentric feed-line as used for short-wave aerials, the signal currents normally flow on the inside surface of the outer tube,



Aerial arrangement.

though interfering currents may also be induced on its outer surface. The invention is concerned with means for eliminating these undesirable currents without, at the same time, attenuating the signal currents.

As shown in Fig. (a), this object is attained by attaching one or more auxiliary wires X, Y to the outside of the tubular sheath S. The first wire X is located a quarter wavelength away from the end of the sheath, whilst the second is connected a quarter wavelength farther down. The aerial proper A is branched across the outer sheath S and the inner core which is shown at C.

In Fig. (b) the auxiliary wire is replaced by a bifurcation X of the main feed-line, so that the two form a U-shaped termination, to which the two limbs of the aerial are attached as shown. The condenser K serves to increase the impendance of the coupling to undesired frequencies.

W. S. Percival and E. L. C. White. Application dates February 15th and July 27th, 1934. No. 438506.

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CONTENTS

EDITORIAL COMMENT

British Sets for Overseas

A Standard Design for Export ?

FOR years now Britishers overseas have complained that receivers of British manufacture suitable for their needs are nearly unobtainable and that manufacturers of other countries are capturing, or have already captured, a market which ought to belong to the set producers at home.

We are afraid the principal reason why sets of British manufacture are so rare abroad is simply that our producers here have never seriously set about providing for this market. We have repeatedly urged our manufacturers to do something to remedy this position, but still time goes on and little, if anything, is done.

Apart from the question of the design of a suitable set which will incorporate short waves, overseas purchasers find that prices are high, servicing difficult, and that it is often nearly impossible to obtain spares when these are necessary. We have on previous occasions pointed out that British manufacturers, if they tackle this market properly, should try to avoid competition between themselves and might, to this end, agree upon territories where individual manufacturers would supply. Such an arrangement would help considerably, we believe, and would also avoid the necessity for local radio firms to stock spares for a variety of British sets.

The position in regard to competing with foreign supplies in the Dominions and Colonies is so urgent, by reason partly of the long delay in making a start, that some unusual method of procedure now seems imperative beyond the proposal to avoid competition put forward above.

Our own suggestion at this stage is that British designers should pool their knowledge and produce a specification for a dependable and efficient receiver for overseas use, and that manufacturers here should agree through their Association to standardise their production of sets for overseas to this specification. Such an arrangement would, we think, result in a better set at a much lower cost and would solve the difficulty of spare parts and servicing to a very great extent. The People's Receiver in Germany is an indication of what can be done in the way of agreement to standardise.

Such standardising is not a policy which we should advocate for the home market or, in fact, anywhere where it could be satisfactorily avoided, but to see our manufacturers neglecting an important potential market is a sight so deplorable that only drastic remedies seem suitable.

B.B.C. and High Fidelity

Possibilities of Short Waves

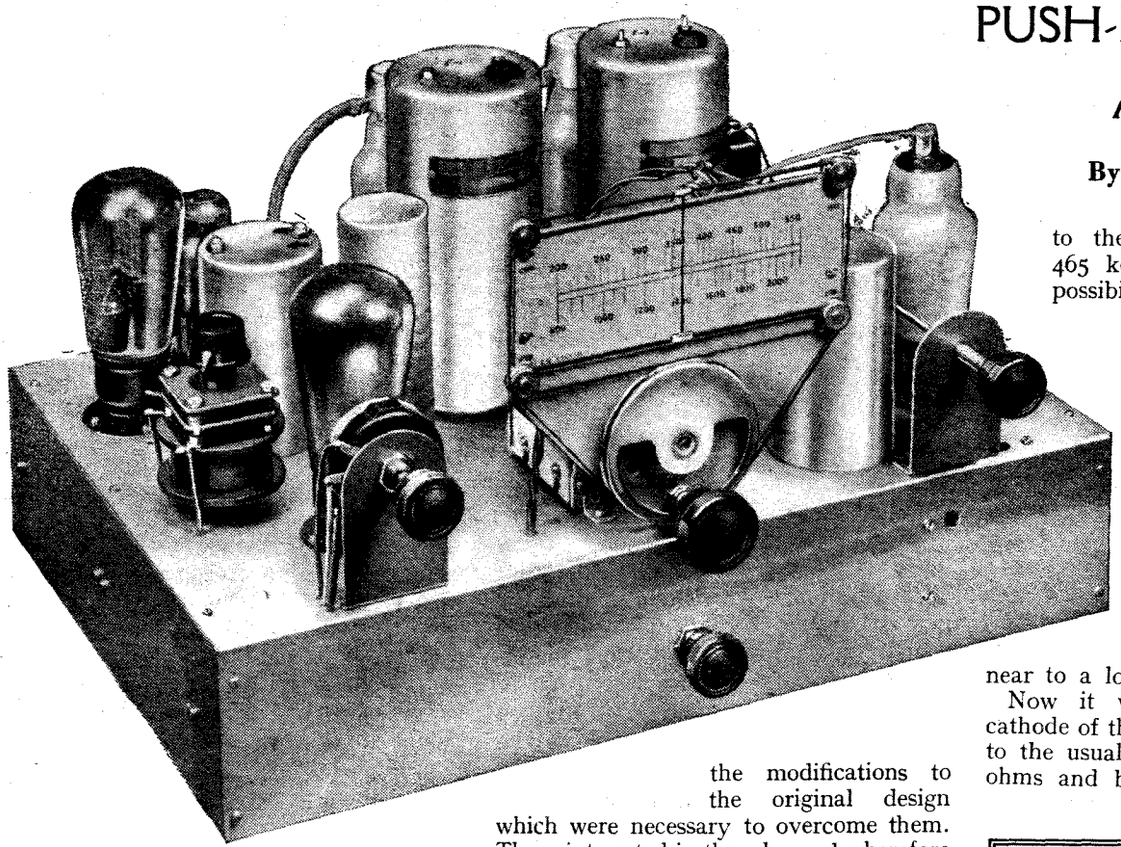
AT a recent meeting a correspondent to *The Wireless World* had understood Sir Noel Ashbridge, the Chief Engineer of the B.B.C., to say that he did not attach much importance to the high fidelity possibilities of sound broadcasting on the ultra-short waves. We are glad to have the assurance in a letter which we publish this week that high quality remains the aim of the B.B.C., although we are reminded that a wide frequency band alone will not achieve this result.

We think, however, the Chief Engineer would concede that the use of ultra-short wavelengths does open up possibilities in the way of high quality which were not available on normal broadcast bands.

QA Super

A SPECIAL RECEIVER FOR THE PUSH-PULL QUALITY AMPLIFIER

By W. T. COCKING



THE highest standard of reproduction demands as close an approach to perfection as possible in every link of the chain, from aerial to loud speaker. Not only must frequency distortion be kept at a minimum, but amplitude distortion must be reduced to the lowest possible level; in fact, as regards its audible effect, it is much more important than any unevenness in the response at different musical frequencies. So far as the low-frequency circuits are concerned, no improvement can be made on *The Wireless World* Push-Pull Quality Amplifier,[1] but up to the present there has not been a wide choice of receivers for use with it. The avoidance of distortion in the pre-detector circuits demands just as careful attention to detail as in the case of the LF amplifier, and the difficulties are actually rather greater.

The receiver which is described in this article has been designed first and foremost for use with the Push-Pull Quality Amplifier, and the reduction of all forms of distortion to a minimum has been made the first aim in design. The development of the receiver was described in detail in a recent issue of *The Wireless World*,[2] where the various difficulties which were encountered were discussed, together with the modifications to the original design which were necessary to overcome them. Those interested in the why and wherefore of the general circuit arrangement, therefore, are referred to that article, and it is only necessary to deal here with the precise details of the final arrangement.

The complete circuit diagram of the receiver appears in Fig. 1, and it will be seen that six valves are used and are connected as a frequency-changer, two IF amplifiers, a diode detector, an AVC amplifier, and a phase-reversing stage for push-pull output. The frequency-changer is a triode-hexode, and it is preceded by a single tuned circuit. This circuit includes the coil L6 on the medium waveband and the coils L6 and L7 on the long waveband, for the switch S2 is then open. The inductance is tuned to the frequency of the wanted signal by one section C5 of the two-gang condenser, the other section C15 of which tunes the oscillator circuit.

Signal-frequency Circuits

The aerial circuit is fixed-tuned to the middle of the waveband by the aerial coils L3 and L4 resonating with the capacity of the aerial itself. On the medium waveband only L3 is operative, for S1 is closed, but both coils function on the long waveband. This aerial circuit is loosely coupled to the signal-frequency tuned circuit by the 0.005-mfd. condenser C4, which is common to both.

In series with the aerial lead to L3, two wavetraps will be observed. The first of these, comprising L1, C1 and C2, is tuned to the intermediate frequency of 465 kc/s in order to reduce any possibility of interference from morse signals in the shipping band. The second, L2 and C3, is a refinement which is needed only when the set is used within a few miles of a powerful transmitter, and it is then tuned exactly to this station. Its function is to reduce the input to the first valve, so that it is not overloaded when the signal frequency circuit is tuned near to a local station.

Now it will be observed that the cathode of the frequency-changer is taken to the usual bias resistance R4 of 1,000 ohms and by-pass condenser C7 of 0.1

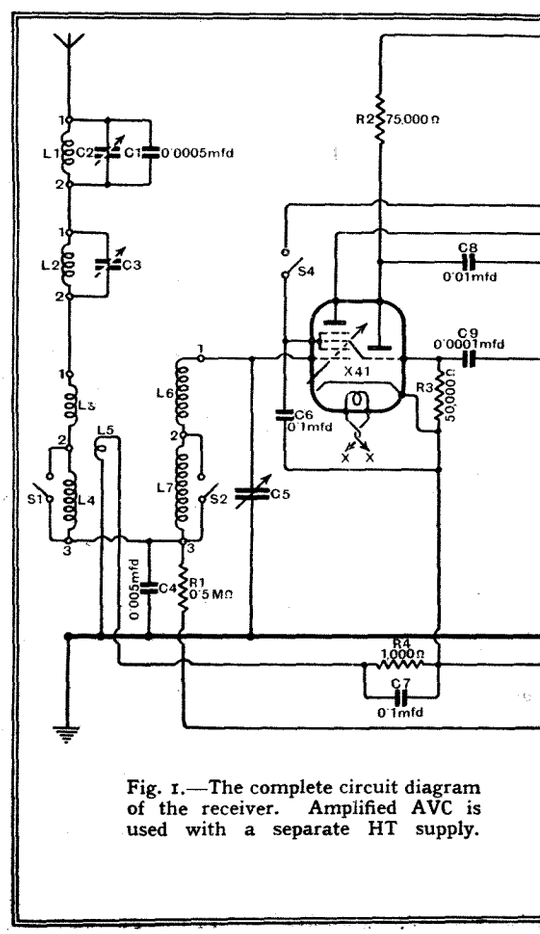


Fig. 1.—The complete circuit diagram of the receiver. Amplified AVC is used with a separate HT supply.

[1] *The Wireless World*, May 11th and 18th, 1934. Reprinted February 22nd, 1935. Now available as a further reprint in pamphlet form.

[2] *The Wireless World*, February 14th, 1936.

mfd. Instead of being taken directly to the earth line, however, these components are earthed through the coil L5, which is coupled to L3 and L4. Actually, this coil consists of only one turn of wire, which is formed by using a long earthing lead for R4 and C7, and wrapping it once round the coil assembly, L3 and L4, at the appropriate point. The purpose of this coil is to reduce second-channel or image interference, which it does very effectively indeed on both wavebands.

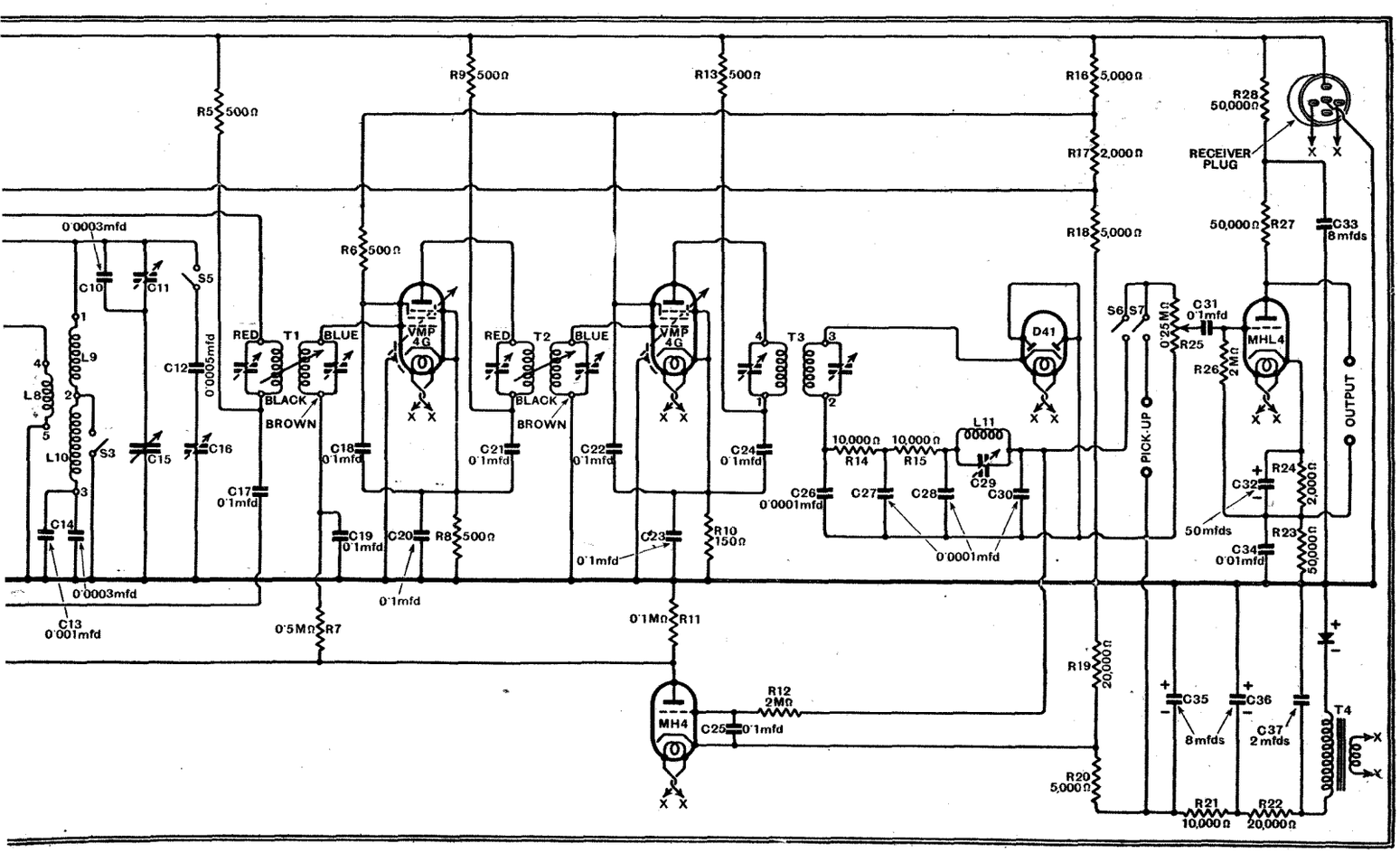
The screen-grid of the triode-hexode is fed at some 70 volts from the voltage divider, and a 0.1 mfd. by-pass condenser is connected to cathode. The switch S4 is inserted in the screen lead to render the valve inoperative on gramophone, and so to prevent any possibility of interference from radio signals. The anode of the hexode section of this valve is joined to the primary of the first IF transformer T1, which is of the variable-selectivity type. The HT supply is fed from the 250-volt line through the 500-ohms decoupling resistance R5, with a 0.1 mfd. by-pass condenser C17 returned to cathode.

The triode section of the valve acts as the oscillator of the tuned anode type. The reaction coil L8 is included in the grid circuit, the grid condenser C9 and grid-leak R3 being given values of 0.0001 mfd. and 50,000 ohms respectively. The anode is fed from the main HT line through the 75,000-ohms resistance R2, and the tuned circuit is shunt-fed through the 0.01 mfd. condenser C8. On the medium waveband S3 is closed and S5 open. The tuned circuit then comprises L9 tuned by the variable condenser C15 in series with the padding capacity consisting of the 0.0003-mfd. fixed condenser C10 in parallel with the trimmer C11. In this way the oscillator is maintained at a frequency 465 kc/s higher than the signal on the medium waveband. On long waves, however, S3 is open and S5 closed. The circuit is fundamentally the same, but the inductance is augmented by the addition of L10, and the padding capacity reduced by the introduction of C13 and C14 of 0.001 mfd. and 0.0003 mfd. In addition, the minimum capacity is increased by the addition of parallel capacity comprising the trimmer C16 and the 0.0005-mfd. series condenser C12.

MUCH attention has been paid in the past to the avoidance of distortion in low-frequency amplifiers and in detectors, but apart from the question of sideband cutting, comparatively little consideration has been given to the early circuits. In the QA Super, care has been taken in design to avoid amplitude distortion in the frequency-changer and IF stages no less than in the LF equipment, and an exceptionally high standard of quality is consequently obtainable

Turning now to the IF amplifier, the first valve is an HF pentode fed from the secondary of the first IF transformer T1. The second transformer T2, which is also of the variable-selectivity type, is connected to its anode circuit. Anode circuit decoupling is provided by the 500-ohms resistance R9 and 0.1-mfd. condenser C21, while the screen grid is decoupled by another 500-ohms resistance R6 and 0.1-mfd. condenser C18. Both condensers are returned directly to cathode instead of to the earth line, following usual practice, since it has been found that this change leads to better stability. The cathode is earthed through the 0.1-mfd. condenser C20, and bias is derived from the voltage drop along the 500-ohms resistance R8, this value being selected in order to keep the amplification at a reasonable figure.

The general arrangement of the second stage is the same as that of the first, and the same type of valve is used. As this valve feeds the detector and must handle quite large signal voltages, it is operated with only the grid bias necessary to avoid grid current, and the bias resistance R10 has a value of 150 ohms. It is shunted by the usual 0.1 mfd. by-pass condenser C23. The screen-grid is fed from the 100-volt line and by-passed to cathode by C22 of 0.1 mfd.; anode circuit decoupling is provided by R13 or 500 ohms with the 0.1-mfd. condenser C24.



QA Super—

The third transformer T3 which couples the second IF valve to the diode detector has fixed coupling between its coils, and the coupling is very close to optimum so that a maximum of energy is passed on to the detector. This detector employs a duo-diode with the two diode anodes strapped together, and is entirely conventional save that, for a reason which will be apparent later, the connections to the anode and cathode are the reverse of the usual. The IF input is applied to the detector through the 0.0001-mfd. condenser C26, and the output is taken through a two-stage filter comprising the 10,000-ohms resistances R14 and R15 with the 0.0001-mfd. condensers C27 and C28. A whistle filter tuned to 9,000 c/s for the purpose of eliminating inter-carrier heterodynes of this frequency then follows; it comprises L11 and C29, with the 0.0001-mfd. condenser C30.

The load resistance of the diode detector is connected across this condenser. It is actually the 0.25-megohm tapered volume control potentiometer R25, and the connections are clear when it is remembered that on radio S6 is closed and S7 open, whereas on gramophone S6 is open and S7 closed. The volume control is, of course, operative on both radio and gramophone.

The AVC System

The LF output of the volume control is fed to the triode phase-changing valve through the 0.1 mfd. condenser C31, and this valve derives its bias through the grid leak R26 of 2 megohms from the voltage drop across the 2,000-ohms cathode resistance R24, which is shunted by a 50-mfds. electrolytic condenser C32. In both anode and cathode circuits of this valve, 50,000-ohms coupling resistances R27 and R23 are included, and the voltage developed across each is taken to feed the two halves of the Push-Pull Quality Amplifier. Decoupling is provided by the 50,000-ohms resistance R28 and the 8-mfds. electrolytic condenser C33. The 0.01-mfd. condenser C34 in shunt with R23 is included for tone-correction purposes, and it gives a useful increase in the high-frequency response.

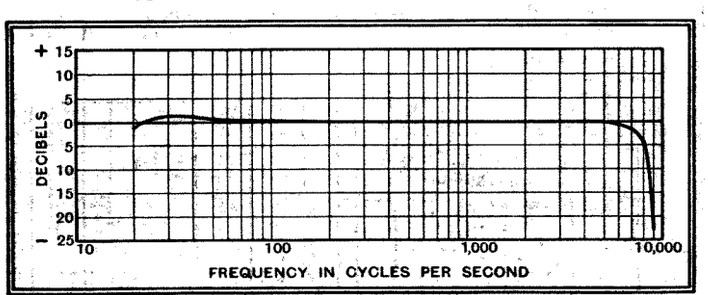


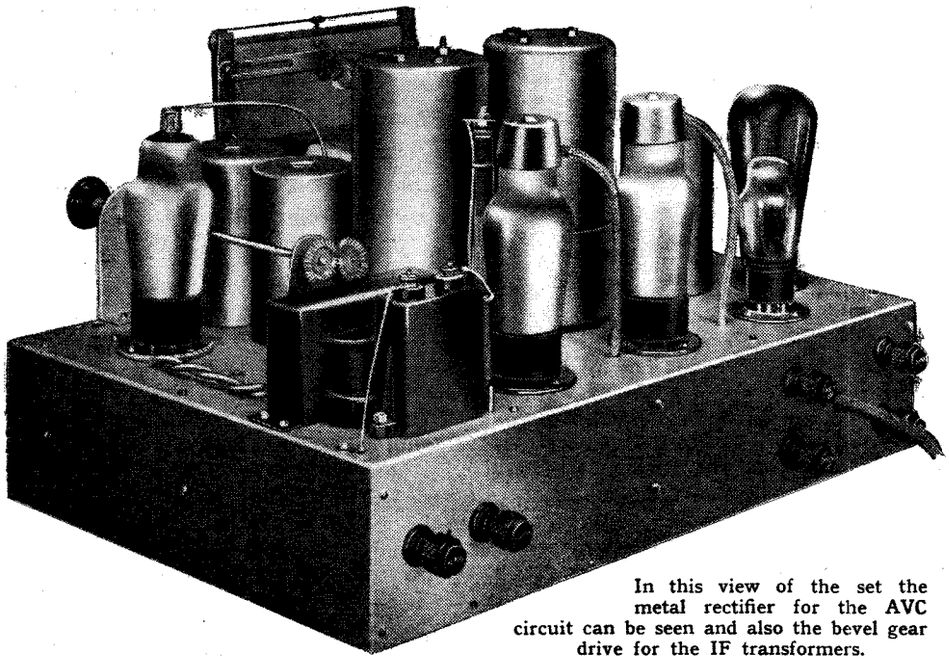
Fig. 2.—The overall frequency response of the receiver with the Push-Pull Quality Amplifier.

