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Television Demonstrations

Need for Propaganda

NOW that daily television test transmissions are taking place and we are only about a month from the date when it is proposed that the B.B.C. shall commence regular experimental television programmes, it is pertinent to ask what is being done to ensure that the public will have ample opportunities for seeing what is being done.

It may be assumed that dealers in different parts of London and the outskirts, as well as the large stores, will arrange to have television sets installed so that they can demonstrate to prospective purchasers. But this, although useful is not enough, because many people hesitate to enter a dealer's premises unless they have some intention of purchasing. Arrangements must, we feel, be made so that the public can see television demonstrations without any obligation, and to do this it seems necessary that reception points should be arranged by bodies not directly interested in the sale of particular television receivers.

Publicity Committee

One suggestion would be that a Television Publicity Committee might be formed jointly by those manufacturers who will market television sets to arrange for public demonstration rooms on the lines of the combined effort which made possible the recent television demonstrations at Olympia in connection with the Radio Show.

A year ago we said: "We hope arrangements will be made in good time so that when the transmissions start the public will be able to attend demonstrations in all parts of the service area of the station without difficulty." We believe that to-day it is still most important that these facilities should be available, since a foretaste of television has been given at Olympia. There is nothing to gain by a delay until we find out how much interest the public displays in something they have no means of seeing for themselves.

It cannot be expected that members of the public in large numbers will put down nearly a hundred pounds for a television receiver until they are reasonably satisfied as to the type of programme and entertainment which is to be offered to them.

The technical perfection and ultimate success of television must depend upon a sufficiency of sales of receivers to provide the means for meeting development expenses. The firms which are now working on the subject are expending very large sums of money, and their return will be in proportion to sales.

If the B.B.C. programmes fail to attract, sales of sets will be small and technical development will be retarded, if not stopped altogether.

It is fortunate that, in this country, the B.B.C. can put out the programmes without being concerned with the question of direct financial return. In America, as we have pointed out before, the fact that programmes are sponsored by advertisers means that television transmissions are not likely to start until the advertisers can be guaranteed a large enough "audience" of lookers-in in possession of sets—a situation which seems to promise a complete deadlock, unless manufacturers themselves are prepared to shoulder the burden of programme expenses until an audience has been created.

Parallel Wires as RF Transformers

A PRACTICAL METHOD OF MATCHING FEEDER AND AERIAL

By F. R. W. STRAFFORD

(Research Dept., Belling and Lee, Ltd.)

AS the author of this article points out, the physical size of wave aerials used at television frequencies is so small that most experimenters have facilities for installing them. The use of a pair of parallel wires as a coupling transformer for linking such aerials to a feeder line is described.

IT may come as a shock to the technically complacent to learn that it is not necessary to visualise a compact coil arrangement for radio-frequency transformers. At frequencies from 30 megacycles (10 metres wavelength) upwards it is a practical proposition to erect an aerial whose lead-in system is impedance-matched by means of a transformer comprising a pair of parallel wires.

When it is practicable to erect aerials whose dimensions are not less than one-quarter of the wavelength to be received a fairly new technique in aerials and their correct impedance termination is introduced. A vertical wire approximately 3.5 metres in physical length erected well clear of the earth and other conductive surroundings will resonate sharply under the influence of a signal of which the wavelength is 7 metres. This half-wave dipole, as it is called, is highly efficient at this particular wavelength and could not be improved upon by an inverted L of maximum Post Office dimensions.

The efficiency of a half-wave dipole, however, falls off very rapidly at wavelengths above and below that of the resonant condition, but this is a useful behaviour in that it reduces the strength of unwanted interference mainly located at other wavelengths. Naturally one has in mind the specific use of such a dipole at the television wavelengths, which are close enough together to enable one dipole to work efficiently on both the sound and vision wavelengths respectively. Fig. 1 depicts a simple vertical half-wave dipole (heavy line). When influenced by signalling waves of twice its linear dimension of length the dipole resonates sharply and standing waves of voltage and current are produced along it. One of the dotted lines shows the variation of HF voltage amplitude along the dipole, indicating that it is a minimum at the centre and maximum at either extremity, and in instantaneous phase opposition at any equidistant point from the centre. The other dotted line shows the current amplitude distribution, which is maximum at the centre of the dipole and falls substantially to zero at the two extremities.

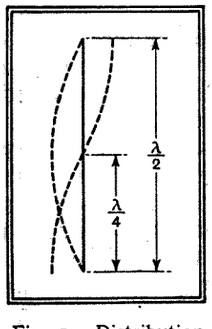

Fig. 1.—Distribution of current and voltage in a dipole aerial.

It may be proved mathematically that the impedance at the centre of a half-wave dipole remote from earth is approximately 73 ohms, but this value is liable to considerable variation when the dipole is closer than one half-wavelength to a highly conductive earth. This value of centre impedance is termed the radiation resistance of the dipole, and it is this value multiplied by the square of the current at the centre of the dipole which represents the amount of HF energy which is being dissipated in the dipole.

In order to couple a half-wave dipole to a receiver or transmitter (the technique for either is similar) it is at once clear that the impedance of the dipole must be appropriately matched to the coupling networks if maximum transference of energy is to be obtained between the aerial and the receiver. Such a system, moreover, must exert no influence upon the dipole as such, and must therefore be incapable of acting as an aerial itself. An ordinary single wire lead-in will not fulfil these requirements with half-wave dipoles, but the transmission line will.

A transmission line, perhaps better known as a feeder, consists of a pair of conducting wires of uniform cross-sectional area and spacing, insulated from one another by suitable means. Two types of feeders are in general use. There is the open wire type, consisting of two parallel wires (Fig. 2*a*) of 14-2 SWG copper wire spaced at anything from one to ten inches apart. The other type is known as the co-axial feeder (Fig. 2*b*), and consists of a wire or rod running through the centre of a metal tube and supported therein by suitable insulating spacers. Basically there is no difference in the properties of either type excepting that certain electrical characteristics are more easily obtained in one than in the other according to certain requirements which will be discussed later.

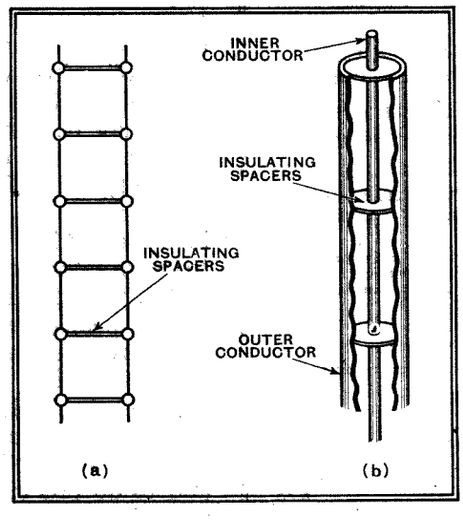

Fig. 2.—Alternative types of feeder for linking an aerial with its associated apparatus.

Now while the feeders depicted in Fig. 2*a* and Fig. 2*b* are of simple physical construction their equivalent electrical network and subsequent behaviour to alternating potentials applied at one end is extremely complex. Fig. 3*a* shows that such a feeder may be represented as an equivalent filter network in which L and R are the series inductance and resistance per unit length of the conductor, M is the mutual coupling between L, while C and R are the parallel capacity and leakage resistances between the conductors per unit length.