If satisfactory results are to be secured from the point of view of quality, the detector input must be held constant within quite narrow limits, and an unusually effective AVC system has therefore been developed.[3] The DC output of the detector is used to control the grid bias of the frequency-changer and the first IF amplifier through the medium of a triode amplifier. It will be seen that the anode of this valve is returned to the earth line through the 100,000-ohms resistance R11, and that the grids of the controlled valves are taken to it through decoupling resistances R1 and R7. The valve is given an initial grid bias sufficient to bias it well beyond the point at which anode current ceases to flow, and there is then no voltage drop across R11 and no AVC bias applied to the early stages.

Now the grid of this valve is taken through a filter to one end of the detector load resistance, the other end of which is taken to a point about 100 volts negative with respect to the earth line. The cathode is taken to a point rather less negative than this, the difference representing the grid bias already referred to; actually, the grid bias is the voltage drop across R20 and its anode voltage the drop across R19.

The reason for the reversal of the anode and cathode connections of the diode detector, already referred to, now becomes apparent. Because of this, the detector applies a positive bias to the AVC valve, which partially offsets the initial negative bias. Nothing else happens until the detector output is sufficient to reduce the AVC valve bias to the point at which this valve begins to pass anode current. A voltage drop then appears across R11 and the valve anode takes up a potential negative with respect to the earth line, and this is communicated through R1 and R7 to the grids of the controlled valves as additional grid bias.

Although at first sight rather complicated the system is really a very simple one, and it is extraordinarily effective, holding the detector input constant within the limits of the ratio 1.3-1 for an aerial input variation as great as 15,000-1. This cannot be approached by any system of non-amplified AVC. The method has also one other advantage, which is that AVC is not affected by the modulation of the signal, for the filter comprising the 2-megohms resistance R12 and the 0.1-mfd. condenser C25 effectively removes the modulation from the input to the AVC valve. The delay in AVC is obtained after this point by suitably adjusting the voltage across R20, and consequently no distortion can be introduced through the use of delayed AVC.



In this view of the set the metal rectifier for the AVC circuit can be seen and also the bevel gear drive for the IF transformers.

A source of voltage negative with respect to the earth line is necessary with this arrangement, and about 100 volts are needed. It is customary to obtain such a voltage by inserting a resistance between the earth line and negative HT, but this is hardly possible in the present case because the voltage output of the mains equipment in the amplifier is insufficient. Furthermore, when this method is adopted difficulty nearly always arises in preventing feed-back effects which are very liable to cause motor-boating. All these difficulties have been overcome, therefore, by providing an entirely separate HT supply for the AVC valve.

AVC Voltage Supply Circuit

A metal rectifier of the half-wave type is used and provides an unsmoothed output of some 200 volts at about 5 mA. when fed with 175 volts RMS from the transformer secondary. In order to avoid the need for bringing the mains into the receiver, and any consequent risk of modulation hum being introduced, the primary of this transformer T4 is wound for 4 volts and is connected across the heater supply to the valves. If a transformer different from the one specified be used, it is important to note that its primary current

[3] *The Wireless Engineer*, Correspondence, February 1935.

QA Super—
must not exceed about 2.5 amperes, otherwise the mains transformer in the amplifier will be overloaded.

The reservoir condenser C37 has a value of 2 mfds., and smoothing is effected by the two resistances R22 and R21 of 20,000 ohms and 10,000 ohms respectively in conjunction with the 8-mfds. electrolytic condensers C35 and C36. The total current drawn from the equipment is some 3.5 mA., which is taken by the voltage divider R19 and R20. The latter resistance has a value of 5,000 ohms, so that 17.5 volts is developed across it and is the initial grid bias of the AVC valve. The voltage across the other resistance, 70 volts, is the anode voltage of this valve.

The constructional details and initial adjustments of the receiver will be given in next week's issue, together with a full description of the performance of which it is capable. In the meantime, however, some brief notes on the results of the tests applied to the set may be of interest. The quality of reproduction was found to be of an exceptionally fine order. The frequency response curve at "low selectivity" is shown in Fig. 2 and indicates how evenly the response is maintained up to 8,000 c/s, the desired upper limit. The drop at this point is just 4 db.—a negligible amount.

The frequency response curve does not by any means tell the whole story of the quality. It is possible for a set to have a perfect frequency characteristic and yet to give appalling quality, while a set can give pleasing results in spite of having an imperfect frequency response. The reason is, of course, that the frequency response curve only shows one of the characteristics of the receiver affecting quality, and it does not indicate how the apparatus functions as regards amplitude distortion, to which the ear is actually far more sensitive. The outstanding qualities of the QA Super cannot be realised, therefore, from a study of the response curve. Although the frequency response is considerably better than the average and is probably as good as it is possible to use at the present time, it is in the freedom from amplitude distortion that the reproduction so excels that obtainable from ordinary apparatus.

It is not surprising to find, therefore, that the quality proved on test to be really outstanding. The sensitivity was adequate for the reception of all worth-while stations, while the selectivity could be adjusted at will to suit the interference conditions prevailing. At maximum, the selectivity proved quite high, and it proved readily possible to receive the Deutschlandsender free from all intelligible interference while both Droitwich and Radio-Paris were working, although a considerable amount of sideband splash from these strong transmissions was naturally evident.

(To be concluded.)

LIST OF PARTS

After the particular make of component used in the original model, suitable alternative products are given in some instances.

1 Two-gang condenser, 0.0005 mfd., **C5, C15** **Polar "Midget"**
1 Dial **Polar VP Horizontal Drive** (Utility)
2 Bulbs for above, 4 volts, 0.1 amp. **Bulgin B410**
2 Reaction condensers, 0.0005 mfd. with knobs **C2, C3** **Ormond R509**
1 Aerial Coil, L6, L7 **Bulgin C6**
3 Aerial loading coils, L1, L2, L3, L4 **Bulgin C42**
1 Oscillator coil 465 kc/s, **L8, L9, L10** **Bulgin C59**
1 IF transformer, 465 kc/s, **T3** **Bulgin C50**
2 IF transformers, variable selectivity, 465 kc/s with 6in. extension rod and adaptor for ¼in. knob, **T1, T2** **Sound Sales IF465**
2 Trimmers, 0.0003 mfd., **C11, C16** **Sound Sales 3VC**
1 Transformer, Primary: 4 volts 50 c/s. Secondary: 175 volts 5 mA., **T4** **N. Partridge WW4**
(All-Power, Bryce, Challis, London Transformer Products, Claude Lyons, Sound Sales, Vortexion)

Fixed Condensers
5 0.0001 mfd. **C9, C26, C27, C28, C30** **Dubilier 665**
2 0.0003 mfd., **C10, C14** **Dubilier 665**
2 0.0005 mfd., **C1, C12** **Dubilier 665**
1 0.001 mfd., **C13** **Dubilier 670**
1 0.005 mfd., **C4** **Dubilier 670**
2 0.01 mfd., **C8, C34** **Dubilier 670**
12 0.1 mfd. Tubular, **C6, C7, C17, C18, C19, C20, C21, C22, C23, C24, C25 C31** **Dubilier 4513**
1 2 mfds. 250 volts DC working, **C37** **Dubilier "BB"**
(Bulgin, Polar-N.S.F., T.C.C., T.M.C.-Hydra)
1 50 mfds., Electrolytic, 12 volts DC working, **C32** **Dubilier 3013**

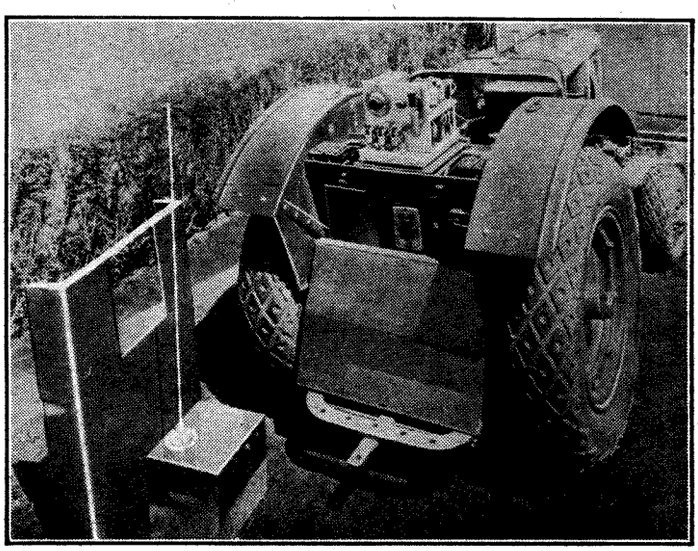
Fixed Condensers *(continued)*
1 8 mfds., Electrolytic, **C33** **Dubilier 0281**
(Polar-N.S.F., T.C.C.)
2 8 mfds., Electrolytic, 150 volts DC working, **C35, C36** **T.C.C. "AT"**

Resistances
1 150 ohms ½ watt, **R10** **Bulgin HW38**
5 500 ohms ½ watt, **R5, R6, R8, R9, R13** **Bulgin HW2**
1 1,000 ohms ½ watt, **R4** **Bulgin HW3**
1 2,000 ohms ½ watt, **R24** **Bulgin HW5**
1 5,000 ohms ½ watt, **R20** **Bulgin HW10**

Resistances *(continued)*.
3 10,000 ohms ½ watt, **R14, R15, R21** **Bulgin HW15**
4 50,000 ohms ½ watt, **R3, R23, R27, R28** **Bulgin HW23**
1 75,000 ohms ½ watt, **R2** **Bulgin HW24**
1 100,000 ohms ½ watt, **R11** **Bulgin HW25**
2 500,000 ohms ½ watt, **R1, R7** **Bulgin HW31**
2 2 megohms ½ watt, **R12, R26** **Bulgin HW34**
(Ferranti)
1 2,000 ohms 1 watt, **R17** **Erie**
2 20,000 ohms, 1 watt, **R19, R22** **Erie**
1 5,000 ohms 2 watts, **R18** **Erie**
(Amplion, Bryce, Dubilier, Ferranti, Claude Lyons, Polar-N.S.F.)
1 5,000 ohms, **R16** **Bulgin PR9**
3 10-way resistance boards **Bulgin C32**
1 Tapered volume control, 0.25 megohm, **R25** **Reliance SG25**
(Ferranti, Claude Lyons, Rothermel)
1 Multi-contact switch, S1, S2, S3, S4, S5, S6, S7 **Magnum WW7**
1 Whistle suppressor, L11, C29 **Kinva (QA receiver type)**
(Scientific Supply Stores)
1 Metal rectifier, half-wave **Westinghouse H50**
3 Valve holders 5-pin (without terminals) **Clix Chassis Mounting Type V1**
3 Valve holders 7-pin (without terminals) **Clix Chassis Mounting Type V2**
6 Ebonite shrouded terminals, A, E, PU (2) output (2) **Belling-Lee "B"**
1 5-way cable with twin 70/36 leads and 5-pin plug **Goltone R15/114**
2 lengths screened sleeving **Goltone R39/281**
2 Screened top connectors **Bulgin P64**
1 Plug top connector **Belling-Lee 1175**
1 Pair bevel gears, equal sizes 1-1 ratio ⅞in. dia. x 26 teeth **Meccano Type 30**
1 Knob **Bulgin K12**
3 Knobs **Bulgin K14**
Chassis, complete with brackets and screens **B.T.S.**

Miscellaneous:—
1 oz. No. 16 and 4 ozs. No. 20 tinned copper wire, 9 lengths systoflex, 2 lengths brass studding 4BA 1¼in. long, etc. Screws:—4 6BA brass screws 1in. long; 8 6BA brass screws ½in. long; 65 6BA brass screws ¼in. long; 4 4BA brass screws ½in. long; 85 6BA brass nuts and washers; 12 4BA brass nuts and washers. **Scientific Supply Stores**
(Peto-Scott)

Valves:—
2 VMP4G metallised, 1 D41 non-metallised, 1 MH4 non-metallised, 1 MHL4 plain or metallised, 1 X41 metallised. **Osram or Marconi**



RADIO-CONTROLLED TRACTOR which has aroused much interest in America. The ultra-short-wave transmitter, with its 5ft. aerial, can direct the movements of the tractors up to distances of two or three miles.

Alternative Programmes

I.—Neglected Possibilities of the Regional Scheme

By P. P. ECKERSLEY, M.I.E.E.

I HAVE been reading some very interesting articles in *The Wireless World* about the Regional Scheme. My paternal interest in the twin-transmitter alternative programme method of broadcasting prompts me to comment on certain of the ideas set out in the articles in question.

It was said that the Regional Scheme was based fundamentally on the use of the crystal set. Yes and no! It would be more accurate to say that the Regional Scheme was based upon the idea that the receiving set necessary to enjoy the advantages of a twin-programme service could be cheap and robust; our aim was to guarantee to the great majority of British listeners the clear hearing of at least two programmes whatever, within reason, the local conditions of reception. The Regional Scheme was therefore based on one factor, and one factor only, namely, the creation of strong and unfading signals, in every part of the country, from at least two transmitters sending out alternative programmes. The fact that a signal strong enough to overcome interference could be picked up by a crystal set was a technical incidental, although a great help in proselytising a democratic policy!

The Regional Scheme was conceived in 1924. It was not officially sanctioned until 1927-28. The first twin-wave station designed and built as such was put into service in 1929.

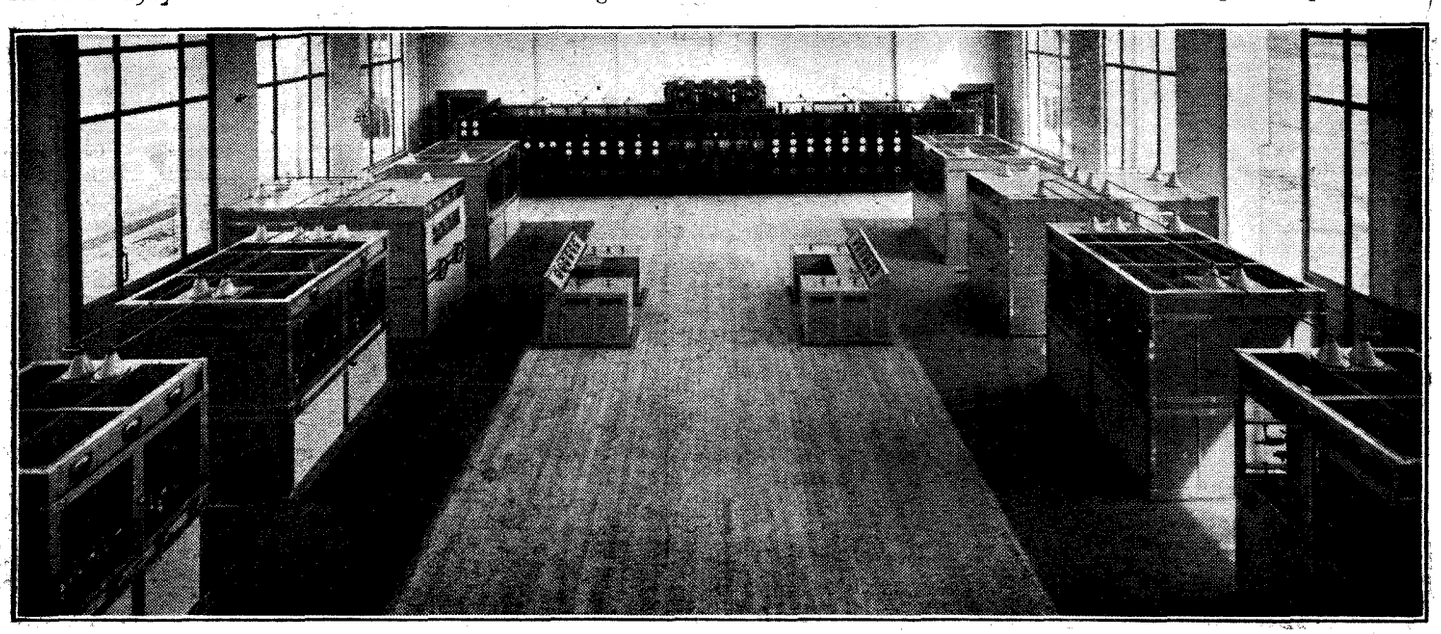
At the time of the conception of the Regional Scheme some opposition was raised to the basic idea that reception should be made easy because, it was alleged, the radio trade, which financed the B.B.C., would not get a legitimate profit from the sale of receivers unless these were unreasonably expensive. It was so easy for the home constructor to make a crystal set of sorts that some felt that sales of valve sets would be checked if transmission facilities were extended to make crystal set listening universally possible.

AVC Alters the Situation

Then again, the Post Office authorities were, quite understandably, worried about our spending large sums of money on a scheme which assumed Britain's exclusive possession of, I think, eleven wavelengths before the Washington conference had even sanctioned the use of the medium band, much less the long waves, for the use of the broadcasting services at all. Then again, the ordinary receiving set of 1927 had no autogain circuits. This was perhaps the most cogent reason for our aiming at the limited ideal of only a two-programme service for every listener. It was apparent that it was quite hopeless to expect a listener to twiddle a volume knob all night to compensate for fading, assuming that he wanted to listen to, for instance, Northern Regional in London, West Regional in Newcastle, or, more generally, wished to pick up stations outside their two service areas.

All the above factors show how it was inevitable for us to concentrate on our "A, B and C service area" policy and to lay down, as a basis of our scheme, that its only aim was to distribute two alternative programmes throughout the British Isles. It was also a part of this policy to try to ensure that anyone could get these programmes on a simple set and that, above all, the service should be a day and night uninterrupted and unwavering service which could be reproduced, with good quality, for a modest expenditure of money.

Let it be said quite frankly that, with the limited number of wavelengths at our disposal, it was, even in 1927, impossible to distribute our stations, however powerful, so as to fulfil all the requirements of the specification. There were, therefore, alternative courses, either to abandon the idea of providing a two-programme service and concentrate on the distribution of one programme so that every listener could get an uninterrupted service of that programme (this was just possible at that time) or to use the twin-wave transmitters, and frankly admit that a small percentage of listeners must suffer in order that the much larger percentage should benefit by the extra facility. I was strongly in favour of the latter policy, because calculations showed that my twin-wave scheme would give 80 per cent. of



Alternative Programmes. A photograph of the London National and the London Regional transmitters taken when Brookmans Park was opened. The transmitters face each other in the main hall of the station building.

Alternative Programmes—

the population good service conditions of alternative listening, and 90 per cent. of the population good service conditions for the reception of one programme. The B.B.C. accepted the implications of the Regional Scheme and went ahead.

To-day two new factors have been introduced which may make a modification of the original policy both advisable and even necessary. These new factors are: first, the introduction of autogain in most receivers; secondly, the great increase of power of all European stations.

The existence of autogain circuits in receivers vastly extends what might be called, by the less conservative, the service area of stations, the increase of power of foreign stations equally reduces what I still call the true service area of stations. More specifically the use of autogain means that the deleterious effects of fading are minimised, and that an ordinary, reasonably priced set will pick up all the regionals at night without the listener having to hang on to the volume-control knob; what, however, autogain cannot do is to reduce what, to me, is the supreme disadvantage of distant listening, the background noise which rises and falls as the signal weakens and strengthens. The great increase of power of foreign stations, unaccompanied by a wider separation between their carrier frequencies, means that, at night, what would in the old days be called a local station giving a steady 2-millivolt signal is now hopelessly jammed by spectrum overlap effects. In consequence of this interference the receiver must cut off "top" and so destroy quality for the sake of a moderate freedom from the all too familiar monkey-chatter noises caused by sideband jamming.

But the writer of the articles I have referred to, and which have prompted my raking up my views on the Regional Scheme, says that it is imperative, for instance, to have a local station of large power at Newcastle, but at the same time argues that different programmes should be radiated by regional stations because, by implication, any decent receiver, located outside what I should still define as a service area, can pick up these transmissions. In other words, fading doesn't matter, but it does!

I should like to say a good deal more on this subject but limitations of space make it necessary to conclude this first part here. I hope to continue and conclude the discussion in a further article, but one may summarise what has been said up to now as follows:—

The Regional Scheme was designed to give, so far as it was technically possible, true service conditions—namely, an uninterrupted and unwavering signal to all British listeners—of at least two programmes. To-day service area is reduced by foreign-station jamming, but the modern set does make it possible to receive stations at night outside their true service areas, albeit with a sacrifice of resulting quality. What modifications of the Regional Scheme are therefore advisable? I hope to answer this question in a forthcoming article.

Distant Reception Notes

THOUGH I don't remember seeing any announcement on the subject, Cologne appears to have been able to replace its damaged aerial with something quite effective. You may remember that in the autumn the big anti-fading aerial was wrecked by a gale and that the station had to fall back on the old 17-kilowatt transmitter. It was then announced that there was no possibility of re-erecting the aerial before the summer, and all of those who listen to Continental stations expected that one of their best friends would be out of action for a long while. I happened to be using my set the other morning to listen to an item from the North Regional. When this was over I moved the dial slowly upwards to see if anything else of interest was to be found, and, rather to my surprise, Cologne was coming in with very respectable quality and volume. On referring to the official lists I see that Cologne is now credited with its full 100 kilowatts, so I imagine that a "jury" aerial has been rigged up pending the reconstruction of the anti-fading aerial system which will take place once the season of winds and gales has passed.

On the other hand, Stuttgart is still in the business-as-usual-so-far-as-it-can-be-managed condition of some months ago. Extensive alterations are in progress, and until these are completed it is not possible to use the main transmitter at such times as the workmen are busy with their jobs. Stuttgart, therefore, uses the stand-by transmitter rated at only 2 kilowatts until 3 p.m. From then onwards the high-power plant with its 100-kilowatt transmitter comes into action.

It was expected that the new Toulouse P.T.T. station at Muret would take over at the end of last year the full programme service with an output rating which would start at about 60 kilowatts and would work up eventually to something very much greater. As matters stand, the old 2-kilowatt plant is still doing the best that it can, for the very good (or very bad) reason that the new transmitting apparatus is not yet ready to take over the full service. Just who is responsible for the delay it is rather difficult to say. The contractors blame the broadcasting authorities and the broadcasting authorities blame the contractors. At the present time a law-suit between the two is threatened, and, should matters come to that pass, no man can say when Toulouse Muret will be heard, for the law never hurries in any country, and in France its proceedings can be very leisurely.

Actually, Toulouse P.T.T. is testing, with a rating of 60 kilowatts, on certain evenings after 11 o'clock. Let us hope that the threatened legal action will be avoided and that the tests may soon become regular transmissions.

Lahti, the Elusive

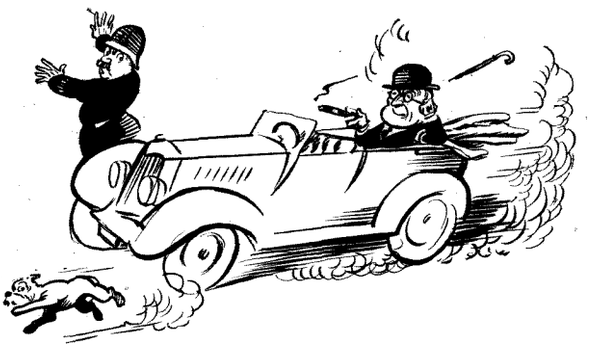
I don't know whether the locality in which I live is responsible, but I have never been able to make much of Lahti. Some years ago, when it possessed one of the highest-powered transmitters on the long waveband (a 40-kilowatt station was a big one then), I never got beyond weak reception with my most sensitive receiving set, and I don't think that Lahti has averaged for the last two or three years more than about one entry ("faint") in my long-distance log. The new transmitter is now in action with an output rating which is variously stated as anything between 150 and 220 kilowatts. I couldn't make much of the 40-kilowatt Lahti, and, frankly, I don't find that the new station comes in as a very big signal. Am I peculiarly badly placed? Do other long-distance listeners receive Lahti as a really big long-wave Continental station should be received? I am still wondering, and I shall be very glad to hear from readers who have been more successful with this station than I have. D. EXER.

Photo: Radio Today

Sound-proof demonstration booths at the disposal of salesmen in a large radio store in America. Demonstrations of different models can be given to customers simultaneously without mutual disturbance and with no annoyance to the rest of the office.

UNBIASED

By FREE GRID



Had invented a self-steering car.

Real Automatic Tuning

THE research departments maintained by wireless manufacturers seem to busy themselves in bringing out an almost endless number of new devices and circuit arrangements, all allegedly designed to make the listener's lot a happier one. Few manufacturers seem to turn their attention to things that really *are* wanted.

Such things as automatic tuning are admirable in themselves, but the name is rather misleading. When I first heard of automatic tuning I thought that at long last my ideal set had been designed, but I was soon disillusioned. After all, if somebody told me that they had invented a self-steering car, I should expect a vehicle which would take me to my destination while I dozed peacefully in the back seat, having first adjusted the destination control to the place where I wanted to go. I should certainly not call it a self-steering car if it was merely a vehicle which steered itself faithfully and accurately round corners after the wheel had first been given a rough twist in the desired direction.

The truly self-tuning receiver is, however, by no means such a fantastic impossibility as would be a truly self-steering car, and that it will fill a long-felt want when it does come few people can doubt. Most of us have a marked predilection for some particular form of entertainment over all others. Although most of us are sufficiently depraved to show a preference for light entertainment, there are those whose sole joy in life is Bach or Bartok.

From among the large number of the world's broadcasting stations it is usually possible to select something going on to suit any taste at most times of the day. Unfortunately, however, this calls for constant jumping up to the controls to tune in a fresh station. Lovers of chamber music, for instance, tune in one of these alleged concerts from London, and no sooner do they succeed in becoming enjoyably miserable than it is succeeded by a mirthful jazz programme. Almost certainly a chamber concert is just beginning somewhere else in the etheric void, but the listener must jump up and tune it in.

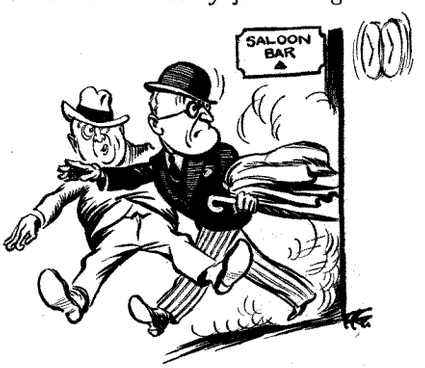
What is wanted is a set with a selector switch which can be adjusted to jazz, chamber music, or whatever else is wanted, and then left to itself for the evening while it noses out the particular items required from the welter of noise all over Europe. One of these so-called automatic tuning receivers already in existence would do the trick if broadcasting stations could only be induced to co-operate.

It would be done in this way: Supposing that Droitwich were just concluding a symphony concert. The engineer in charge would slowly turn his tuning knob, gradually changing his wavelength to that of some other transmitter in Europe which was just commencing the same sort of programme. Naturally, all the "automatic tuning" sets which were on the Droitwich wavelength would follow it like Mary's Little Lamb to the new wavelength, on which they could be left.

Of course, it would be simpler if all the stations of Europe got together and arranged programmes in such a way that one transmitter was always churning out jazz, another organ recitals, and so on. This does not mean that the same type of programme would always be coming from the same studio. Judicious juggling with land lines would render studios entirely independent of their local transmitters, and *vice versa*.

My New Clock

SINCE the coming of broadcasting the advocates of the 24-hour clock have become more and more insistent in their demands that we should come into line with the Continent by jettisoning our old-fashioned a.m. and p.m. My own view is that we should either leave the whole thing severely alone or go the whole hog.



Over-straining my heart.

On the Continent, while deriding our use of a.m. and p.m., they do an equally silly thing by painting two sets of numerals round their public clock dials; when the hands both point upwards, i.e., to 12 as well as to 24 o'clock, there is nothing to give you an inkling as to whether it is noon or midnight.

The logical thing would be to divide the clock dial into 24 hours instead of 12, and, by suitable gearing, to halve the speed of the hands. Curiously enough, the only public clock of this kind that I have ever seen in this country is at Clacton-on-Sea. We are such creatures of habit, however, that we read the time by the angle of the hands rather than by the figures at which they are pointing, and this reprehensible habit was the cause of my overstraining my heart in a mad dash to the station one day last summer in order to catch my return excursion train. A casual glance at the clock had led me to suppose that it was ten minutes to seven, whereas actually the clock indicated ten minutes to one in the afternoon.

Translucent Dial

I am glad to say, however, that, as a result of experimenting with my battery of wireless programme clocks (a separate one to indicate the time at every broadcasting station in the world), I have averted the possibility of a similar contretemps in future. My new clock, really an adaptation of the ordinary AC mains type, has neither hands nor figures. The dial is of the translucent type, and the figures and hands are reflected on to the back of it by an episcopic arrangement, the necessary illumination coming from suitably disposed flash-lamp bulbs operated from the mains. A simple automatically operated switching arrangement causes the light to reflect two sets of figures from 1-12 and from 13-24 according to the time of the day.

In addition, should the electric light supply fail, thus causing the figures to disappear, a spring-loaded relay opens so that they do not reappear until the relay is once more set by hand. Thus, the clock shows either the correct time or a blank face. This latter refinement is actually due to the suggestion of a very old friend of mine who had some very embarrassing experiences as the result of always taking the time indicated by his electric clock at its face value.

Although electric clocks generally have some device, such as a large seconds-hand, to show whether they are working or not—or, as in the case of the self-starting type, a red disc to show that they are not indicating the correct time—such signs are easily overlooked. If a completely blank face is shown there can be no mistake.

EVENTS OF THE WEEK IN BRIEF REVIEW

Current Topics

More Listeners

BRITISH receiving licence figures continue to grow. At the end of January last the total number of licences in force was 7,479,680, compared with 6,887,471 in January, 1935.

I.F.S. Chooses Identification Signal

ATHLONE is to have an identification signal. The broadcasting authorities propose installing an electrical device playing about seventeen notes of an Irish air. Twenty tunes were broadcast on February 11th and 14th, and listeners' votes are now being collated.

"Ultra-shorts" on Everest

SIX "Eddystone" combined transmitters and receivers operating on 5 metres are to be used by the Mount Everest Expedition to maintain contact between the various camps. It will thus be possible to transmit rapid instructions from the main camp to the advance parties instead of relying on foot messengers.

Radio "Black-out"

IT has been left to Hucknall, Notts, to discover a new radio phenomenon. This takes the form of a "black-out of reception" occurring each night about 6 o'clock, but affecting only one part of the town. According to accounts given at a meeting of the Nottingham branch of the Wireless Retailers' Association, the "black-out" is caused by a noise which obliterates the programmes. Radio service men in the district attribute the trouble to mains-borne interference set up by some kind of machinery and propagated along the electric cables. The Post Office is investigating the matter.

Operators Wanted

SHIPS' wireless operators are once again in demand owing to the improvement in trade, and it is understood that a number of men without previous sea experience will be required by the Marconi Co. this year.

Nineteenth-century Amateur

COLONEL MEADE DENNIS, who has just been elected a Vice-President of the Radio Society of Great Britain, provides a link with radio's earliest days. He constructed his first experimental set in 1898, and has been a keen wireless amateur ever since. His present transmitter, using the call sign EI2B, is situated at Baltinglass, I.F.S.

High-power Synchronisation

AN important technical experiment will take place in Germany from March 2nd to March 7th. Three high-power broadcasting stations—Berlin, Breslau and Heilsberg—will be synchronised on the Berlin wavelength of 356.7 metres.

It is officially stated that the experiment is only a temporary one to provide data for a communication to the Comité Consultatif Internationale de Radiocommunication.

New French Stations

FOUR new French Regional stations are scheduled to come into operation this year. Radio-Paris is to be re-established near the centre of the country with a power of 150 kilowatts. The others are Limoges (100 kilowatts) working on 328.6 metres; Bordeaux (100 kilowatts) on 278.6 metres; and Rennes (120 kilowatts) on 288.6 metres.

The Colonial station, which is to be transferred from Pontoise to the centre of France, will employ a power of 50 kilowatts.

SIR NOEL ASHBRIDGE was one of the guests at the Annual Staff Dinner and Dance of Murphy Radio at Grosvenor House, Park Lane, on Friday last. Included among the 1,430 present were representatives of the suppliers and dealers. Mr. Frank Murphy presided.

Ampère's Centenary

LYONS is preparing to celebrate the centenary of the death of Ampère from March 5th to March 15th—dates which happily coincide with those of the Lyons Spring Fair. The programme includes an exhibition of "Electricity from the Earliest Ages," and a visit to Ampère's home at Poleymieux.

Electrical Music

"ELECTRICALLY Produced Music" is the title of a lecture to be given by Mr. G. G. Blake, M.I.E.E., F.Inst.P., at a meeting of the Royal Society of Arts, Adelphi, W.C.2, on Wednesday next, March 4th, at 8 p.m. The paper will be illustrated by lantern slides, experiments, and musical demonstrations, and will be followed by a recital of "Electrond Music," by André Ledor.

Concessions for I.F.S. Amateurs

FOLLOWING conversations between the Irish Radio Transmitters' Association and the I.F.S. Post Office, many additional concessions have been obtained for amateurs in the Free State. The hitherto rather stringent regulations have been relaxed somewhat, and should greatly encourage the growth of amateur radio there.

Television by Line

A HIGH-FREQUENCY cable 250 miles long, suitable for television transmission, is already in use in Germany, and the Post Office laboratories report successful sending of high-definition pictures over this distance with a frequency band of about 500,000 cycles.

Last August the German authorities foreshadowed the introduction of television by telephone between Berlin and a large provincial town. It is now announced that such a service will be opened this spring between Berlin and Leipzig in connection with the Leipzig Fair.

Meanwhile, France is popularising television by means of demonstrations at various post offices, the public being admitted on payment of a small sum.

At the Leipzig Fair

A WIRELESS section will be a feature of the Leipzig Engineering and Building Fair, which opens on March 1st and will continue until March 9th.

POLICE CYCLE RADIO. A Liverpool constable setting out with his radio-equipped cycle, which carries a frame-aerial valise receiver operating on about 148 metres. Note the miniature loud speaker on the handle-bar.

Hall 6, one of the larger buildings in the exhibition, will be entirely devoted to electrical engineering and wireless, and, as usual, it is expected that there will be a number of novelties on show. It is understood that "universal" AC and DC sets will be much in evidence. AVC, novel tuning systems, and portable superhets. for the "week-ender" are among the promised exhibits.

"Records" and "Transcriptions"

A SURPRISE ruling of the American Federal Communications Commission now permits broadcasters to make use of recorded talent without intimating the fact at more frequent intervals than half an hour.

An interesting clause in the regulations provides that a distinction must be drawn between electrical transcriptions and gramophone records. A gramophone record can be referred to as a "record" or a "recording," while a steel tape rendering is termed a "transcription" or "mechanical reproduction."

Gearing the Aerial

IMPEDANCE-MATCHING SYSTEMS SIMPLY EXPLAINED

By "CATHODE RAY"

IN the early days aerials used to be elaborate. Crystal sets and "R" valves being what they were, one could not afford to throw away the advantage of a large and efficient collector. Then, as receivers became more and more sensitive, it was no novelty—rather, the rule—to receive the world on a bedspring or other frivolous type of aerial. Now, the pendulum is on the back-swing; once again more care is to be devoted to the aerial.

But with a difference. It is not that the picture-rail aerial does not bring in enough; it brings in too much, but of the wrong sort. With range to burn, the modern receiver does not grumble because the haphazard indoor aerial is so badly screened by its situation in a (very literally) built-up area that it collects only a fraction of what is blowing by outside; the loss can be offset by pulling some amplification out of reserve. The real trouble is that such an aerial is close to the baleful influence of the mechanised forces of the modern household—suction cleaners, refrigerators, fans, thermostats, even ordinary switches; and interference from farther afield radiated by the house wiring. Moreover, the extra amplification needed for the programme makes the interference all the louder. Hence the tendency to erect a very good aerial out in the open ocean of waves from the world's broadcasters, and, as far as possible, from the growls and scratches of internal disturbance.

It may simply be a rather carefully arranged aerial of the ordinary type. Or it may be a full-dress "anti-static" effort, such as the screened down-lead type. The successful reception of television in any but well-favoured situations is going to depend very largely on the use of special types of aerial; we may expect to see aerial "arrays," after the manner of long-distance commercial radiotelegraph stations.

But to consider the screened down-lead aerial, which is of the present and not merely of the future. It consists of the aerial proper, erected in the position most calculated to pick up foreign stations and least calculated to pick up undesirable noises (if one may be permitted to draw the distinction); and, joining it to the receiver, a lead-in which is completely screened, for continuing the exclusion of the said noises. To do the thing properly you have to include impedance-matching transformers at each end of the screened portion. At this point in the argument we get the cue for a dissertation on impedance, what it is, and why it has to be matched.

Motor Car Analogy

That is an exceedingly onerous task in the space left, but perhaps in these days it is allowable to refer the reader to simple mechanical devices of everyday use, such as the motor car gear box. It does not create power, nor, on the contrary, should it absorb or utilise power on its own. The object is to link the job of work to the source of power in the most effective (in technical language, *efficient*) manner.

A car stalls on a steep hill if it is kept in top gear; not because the engine power is inadequate, but because it is not *matched* to the load. In such circumstances the gear must be changed; in other words, the road wheels must be made to do fewer revolutions in proportion to the engine revolutions. What is lost in speed is gained in force. The corresponding process in electrical work is to vary the ratio of primary to secondary turns in a transformer coupling the two. The numbers of turns can be compared to numbers of teeth in gear wheels.

A steep hill is a high-impedance load (ohms) calling for an intense force (voltage) but little speed (current). The engine is a relatively low-impedance supply of power, because when it is working most efficiently it is turning over very fast. So a low gear is used, corresponding to a step-up transformer. If you know your mechanics—and electrics—you will point out to me that a step-up gear box uses many teeth on the primary (driving) wheel compared with those on the secondary wheel, whereas the turns on a step-up transformer are the other way round. Quite true. If you press the comparison as closely as actual numbers you have to remember that it is an upside-down comparison (*reciprocal*, to a mathematician).

An aerial consisting of a short or moderate length of wire suspended clear of everything is a fairly high impedance. It is also the source from which the first stage in the receiver derives its signal power. So it is important how the two are linked.

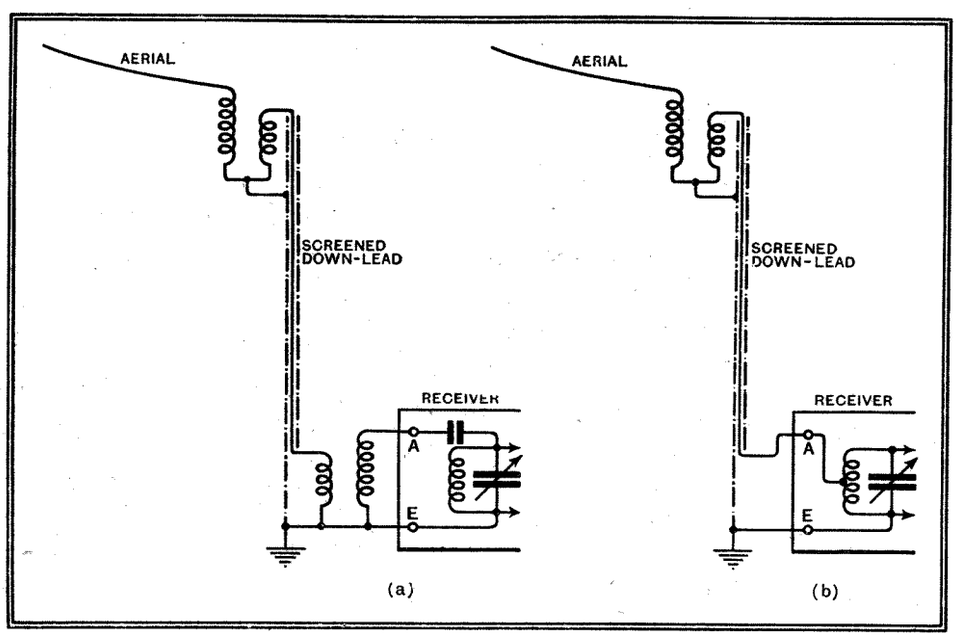


Fig. 1.—(a) Showing a low-impedance screened aerial lead-in with transformers at each end for matching it to the high-impedance aerial and receiver. (b) When the receiver circuit is itself suitable for a low-impedance connection, no external transformer is needed at that end.

Very often the input—the circuit between aerial and earth terminals—is of high impedance. That is particularly so when the connection from the aerial terminal to the tuner is made *via* a condenser of small capacity—a very usual arrangement. A high-impedance aerial can then be connected directly to the terminals with quite happy results.

But a long, rambling aerial, with a lead-in lying close up against walls and things, is of comparatively low impedance. And when the lead-in is encased in an earthed metal tube for interference prevention, the impedance is very low. Unless electrical gear boxes are installed, there is a serious loss of efficiency at *two* points—where the high-impedance aerial joins the low-impedance

Gearing the Aerial—

lead-in, and where the low-impedance lead-in joins the high-impedance set. So vendors of anti-interference aerial kits usually supply a pair of suitable gear boxes under the name of transformers; and, if they are used in the manner intended, the losses (which are sometimes unfairly attributed to this type of lead-in itself) should be avoided.

What is not always made clear—and here at last is what I have been getting at all along—is that what is sauce for the goose should not be poured over the gander. Although the high-impedance input is very common practice, there is rather more to be said in favour of the system that "taps down" the aerial coil, or adopts the equivalent means of a step-up transformer. This is done in the interests of selectivity chiefly, but if you have followed my argument you will see that, incidentally, it constitutes a low-to-high-impedance link. It is, in fact, most efficient when a low-impedance aerial is directly connected to it. It is absurd, then, when one has a low-impedance lead-in for interference exclusion, to go to the trouble (and possibly expense) of interposing a step-up transformer which actually introduces a cause of inefficiency instead of removing it. When a receiver is by nature adapted for a low-impedance aerial lead, which is what one happens to have, it is superfluous to introduce a transformer to adapt the lead to a high impedance.

The mere fact that the circuit diagram of the receiver shows the aerial circuit to be of the tapped coil or transformer variety does not guarantee that the transformation ratio is suitable for working direct from a screened lead-in. It must be tapped really low down, or be of a high ratio. When this is so, the system is far better than an external matching transformer, for it is automatically changed to suit the waveband when the wave-change switch is operated.

NEW MULLARD VALVES

TWO new battery valves will shortly be released by Mullard. The first is an output pentode, the PM22D, with a mutual conductance of 4.0 mA/V. Its filament consumes 0.3 ampere at 2 volts, and the valve is rated for 150 volts anode and space-charge grid potentials. It is priced at 13s. 6d.

The second valve is a duo-diode with an *indirectly* heated cathode consuming only 0.09 ampere. This feature makes it especially convenient when delayed AVC is required. Its type number is 2D2, and it is priced at 5s. 6d.

V.G. Home Recorder

Self-contained Unit for Attachment to Existing Gramophone or Radio-gram

THE V.G. Manufacturing Co., Ltd., whom it will be recalled are suppliers of the "Simplat" coated glass sound-recording discs to which reference was made in *The Wireless World* of December 13th last, has now introduced a home recorder designed for attachment to any existing gramophone or radiogramophone. Subject to the capability of the motor this equipment will record on discs up to 14in. in diameter.