When an alternating EMF is applied across one end of a feeder it is thus quite obvious that the same amplitude of EMF is unlikely to appear across a valve voltmeter at the other extremity, particularly if such a feeder is, say, 1,000 feet in length and the frequency of the applied EMF is as high as, say, 50 megacycles (6 metres). Each condenser is charged and discharged across R, and through its neighbouring L, R and C, so that one must visualise a wave of EMF surging along the

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line at some finite speed. An interesting experiment which clearly indicates the behaviour of feeders whose length is greater than the wavelengths of applied EMF's may be conducted by using the circuit arrangement in Fig. 3*b*. A number of flashlamp bulbs of equal rating are placed at random distances along the

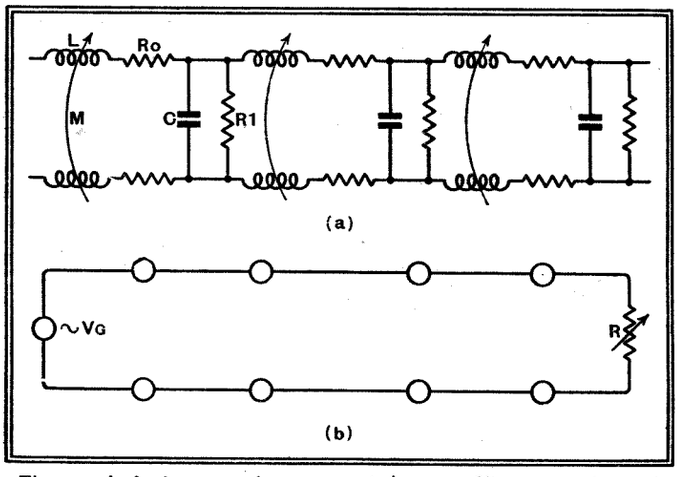

Fig. 3.—A feeder may be represented as a filter network, as in diagram (*a*). Diagram (*b*) in which the circles represent flashlamp bulbs inserted in the lines, shows a method of experimentally determining the behaviour of a feeder.

feeder, which must be long compared with the wavelengths of the oscillations from the generator Vg. These bulbs must, however, be opposite in pairs. The resistance R must be substantially non-reactive and variable between 50 and 1,000 ohms. The feeder wires should be about 20 SWG copper wire spaced approximately four inches apart. With R set to 1,000 ohms the output of Vg is adjusted until the lamps glow.

Indication of Matching

It will then be noted that while opposite pairs of lamps glow with uniform brightness there is quite a random distribution of brightness along the line. For example, a pair of lamps in the centre of the line may be dimly glowing, while pairs situated at either extremity may be glowing brightly. It is quite obvious that the current through the feeder is by no means uniform throughout its length. If the resistance R is now reduced slowly a critical value will be found at which all lamps glow at approximately equal brilliance, there being a slight but progressive diminution of intensity as the distance from the generator increases. Under this condition of resistance termination to the feeder is said to be non-reflecting and matched to the load resistances. It may be shown mathematically that the value of this resistance is very nearly equal to $\sqrt{\frac{L}{C}}$ of the feeder, Fig. 3*a*. This value is termed the surge impedance or characteristic impedance of the feeder. Naturally this varies with the linear dimensions of the feeders, so that there is a correct value of terminating impedance for every feeder such that this value is equal to the surge impedance of the feeder. Under these conditions the current flows uniformly down the feeders with a slight but progressive diminution in intensity which depends mainly upon R, and the frequency of the EMF it is desired to transmit. Naturally as R becomes lower and the frequency higher the attenuation constant for the feeder becomes greater. It is possible, however, to design an open-wire feeder to have an attenuation of less than 1 decibel per hundred feet of length at 6 metres (50 megacycles), while the same value may be obtained with co-axial feeders by very careful design. In general, the attenuation per unit length of a co-axial feeder will be greater than that of the open-wire type.

The value of the surge impedance Z_o of any feeder which is air spaced may readily be calculated from the formula:—

$Z_o = 276 \log_{10} \frac{d}{r}$ ohms for the open-wire type.

$Z_o = 138 \log_{10} \frac{r_2}{r_1}$ ohms for the co-axial type.

Where

d = Distance between wires.
r = Radius of wires.
r_1 = Radius of inner conductor.
r_2 = Radius of outer conductor.

It will be found impracticable to construct an open-wire feeder with a surge impedance of less than 100 ohms, and it is here that the co-axial feeder may be substituted, since surge impedances ranging from 20 to 100 ohms may be obtained with comparative ease of design. An additional advantage of the co-axial feeder is that its outer cover may be earthed to prevent electrical shocks, or the whole feeder may be completely buried, a useful property in the case of long-distance lines.

Having discussed the half-wave dipole and the feeder as separate entities, it now remains to consider how the two may be associated so that a correct impedance matching results, and at the same time the properties of the dipole are not destroyed.

If a feeder whose surge impedance is 73 ohms is connected in the centre of a half-wave dipole (Fig. 4*a*), a perfect match results, since it was pointed out earlier that this is the radiation resistance of a half-wave dipole remote from conductive surroundings.

This type of aerial is known as a doublet, and is extremely effective in either the vertical or horizontal position at the wavelength for which it is designed. A piece of tightly twisted lamp flex may be used for the feeder, since its surge impedance is in the region of 73 ohms, although mostly on the high side, depending largely upon the dielectric constant of the insulating material being greater than unity (assumed for other calculations), and the inductance per unit length is a function of the twisting of the conductors as they overlap. The value must, therefore, be measured by the use of suitable inductance and capacity bridges.

High-Impedance Feeder

Fig. 4*b* shows the mode of connection for a feeder whose surge impedance is greater than 73 ohms (e.g., 400 ohms). In this case it must be connected between two points equidistant from the centre of the dipole at which the impedance is equal to that of the feeder. These points are best established experimentally by exciting the aerial by an oscillator and placing two flashlamp bulbs one-quarter wavelength apart in any one conductor of the feeder. The tapping on the dipole is then adjusted so that the lamps glow with equal brilliance, in which case the matching is correct and the feeder is thus correctly terminated.

Although it has been stated that the presence of a correctly matched feeder does not influence the proper functioning of a dipole, this is only strictly true if the feeder is taken away at right angles to the dipole for some distance not less than one-half wavelength. If the feeder is arranged so that it runs parallel with the dipole, and

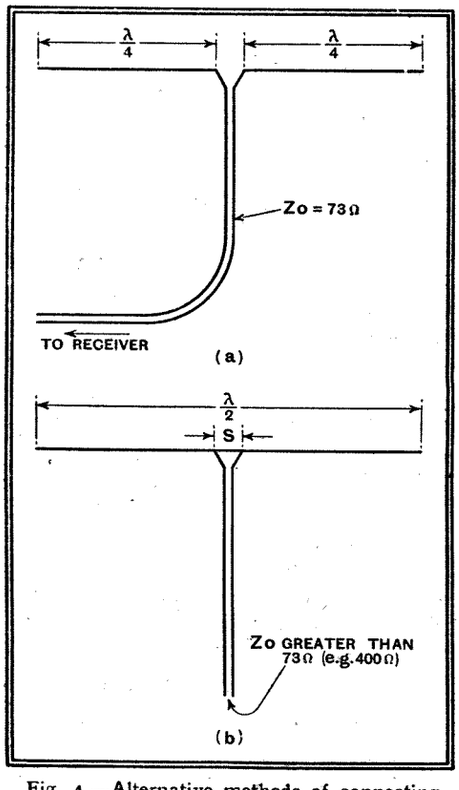

Fig. 4.—Alternative methods of connecting a feeder.

is closer than one-quarter wavelength to it, there is a possibility of endowing the dipole with marked directional effects and also possible difficulties in the way of obtaining a precise impedance match.

The foregoing has dealt with dipoles and

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feeders generally in which the impedance matching of the two has been carried out without the use of transformers, but by connecting the feeder at or near the centre of the dipole.

Supposing that it is inconvenient from a structural viewpoint to connect the feeder to the centre of a typical half-wave dipole erected vertically in a garden. The end of the dipole presents an impedance of approximately 5,000 ohms at either end at 7 metres, assuming that a substantial gauge of copper wire is used and the aerial is well insulated from supporting ropes, etc. It will be found a practical impossibility to construct a feeder with a surge impedance of 5,000 ohms, so that recourse to some transformer scheme must be made, whereby a low-impedance line may be accurately matched to the end of a half-wave dipole. Take, for example, a typical case of a 75-ohm co-axial feeder which is buried for the length of the garden, and which is to terminate on the lower end of a half-wave vertical dipole suspended above it. It is a case of matching 75 ohms to 5,000 ohms without introducing any factor to influence the performance of the dipole in an adverse manner.