Two screws only suffice to fix it and generally space will be available on the motor board beside the turntable. It is advised, wherever possible, to install a heavy-duty motor such as the B.T.H., Metro-Vickers recording motor type B.Y.C. 1505, Saja recording motors, or similar models. Perfectly satisfactory results are obtainable with standard motors, though with some types of discs it may be necessary to restrict the outside diameter of the recording.

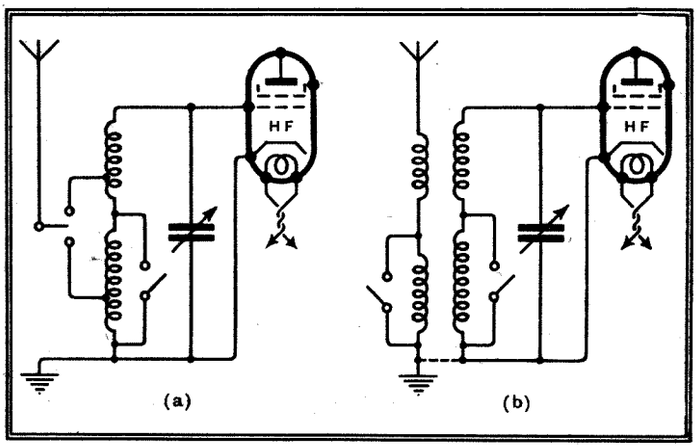
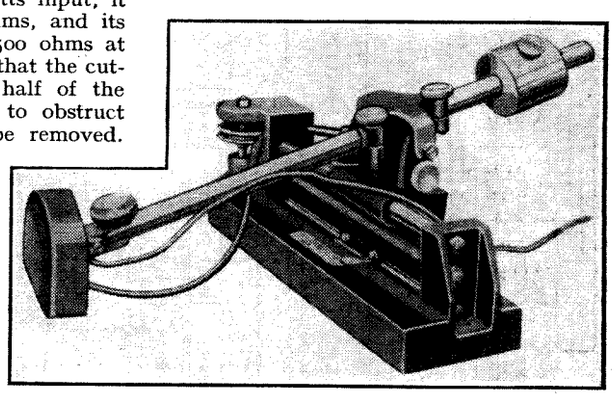


Fig. 2.—(a) A circuit diagram like this does not profess to show even approximately the step-up ratio. Only when the aerial tappings are very low down the coils, giving a high step-up ratio, is the arrangement suitable for direct connection to a screened lead-in. (b) Alternative arrangement which comes to the same thing.

The cutting head is of the electro-magnetic type and requires about 1½ watts input; it has a DC resistance of 800 ohms, and its impedance is approximately 2,500 ohms at 1,000 c/s. Care must be taken that the cutting head is able to traverse half of the record, and any fittings likely to obstruct its travel should accordingly be removed. There are no delicate adjustments needed and any type of recording blank may be used.



V.G. recording unit for use with an existing gramophone.

The tracking device consists of a worm screw fitted with reduction gear and driven by a rubber belt from the turntable spindle. The cutter arm is suspended in needle bearings and is provided with an adjustable weight and the whole slides on two parallel rods. Every precaution has been taken to ensure perfect recording by eliminating side movement and backlash.

The tracking mechanism is brought into action by a lever engaging a small segment with the worm screw thus moving the tone arm attachment. Recording can be effected either from the inside to the outside, or vice versa, by crossing the transmission belt. There is included with the apparatus a cone adaptor with three belt grooves for the spindle of the motor, thus enabling three different speeds for the tracking mechanism. The smallest is 185 grooves to the inch, which gives a playing duration of nine minutes for a 12-inch record running at 78 r.p.m. Only by very accurate construction and the elimination of side play is it possible to achieve such close spacing.

The apparatus will record also at 33⅓ r.p.m. for film work, etc., and it can be used for reproducing as well, it being necessary only to loosen one screw, so giving the tone arm a free swinging movement.

The tracking unit, including cutting head as illustrated, costs £17. H.B.D.

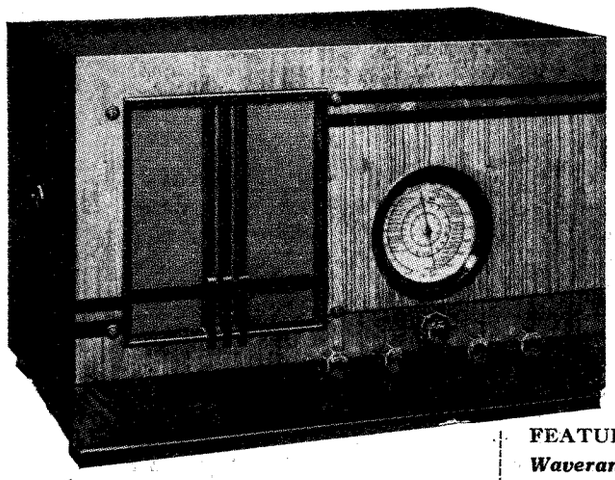
Wireless.—By Robert William Hutchinson, M.Sc. 3rd Edition. Pp. 316+viii, with 224 illustrations. University Tutorial Press, Ltd., 25, High Street, New Oxford Street, W.C.2. Price 3s. 6d.

THIS book opens by explaining in clear and simple language those fundamental concepts upon which all electrical study is based, and continues by explaining the nature and derivation of the units in which electrical quantities are expressed. Further chapters are devoted to an explanation of more purely wireless matters and the operation of simple receiving and transmitting gear is dealt with in detail.

This is the third edition of the book, and much new material has been included in an endeavour to bring the book up to date. Much of the descriptive matter is of obsolete apparatus, however, and modern receivers are not very fully represented. The superheterodyne, for instance, is very briefly described, less than one page being devoted to its theory, and about four pages to a description of the circuit and performance of two commercially produced receivers. These are, perhaps, minor points, and the book is certainly one which will admirably meet the needs of those who wish to obtain some insight into the workings of wireless apparatus. It is very clearly written and unusually free from errors.

Marconiphone MODEL 345

A Powerful All-wave Receiver with Good Quality of Reproduction



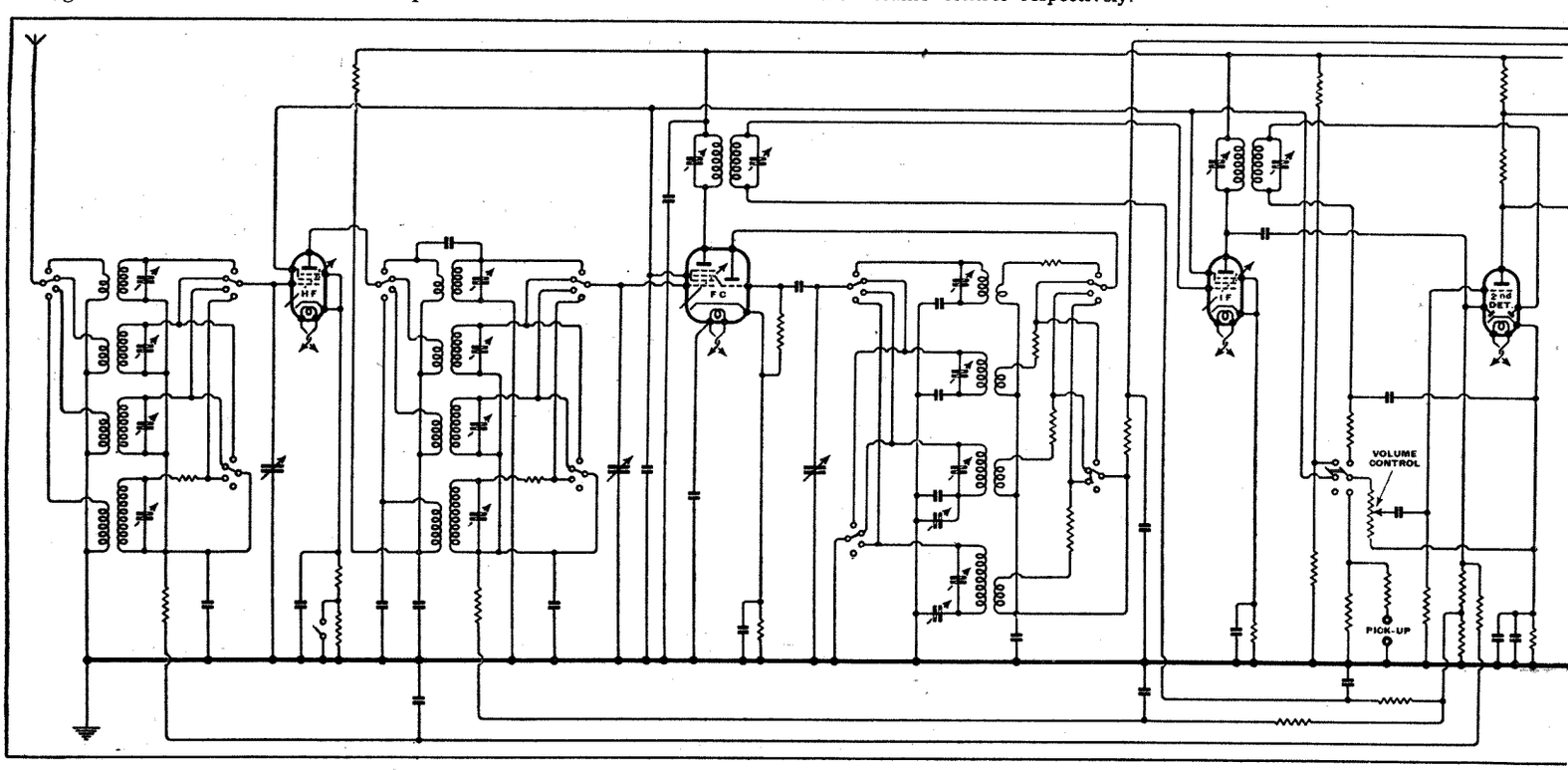
FEATURES.—*Type.*—*Superheterodyne receiver for A.C. mains.* *Waveranges.*—*(1) 16.5 to 50 metres; (2) 47 to 140 metres; (3) 185 to 560 metres; (4) 750 to 2,200 metres.* *Circuit.*—*Var.-mu pentode HF amplifier — triode-hexode frequency-changer — var.-mu pentode IF amplifier — double-diode-triode second detector — pentode output valve. Full-wave valve rectifier.* *Controls.*—*(1) Tuning. (2) Volume. (3) Waverange. (4) and (5) Bass and treble tone controls. (6) Gramophone switch. (7) On-off switch.* *Price.*—*17½ guineas.* *Makers.*—*The Marconiphone Co., Ltd.*

THIS is no mere adaptation of an existing broadcast set, with short-wave coils tacked on to earn the description of an all-wave receiver. From the beginning it has been designed primarily with the short-wave performance in mind, and the close attention to detail which this implies is of advantage rather than otherwise to the performance which we may expect from the medium and long waves. The whole of the screening system has been worked out with special attention to the flow of earth return currents by the shortest possible path, and the wiring has been carefully considered from the same point of view. Specially designed wave-range switches of the low-capacity rotary type are used and the switching has been arranged so that coils are shorted and open-circuited in the proper sequence and trouble due to the absorption of energy in circuits not actually in use is eliminated.

The short-wave coils, together with their appropriate switches, are mounted in a series of screened compartments immediately below the three-gang tuning condenser. This condenser floats on rubber mountings, and each section has its own independent earth through heavy gauge copper braiding to the chassis. The leads carrying HF currents are of rigid wire passing through large-diameter clearance holes in the chassis. In this way absolute accuracy of ganging is assured on the short wavebands. To prevent all possibility of capacity changes due to warping or distortion of the chassis, this has been constructed of unusually heavy gauge steel and is cadmium plated. The tone and volume controls are mounted outside the main compartment on a subsidiary steel strip.

The circuit has been designed to operate on an ordinary domestic aerial, and there is a stage of HF amplification operating on all four wavebands. The two groups of tuned circuits associated with this valve ensure not only an increase of signal strength in relation to the prevailing background noise, but also the elimination of double tuning points on the short wavebands. The HF valve is of the variable-mu pentode type and is controlled from the AVC line. The standing bias is adjusted to give a higher initial sensitivity on the two short waveranges.

Complete circuit diagram. Separate tone controls are provided for bass and treble and the gramophone and mains on-off switches are mounted independently from the wave-range control and the volume control respectively.



Marconiphone Model 345—

The frequency-changer valve is of the triode-hexode type and is controlled from the AVC line on all but the shortest waveband. The intermediate frequency is adjusted to 460 kc/s and is amplified by a single stage with four tuned circuits, the valve being controlled by a reduced value of AVC derived from a potential divider. The second detector valve is of the double-diode-triode type, and in addition to signal rectification and LF amplification provides the AVC, which is given the requisite delay for best results on weak short-wave stations. In order to relieve the low-capacity waverange switches of the duty of changing over to gramophone reproduction a separate switch has been fitted at the back of the cabinet for this purpose. This is of the double-pole type and the connections are so arranged that the pick-up may be permanently connected to the set without detriment to the radio performance.

Separate Volume Controls

The second detector is resistance-coupled to a high-efficiency pentode in the output stage. Separate volume controls are provided, the bass consisting of a variable coupling capacity between the second detector and output valve grid and the treble control of a series of shunt condensers across the output transformer primary. There is provision for a low-impedance external loud speaker. A full-wave valve rectifier supplies the HT current, and the mains transformer is fitted with an electrostatic screen between primary and secondary windings to suppress direct pick-up from the mains.

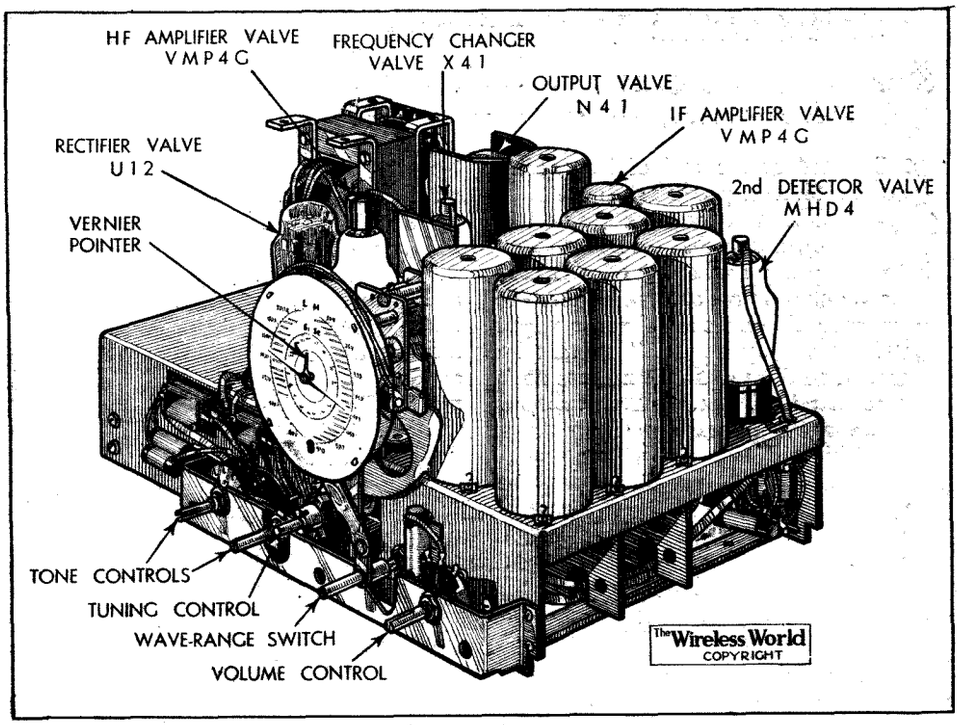
The mains switch is fitted separately on the side of the cabinet, and consequently there is no necessity to carry mains leads among the components under the chassis in order to reach the volume control where the on-off switch is customarily fitted.

The tuning scale is of the circular type and is fitted with a subsidiary pointer working over an inner scale arbitrarily calibrated in degrees. This pointer is driven from a part of the slow motion mechanism and forms a kind of "second" hand to the main indicating pointers. This innovation is a great boon on the short waveranges, where it is usually possible to tune through a station with a barely perceptible movement of the main pointer. The subsidiary pointer, on the other hand, covers three or four degrees in this process, and it is quite a simple matter to estimate to a nicety the position of exact tune. With this device, in fact, there is little need for a tuning indicator, with its attendant electrical complication.

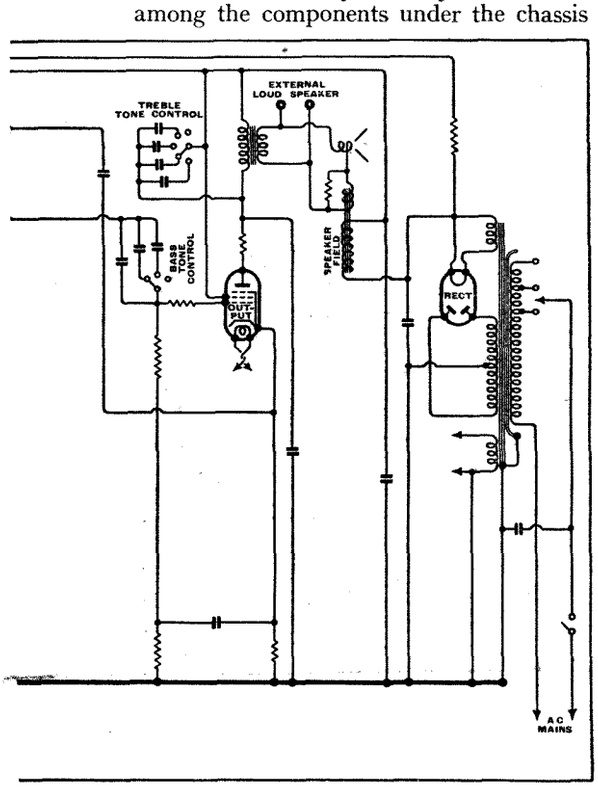
On first switching on the set there seemed to be a considerable amount of background noise, but after making a more thorough acquaintance with the controls the conclusion was reached that this was a natural result of the unusually generous reserve of amplification provided. When distant stations were reduced in volume to the level at which they would be received on an average sort of all-wave receiver the background receded to a negligible level and under normal circumstances no trouble was experienced on this score when receiving the American short-wave stations.

Throughout the tests we were unable to make use of more than half the range of the volume control, but even so all the worthwhile Continental and American stations could be received. Under conditions which permitted the use of the full sensitivity of the circuit the performance would be indeed phenomenal.

As a normal broadcast receiver the set fulfils every demand which is likely to be made of it, and the performance on the long waves is unusually clean-cut and free from background noise. It is possible to receive the Deutschlandsender between Droitwich and Radio-Paris with good quality and only a moderate reduction of high-note response. On the medium waveband the Brookmans Park transmitters spread about 1½ to 2 channels on either side of their normal settings. There is not a single self-generated heterodyne whistle to be found on any of the four wavebands and the two short waveranges are quite free from double tuning points.



The chassis is of unusually rigid construction and the rubber-insulated tuning condenser gives freedom from microphone feed-back up to the full limit of sensitivity.



Good Reproduction

It is obvious that a real effort has been made to provide better quality of reproduction than one normally expects in a receiver of such high efficiency, and the new type of moving-coil loud speaker with corrugated diaphragm, although small in diameter, has all the good qualities of reproducers of the so-called "auditorium" type. The variable bass control is a valuable asset, particularly when operating the set at low volume levels, while the "brilliant" tone control enables one to compensate for the change of quality consequent upon the difference in selectivity between the medium and long waveranges. The general body of tone is smooth and exhibits none of the defects which are often associated with the use of a pentode in the output stage.

Here is a set which we can confidently recommend for its exceptionally lively performance and good quality of reproduction and which can more than hold its own with the excellent all-wave receivers which we import from our American cousins.

Measurements on Receivers

Principles and Units

(Concluded from page 198, Feb. 21st issue)

HAVING dealt with methods of measuring the fundamental qualities of sensitivity, selectivity, and fidelity, the author goes on to explain the decibel system, and then shows how secondary attributes of the modern receiver are assessed.

By A. L. M. SOWERBY, M.Sc.

AS stated at the end of last week's instalment, power ratios are often expressed in terms of the decibel (db.), a unit that calls for a somewhat lengthy explanation. If by turning up the volume-control of a set we increase the power ten times, we say that the output has "increased by 10 db.," so that an increase of 10 db. means "ten times up." Suppose now that, starting from this new level, we again increase the output by 10 db. This will make a total rise in output of 20 db. in the two stages, and the output will have reached 100 times its original level. Thus, where successive steps are considered, we *add* the decibels corresponding to the various steps to get the total change in db., while we *multiply* the ratios corresponding to the same steps to get the overall ratio corresponding to the total change.

This is merely a way of saying that the decibel is a *logarithmic* unit, each successive decibel corresponding to an increase of (about) 25 per cent. in the power, and therefore implying the addition of more power at each successive decibel step than at the last. The chart of Fig. 6, with the inscription beneath it, enables ratios to be converted into decibels, or vice versa, at sight.

The justification of the decibel notation is that a change in output from 10 to 50 milliwatts (7 db.) would seem to the ear identical with a change from 50 to 250 mW. (also 7 db., since the ratio is again 5 to 1). On the fidelity curve of Fig. 5 these two changes are represented by very different changes in height, so to that extent the curve is misleading. In Fig. 7 the curve is replotted (as a full line) to a decibel scale (taking the output at 400 cycles as the reference, or "zero" level), in which form it gives a much fairer picture of how the set would sound. To get one's bearings among the unfamiliar units it is useful to remember that a change in power output of 1 db. is just barely detectable when the best possible conditions for comparison are provided.

It is sometimes convenient to measure a change in gain in a set in terms of the change in power output to which it gives rise. If—by reducing a bias voltage, for example—we increase the gain of an HF stage three times we shall increase the audio voltage at the grid of the output valve in the same ratio. This will raise the AC anode voltage three times, and therefore raise three times the current this voltage drives through the fixed impedance of the loud speaker or output meter. The power, in consequence, will go up *nine* times. This corresponds to a rise of about $9\frac{1}{2}$ db.; we say, therefore, that the increase in gain has been such as to produce a rise in power of $9\frac{1}{2}$ db. So far all is clear. But the change in gain might equally well have been observed by finding that on reducing the bias the signal voltage at the anode of the valve concerned increased three times. If we want to talk in terms of decibels—that is, of power ratios—we shall still have to call this a change of $9\frac{1}{2}$ db. The 3 to 1 change in voltage alone represents (Fig. 6) $4\frac{3}{4}$ db., and the 3 to 1 increase in current that it drives through the anode circuit represents another $4\frac{3}{4}$ db., making, in all, the $9\frac{1}{2}$ db. directly measured. Thus we see that if a current or voltage ratio is measured we can express it by doubling the decibel change corresponding to the ratio as given in Fig. 6.

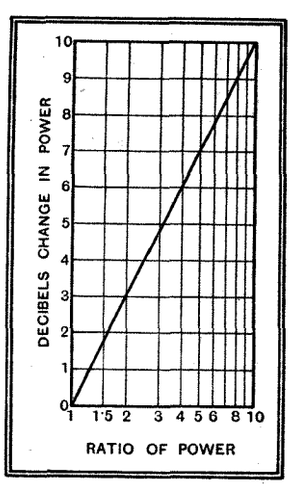


Fig. 6.—Conversion of power ratios to decibels. Ratio 2 is 3 db.; ratio 20 is 13 db.; ratio 200 is 23 db.: 10 db. is *added* each time the ratio is *multiplied* by 10.

But it will also be observed that the expression of a voltage or current ratio in decibels is an unnecessarily roundabout way of putting it. In the case we have discussed it would be much simpler, as well as much clearer, to say that the change in grid bias has raised the sensitivity of the set three times.

Returning to the subject of fidelity curves, one must always remember that the ear is a most amazingly tolerant organ, accepting without serious protest music from which an unbelievably large amount is missing. Especially is this the case when the music is complex; much more omission, and particularly more real falsification in the form of additional harmonics, can be permitted in listening to a complete orchestra than when listening to a string quartet. (Does this supply the reason for the comparative unpopularity of chamber music?) Then, again, one must remember that the curve represents truly enough the power handed to the speaker, but tells us nothing of what the speaker does with it. The commercial designer chooses a "high-pitched" speaker if he has to make a set so selective that the reproduction of the high notes has suffered; this choice provides a rough-and-ready tone-correction that may make the set sound much better (or worse) than the fidelity curve suggests.

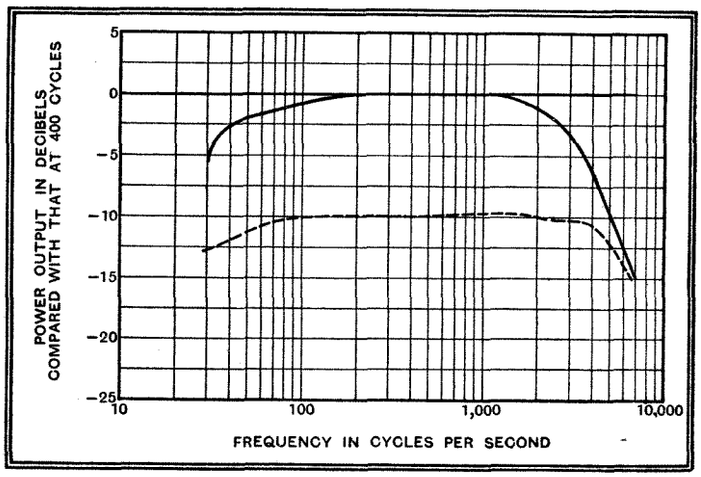


Fig. 7.—Full line: Curve of Fig. 5, replotted to a decibel scale. Dotted line: The full-line curve may change to some such curve as this on turning down the volume control, if this is "compensated."

Compensated Volume Control

If interest warrants, supplementary curves may be taken to show the fidelity obtained at settings of the volume-control other than the highest. In modern sets "compensation" is often applied to accentuate both bass and treble at low volume levels to make up for the lesser sensitivity of the ear to high and low frequencies when the total volume is small. In the absence of compensation the fidelity curve will drop bodily, without change of shape, on turning back the volume control. The dotted curve of Fig. 7 shows what may be expected if the control is compensated.

Measurements on Receivers—

In a similar way, the effect of the tone-control, if one is fitted, may be investigated if desired. This will be found, in practically every case, to do no more than cut off still more of the already inadequate high notes.

The presence of reaction in a set is a source of extreme embarrassment to anyone who wishes to make measurements. So far we have ignored it, and the measurements detailed are all traditionally made with reaction set at zero. By its aid, as every user of a simple set knows, the sensitivity, selectivity, and fidelity can be continuously varied over a very wide range. The difficulty, if we once start applying reaction, is to know where to stop, or, having found a setting, how to repeat it. Yet the simpler sets are so seldom used without reaction that one might well hold that no measurements made without applying at least a little had any practical meaning at all.

One might, more or less fairly, try to get measurements for two conditions of reaction, one increasing the sensitivity three times ("slight reaction") and one increasing it ten times ("much reaction"). More increase can be had with some sets; it all depends on the amount by which the detector damps its grid circuit before reaction is applied.

It should be pointed out that it is unexpectedly difficult to take reproducible curves with the set balanced precariously on the edge of oscillation; the most one can do is to make a rough estimate of the maximum sensitivity attainable. It is often surprisingly high.

But the whole question of measuring sets embodying reaction is such a thorny one that, having indicated the difficulties, the writer proposes to let discretion usurp the place of valour, and we now tactfully change the subject.

With sensitivity, selectivity, and fidelity all measured, one might think there was not much more to learn about the set. There is, actually, much more than this article can possibly contain; we shall have to select, and yet be brief.

In a superheterodyne we ought to find the image-interference ratio. If a superhet using 100 kc/s as intermediate frequency is tuned to a signal at 1,000 kc/s, the oscillator will be tuned to (1,000+100=) 1,100 kc/s. This same setting of the oscillator will bring in a station transmitting on (1,100+100=) 1,200 kc/s. It is the duty of the signal-frequency tuned circuits to keep the intruder out, and the point of the measurement to see how far they succeed in so doing. We proceed thus:

First we measure the sensitivity of the receiver at 1,000 kc/s in the standard way. We find it to be, say, 50 μV. Then, without touching the set, we tune the generator to 1,200 kc/s (in general, to signal frequency plus twice IF) and increase the input until this signal, from which the signal-frequency circuits are detuned, gives in its turn the standard output of 50 mW. For this, perhaps, 100 mV. is wanted. This means that the interfering station will have to be 2,000 times as strong at the aerial before it is heard at a strength equal to that of the wanted station; accordingly we record that "Image-interference ratio at 1,000 kc/s is 2,000." It varies, of course, over the waveband.

Measuring Automatic Control

We may next check up the behaviour of the AVC system, if there is one. The signal strength at which the AVC begins to operate can be determined by slowly increasing the input while watching for the first movement of a milliammeter connected in the anode circuit of one of the controlled valves. We can also observe whether at this input the output meter shows that the last valve is exactly fully loaded; if not, we vary the modulation-depth until this state of affairs is reached. We can record our results in some such form as "AVC starts at 240 μV. in; full output (2 W.) at 25 per cent. modulation." This tells us that the AVC will allow a 250-μV. station to give the loudest output of which the set is capable provided the modulation depth rises to 25 per cent.; if it is more, the volume control will have to be turned back. Weaker stations will only give full output provided they are modulated more deeply than this; a depth of 100 per cent. would be needed for a 60-μV. station. In passing, it is interesting to notice that the sensitivity of this set is about 32 μV.

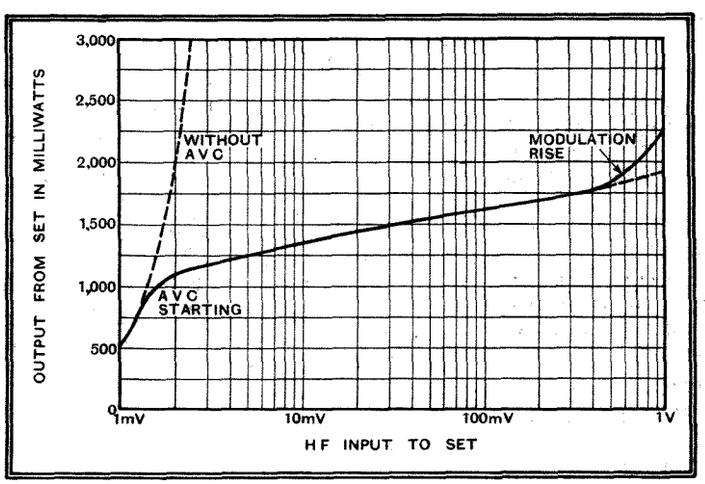


Fig. 8.—Typical AVC curve, showing slow rise of output after AVC takes control. Note modulation-rise after 500 mV. input.

Now we turn back the volume control till the meter registers some known fraction (conveniently one-tenth) of full output, after which we can proceed to put up the input and observe the rise in output without danger of overloading the output valve. We plot output against input, getting a curve such as that of Fig. 8; the flatness or otherwise of this is an indication of the effectiveness of the AVC system. If we like we can summarise the curve in figures, amplifying the note in the last paragraph to "AVC starts at 240 μV. in; full output (2 W.) at 25 per cent. modulation. Rises 6 db. at 250 mV. in." Brief, but reasonably sufficient.

At large inputs there sometimes arises a fault known as **modulation-rise**. The effect is that a carrier, supplied to the set at 30 per cent. modulation, arrives at the detector modulated to perhaps 45 per cent. At the same rate of modulation-rise an initial modulation of 66 per cent. is raised to 100 per cent., which is too deep to be dealt with without distortion by the detector, while at still greater initial depths the distortion can become really bad. The cause is overload of one of the early valves, and the presence of modulation-rise may be suspected whenever the AVC curve tips up suddenly towards the highest inputs, as does that of Fig. 8.

So long as modulation-depth stays constant, the ratio of LF output from the detector to HF input supplied to it will clearly stay constant. With one valve voltmeter connected to the detector input (re-tune!) and another at any convenient place in the LF chain, this ratio is checked for constancy as the input signal is increased, keeping its modulation unchanged at 30 per cent. A curve such as that of Fig. 9 results from this measurement, and since we know that the flat part corresponds to the 30 per cent. modulation we can superpose on it a scale like that shown on the right, and read off modulation-rise directly. If we regard a rise to 32½ per cent. as "just perceptible," we can record: Modulation-rise to 32½ per cent. at 450 mV.; to 51 per cent. at 1V."

These measurements have told us a lot about the overall performance of the set, but give no clue as to how this performance is attained. For this we need to make measurements on individual stages—and, if necessary, on single components.

In analysing, stage by stage, the performance of a set, we have to perform measurements which, compared with those already done, are simple to carry out when one has decided what to do.

For purposes of measurement it is customary to divide a set up into individual stages on the lines of the following table:—

1. Aerial to 1st grid ("Aerial Step-up").
2. 1st grid to 2nd grid, 2nd to 3rd, and so on until the detector is reached ("Stage Gain").
3. Detector input (HF) to detector output (LF) ("Detector Efficiency").
4. Detector output (LF valve grid) to output valve grid ("LF Stage Gain").
5. Output valve grid (volts) to output valve anode (power) ("Power Efficiency"—in milliwatts per volt *squared*).

Measurements on Receivers—

Aerial step-up is measured as the ratio of the volts developed at the first grid to the voltage applied to the dummy aerial, and depends on the magnification of the tuned circuits, the degree of coupling between them if there is more than one, and the manner in which the aerial is coupled in. The figure obtained varies, often widely, with wavelength, and is measured with an unmodulated carrier. The valve voltmeter connected to the first grid to measure the signal there will necessitate retrimming if ganging is to be maintained.

Stage gain, too, is measured as the ratio of volts out to volts in, and requires no special comment as to methods of measurement. The output from the signal generator is applied direct (no longer through a dummy aerial) to the grid of the valve whose gain is to be measured, and the valve voltmeter is connected, with retuning as necessary, to the grid of the next valve. If the stage being measured is an HF stage or a frequency-changer, measurements must be made at several wavelengths, whereas if it is an IF amplifier it is only necessary to make one measurement, at the intermediate frequency itself. In the case of a frequency-changer, the measurement automatically gives the ratio of IF volts out to HF volts in; this is usually called the **conversion gain.**

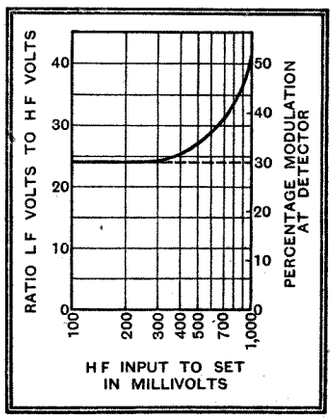


Fig. 9.—Illustrating modulation-rise: except at high inputs, the LF output from the detector is proportional to the HF input (curve horizontal). At high inputs, the LF output rises owing to rise in effective modulation-depth.

Verifying Measurements

It is useful to check the product of the individual stage gains and the aerial step-up against the overall gain from aerial to detector, separately measured exactly as though the whole were one stage. A discrepancy here means either valve-damping on the tuned circuits or its opposite, stray reaction, and should be traced to its lair by further checks if the point is considered worth pursuing. At times a set using badly designed components shows unexpectedly high gain, or one with well-designed components is unaccountably poor in performance; one may like to know exactly why.

From the practical point of view it is important to note that the AVC system, if there is one, must be put out of action during stage-gain tests; if the signal at the second grid is raised to one volt for convenient reading on the valve voltmeter, there will be quite a signal at the detector, and one does not want the first valve, whose gain is being measured, to be biased right back. For similar reasons, care must be taken that no valve that can upset the measurements (by grid damping, etc.) is allowed to overload.

The measurement of **detector efficiency** is a little less straightforward. It is clear that if a theoretically perfect detector is given one volt of carrier, modulated to 30 per cent., it will give an output of 0.3 volt of audio-frequency. If it is a diode, the output can generally be measured directly with a valve voltmeter, and no great difficulty arises. If, however, it is a triode, tetrode, or pentode acting as amplifier-cum-detector (e.g., as a grid rectifier) the matter is much more complex, since one has to measure the output in the anode circuit after it has been subjected to the LF amplification of the valve.

Usually the soundest course is to apply one volt of unmodulated carrier to the grid, to superpose on that, from a separate LF oscillator, an LF voltage of about 0.3 volt, and then to measure the LF output at the anode. This gives the LF gain given by the valve with the grid bias it assumes when a 1-volt HF signal is applied. Now we put on one volt of HF, modulated to 30 per cent., and measure the LF output again. The efficiency of the valve as a pure detector is obtained by dividing the output by the gain found in the previous measurement, and comparing the result with the theoretical 0.3 volt that a perfect detector would give.

Often, however, one is content to determine the output/input ratio of the stage as a whole, without bothering to divide it up into the two contributions of amplification and detection.

The measurement of LF gain is simple, provided that an LF oscillator is available as a source of signal. In its absence one may rely on the known performance of the detector stage, and perform the measurement by supplying a modulated HF carrier to its grid. At this stage one may care to investigate the fidelity of the set from the detector onwards, supplying to the detector a constant carrier modulated to a constant depth with various frequencies. This enables one to distribute blame for departures from perfect fidelity between the HF and LF sides of the set. High-note loss is often due to resistance-capacity filters used to keep HF or IF currents out of the LF side, while low-note loss may be due to an inadequate transformer primary or to a too-small grid condenser. If low notes, missing in the complete set, reappear when the input is to the detector grid, the cause is usually feedback along the AVC line, resulting in re-modulation of the carrier, in inverse phase, by one of the early valves.

Any or all of these faults may be run to earth, if interest warrants, by stage-by-stage tests of the det.-LF system.

The power given by the output valve is proportional to the *square* of the voltage on its grid, for the rather obvious reason that doubling this doubles both the AC current and the AC voltage in its anode circuit, so quadrupling the power. By applying exactly one volt of LF to the grid of the output valve one avoids all arithmetical complications, for the power as read on the output meter is the "Power Efficiency" in milliwatts per volt squared.

In running through a set in this way many points of interest are sure to be found, each of them leading to further measurements for its further elucidation. Suppose an IF transformer uses quite large coils that look as though they ought to be efficient, and yet the IF stage-gain is only 100 times instead of the 250 times that such coils would lead us to expect. One investigates farther—the coils may have been designed for the very highest selectivity, in which case their inductance, and therefore their dynamic resistance, will be quite low. Or they may be very loosely coupled, or even be wound with quite the wrong gauge of wire. Or perhaps the valve may be working at a very low screen voltage, or be over-biased for some reason (AVC system not disconnected? Or left floating?). So long as one is sure that one's measurement is a fair one, and that it honestly reproduces working conditions, such discrepancies as these are always interesting to follow up.

It would be easy to go farther and to indicate the means one would adopt to "vet" thoroughly an IF transformer or an aerial filter and its coupling system—but that would take us out of the realm of set-measurements to the even wider range of measurements of components—and this article is already more than long enough.

The Radio Industry

THE annual general meeting and luncheon of the Electrical Industries' Benevolent Association (36, Kingsway, London, W.C.2) is fixed for April 3rd at the Savoy Hotel.

◇ ◇ ◇

Partridge Wilson & Co., Ltd., of Davenset Works, Evington Valley Road, Leicester, draw attention to the fact that the Davenset Auto Charger is not, like many appliances for recharging car batteries, a mere trickle charger, working at a very low current; it operates normally at a rate of 6 amps.

◇ ◇ ◇

A booklet of interest to architects and builders, as well as to the radio trade, has been issued by Universal Services, 148, High Holborn, London, W.C.2. This company undertakes the installation of broadcast reception facilities in the widest sense, either in large blocks of flats, etc., or on a smaller scale, and have special facilities for overcoming the difficulties that are often encountered in such installations.

◇ ◇ ◇

Mr. W. Grainger Brown, of the senior staff of the G.E.C. Radio Section, has taken up an important appointment in the Malayan branch of the company.

◇ ◇ ◇

The business of Shaftesbury Supplies is now being conducted on a larger scale by a new company, Shaftesbury Microphones, Ltd., 24, Aldersgate Street, London, E.C.1. A new factory devoted solely to the manufacture of public address equipment is now in operation.

PHILIPS-MILLER SOUND RECORDER

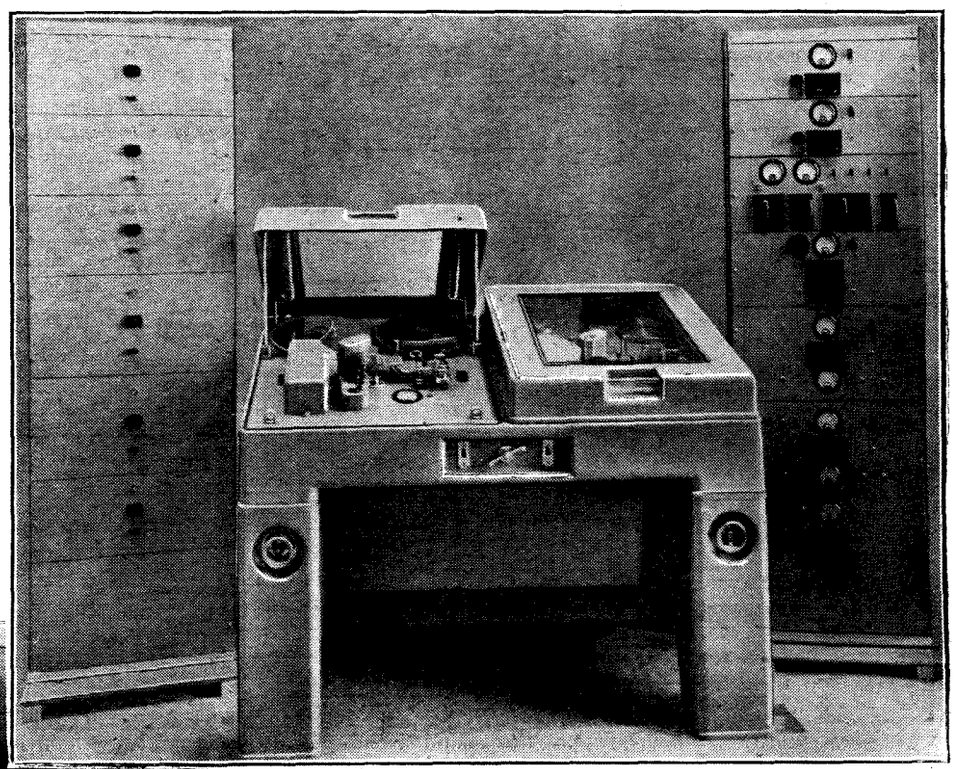
The New Electro-mechanical System for Recording Sound on Film

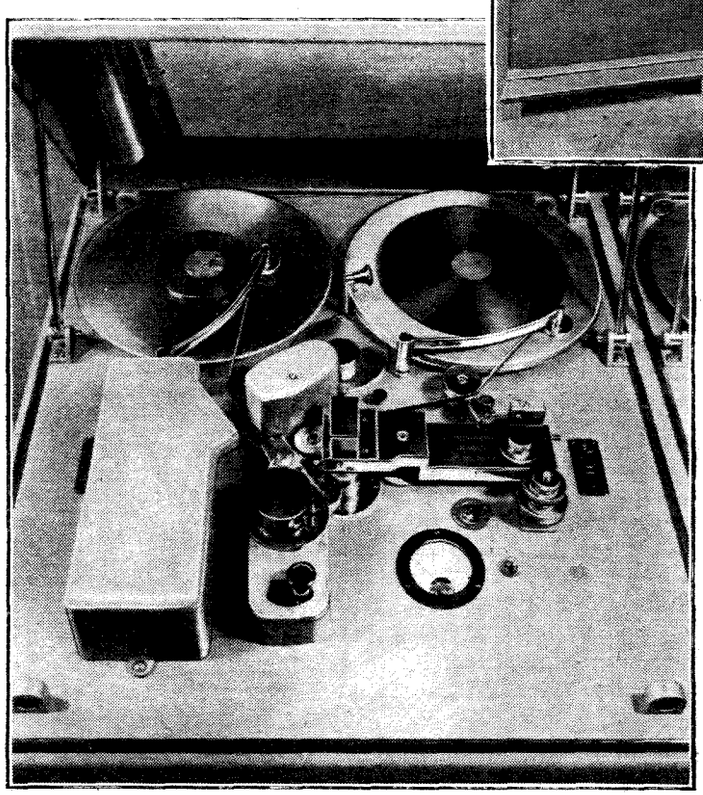
THE problem of storing sound for future use has been tackled from many angles, the gramophone disc, sound film, magnetic tape, and talking pictures being some of the better-known examples. To these has now been added a new system sponsored by the well-known Dutch firm of Philips and controlled in this country by Philips Cine Sonor, of Wardour Street, London, W.1.