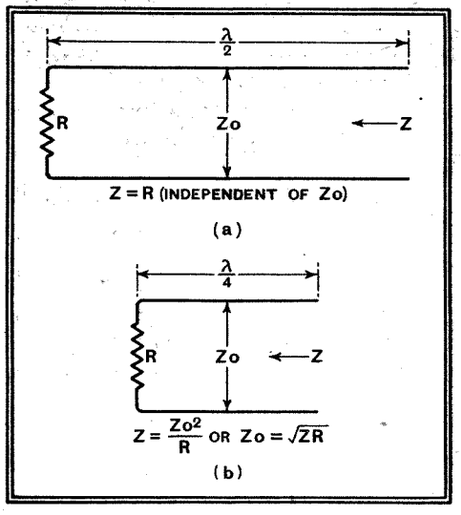


Fig. 5.—Half-wave and quarter-wave feeders.

An appropriate matching may be made by means of an additional feeder of certain length and characteristic impedance. This feeder is termed a quarter-wave transformer, and is highly efficient at the one wavelength for which it is designed.

Before dealing with this type of transformer, reference must be made to Figs. 5*a* and 5*b*, in which feeders are accurately cut to one-half and one-quarter wavelength respectively. R is the terminating load, which is 5,000 ohms in the case of the vertical dipole contemplated. Z_o is the characteristic impedance of the feeder, while Z is the impedance which must be placed at the other extremity of the feeder to ensure correct matching to the load R. In the case of the half-wave feeder, Fig. 5*a*, it can be proved that Z is entirely independent of R, so that in the case of a doublet aerial it does not matter what type of feeder is used providing its length is the same as that of the doublet itself,

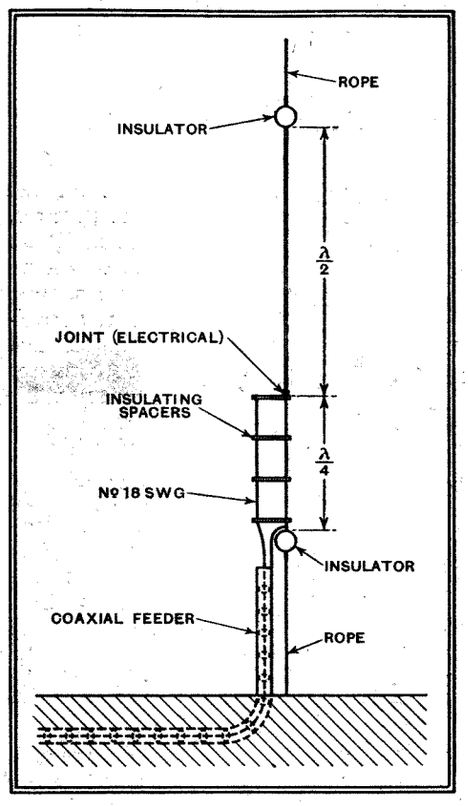


Fig. 6.—Practical arrangement of a system of linkage in which a quarter-wave parallel-wire feeder is used as a coupling.

namely, $\lambda/2$. Fig. 5*b* is far more interesting. The correct impedance Z is now in function of Z_o and R, so that if Z and R are fixed it is merely necessary to obtain Z_o from the formulæ shown in order to obtain the correct matching.

In the case considered, R is 5,000 ohms and Z is 75 ohms. For this formula Z_o = 610 ohms. From the original formula for Z_o, the surge impedance of open wires, it is found that a value of 610 ohms may be obtained by the use of two wires of 18 SWG spaced four inches apart.

Fig. 6 is the structural arrangement for carrying the proposals into effect, and by which a 75-ohm co-axial feeder is correctly matched to a half-wave dipole at the 5,000-ohm impedance point for maximum efficiency on 7 metres.

The method of matching by means of quarter-wave feeders is well known and used by certain communication companies in their transmitting aerial arrangements for short-wave work from 10 metres upwards, but a wide field of experimental aspect at the television frequencies is open to those who possess an average garden, since the dimensions are such that simple structures may be easily erected.

Notes on Contrast Expansion

IN the above article, published in *The Wireless World* of September 18th, the paragraph at the foot of col. 2 should begin "We can now call *minimum* desired attentuation A1 and *maximum* A2 . . . "

Similar transpositions took place in col. 3, where line 11 should read "Taking A1 (*maximum* volume) . . ." and line 24, "Taking A2 (*minimum* volume), *maximum* attenuation. . . ."

For the Short-wave Enthusiast

Short Wave Wireless Communication (Third Edition). By A. W. Ladner, A.M.I.C.E., and C. R. Stoner, B.Sc., A.M.I.E.E. Pp. 453+xiv, 11 plates and 248 other illustrations. Chapman and Hall, Ltd., 11, Henrietta Street, London, W.C.2. Price 21s.

TO those who have not seen either of the two earlier editions this volume may justifiably be introduced as the standard British textbook on the subject. And when it is described as a textbook this must not be allowed to call up visions of academic theory set down by out-of-the-world professors. Though the authors are teachers, they are practical engineers, and their work tackles the subject from this standpoint, only the necessary theory being included.

The previous editions have been revised and enlarged to the extent of 70 pages, including an entirely new chapter on commercial wireless telephone circuits. There is a brief history of short-wave work, a concise treatment of wave theory, and chapters on modulation, push-pull, constant-frequency oscillators, high-frequency feeders, aerials, and other aspects of transmission and reception. Ultra-short waves receive special attention in a final chapter, and there are several appendices containing useful data.

Although the book is presumably intended primarily for engineers and students, it should be possessed by every amateur seriously interested in the subject. Incidentally, the authors pay a tribute to the pioneer work of amateurs in demonstrating the possibilities of short waves.

There is a great amount of eminently clear and practical guidance for those concerned with transmission, to which the major part of the book is devoted. Detailed information about receivers, which is abundantly available elsewhere, should not be sought here, but the chapters on feeders and aerials are particularly valuable for reception as well as transmission, and the chapter on propagation should be carefully studied for enlightenment on the peculiar behaviour of waves of various lengths. A short description of the "Single Span" type of receiver is included.

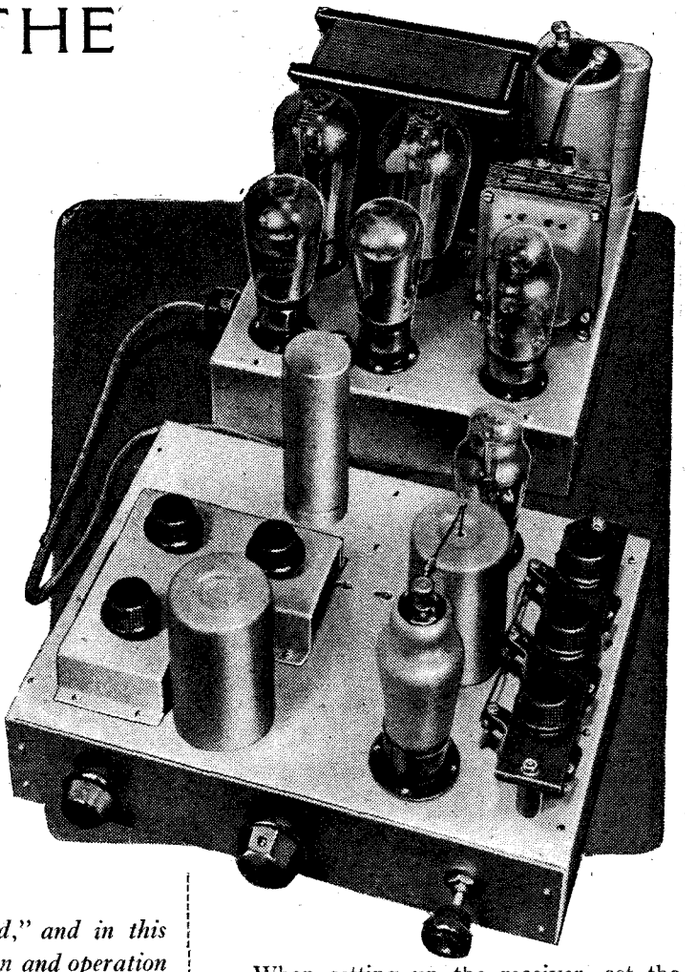
In such a rapidly developing field as this it is inevitable that some of the latest results are missing from even a newly published book, but there seems little excuse for the war-time V24 to be represented as the last word in low-capacity valve construction, when the vastly superior "acorn" has been "out" for a year or two. On the whole, however, the work is up to date, and the further editions that will unquestionably be demanded will no doubt keep it so.