Known as the Philips-Miller system, it utilises a specially prepared tape somewhat resembling a film with a black surface. Sound recording is effected by cutting into the moving tape with an obtuse-angled chisel; the cutter, moving pistonwise, cuts a groove of varying depth, and, owing to the special shape of the cutter, of varying width also. The width of the track is governed by the amplitude of the sounds, while serrations along the inside edge give the different frequencies. For reproduction a beam of light and a photocell are used.

Recording in this manner does not necessarily demand deep cutting, as this is only subsidiary to the main issue, which is the width of the track cut. By suitably choosing the angle of the cutter point, a track in the black layer 2 millimetres wide can be obtained by a cut of 0.05 millimetre in depth.

Thus, very little power is required to operate the cutter even for relatively large amplitudes, and, as deep cutting is not needed, the moving parts can be made very light. As a consequence, the frequency range is stated to be exceptionally good, the system having a virtually flat characteristic from 50 c/s to 8,000 c/s.





(Above) Complete equipment for recording broadcast programmes. (Left) One of the twin machines each of which incorporates a sound head with the cutter unit

The special composition of the black layer, which consists of grains of colloidal size, gives a sharp definition to the sound track. This not only assures faithful recording of the highest frequencies, but contributes to the high signal-to-noise ratio that is claimed for this system. One of the features of the Philips-Miller recorder is that monitoring of the actual sound track can be effected during the recording process by mounting the reproducing equipment, exciter lamp and photo-cell, immediately behind the cutter, and thus listening to the recording within one-third second of cutting the track.

The machine shown in the accompanying illustrations is designed for broadcasting use, and comprises the cutting machine, seen in the centre, rack-built amplifiers on the right, and power supply equipment on the left.

Twin machines

The cutting heads are duplicated, and feed into separate amplifiers, and quick changes from one to the other can be made without any perceptible break in the recording. Alternatively, two separate programmes could be recorded simultaneously on different tapes.

The amplifying equipment embodies, in addition to all controls, a monitoring amplifier for each machine, as combined with the cutter unit is also a sound head.

Copies of the recording can be made quite easily by a photo-mechanical process—that is to say, the output from the sound head is amplified in the usual way and then fed to another cutter. Many copies can be made from one master without loss of definition, since the sound track is not subjected to mechanical wear. The dual machine illustrated can, of course, be employed for copying, so that no additional apparatus is required. H. B. D.

Listeners' Guide for the

THE outstanding event of the week will be the broadcast by H.M. The King, which will go out from all the British transmitters as well as the Empire station at Daventry at 4 p.m. on Sunday next, March 1st. Although this will be the first broadcast by the King since his accession, the voice of His Majesty is familiar to listeners all over the world, for, as Prince of Wales, he has broadcast from the Home and Empire stations on more occasions than any other member of the Royal Family. King Edward's first broadcast was from "2LO, London," in October, 1922, when licence holders numbered about 18,000.

CZECHOSLOVAKIA IN THE LIMELIGHT. Tuesday's internationally relayed concert comes from Prague and will consist of orchestral works by Janacek and Suk. It will be heard in the B.B.C.'s Regional transmission at 8. The announcer will be Madame Maria Tomanova, who is here seen in national dress at the Prague microphone. Mme. Tomanova speaks nine languages, including English.

PEOPLE who commit appalling mistakes are always interesting, and nothing could have been more appalling—at any rate, to Thomas Carlyle and John Stuart Mill—than the accidental burning of Carlyle's MS of "The French Revolution." The deed was done by Stuart Mill's maidservant who, evidently addicted to the common feminine propensity for "clearing up," threw the precious papers on the study fire. It is this young lady who forms the subject of Sunday's "Imaginary Biography" (Nat., 6.45) by Michael Oakeshott, to be read by V. C. Clinton Baddeley.

Carlyle forgave Mill, but did Mill forgive the girl?

◈ ◈ ◈

ADAPTED BY "EGG"

No more charmingly suitable artiste than Edith Day could have been found for John Watt's production of "Rio Rita," the West End success, which is to be broadcast in a radio version on Monday (Nat., 8.5) and Tuesday (Reg., 9). This romantic musical comedy, by the way, has been adapted for the microphone by "Egg," a nickname which hides the identity of Henrik Ege. The owner of this challenging surname has been given at least half a dozen nicknames by his colleagues at Broadcasting House.

◈ ◈ ◈

CZECH MUSIC IN EUROPEAN CONCERT

Two of Czechoslovakia's greatest musical composers are still living and will be represented in the programme chosen for the European concert which that country provides on March 3rd. They are Joseph Suk and Leos Janacek. The concert, which will be relayed by the B.B.C. on Tuesday (Reg., 8), will consist of Suk's Fantasy for Violin and Orchestra, played by Javoslav Stephanik, and the Prague Wireless Symphony Orchestra and the Janacek's Sinfonietta for orchestra. The latter composer is eighty-two, and is still writing music of astonishing vitality. Suk, who is sixty, is a son-in-law of the great Dvorak.

◈ ◈ ◈

KETTLE DRUMS IN "FUNERAL MASS"

A "Mass for the Dead" and a "Funeral Symphony" suggest anything but a bright programme, but the Berlioz concert on March 4th (Nat., 8.30) at the Queen's Hall will be full of brilliantly "live" music. Sir Hamilton Harty will be conducting Berlioz' "La Grande Messe des Morts" and the "Symphonie Funèbre." Berlioz was a master of orchestral effects, and was fond of bizarre and unusual combinations of instruments. He dreamed of a vast orchestra of thirty pianos, hundreds of violins; and every possible kind of percussion instrument. In the "Grande Messe" he wrote important parts for an unusual number of kettle-drums.

◈ ◈ ◈

"... AND A PRIME MINISTER"

LANCE SIEVEKING'S radio productions are always original, and as he is dealing next week with a farcically fantastic play, "The Dreaming Man," by Leonard Crabtree, we may expect something very original indeed. The dreamer in this case is a disgruntled man who experiences in an intermittent dream one summer afternoon a more complete wish fulfilment of worldly success than most of us are able to realise.

Carleton Hobbs is taking the part of George Harley, the dreaming man, and Beatrice Gilbert that of Gertie Harley, his wife. The supernumeraries include a bus conductor, a telegraph boy and a Prime Minister. (Thursday, Nat., 8.15; Friday, Reg.)

◈ ◈ ◈

LOOE FISHERMEN

AN unusual "studio"—a Sunday school classroom—will be employed by the Looe Fishermen's Choir for their Tuesday's broadcast (Reg., 7.30) entitled "In the Shade." Listeners will be overhearing an unofficial "rehearsal."

◈ ◈ ◈

ACROSS AMERICA IN SONG

THE American tramp or "hobo" has a minstrelsy of his own which Alaistair Cooke will draw upon for his gramophone recital at 8 in the National programme on Thursday. It is called "New York City to the Golden Gate."

◈ ◈ ◈

BATTLE OF WITS

A UNIQUE and amusing broadcast takes place in Scandinavia to-morrow (Saturday) at 7, when a joint "Fancy

VIVIENNE BROOKS, the convent-educated "blues" singer, photographed with Henry Hall at rehearsal. She makes her début with the B.B.C. Dance Band in "Henry Hall's Hour" to-morrow night at 11.

Week Outstanding Broadcasts at Home and Abroad

Dress Ball" will be broadcast in alternate periods from Oslo and Stockholm. In each city there will be audiences in the studio, and as there will be microphones and loud speakers at both ends the illusion of one great assembly will be created. Several "hot" bands will take part, and two compères are to decide "over the air" which is the wittier nation, the Norwegian or the Swedish.

◈ ◈ ◈

ALONE IN COPENHAGEN

"A YOUNG girl arrives in Copenhagen" is the title of a promising "O.B." which

MAJOR ANDREW HARRIS, M.V.O., conducts H.M. Welsh Guards Band in a programme of traditional Welsh music on the Regional wavelengths at 5.45 on Sunday.

Kalundborg is relaying at 8.45 on Monday. Music, speech and sound effects will combine to build up an impression of the girl's adventures during an exciting week in the Danish capital.

◈ ◈ ◈

OPERA—THREE MONTHS OLD

ELECTRICALLY recorded opera is the highlight of German broadcasting this week. Wagner's "Rheingold," which Leipzig offers at 7.45 on Wednesday, will be an electrical recording of a broadcast which took place as long ago as November 28th of last year. It will be interesting to see whether the steel tape has preserved the opera in its original freshness.

The same night at 11 Stuttgart gives an electrical recording of Verdi's "El Ballo en Maschera," and on Thursday, also at 11 o'clock, Frankfurt gives an electrical recording of Mozart's "Il Seraglio."

◈ ◈ ◈

"ULTRA MODERN" OPERETTA

WHILE opera and musical comedy are not in the ascendant this week there are one or two attractive items. To-morrow at 7.10 Deutschlandsender offers a modern operetta, "Der Treffer ins Schwarze," by Karl Knauer, which is said to interpret the ultra-modern spirit of the "Reich."

"Jaromira, the Robber's Bride," by Gebhardt—a musical comedy version of Ye Olde Gangster motif—is featured by Hamburg at 8 on Wednesday.

HIGHLIGHTS OF THE WEEK

FRIDAY, FEBRUARY 28th.

Nat., 8, Piano Recital by Cyril Smith. 8.30, "The Air-do-Wells." 10.20, St. Michael's Singers.
Reg., 6.30, "The Student Prince." 8.30, "March of the '45." 10.30, Jack Jackson and his Band.
Abroad.
Warsaw, 7, Opera: "Manru" (Paderewski).

SATURDAY, FEBRUARY 29th.

Nat., 8.30, 'St. David's Day," by the Rt. Hon. D. Lloyd George. 8.45, A Welsh Concert.
Reg., 8.30, Romance in Rhythm (Geraldo and his Orchestra). 11, Henry Hall's Hour.
Abroad.
Deutschlandsender, 7.10, Operetta: "Der Treffer ins Schwarze" (Karl Knauer).

SUNDAY, MARCH 1st.

Nat., Luton Band. 9, Albert Sandler and the Park Lane Hotel Orchestra.
Reg., 5.45, Band of H.M. Welsh Guards in Traditional Welsh Music. 9.20, Sir Hamilton Harty conducts Sunday Orchestral Concert.
Abroad.
Vienna, 7.5, Strauss Concert from the Musikvereinssaal.

MONDAY, MARCH 2nd.

Nat., Foundations of Music: Mendelssohn's Organ Works. (Throughout week). 8.15, Musical Comedy: "Rio Rita."
Reg., 8.15, Bach Choir Concert.
Abroad.
Kalundborg, 8.45, "A Young Girl in Copenhagen."

TUESDAY, MARCH 3rd.

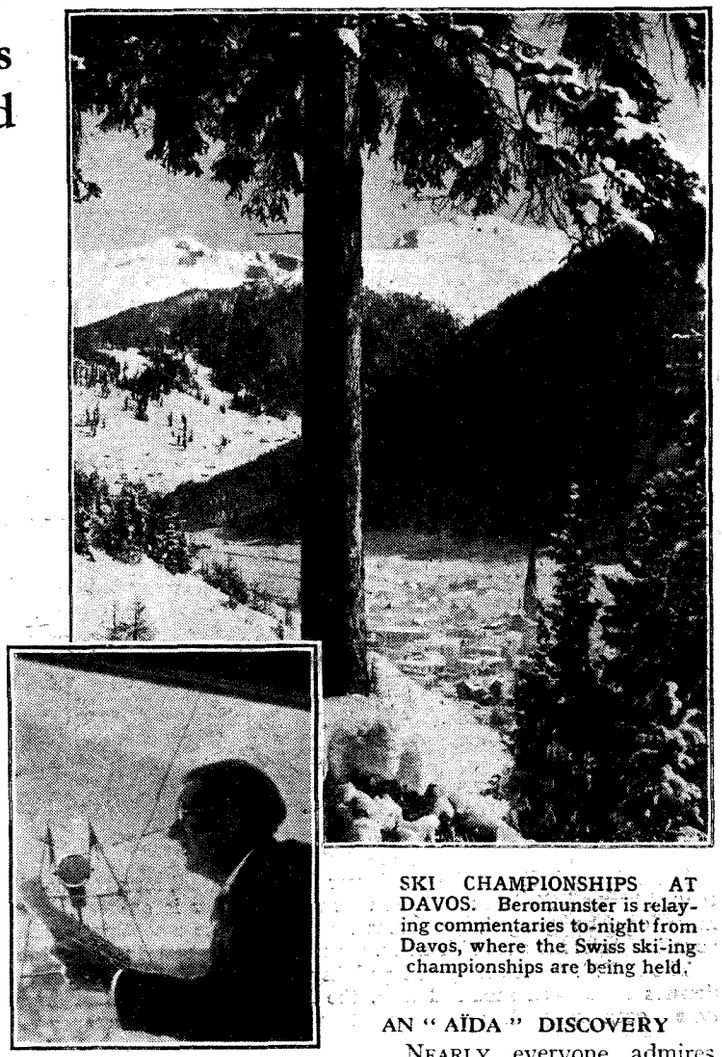
Nat., 8, Variety: Jeanne de Casalis, Western Bros., etc.
Reg., 8, European Concert from Czechoslovakia. 9, "Rio Rita."
Abroad.
Berlin, 7.10, "Musical Pearls," a musical hour with a small orchestra and pianoforte. Soloist: Johannes Strauss.

WEDNESDAY, MARCH 4th.

Nat., "The Rocky Mountaineers." 8.15, B.B.C. Symphony Concert. (Berlioz Programme).
Reg., 8.30, Stanelli's Bachelor Party.
Abroad.
Strasbourg, 8.30, Oratorio: "Les Béatitudes" (Cesar Franck) from the Palais des Fetes.

THURSDAY, MARCH 5th.

Nat., 8.30, The Fol-de-Rols in a Seaside Summer Show. ¶B.B.C. Dance Orchestra.
Reg., 8.15, Radio Play: "The Dreaming Man" (Leonard Crabtree). ¶Piano Recital by Anderson Tyrer.
Abroad.
Kalundborg, 7.10, Erna Berger (soprano) of the Berlin State Opera, with the Radio Symphony Orchestra. Conductor: Fritz Busch.



SKI CHAMPIONSHIPS AT DAVOS. Beromunster is relaying commentaries to-night from Davos, where the Swiss ski-ing championships are being held.

AN "AÏDA" DISCOVERY

NEARLY everyone admires Verdi's great opera "Aïda," but it has been broadcast from the Italian stations so frequently of late that British listeners have begun to ask why. The answer comes like a flash if one examines the plot, which concerns the defeat by the Egyptians of an ancient King of Ethiopia. "Aïda" is being broadcast by Rome at 7.45 to-morrow.

Rossini's immortal "Barber of Seville" comes from Berlin (Funkstunde) at 7 on Sunday.

The only other operatic programme of note is a Toulouse concert version of Mozart's "Figaro" at 9.10 on Tuesday.

◈ ◈ ◈

KIPLING ON THE CONTINENT

THE first Continental station to pay tribute to Kipling since the poet's death is Kalundborg, which, at 7.30 on Monday, will give a programme consisting of Cyril Scott's musical "Impressions from the Jungle Book," "Soldier Songs" sung by Per Knudsen, and Kipling's poems recited by the Danish elocutionist Tavs Neiiendam.

THE AUDITOR.

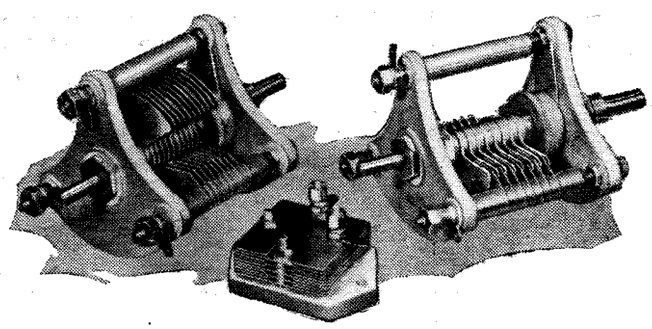
New Apparatus Reviewed

RECENT PRODUCTS OF THE MANUFACTURERS

B.T.S. SHORT-WAVE CONDENSERS

A FEW minor alterations have been effected in the construction of the B.T.S. short- and ultra-short wave condensers since last we tested and reviewed them. The back plate, which in the earlier models had a two point support leaving the terminal rod for the moving vanes free, is now shaped to include all three terminal points, thereby considerably strengthening the component and eliminating all likelihood of side stress on the unsupported rod fracturing the front plate.

Those tested include two of 160 m-mfds. and one of 67 m-mfds. nominal capacity. The two former each has a minimum of 7 m-mfds. and a maximum value of 161 m-mfds. in one case and 165 m-mfds. in the other. The minimum and maximum of the smaller size were 6.5 m-mfds. and 72.5 m-mfds. respectively.



Latest specimens of B.T.S. short-wave variable and air-spaced fixed condensers.

The rotor spindle of the condenser is extended beyond the back plate so that two or more can be ganged, and small flexible coupling units are available at 1s. each.

The B.T.S. fixed air-spaced padding condensers have been modified also, the latest type occupying less baseboard space. Measurements made with some new specimens showed very close agreement with the marked values. Both in these and in the variable condensers silver-plated vanes are used as formerly, while the prices also remain unchanged, viz., 8s. 6d. for the 160 m-mfds. variable condenser, 7s. 6d. for the 67 m-mfd model, and 3s. 3d. each for the padding condensers, which are available in sizes up to 200 m-mfds.

PARTRIDGE FILTER CHOKE

IN addition to manufacturing mains transformers, chokes and output transformers of orthodox pattern, the firm of N. Partridge has made a speciality of the design and construction of LF components for special purposes, one example of which has been sent in for test.

This is a filter input choke for use in the G.E.C. 32W and 45W low-loading push-pull amplifier circuits. This particular choke is suitable also for use in any similar or Class "B" LF amplifier in which the mains transformer voltage does not exceed 700 RMS across each half of the secondary, and the load fluctuation under working conditions is between 100 and 500 mA.

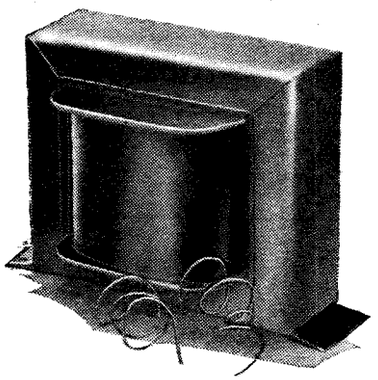
With this style of amplifier it is customary to employ an HT supply circuit in which the usual reservoir condenser following the rectifier is omitted, but between the valve and the smoothing circuits proper is included a special filter choke. Voltage regulation is very largely dependent upon the correct design of this component.

The inductance values given for this choke when passing DC of between 100 and 500 mA are as follows:

Current in mA.	Critical value of L below which voltage will rise.	Inductance of filter choke (Test V = 12 RMS).
100	5.3 henrys	9.0 henrys
200	3.0 ,,	6.5 ,,
300	2.1 ,,	3.5 ,,
400	1.7 ,,	2.25 ,,
500	1.4 ,,	1.75 ,,

Tests made with the specimen choke submitted confirm the maker's claim that the critical value is never passed; indeed our inductance measurements were slightly higher, which is all to the good.

The winding is paper-interleaved throughout as the choke is subjected to very high terminal voltages under working conditions,



Partridge special filter input choke for HT supply units of low-loading push-pull amplifiers.

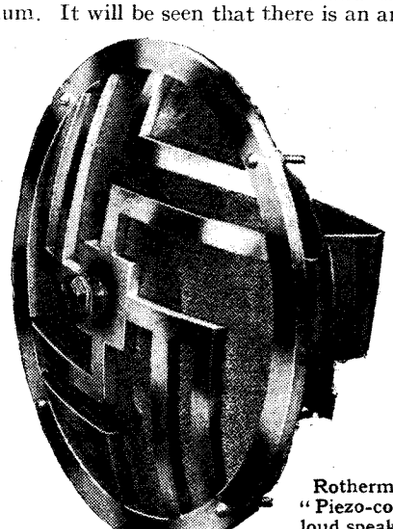
whilst the exceptionally low DC resistance of 40 ohms accounts for a very small voltage drop, even with the highest permissible current.

The price of this component is 24s.

"PIEZO-COIL" LOUD SPEAKER

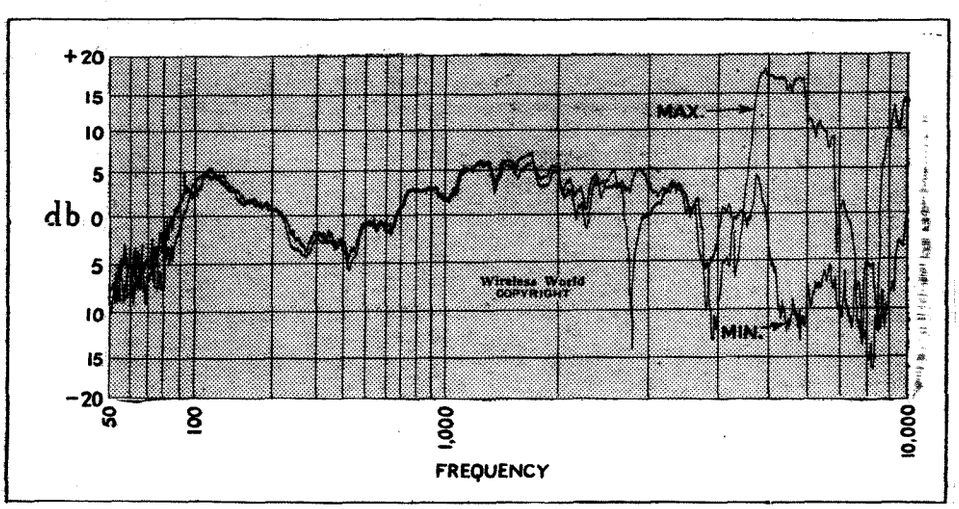
THIS reproducer is a combination of a moving-coil loud speaker and a piezo-electric "tweeter" with the necessary matching circuits and a tone control which enables the high frequency response to be adjusted to suit the frequency characteristic of the receiver.