M. G. S.

Motor Cycles and How to Manage Them. Twenty-sixth Edition, 272 pp. Price 2s. 6d. net, by post 2s. 10d. Iliffe & Sons, Ltd., Dorset House, Stamford Street, S.E.1.

The twenty-sixth edition of this book has now made its appearance and deals with all aspects of motor cycling in an extremely lucid style. "Motor Cycles and How to Manage Them" should be invaluable to all enthusiasts.

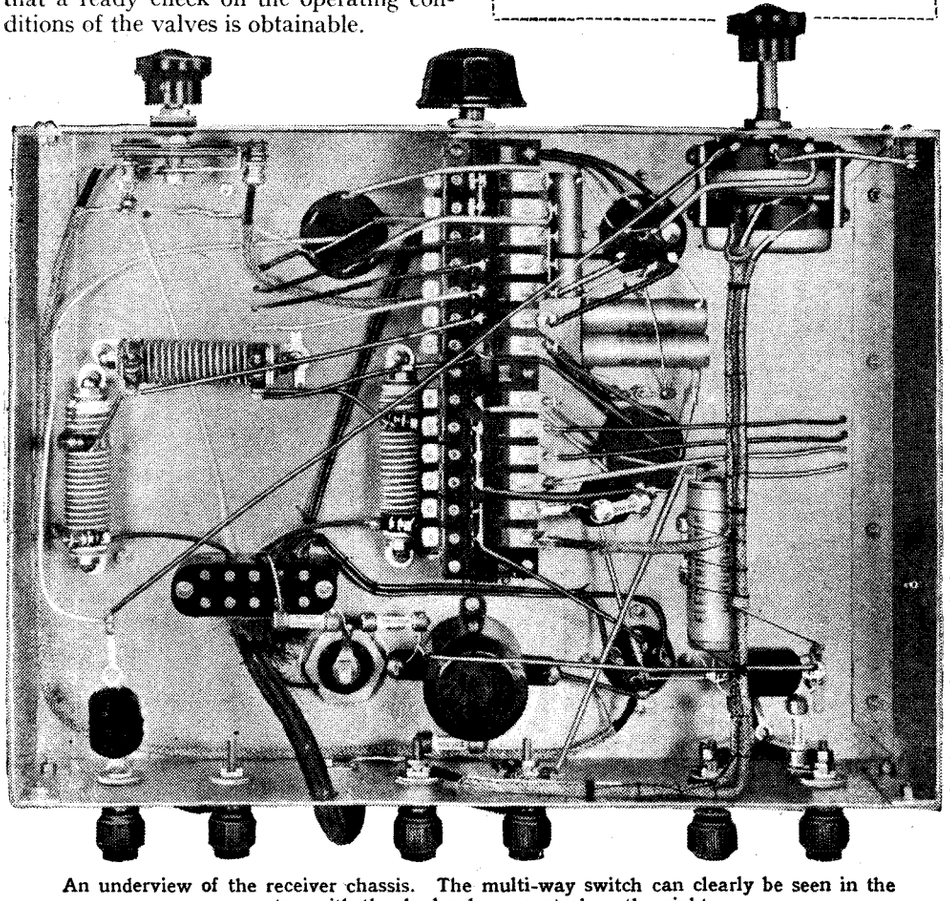
CONSTRUCTING THE *Wireless World* Pre-tuned Quality Receiver



By W. T. COCKING

THE theoretical considerations underlying the design of this receiver were discussed in last week's issue of "The Wireless World," and in this article the construction and operation are dealt with.

THERE is little which need be said about the actual construction of the equipment, for there is nothing difficult about it, and full details appear in the various drawings. It should be noted, however, that it is necessary to insulate the spindle of C11 from the chassis. There is, too, nothing difficult about the operation, and a table of the voltages and currents prevailing in the various circuits is given so that a ready check on the operating conditions of the valves is obtainable.



An underview of the receiver chassis. The multi-way switch can clearly be seen in the centre, with the dual volume control on the right.

When setting up the receiver, set the switch to position 1 (fully anti-clockwise) and tune in one medium-wave station by C2 and C8, using reaction if necessary. Then set the switch to position 2 and tune in another medium-wave station, this time using C3 and C9; lastly, set the switch to position 3 and tune in a long-wave station with C4 and C10.

Adjusting the Receiver

It should always be possible to receive the local stations without mutual interference, although in a few cases where one is received more weakly than the other it may be necessary to employ a little reaction in order to sharpen the tuning while listening to the weaker station. In the case of the third station, the one selected must necessarily be one which is within the capabilities of the set, and it will usually be necessary to use reaction to provide the requisite sensitivity and selectivity. It may sometimes happen that while the sensitivity is adequate without reaction, the selectivity is not; the correct procedure is then to turn down the volume control while increasing reaction so that the volume remains the same and reaction, in effect, increases only the selectivity. For this procedure to be effective it is necessary to perform the initial tuning of the circuits while making use of reaction. It is therefore wise to tune the circuits with the volume control set so that signals are quite weak, and reaction advanced so that the detector is near the oscillation point.

Pre-tuned Quality Receiver—

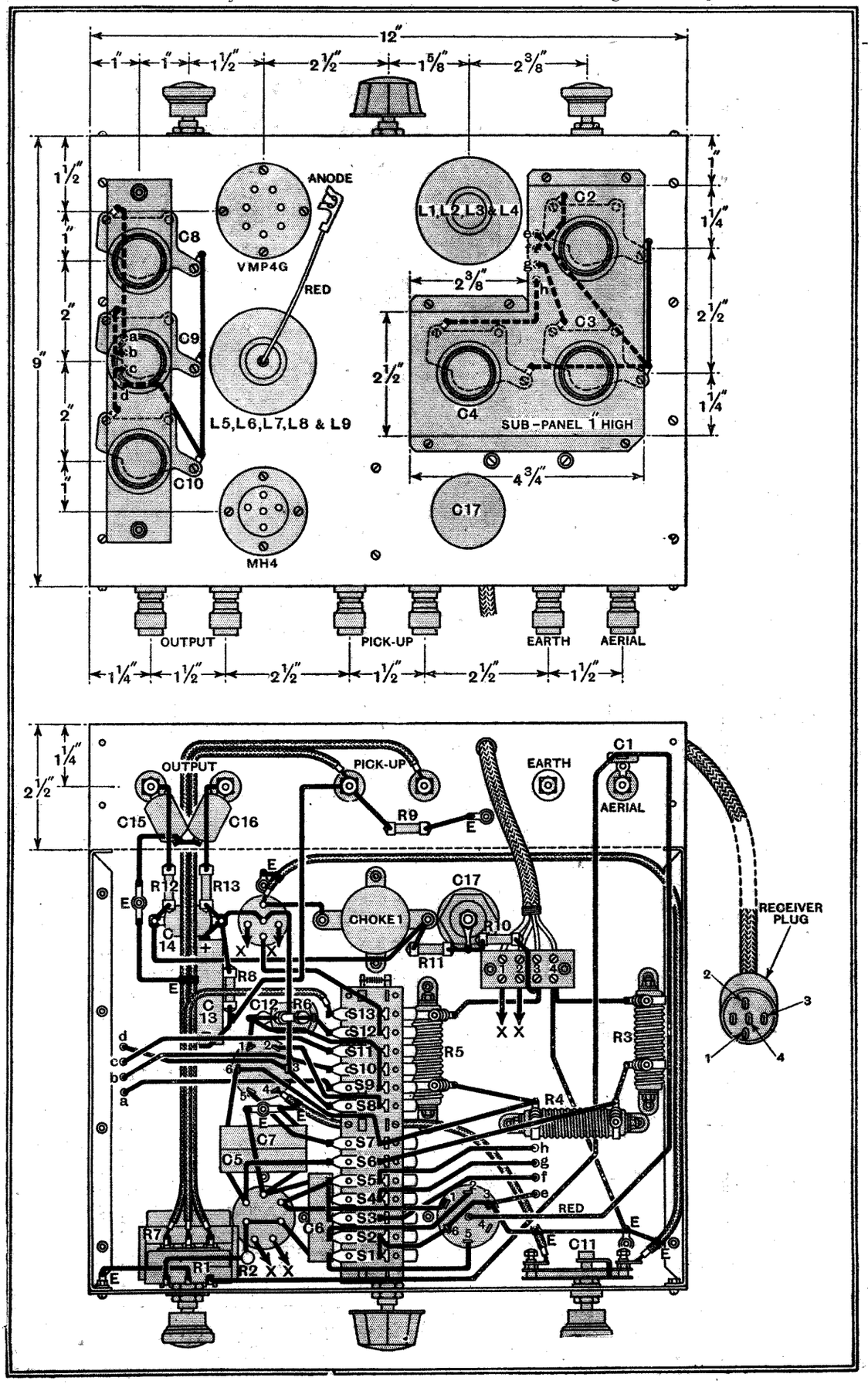
When this is done, only the panel controls need be operated when changing from one station to another. In general, reaction should be at a minimum, the desired station selected by means of the switch, and the volume adjusted to the required level by the volume control. If the sensitivity is inadequate, reaction can be brought into play. If the selectivity is inadequate, however, the volume can be reduced and then brought back again to normal by means of reaction.