Two axial curves were taken with the tone control set for minimum and maximum. It will be seen that there is an ample reserve of top response to correct for possible sideband cutting, and it should be possible to find an intermediate setting of the control to suit any given conditions and to give good balance. A sharp dip occurs in the vicinity of 8,000-9,000 cycles, which is an advantage from the point of view of suppressing heterodyne whistles, and the low frequency portion of the curve is confined within ± 5 db. from 70 to 3,500 cycles. Not the least attractive feature of the performance is the absence of the trough at 1,000-1,500 cycles and the peak between 2,000 and 3,000 cycles which is of frequent occurrence in speakers with cone diaphragms.



Rothermel "Piezo-coil" loud speaker.

The makers are R. A. Rothermel, Ltd., and the price is £5 5s.



Axial response curves of Rothermel "Piezo-coil" loud speaker with tone control in maximum and minimum positions. Microphone distance 4 ft., power input 1 watt.

Letters to the Editor

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

Ultra-short Waves and "High Fidelity"

IN your issue of January 31st I notice a letter which would seem to show that some remarks which I recently made at a discussion on ultra-short wave broadcasting at the Institution of Electrical Engineers were misunderstood. Your correspondent has apparently interpreted my remarks as meaning that I did not consider that "high-fidelity" broadcasting was worth considering seriously. What I did say was that, while the use of ultra-short waves should make it possible for a wider band of frequencies to be transmitted than on ordinary broadcast wavelengths, there was a tendency for some people to assume that "high fidelity" consisted only of transmitting a wide frequency band. Some of the other requirements of high-fidelity transmission and reproduction were, in my opinion, at least as important, if not more important.

I am surprised that anyone should have accused the B.B.C. of being insufficiently interested in the transmission of high-quality broadcasting, since from the beginning it has paid at least as much attention to this problem as any other broadcasting organisation, and far more than most.

The British Broadcasting Corporation,
N. ASHBRIDGE, Chief Engineer.
London, W.1.

Programme Distribution

I CANNOT agree that the simultaneous broadcasting of news is a serious drawback, as we have all become accustomed to it and know when to expect it. I do, however, consider that *real* alternatives should be provided by the various Regional transmitters. At the present time the only alternatives offered are the choice of evenings. For instance, a play broadcast in the Regional programme to-day will be heard on the National transmitter to-morrow. To all intents and purposes, B.B.C. alternatives are a farce.

If the Regionals gave different broadcasts as a regular thing, one would acquire the habit of looking at the programmes to see what is offered; whereas at present a glance at the National and London Regional offerings decide one whether to turn to the Continent for entertainment.

From this part of the world, using a "W.W." New Monodial, all the home stations can be received. London Regional fades badly and distorts, and Western Regional is even worse in these respects. North Regional would be excellent if it were not for the fact that the National programme is *always* superimposed on it. Scottish Regional nearly always is received perfectly. Can somebody inform me whether my experience with North Regional is peculiar to the set or locality?

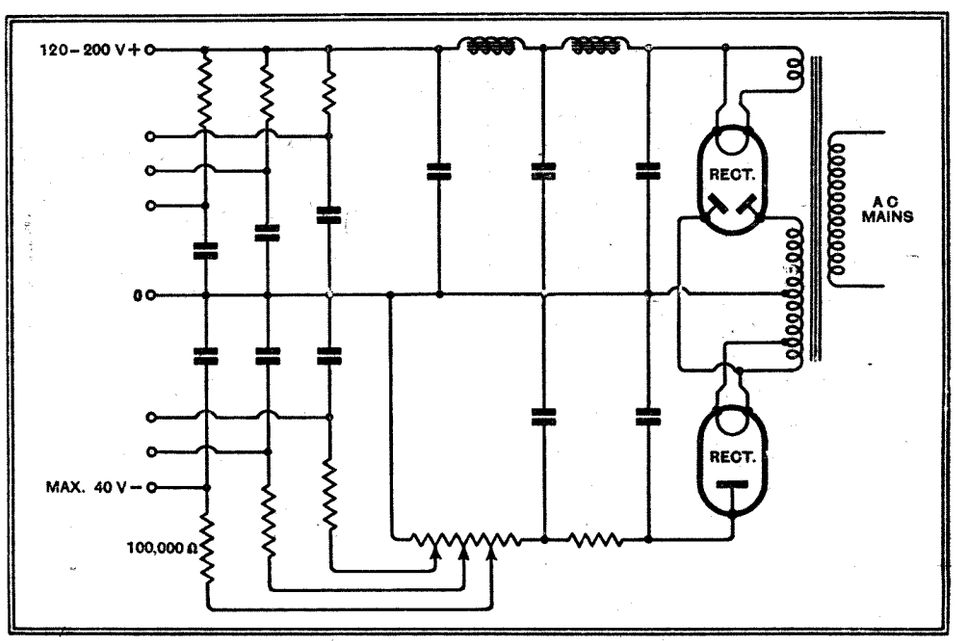
GEOFFREY E. PEACHEY.
Pook's Hill, Hove, 4, Sussex.

LET the B.B.C. follow Germany's lead—and progress as the age demands.

In my opinion three good transmitting stations (at least 100 kW) discreetly placed would give good reception in any part of the Kingdom provided the listener followed progress too and used an up-to-date set. Why should the B.B.C. consider listeners who do not consider themselves? It is surprising that even up-to-date business men of up-to-date business methods still retain obsolete receiving sets. JOHN BRAITHWAITE.
Workington.

"Stabilised Grid Bias"

MY attention was attracted to an article in *The Wireless World*, January 3rd, about stabilised grid bias by Mr. Charles Lawler. He publishes a circuit for supplying extra grid bias without the need of a second transformer. I remember that a similar idea was adopted in the old "Philips" HT supply No. 3003 (blue box) and the diagram was as in the accompanying drawing. C. W. RUYSINK.
Hengelo, Holland.



System adopted for obtaining an independent grid bias supply in a Philips HT unit.

Ultra-short Wave Broadcasting

THE ultra-short wave transmissions from Broadcasting House, mentioned under "Broadcast Brevities" in your issue of February 7th, were well received here, approximately twenty-eight miles from Langham Place, from Monday, February 3rd, to Friday, February 7th, and are coming in well this afternoon, February 10th. The London Regional programmes have been used throughout the period. The wavelength is apparently 7.48 metres. The hours of working have been regular, from just before 10.30 a.m. until 5 p.m. I believe that there has been a lunch interval from 1 to 2 p.m.

The receiving aerial in use is an indoor horizontal half-wave cut to 5.2 metres. It is about 210ft. above sea-level. The receiver is a three-valve super-regenerative. Maximum signals are about R8 and 100 per cent. readable on speech. There is slight, irregular fading.

Taking into consideration the unfavourable situation of Broadcasting House for ultra-short wave work, I am encouraged to hope that this district will be within the service area from Alexandra Palace for properly constructed apparatus using a correctly dimensioned aerial. Pirbright is thirty miles from Alexandra Palace.

ERNEST H. ROBINSON (G-5YM).
Pirbright, Surrey.

High Notes Without Heterodynes

I WAS interested in the letter of Mr. Anthony Fearnley upon the above subject in your issue of January 24th, and in the reply of Mr. P. Winkeler, and in the ensuing editorial comment in your issue of February 7th.

I venture to suggest that the opening paragraph of the third of these requires very considerable qualification, and is, in fact, only true when the field strength of the interfering signal is approximately equal to or greater than that of the wanted signal.

In cases other than the above it is possible to eliminate the interference by simple means.

As stated by Mr. Winkeler, the heterodyne can be silenced by a suitable filter, and the remedy for the side-band splash is suggested in Mr. Fearnley's first sentence.

As is well known, if the AVC line voltage is prevented from falling below a certain value a limit can be set whereby signals of a field strength below this limit are not received.

Moreover, the action of the AVC is itself selective, and by reducing the sensitivity of the receiver when turned to a strong carrier tends to eliminate interference. Anyone situated within the service area of a broadcasting station should find no difficulty in obtaining reception at maximum fidelity *provided always that the input valve is not overloaded.*

The real trouble lies in the fact that the

Letters to the Editor—

frequencies specified by Mr. Fearnley are not available, as, except in certain transmissions from the London Regional, the upper limit, set by the limitations of the land lines used, is approximately only 8,500 c/s—but that is another story.

It may be of interest to note that where "monkey chatter" is in evidence, it only occurs when the band width accepted is of a certain value. If the width is increased the "monkey chatter" disappears and an intelligible signal is received from the interfering station. If this is of a relatively low level it is to many people more tolerable than the former.

In conclusion, may I say that this letter is addressed to you in the hope that prospective owners of high-fidelity receivers will not be deterred by the views previously expressed, but that their voices may be added to swell the demand for a higher quality in broadcast transmissions.

Bury, Lancs. W. HORRIDGE.

High-note Boosting

AFTER reading your editorial comment in February 7th issue, I thought the following information would be of interest to you:—

When Sir Noel Ashbridge, H. Bishop and B. N. MacLarty delivered their paper to the I.E.E. on the Droitwich station, I asked the chief engineer of the B.B.C. the following question: ". . . With series modulation, however, I presume it is quite possible to obtain a rising characteristic?

"In view of the fact that receivers are far more distortionless than they used to be, would it not be desirable to raise the level of the higher audible frequencies? . . . I should like to know the opinion of the B.B.C. on this point."

Sir Noel gave the following reply (Journal I.E.E., Vol. 77, page 487):

". . . Apart from the question as to whether such a procedure is sound from the point of view of the receiver designer, difficulties would probably be encountered in the design of the circuits of the transmitter, due to excessive voltages at the higher modulation frequencies."

Lichfield. D. R. PARSONS.

Deaf-aid Components

IN reply to H. B. Houghton, I heartily endorse his remarks regarding the deaf-aid business. M.R. Supplies, however, provided me with a deaf-aid microphone, price 8s. 6d., and a midget earpiece, price 14s. 6d., in November last. With a 3-volt battery this apparatus compares very favourably with many standard deaf aid.

I have since been experimenting with a valve amplifier. The deaf-aid microphone becomes too noisy on account of the looseness of the granules in these very sensitive types. Siemens' Neophone, price 6s., as used in the latest G.P.O. telephones, is excellent, but requires a transformer. One taken from an old G.P.O. telephone transmitter serves me well. (These are masquerading under a variety of names in the second-hand market.) I have fitted the microphone on to an adaptation of J. H. Reyners' Midget set, described recently. A pentode output transformer is used. The reproduction is a little harsh, but is very promising as a starting point. I write at this stage in the hope of assisting your querist. I may say that I am very deaf myself, and would welcome any further articles on the subject of deaf aids.

The chief trouble about the existing forms of deaf aid is not really their expense, but that even under the most favourable conditions they only restore to the deaf a fraction of what they have lost.

JOHN A. HAMILTON.

Glasgow, S.1.

IF Mr. Houghton, whose letter on the supposed deaf-aid ramp was published in your issue of the 7th inst., would get in touch with me, I think I could fit him up with any small microphones or earpieces he might require at reasonable prices.

But he should remember that even then he may not necessarily be able to make up the hearing aid best suited to his needs. That is a matter for a specialist, who will expect to be paid well for his time; and if Mr. Houghton deals with a reputable firm he will get the generous after-service and personal attention which are absolutely essential in dealing with deafness. If he is a man with an eye to the future, he should be willing to allow a certain amount for development work.

He should remember, too, that overhead charges in the deaf-aid industry are of an entirely different order from those obtaining in the wireless trade, and that quantities will always be small when deaf people are led to believe that it is possible to hear with something that is completely invisible and of no size and weight.

But Mr. Houghton is surely asking too much when he expects the manufacturer to the trade to supply "special parts" direct. The purveyor has probably invested a great deal of money in his business and has created a demand for his goods by expensive advertising and other means; and should be expected to have a sole right to his special parts, as is the case in every industry.

There is room for improvement, no doubt, but not along these lines.

pp. Amplivox, Ltd.,
A. EDWIN STEVENS, Governing Director.

London, W.1.

The "W.W." Variable Selectivity Four

I SHOULD like to place on record my satisfaction with the excellent design of this set, together with the equally satisfactory low cost of construction for the results obtainable. Now it is worth while buying *World Radio* to follow the foreign programmes. F. F. GOSSLING.

Dover.

News from the Clubs

Presidential Address "Over the Air"

THE President of the newly formed West London Radio Society, Mr. Douglas Walters (G-5CV), gave his presidential address "over the air." After attending a demonstration of a Lissen short-wave superhet at the Ealing Town Hall, Mr. Walters returned to his residence and transmitted his address by radio telephony. Excellent strength and quality were obtained on loud speakers in the hall. Hon. Sec., Mr. H. A. Williamson, 22, Camborne Avenue, West Ealing, W.13.

Ultra Short-wave Test

A 5-metre demonstration will be carried out by Mr. W. B. Sydenham, B.Sc. (G-5SY) at a meeting of the Exeter and District Radio Society at 8 p.m. on Monday next, March 2nd, at the Y.M.C.A., High Street. Full particulars regarding membership can be obtained from the Hon. Sec., Mr. W. J. Ching, 9, Sivell Place, Heavitree, Exeter.

For Cheshire Enthusiasts

An amateur "Transmitting and Short-Wave Club" has been formed for radio enthusiasts in the districts of Hoylake, West Kirby, Grange and Heswall. All members of the R.S.G.B. are automatically admitted; certain qualifications are required of all other applicants. Full particulars of membership can be obtained from the Hon. Sec., Mr. B. O'Brien, "Caldy," Irby Road, Heswall, Cheshire.

Television

Mr. J. H. Reyner, B.Sc., will demonstrate television in his laboratory during a visit paid there by members of the Golders Green and Hendon Radio Society on Saturday, March 7th. All communications should be addressed to Lt.-Col. Ashley Scarlett.

In Kentish Town

Members will be welcomed at the meetings of the Kentish Town and District Radio Society, which are now held on Tuesday evenings at 8 p.m. at Holmes Road School. Hon. Secretary: Mr. E. A. C. Jones, 62, Lincoln Road, East Finchley, N.2.

Loud Speakers on Trial

"Please bring your loud speaker, irrespective of its vintage," is the invitation extended to members and friends of the Croydon Radio Society in connection with the special "Loud Speaker Night" which has been arranged for Tuesday next, March 3rd. The meeting will be held at 8 p.m. at St. Peter's Hall, Ledbury Road, South Croydon. Hon. Sec., Mr. E. L. Cumbers, 14, Campden Road.

The Acid Test

Leading commercial speakers were heard and compared at a recent meeting of the Leicester Amateur Radio Society, and after a searching examination a vote was taken. The Magnavox 66 achieved top place.

Television Lectures

A series of lectures on Television is being staged by the Southend and District Radio Society. The Society is fully licensed for experimental transmission, and is now affiliated with the Radio Society of Great Britain. The Hon. Sec., Mr. F. S. Adams, of "Chippenham," Eastern Avenue, Southend-on-Sea, will be pleased to hear from prospective members.

English "Acorns"

Mr. F. H. Haynes, President of the Ilford Radio Society, covered a wide field, including valves, speakers, receiver design, and the present position of television in his annual chat on "Latest Developments." He exhibited a new large cathode ray tube and, among special new valves, two English acorn triodes. Hon. Sec., Mr. C. E. Largen, 44, Trelawney Road, Barkingside, Ilford.

A Short-wave Dinner

The third annual dinner and dance of the London Chapter of the International Short-Wave Club will be held at Maison Lyons, Shaftesbury Avenue, on Saturday, March 7th. Full particulars can be obtained from Mr. A. E. Bear, 10, St. Mary's Place, Rotherhithe, S.E.16.

Random Radiations

By "DIALLIST"

Congratulations

EVERY wireless man will be glad to learn that Professor E. V. Appleton has been appointed to a Professorship in Physics at Cambridge University. Professor Appleton is an old Cambridge man, but for many years now he has been working at London University. He will return to Cambridge in October, when the University year begins, and will no doubt help to carry on the great traditions of the Cavendish Laboratories, where some of the most remarkable discoveries of modern times have been made.

Professor Appleton is probably best known by his work on the reflecting envelopes which surround the earth. His experimental work upon short-wave radiation led to the discovery of the layer lying far beyond the Heaviside which bears his name. We may be sure that his work will go forward with renewed energy when he returns in the autumn to his spiritual home.

Fireworks

I WONDER if you know "Squibs"? He is one of the sprightliest of Continental sporting commentators, and I never miss him if I can discover when he is to be at work. Squibs is, I believe, a Swiss; at any rate, I seem usually to pick him up from Sottens. He works on lines quite different from those of H. B. T. Wakelam, Howard Marshall, John Snagge or any of our commentators. There's no detached calm, no *phlegme* about him; when he watches a game of any kind he's out to enjoy himself thoroughly, and he lets himself go. One side is attacking the other's goal. His words come faster and faster; his voice runs up the scale. The critical moment arrives. Squibs emits a shrill Oooo. The danger is averted. He gasps with relief, and without any aid from television you see him mopping his brow. In a voice shaking with emotion he tells what a narrow squeak it was.

Squibs was magnificent when reporting the Olympic ice hockey match for one of the Continental transmissions. He will no doubt deal with other big events in the games, and I strongly recommend you to bear him in mind as a particularly thrilling commentator.

A Suggestion for the B.B.C.

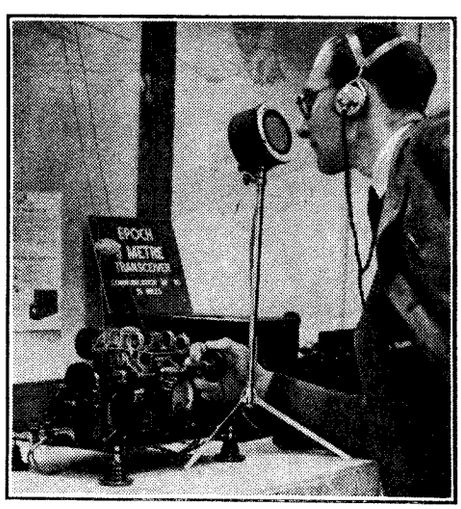
Speaking of the Olympic ice hockey match calls to mind a rather regrettable fade-out which occurred during the most crucial game of all, that between this country and the United States. The closing stages of the game's normal period were magnificently described by a Canadian commentator and when the siren blew for "time" the score was still love all. Very wisely, the B.B.C. decided to continue to broadcast the account of the extra periods which became necessary. Two of these were played, and still there was no score. The time by now was 10.15 p.m., and already a piano recital had had to be cut out of the Regional programmes and the News was overdue. The only solution that those in charge of arrangements could find was to fade-out the relay from Garmisch-Partenkirchen. I do think that they might have left just one station sending out this running commentary. Ice hockey is a pretty popular pastime to-day, but whatever the game may be it is always breathlessly exciting to listeners of sporting tastes if this country is concerned in it and is within an ace of winning an Olympic and a World Championship. Similar problems may arise when the main programme of the Olympic Games comes along. May I make the suggestion that there should be no more fade-outs at breathless moments, but that one station should be kept at work for the relay.

Home Station Reception

IN a recent issue the Editor asked for reports on what B.B.C. stations were regularly receivable in certain localities at good strength and with quality that compares with the "local." Well, here's mine. I live in a Chiltern valley some 25 miles north-west of London and 15 or 16 miles as the crow flies from Brookman's Park. In broad daylight the simple kind of superhet that is so popular nowadays gives me really first-rate reception from Midland, Western and Northern Regionals in addition to the locals and Droitwich. The Scottish Regional, though receivable, is not up to my standard of volume and quality, and I can hear nothing but a whisper from the Scottish National. After dusk both the Scottish Regional and the Scottish National begin to come in well, though sometimes reception of them is spoilt by fading or interference. My report, then, is I can receive the Regional programme at any time with "local" quality and volume from four stations, and the National programme equally well from two. So good is daylight reception of the stations mentioned that I decided to see how a three-valve set of the familiar HF detector and LF kind would fare. As I expected, all of these transmissions are well within its range at any time.

The Demand for Alternatives

It seems to me that the desire for a greater choice of programmes from the home stations is not only widely felt, but completely justified. Germany was perhaps the first country whose broadcasting authorities cast off the shackles of the crystal complex. If you look through the German programmes for any day you will find that though stations relay certain important items from one another, all of the big ones do in the main give programmes of their own. In France there are probably more crystal sets in use than in any other European country—the number was stated in recent official figures to be about a quarter of a million. Yet the French authorities don't hesitate to transmit many alternatives in the P.T.T. programmes. I am sure that a larger number of "individual" programmes from our own stations would be much appreciated; but it must not be forgotten that there is one rather important objection. Provincial listeners have the firm idea that the London programmes have most money lavished upon them and are therefore the best. Whether I travel east, west or north I always find amongst listeners this demand for London. There are many places in which the London Regional is not well received, and in these there is a strong feeling that the local should relay London. This difficulty might be surmounted by making the London programme the National programme and radiating it from Droitwich and the present National stations. Local programmes could then be given by the present Regionals.



"ULTRA SHORTS" AT B.I.F. An Epoch 5-metre 'phone transmitter-receiver at the British Industries Fair, Shepherd's Bush. Compactness and simplicity are leading features of this handy little equipment, which has a range of 20 miles under favourable conditions.