A full-size blue print of the wiring diagrams is available from the Publishers, Dorset House, Stamford Street, London, S.E.1. Price 1s. 6d., post free.

It is a wise plan to set reaction at a minimum before changing stations, for it is likely that a setting of this control which is a long way from the oscillation point for one wavelength may be beyond that point for another. Similarly, the volume control should be turned down when turning from a weak station to a strong one, to avoid overloading. In this connection it is worth noting that on a strong signal the volume steadily increases as the volume control is turned up, until a point is reached at which no further increase can be obtained; if, however, the control is turned still further there may actually be a decrease; this being the overload point of the detector, and distortion takes place when it is exceeded.

When tested in London, the two medium-wave circuits were tuned to the London National and Regional transmitters, and the long-wave circuit to Luxembourg, Radio-Paris, or Huizen. At the point of reception the National is considerably weaker than the Regional, and at times it proved necessary to use a trace of reaction to avoid a faint background of the programme of the latter station. Huizen on the long waveband was easily received free from interference, but careful tuning was necessary to obtain Luxembourg or Radio-Paris without a small background from Droitwich; it could be done, however.

An alternative arrangement of the tuning circuits, of course, would be to tune the long-wave circuit to Droitwich and one of the medium-wave to London



Full details of the construction and wiring of the receiver unit are given in these drawings.

Pre-tuned Quality Receiver—

Regional, thus leaving the third circuit free for some other medium-wave station. Even in daylight North Regional, Cologne, and Brussels provided good signals, but some difficulty was experienced in completely separating Cologne from North Regional, for it is the weaker signal of the two.

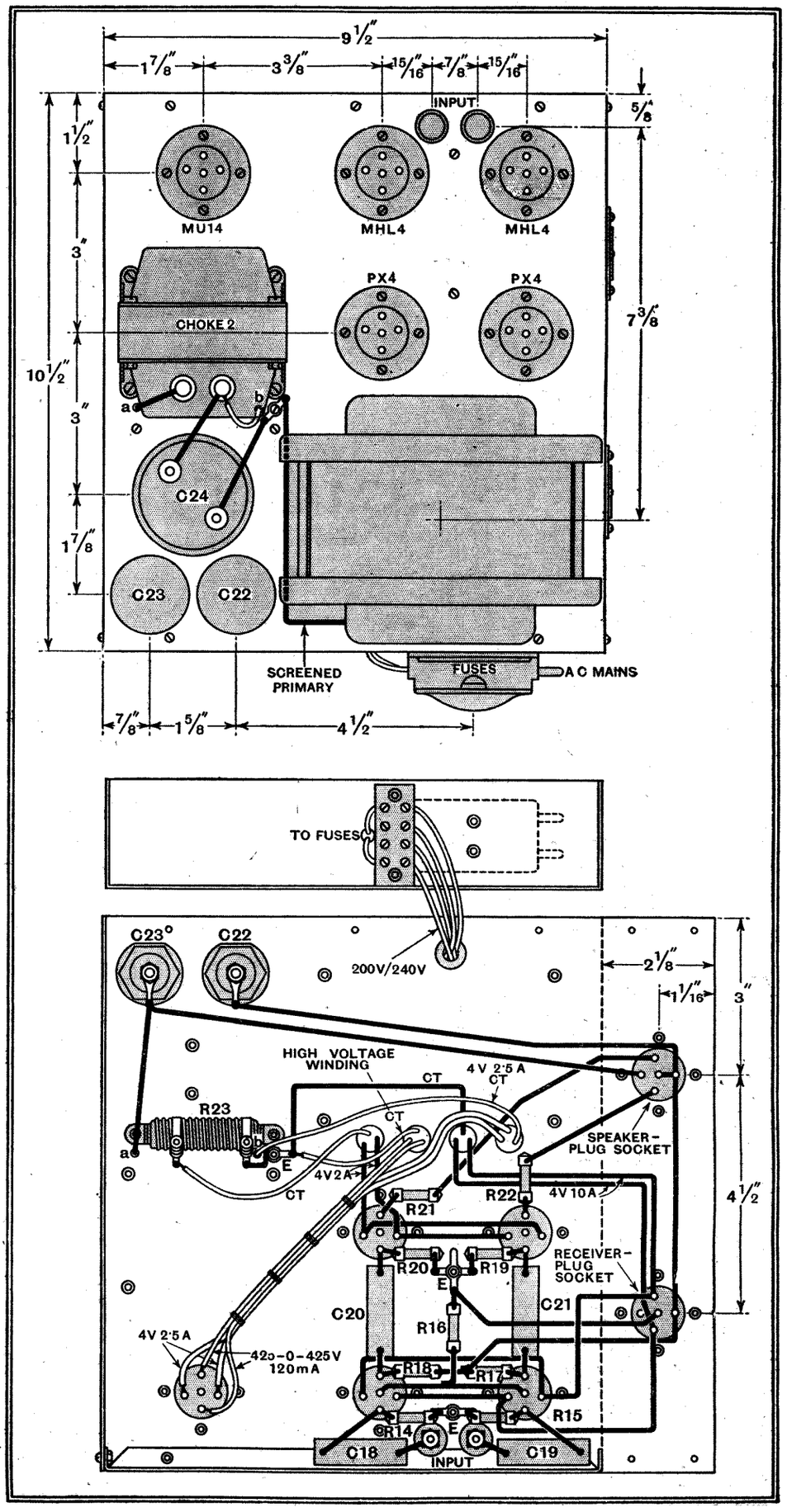
The set is not, of course, intended for the reception of such stations, but the above details give some idea of its capabilities when operated on an outdoor aerial. It is intended that it be used chiefly for high-quality reception of the two locals, but a third circuit is provided in order to permit an additional station being received in those localities where this proves possible.

The quality of reproduction with the specified loud speaker, a Magnavox Duode 33, reached a very high standard indeed. The volume proved adequate for all normal requirements, with a complete absence of mains hum, and all frequencies from the highest to the lowest appeared to the ear to be adequately represented. The overall frequency response curve was shown in Fig. 3 last week, in which the dotted curve shows the performance on gramophone and the solid on radio at 300 metres, with reaction at zero. The curves show the overall performance up to the primary of the output transformer, and it will be seen that at as low a frequency as 20 c/s the response is only −1 db., while at 10,000 c/s it is −1.5 db. on gramophone and −2.5 db. on radio.

Eliminating Whistles

It is interesting to note that the difference between the two curves is due to sideband cutting in the tuned circuits and to the grid leak and condenser combination of the detector. The loss on gramophone occurs chiefly in the filter circuit in the detector output. On both radio and gramophone the loss is too small to be audible.

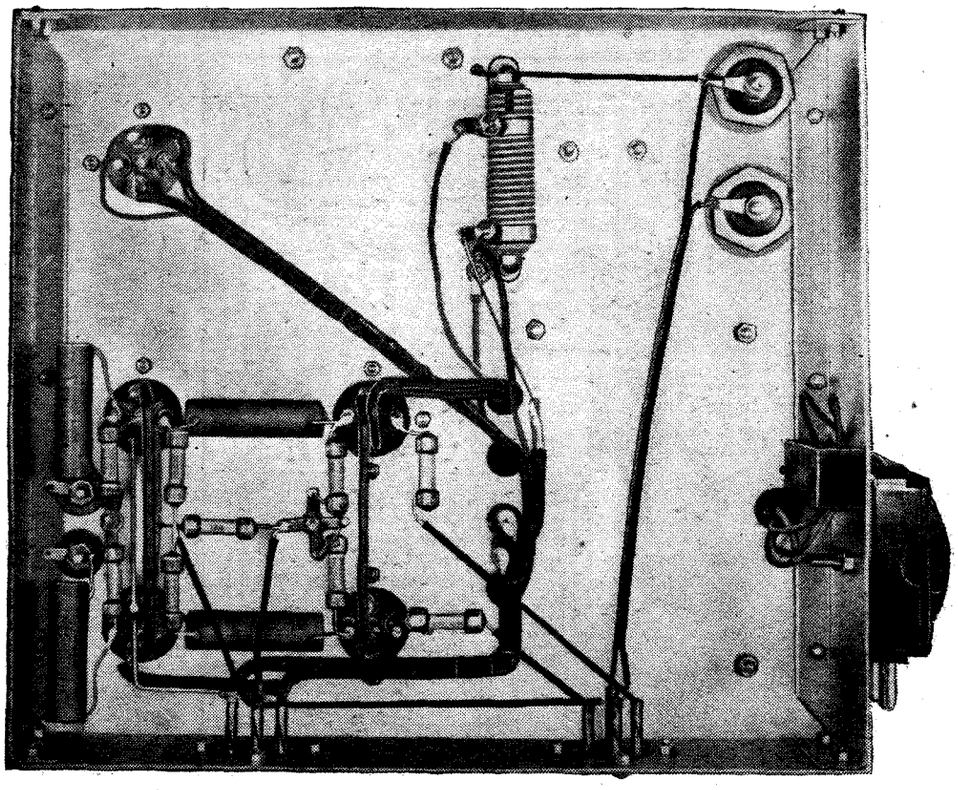
In view of the excellent high-frequency response characteristics of both the receiving equipment and of the recommended loud speaker, it is possible that unless the equipment is used very close to the local stations a continuous high-pitched whistle may appear at night time. This is because a station on an adjacent channel may prove strong enough after nightfall for its carrier to beat with that of the local and give an audible heterodyne note of some 9,000-10,000 c/s. The note is, of course, quite weak, but it is sometimes loud enough to be irritating. It is worthy of note, therefore, that the effect can be overcome by adding a whistle filter. It is usually possible to do this in the receiver, but in this case it is easier to do it in the loud-speaker circuit, and the speaker makers can supply a whistle filter (black case type) suitable for their speaker. It is connected in series with the speech coil—that is, the connection between one speech coil terminal and one secondary terminal on the output transformer secondary is broken and the filter joined to these two points. The adjusting screw is then moved with a screwdriver until the whistle disappears or is at its weakest. Musical



In the power unit the wiring is nearly all carried out on the underside of the chassis.

Pre-tuned Quality Receiver—

frequencies in the neighbourhood of the whistle are also eliminated, it is true, but the effect on reproduction is quite small, and the net result is much pleasanter than the whistle.



An underbase view of the power unit which clearly shows the short and direct connections obtained in the AF circuits

In setting up the apparatus in a cabinet no difficulty should arise. It is well to keep the mains transformer at some distance from the HF choke Ch1, for if they are too close there is a chance of a hum being picked up. The output leads, inter-unit leads, and speaker should not be allowed to approach the receiver too closely, for the efficiency of the filter incorporated naturally falls off on this long waveband, and there is a chance of feed-back effects causing instability on this waveband if appreciable coupling exists between the input and output circuits. No difficulty from this cause has been found in developing the receiver, and none should arise with any reasonable layout of the units. The leads between the two units should not exceed about two feet, but the speaker leads can be any reasonable length without ill effects—ten feet or more is not too much, and the transformer and field leads can be bunched together to make a tidy cable connection.

The equipment is in no way critical in regard to values, and any types of similar characteristics to those specified can be employed. It is important, however, that both output values, and also both values in the penultimate stage, are of the same type. In the Mullard range, suitable alternatives are the AC044 for the output stage, the 244v for the intermediate stage, and the 354v and VP4 for the detector and RF stages respectively, while the IW4 is suitable as the rectifier. Among the Mazda valves, the PP3/250 can be used in the output stage, the ACHL as the detector, and ACVP1 for the RF amplifier; while the Cossor 4XP is another valve suitable for the output stage. In this make, the types suitable for the RF, detector, and AF stages are the MVS Pen, 41 MHL, and 41 MLF.

Chelmsford College

Training for Wireless Engineers

WHEN it is realised that the first wireless school was established by the Marconi Company at Frinton some thirty-five years ago, our art seems to be becoming quite mature. The demand for instruction increased so rapidly that the school was transferred to Chelmsford in 1904, and now, to cope with the ever-widening ramifications of wireless communication, a new college building is in the course of erection. The old premises have been extended and modernised to form a students' hostel.

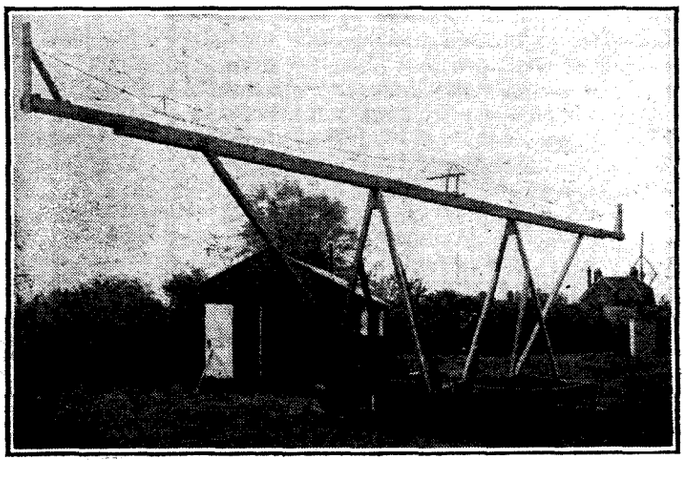
Several courses of instruction have been planned for the next session, which begins on October 5th. Part 1 of the general course, intended partly for foreign students who require training in English, embraces AC theory and wireless principles, lasts three months. It is followed by Part 2, lasting five months, which constitutes a fairly comprehensive course in radio communication, including practical experimental work and lectures.

For students speaking English and having the necessary technical qualifications there is a Special Course combining the technical work of Part 1 with the experimental and lecture work of Part 2; this occupies five months.

In addition to the general radio engineering instruction set forth above, there are also specialised courses of study in naval wireless communication, direction finding, television, broadcast receiver design, broadcast transmitter design, and telephone terminal equipment.

The Principal of the College is Mr. H. M. Dowsett, M.I.E.E., F.Inst.P., and instruction is given by engineers of the company who are in constant touch with the latest developments.

Terms for both instruction and residence can be obtained from Marconi's Wireless Telegraph Company.