Wireless in the Wilds

ONE of the most interesting wireless exhibits at the Olympia section of the British Industries Fair is the little Transceiver, designed by Mr. E. W. Harris, a British amateur experimenter. A tiny combined transmitter and receiver of this kind was described in detail some time ago in the *Wireless World*. It makes use of an ultra-short wavelength in the neighbourhood of 5 metres and a range of 20 miles or so is claimed for it. Mr. Harris believes that it may be of the greatest use to those who live in places where communications are difficult. It may, in fact, come to replace the native runner for emergency messages. There are many "jungley" parts of the world where wireless has already shown what it can do in this way. In Sarawak, for instance, it used to take a pretty long while to get messages from the capital to outlying towns and villages, which are often served by "roads" that are mere paths cut through the forests. When the telephone was tried it worked for a while—until the natives discovered that as much copper wire as they wanted was there for the snipping. Now wireless is regularly used with excellent results. The Transceiver may prove equally useful in smaller areas.

This Week's Find

WHILST perusing the other day an account in one of the lay papers of the Octophone, that remarkable instrument which enables the blind to read printed books, I was moved to mirth by finding that "A ray of light, working on the solignum principle, passes under the lines of type, and as it touches each letter the sound for that letter is made."

As wireless folk have long known, the best method of keeping aerial masts free from rot is to give them a good dressing of selenium. There is, however, no known means of producing the same result in the writings of the lay reporter who tackles wireless and kindred subjects.

HINTS and TIPS

Practical Aids to Better Reception

Improvised Valve Holders

COMPACT valve holders for sub-baseboard mounting, as commonly used for light-weight portable receivers (such as the Three-in-One recently described) are not always readily obtainable. A correspondent reminds us that in such cases a very satisfactory substitute can be devised from an old-type anti-microphonic holder.

These holders are generally built up in the manner indicated in Fig. 1, where the external moulding, which for our present purpose is discarded, is shown in dotted lines.

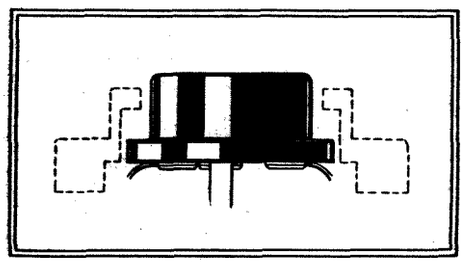


Fig. 1.—The central portion of an old-type anti-microphone valve holder may be used for sub-baseboard mounting.

The flange of the central portion should be secured to the underside of the baseboard by means of small screws, but it is usually so narrow that the drilling of the necessary holes may be found difficult. If so, it will be permissible to adopt the alternative plan of securing the holder in position by means of small clips made from the metal stops originally employed in the construction of the holder.

A Misleading Click

A PAIR of discarded headphones and a dry cell are still widely used for testing through high-resistance circuits. As is well known, continuity through a metallic circuit is indicated by a decided "click," of which the intensity varies inversely with the amount of resistance in the circuit. Similar "clicks" are heard when testing through a condenser, but, if everything is in order, no sound is heard on interrupting the test circuit in this case.

Bearing these facts in mind, it is easy to see that misleading results may sometimes be obtained when testing through a fine wire winding such as that of an LF transformer, smoothing choke, field coil, etc. Even though the winding may be broken, a "click" may be heard, due to the flow of charging current into the capacity existing between the two halves of the broken winding. However, one soon learns to differentiate between the "capacity click" and the "continuity click."

In certain cases these peculiarities of headphone testing may be turned to good account when dealing with fine wire windings of the kinds already mentioned. It is by no means unusual to find that such windings develop faults near their extreme ends, sometimes at the points where the main winding is joined to the lead-out wires, or sometimes at the terminals themselves. Faults in these positions may well be revealed by the total absence of any "capacity click," and an indication is then given that it may possibly be quite a simple matter to effect a repair. On the other hand, a strong "capacity click" shows fairly conclusively that a break exists in the middle of the winding.

Earthing Screened Leads

WHEN screened leads are used to prevent interaction between HF circuits, it is obviously necessary that the metallic braiding which covers the wire should be carefully earthed. In point of fact, this question of earthing is of great importance, and in certain cases it is necessary to earth the braiding at both ends; further, the actual point at which the connection is made may have some bearing on stability.

With regard to the details of the connection, the usual plan is to wrap the end of a length of tinned copper wire around the braiding and then to solder the joint. Considering the relatively low voltages that are employed in broadcast receivers it is rather surprising that joints made in this way often give rise to trouble. It would appear that quite a small amount of heat is enough to impair the insulating properties of the sleeving beneath the metal braiding and so to pave the way for a complete breakdown of insulation. But if the joint is not soldered there is always the possibility that a high resistance contact will develop.

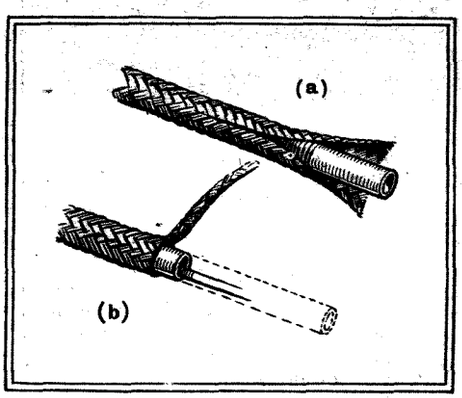


Fig. 2.—An earthing pigtail on screened sleeving.

A commonly used method of avoiding the need for the application of heat is indicated in Fig. 2. The first step is to cut along the braiding with a pair of scissors in the manner shown in diagram *a*, and then to twist the end into a pigtail for connection to the earthing joint (diagram *b*).

This method is not always satisfactory, for the reason that the braiding tends to become unravelled. A better method is illustrated in Fig. 3. The procedure is to employ a piece of braiding about 2in. longer than the wire it is to cover, and, by means of some pointed tool, to open out a hole through which the end of the insulated wire may be forced. The projecting end of the braiding is then twisted into a pigtail as before.

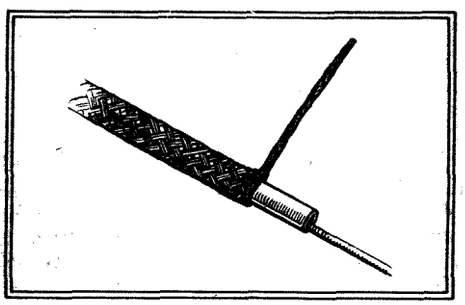


Fig. 3.—The best way of making an earthing connection on a screened lead.

Microphone Amplification

ANY broadcast receiver fitted with pick-up terminals is theoretically capable of acting as a microphone amplifier. But in practice the ordinary set gives hardly enough amplification for full output when used with a microphone of average sensitivity. This applies especially to microphones of good frequency characteristics, for the general rule is that such instruments give relatively low outputs.

More often than not an extra stage of amplification will be needed for really satisfactory results, and it is the purpose of this note to suggest that if the microphone is to be used intermittently and for short periods, the extra amplifier might well be battery operated, even though the set with which it is worked is driven from the mains. Here is a case where dry-cell LT is likely to be entirely satisfactory.

No great amount of amplification will ordinarily be needed, and so current consumption will be so low that the expense of an independent mains unit would not be justified. Of course, current might in many cases be obtained from the power supply circuits of the set itself, but this plan would involve internal alterations and would introduce serious risk of undesirable interaction.

BROADCAST BREVITIES

By Our Special Correspondent

Chaos at the Palace

AT the moment the scene in the Alexandra Palace television studios "baffles description," so I will proceed to describe it.

When I visited the Palace last week my chief concern was not so much to see what work had been accomplished as to avoid tripping up over scaffolding poles and falling into pools of liquid concrete.

Rooms with a View

The floors of the studios have been laid but, in the main, the whole "television" wing of the Palace is a mere shell. The offices, which will occupy the tower, will at any rate be delightful in summer for members of the staff, for the windows command extensive views over the countryside.

The room which will house the "electric eyes" seemed somewhat small. Little windows cut through the brick and mortar look down on to the main television studio.

The Canteen

The canteen is still in a dilapidated state, but I understand that it is to become one of the best restaurants in the London area — much more attractive than the "grub dungeon" at Broadcasting House, though considerably smaller.

Lofty Studios

It is clear that the B.B.C. is concentrating on making the studios the most attractive part of the building, as these are really lofty apartments. Unfortunately, the columns supporting the joists are something of an eyesore, but these cannot be moved without endangering the structure; even B.B.C. authority is not strong enough to maintain an unsupported roof.

Crossing the Hall

By the way, members of the public who visit the Palace will not have to peep behind the scenes for diverting entertainment. The old theatre which has been taken over for television shows is separated from the new studios and dressing rooms, and in order to get from one to the other the artistes will have to cross one of the public halls. Bathing machines, sedan chairs, or outsize dressing gowns seem to be indicated.

New "B.H." for Belfast

CONTRACTS are about to be signed for a new "Broadcasting House" for Belfast. Unlike most of the other provincial centres, Belfast is not to be fobbed off with a second-hand building, for the new premises really will be new. I understand that leading architects will be invited to submit plans.

Bombshell for Sir Stephen Tallents

ALL Fleet Street is smiling grimly at last week's leakage of news concerning the B.B.C.'s Dance Band plans. At the Press Conference on Tuesday, February 10th, Sir Stephen Tallents and Mr. Eric Maschwitz declined point blank to inform the assembled journalists what these plans were, explaining that they were reserved for publication in the *Radio Times* of March 6th.

Their publication in the daily Press on February 17th has prompted all kinds of conjectures as to who had the temerity to undermine the authority of Sir Stephen Tallents in this blatant manner.

The Plans

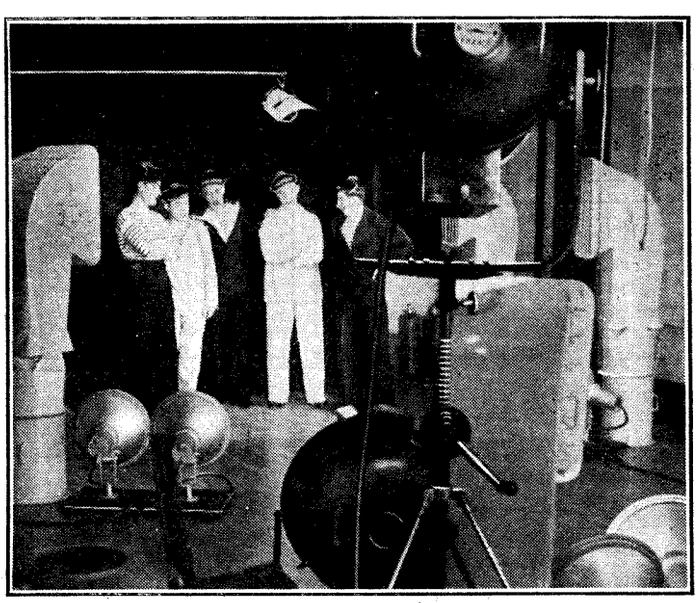
Not that the plans themselves are of such breath-taking importance. What they boil down to is that the late dance sessions are to end at 11.30 instead of midnight in the Regional programme, the last half hour being devoted to a repeat summary of the Second News, followed by a short programme "of general interest." The arrangement comes into force on March 30th, when, for example, this late feature consists of a harpsicord recital by John Ticehurst. On the Tuesday there is a gramophone recital, and on the Wednesday a piano recital by John Hunt. Thursday's late night feature is a reading.

Mid-evening Dance Features

The other change in the programme arrangements will be the introduction of mid-evening dance band sessions on either the National or Regional wavelengths at intervals between 6.30 and 10.20.

The idea is to enable the B.B.C. to broadcast several well-known bands which are prevented for one reason or another from appearing before the microphone after 10.30.

It is emphasised that the new plans are quite "experimental," though they may continue in force indefinitely.



TELEVISING THE "TARS."—A photograph specially taken in the Eiffel Tower studio a few days ago during a nautical act. Owing to the fierce heat of the arc lights it is necessary to maintain a constant stream of conditioned air from the ventilators on each side of the "set."

Unbelievable Organ Effects

THE "Electrone" unit, described in *The Wireless World* of May 24th last, is, I hear, to be incorporated in the B.B.C.'s gigantic new cinema organ in St. George's Hall. This unique thermionic organ produces its notes by means of electro-magnetic pick-ups applied to continuously revolving discs on which varying waveforms have been engraved in metal.

By momentary slowing up of the discs, glissando effects are produced which make the average "Reginald" (i.e., cinema organist) exclaim: "I don't believe it!"

Tact

EVENING visitors might take a hint from Aberdeen's most tactful minister, who, according to the *Evening Express*, heard a wireless set working as he approached the dwelling of one of his parishioners.

Harkening for a moment, he realised that the family was listening to a religious service broadcast from Edinburgh, so, instead of calling, he dropped his visiting card in the letter box and "silently walked away."

A Bad Mix

NO one will quarrel with the B.B.C. for deciding that, owing to its popularity, the Sunday morning broadcast service is in future to be preceded by the sound of bells or an organ from 9.25 to 9.30 a.m. But the Corporation unblushingly states that the announcement describing the service to follow "will be superimposed on the bells or organ voluntary."

In the name of suffering mike, why?

Unwanted Melodies

Again and again it has been shown that speech and music are mutually antagonistic in their claims for listeners' attention. The musical listener is unable to exclude the concord of sweet sounds, consequently he pays scant heed to the talk; the non-musical listener is all ears for the words, so the music is superfluous anyway.

Musical Background for Talks ?

But if the B.B.C. really does wish to develop this queer form of microphone presentation, let it go the whole hog. Because talks have been broadcast for fourteen years without musical accompaniment, this is no reason why the cult of the "musical background" should not be exploited now; perhaps a start could be made with news bulletins.

With a little practice the news announcer could easily control the output of a four-channel gramophone turntable, fading in the "Ride of the Valkyries" as a seething background to earthquake and flood items, changing over to "Blues" or rumbas for the Parliamentary reports, and so on.

Recent Inventions

The following abstracts are prepared, with the permission of the Controller of H.M. Stationery Office, from Specifications obtainable at the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each

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

D.F. AERIALS

IN the Adcock type of aerial, as developed for direction finding, vertically polarised waves are received on a pair of upright aerials, which are spaced apart and connected by horizontal leads which are intended to balance-out any horizontally polarised component that may be present.

In practice, however, it is difficult to eliminate altogether the effect of the undesired horizontal wave, and the present invention aims to secure this result (*a*) by providing a balancing-out coupling between the horizontal leads and the vertical aerials, or (*b*) by using an auxiliary frame-aerial in which the horizontal waves produce an EMF of equal value but opposite sign to the undesired voltage induced in the main aerial system.

R. H. Barfield and L. H. Bainbridge-Bell. Application date 26th May, 1934. No. 438900.

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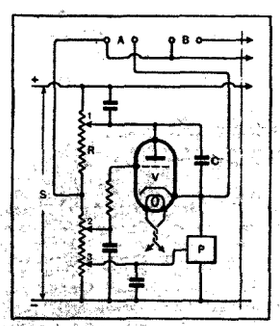
TIME-BASE CIRCUITS

IN a cathode-ray television receiver the terminal points of the scanning spot should occupy definite positions on the fluorescent screen, preferably on the edges. Usually this requires some adjustment as regards both ends of the traverse, say by altering the range of variation of the field applied across both pairs of deflecting-electrodes. But since the latter are set fairly close together, it is also necessary to prevent the electrodes from drawing current from the beam, and so setting-up voltages which tend to distort the picture.



Circuit for cathode-ray time base.

The circuit shown is designed to overcome this difficulty. The two pairs of deflecting plates A, B of the cathode-ray tube are fed with saw-toothed oscillations from a gas-filled valve V, which periodically discharges a condenser C when triggered by the synchronizing-signal. The condenser is charged through a pentode P from the source marked S, which is shunted by a resistance with variable tappings 1, 2, 3. The tapping 1 adjusts the voltage fed to the plates A, and therefore the position of the electron beam. Tapping 2 determines the point at which the discharge starts, and 3 the current flowing through the pentode or limiter valve P. A second similar circuit (not shown) feeds the plates B.

General Electric Co., Ltd., and L. C. Jesty. Application date July 24th, 1934. No. 438386.

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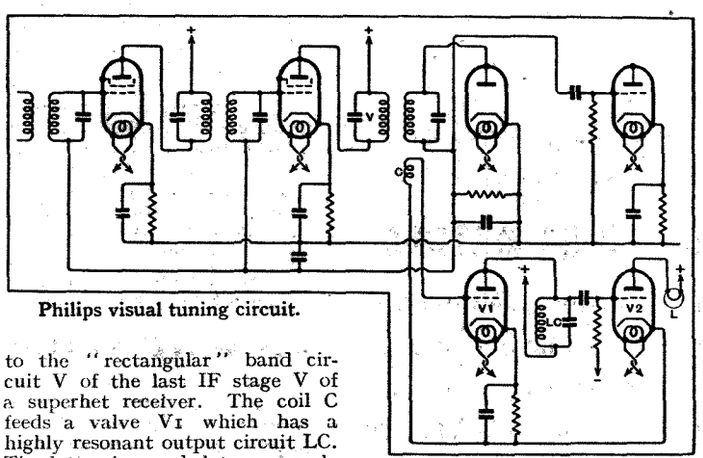
VISUAL TUNING

IF an ammeter or a tuning glow-lamp is inserted in the anode circuit of one of the HF or IF valves of a superhet, it will only operate satisfactorily if the resonance curve of the amplifier is peaked. But for high-quality reproduction it is desirable for the resonance curve to have more of a rectangular shape, so that the tuning-device is accordingly handicapped.

To avoid this difficulty, the voltage for the indicator lamp L is derived from a coil C coupled to the "rectangular" band circuit V of the last IF stage V of a superhet receiver. The coil C feeds a valve V1 which has a highly resonant output circuit LC. The latter is coupled to an anode rectifying-valve V2, which, in turn, supplies the lamp.



Philips visual tuning circuit.

N. V. Philips Gloeilampenfabrieken. Convention date (Holland) July 2, 1934. No. 438255.

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SUPPRESSING "IMAGE" FREQUENCIES

SECOND-BEAT or "image" frequencies are eliminated from a superhet receiver by interposing a suppressor circuit between the HF amplifier and the frequency-changing stage. The suppressor consists of an inductance and capacity tuned in series to the undesired frequency. Both are shunted by a condenser which is adjusted until the circuit as a whole is resonant to the desired frequency. The two condensers of the suppressor are ganged to the main tuning-control of the set.

H. Chireix (assignor to Cie Générale de T.S.F.). No. 2005772. (U.S.A.)

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SIGNALLING SYSTEM

HIGH-FREQUENCY currents, modulated with signals for transmission, are applied to a piezo-crystal oscillator, which is mounted in a concrete block below the earth's surface. The crystal radiates compressional waves through the substance of the earth. These are picked up at distant points by similar crystals which may be embedded in the earth, or mounted on a concrete "mat," and are coupled to valve amplifiers. The system may be used to give directional reception over predetermined strata, or to give selective reception over areas having certain geological characteristics.

A. McL. Nicolson (assignor to Communication Patents Inc.). No. 2007211. (U.S.A.)

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BEACON STATIONS

A ROTATING-BEAM transmitter for air-navigation consists of a number of crossed loops energised with a constant carrier-frequency, but with different tone frequencies, so as to radiate a heart-shaped "field" which will give a characteristic "course" for any selected point of the compass. The speed of rotation of the directed field depends upon the rate at which the amplitude of the carrier frequency in the several aerials is varied.

C. W. Hansell (assignor to Radio Corporation of America). No. 2014732. (U.S.A.)

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HORIZONTAL AERIALS

TO secure uniform radiation in all directions, four half-wave aerials are arranged to form a square in the horizontal plane. They are insulated from each other at the corners. A double feed-line is stretched across one of the diagonals of the square, and energises the aerials in pairs.

M. Gouriaud (assignor to Cie Générale de T.S.F.). No. 2017121. (U.S.A.)

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TELEVISION SYSTEMS

DRAMATIC effects may be produced in television by causing gradual changes to take place in a part only of what may be termed the general background. For instance, a "ghost" may be shown flitting over an otherwise stationary scene. Or the features of a person's face may be gradually changed to represent extreme old age, or to show the effects of disease. Or the thoughts of an actor may be presented as varying "insets" on the main picture.

The invention is concerned with methods of scanning, either by spot-light or flood-lighting, designed to embody "complex" scenes of the kind indicated.

J. C. Wilson and Baird Television, Ltd. Application date 18th June, 1934. No. 438533.

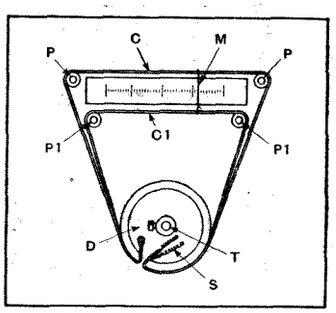

Diagram of tuning dial.

TUNING DIAL

THE tuning-indicator consists of a marker M fastened between two cords C, C1, which are mounted on upper and lower pulleys P, P1, and are driven by the tuning shaft T through a slow-motion drum D so that they travel at the same speed across the face of the indicator scale. The driving cords are tensioned by two end springs S anchored to the drum D, as shown.

General Electric Co., Ltd., and W. H. Peters. Application date 20th September, 1934. No. 438628.

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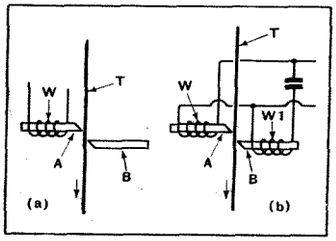
MAGNETIC RIBBON-RECORDERS

WHEN signals are impressed on a metal tape by means of two opposed pole-pieces, it is found that the lower frequencies are inclined to be over-accentuated at the expense of the high notes.

To overcome this defect two "chiselled" pole-recorders A, B are arranged, one on each side of the tape T, and one is placed slightly in advance of the other in the direction of tape movement. The winding W which carries the signal currents is applied only to the pole A, though an auxiliary winding W1, as shown in Fig. (a), may also be applied to the pole B in order to emphasise the higher notes. The amount of "stagger" or displacement between the two poles A, B is adjusted until a straight-line response is secured.



Magnetic recorder device.

Marconi's Wireless Telegraph Co., Ltd., N. M. Rust, and C. J. F. Tweed. Application date May 28th, 1934. No. 439179.