AT THE MARCONI COLLEGE. — Practical work is combined with theoretical instruction; a rotatable aerial to demonstrate directional propagation.

The Radio Industry

A UNIQUE system for relaying speeches was installed recently by Ross & Robinson, Ltd., at St. Andrews University, the occasion being the International Conference of Agricultural Economists. As the Conference was of an international nature, arrangements were made for the addresses to be given simultaneously in three different languages. The speaker delivered his address into one microphone, while on each side of the platform was an interpreter also provided with a microphone. Three separate amplifiers were used, and, as each member of the audience was provided with headphones and a three-way switch, it was possible to listen to the addresses in any of the three languages.

◈ ◈ ◈

A new edition of the Goltone catalogue of radio and electrical accessories has now been issued. In addition to describing more standardised components, the list is a valuable source of information regarding out-of-the-way accessories and materials that are usually difficult to obtain. Special attention is given to interference-suppressing devices.

◈ ◈ ◈

We have received from Norman Rose (Electrical), Ltd., of 94, Tottenham Court Road, London, W.1, a leaflet describing the "Omnisection" valve emission tester.

◈ ◈ ◈

The office of Tungsram Electric Lamp Works has been transferred to Tungsram House, 82-84, Theobalds Road, London, W.C.1; telephone, Holborn 3563.

BROADCAST BREVITIES

NEWS FROM PORTLAND PLACE

Retiming the Talks

SO many topics—from bee-keeping to Empire-building—have been covered in the B.B.C. talks during the last few years that the job of finding something fresh must grow increasingly difficult for the B.B.C. Deputy Talks Director, Mr. Rose-Troup.

It is significant that this winter the "big story" behind the Talks Programme is concerned less with the contents of the talks than the hours of their presentation.

Repetitions

As an experiment certain travel and general interest talks broadcast in the evening are to be repeated between 12.45 and 1 p.m. on Mondays for the benefit of listeners unable to tune in at night. Talks of the kind formerly given between 6.30 and 7.30 p.m. are to be redistributed so as to "crop up" at unexpected moments in the main National programme. Such a series will be "The World Goes By"—a magazine programme of half an hour's duration dealing with the march of events at home and abroad.

Cinema Talks on Sundays

Another "timing" surprise is the choice of 2 p.m. on Sundays for talks on gardening. Also on Sundays—between 6.15 and 6.30—there will be Alastair Cooke's lively cinema talks.

"Scientists at Work"

Regular half-hour talks in the main evening portion of the National transmissions are also an innovation. "This Freedom of Ours"—a series by Mr. Frank Birch—occurs on Thursdays from 8.30 to 9.30 p.m. in the National programme. On Tuesdays, between 9.20 and 9.40 p.m., there will be talks on "Scientists at Work," in which the processes of modern research will be described by experts.

The Audience Talks

LISTENERS who object to studio audiences should be thankful that the B.B.C. is not copying the latest development in this direction in America. During the Sunday night "Community Sings," organised by the C.B.S. network, a portable microphone is taken up and down the aisles of the Columbia Radio Playhouse so that individual members of the audience can express themselves to the "nation of listener participants."

Technical Tips for Producers

THE fact that most broadcast producers, not to mention broadcast artists, know less about the technicalities of the wireless machine than the average motoring learner knows about the "innards" of his car is at last being recognised. And a significant move to end this state of affairs will be made on Thursday next, October 1st, when the B.B.C.'s new Staff Training College comes into being.

Clearing the Air

In a Press interview last week Mr. G. C. Beadle, Chief of the College, and Mr. E. A. Harding, Director of Studies, made it clear that the curriculum will include a modicum of technical training for all students. The effect of this should be satisfactory to all concerned; no longer will orchestral conductors grimly question the need for balance and control; no longer will dramatic geniuses petulantly exclaim because Droitwich cannot rise to the squeak of a bat in a belfry; no longer, in fact, will the engineers be looked upon as a necessary evil.

The indications are that the little technical learning imparted by the school, far from proving dangerous, will engender among producers and artists alike a much more wholesome respect for the engineering side of the B.B.C.'s activities.

Broadcasting as a Profession

Situated in a converted mansion—No. 4, Duchess Street, off Portland Place—the School contains two studios, an echo room, dramatic control panel, recording apparatus, lecture theatres and all the other requirements for a three months' course in broadcasting as a profession.

As Mr. Beadle was careful to point out, the School aims at teaching those arts, or "tricks of the trade," which are peculiar to broadcasting.

Students from Abroad?

The students, of whom there will be from twenty to thirty at a time, will be recruited from the B.B.C. staff to form a "Training Reserve," or credit balance, of talents which should spare the Programme Division that uncomfortable feeling of being on the verge of an overdraft.

The College will provide refresher courses for regional staffs and may also accept students from the Empire and from foreign broadcasting organisations.

Truth About Television Tests

ALTHOUGH the daily television transmissions which are now going out from Alexandra Palace (11-12 and 3-4 daily) may be of better quality than many people expect, it should be understood that they are in no sense the start of the "service." They are not even primarily for the benefit of radio manufacturers and the trade, but are intended to familiarise the B.B.C. engineers with the apparatus and to enable the productions staff to gauge the possibilities of the new medium.

Taking Risks

Actually, those enthusiasts lucky enough to get a "look-in" during October may be rewarded with some more exciting items than are likely to find their way into the ordinary programmes, at any rate, in the early days of the service. The reason is, of course, that all kinds of risks can be taken during an avowedly experimental period. If things go wrong nobody cares very much; there are no reputations lost; no promises broken.

Televising from an Exhibition

The Television staff are fortunate in having the North London Exhibition to draw upon for "O.B." material. At least an hour will be devoted to a tour of the stands in Alexandra Palace.

Other high lights of the experimental period may be cartoons by famous artists, and instruction in golf, boxing, and horsemanship. And look out for "the Picture Page," which will be full of surprises.

Another "Scrapbook"

WHAT a rich vein of programme material Leslie Baily opened up with the "Scrapbook" series! Next in the list is "Scrapbook for 1908" to be broadcast about the middle of November.

Mr. Goyder's Experimental Laboratory

THE B.B.C.'s interest in the technical development of Indian broadcasting has created a very favourable impression in Bombay. Mr. C. W. Goyder, who lately left the B.B.C.'s Research Department to become Chief Engineer of the Indian Broadcasting Company, has had a royal welcome.

Already he is busy on the formation of a first-class experimental laboratory—a recommendation contained in the "famous Kirke report," as one writer describes it—and this is taken as an indication that the peculiar problems of wave propagation in India are fully recognised.

"B.B.C.'s" Overseas

India is only one of the countries of the Empire in which B.B.C. influences are now at work. South African broadcasting follows the Portland Place model, so does a large section of the Australian organisation. And the acceptance by Major Gladstone Murray of the headship of the Canadian Broadcasting Commission sets the seal on another "B.B.C." overseas.

Big Ben Tops the Bill

ACCORDING to listeners' correspondence, the most popular "artist" in the Empire programmes throughout June, July, and August was Big Ben.

There must be something strangely compelling in the famous Westminster chime to evoke 143 letters of appreciation.

Bells Across the Atlantic

ARE British church bells best? If not, there must be some other potent reason for the special relay to America of the bells of Southwark Cathedral on September 18th. The bells were heard for just five minutes over the N.B.C. network.

Is Volume Expansion Worth While?

By JOHN HARMON

FOR BEST RESULTS, COMPLEMENTARY AUTOMATIC CONTRACTION AT THE TRANSMITTER IS NECESSARY

IT is the aim of the radio transmitting stations of the world to reproduce with the utmost fidelity the sounds which are played, spoken or sung into the microphone. It is not for the radio engineer to imitate the painter, who infuses his own personality into his work; we may rather regard him—with apologies, if required—as the successor in a scientific age of the patient monks of the Middle Ages whose ambition was to make

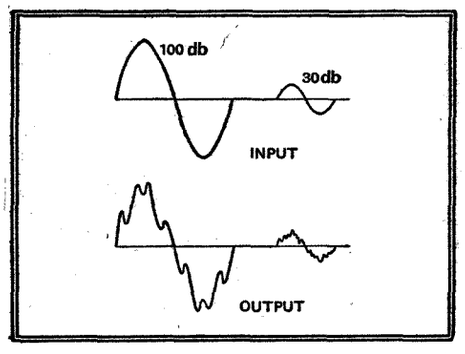


Fig. 1.—The result of attempting to transmit the sound range of a full orchestra. Large signals are distorted, while small signals are drowned in background noise.

copies, with absolute accuracy in line and shade, of their illuminated missals.

To-day fidelity of reproduction has reached a high standard. But in one respect there is still a difficulty akin to that of compressing a quart into a pint pot. In brief, the difficulty is that while the sound level of a full orchestra may vary over a range of 70 decibels, the transmitter is not capable of dealing with a range of more than 40 decibels.

The reason for this limitation is easily seen by reference to Fig. 1. The upper part of the figure represents a pure tone delivered to the studio microphone at very high intensity and immediately afterwards at very low intensity, the difference in sound level being 70 decibels. This corresponds to a power ratio of 10,000,000 to 1, and since power is proportional to the square of the voltage signal, the voltages in the modulating valves must vary in the ratio of 3,170 to 1. Now, it is not feasible to accommodate this large signal range in the carrier wave, for the small signal will be lost in the background of hiss which is unavoidably present in the transmitter (and also in the receiver), while the large signal will carry the modulation to more than 100 per cent. and severe distortion will result. In fact, by the time the signals have reappeared in the audio stage of the receiver they will be more or less as depicted in the lower part of Fig. 1.

It should be mentioned that this difficulty is not constantly present during the transmission of programmes. In talks, for example, the extreme variation of sound level seldom attains 40 decibels, and in dance music the level keeps remarkably constant. It is principally with the full orchestra that such violent variation of light and shade are encountered.

It is the duty of the control engineer to ensure that by manual operation of his volume-control handle the range in volume is kept down to the amount which the transmitter will safely accept. Fig. 2 illustrates the result. We see that the original range from *pp* to *ff* (where we have allowed a change in level of 18 decibels from each musical sign to the next one) is compressed to a range which only goes from *p* to *f*. The effect is exasperating: to some listeners it appears as if the orchestra were advancing and receding; to others as if a blanket were thrown over the loud speaker at intervals.

Compensation at the Receiving End

In previous issues of *The Wireless World* methods have been described of re-expanding the volume range at the receiver so as to approximate to the original range. Full expansion is only advisable in expensive receivers which can deal with

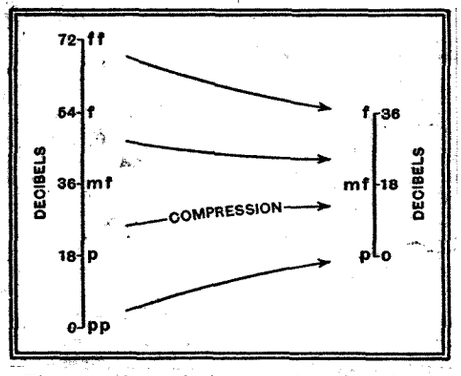


Fig. 2.—A typical example of volume compression.

a range of 70 decibels; the average set is limited to about 50, which corresponds to the change in loudness when the ears are stopped with the fingers. Whatever expansion device is used, some time delay is introduced, due either to the time constant of the resistance-capacity feed-back from the expander circuit to the grid of the first audio valve or to the time required to change the temperature of a lamp filament.

This time delay is in any case required to preserve the character of the musical sounds. For if the grid bias of the audio-frequency valve responds instantaneously to variation in sound level the reproduction is only free from distortion in the case of a pure sine wave corresponding to a single pure tone. If, however, several instruments are sounding simultaneously the loudest one takes charge, and the feed-back modulates the incoming audio signals at a particular frequency and phase. The result is a kind of cross-modulation of the other instruments with the production of unwanted over-tones.

A Compromise Delay Period

Again, with a small time delay of about $\frac{1}{10}$th second, the clear-cut effect of the bow when suddenly applied to the violin or the tinkle of treble piano notes is seriously blurred. Musical attack is much more definite with the light strings of the violin than with the massive strings of the bass viol. Wind instruments are slow to build up a loud note, since the air blast only becomes musical by being transformed into a vibration which slowly increases by resonance. This effect is very noticeable in cinema organs when Heykens' Serenade drops lightly from the fingers of the organist and emerges with a formidable rumble reminiscent of Wagner's Ride of the Valkyries. Accordingly, if the volume expander works with such a small time delay the light strings in *crescendo* passages suffer apparent alteration into the tone of the wind instruments.

On the whole, the most suitable delay seems to be about half a second; this is

Is Volume Expansion Worth While?—

obtained by including in the feed-back circuit a ½-mfd. capacity coupled to a ½-megohm resistance. On gramophone records an expansion of the range from 40 to 70 decibels gives magnificent results with, for example, Tchaikowsky's Fifth Symphony in E Minor, the Siegfried Funeral March by Wagner, and the Scherzo Movement from Beethoven's Ninth Symphony. It must be remembered that in the process of recording the music has been compressed, the level of the pianissimo passages being raised to a degree necessary to mask needle scratch, and the loud passages lowered to ensure that the track width does not exceed the limit allowed by the prescribed spacing of consecutive tracks. Since this compression is performed automatically, very little irregularity is observable when automatic expansion is employed in the reproduction. But there is one moment when the effect of time delay becomes evident; it is in the Scherzo Movement referred to above, where in one passage three loud drum beats occur in succession; in the expanded music they are not equally loud but build up from the first to the third.

When we turn from expansion of records to expansion of broadcast the author is of the opinion that the result is, on the whole, disappointing. The situation is now one in which sound levels are manually controlled at the transmitter, with the introduction of a personal factor which is not obtrusive in the compressed programme but becomes obvious when the expansion circuit is switched on at the receiver. For perfect control the transmitting operator must exercise a perfect degree of anticipation of the position and magnitude of the change in volume level. Such excellence of control is hardly to be expected, and often the peak has gone by before the reduction handle has moved, with disastrous results, especially if in the score the peak is followed by a quiet passage. Defects of this kind are magnified when the volume is again expanded.

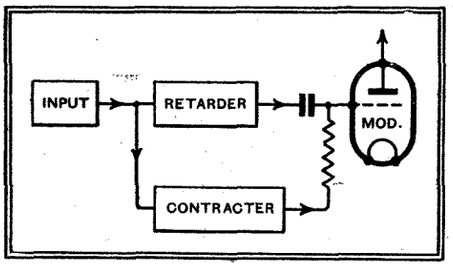


Fig. 3.—An anticipating device for volume contraction.

The first step towards rational control at the transmitter should undoubtedly be the automatic compression of volume according to a definite law, such as one which gives a linear relation in decibels between the original and the compressed sound level. It may be noted that such a scheme has now been for some months in operation at the American station WSFA with satisfactory results.

A further improvement would be to compensate for the time delay in expansion at the receiver by the introduction of an anticipating device at the transmitter, as shown in Fig. 3. Here the main programme passes through a retarding network which produces a uniform delay of one second on all signals transmitted from the input to the modulating valve. From the input a parallel circuit includes a volume contractor which controls the grid bias of the modulating valve. The contractor causes a delay of half a second which is over-compensated by the retarder, and thus the control actually anticipates changes in volume.

NOTES AND NEWS

Recent Events Briefly Reviewed

Broadcasting the Spanish Civil War

FLOYD GIBBONS, who was the N.B.C. special correspondent in Abyssinia, is now in Spain, and has given two broadcast reports through the short-wave station EAQ in Madrid; these were relayed in America through the N.B.C. network.

Australia Bans Records

THE Australian authorities have completely forbidden the radiation of recorded music by amateurs on the 40- and 20-metre band between the hours of 5 p.m. and 8 a.m.

Algerian Static Hunt

THE great anti-static campaign is slowly spreading over the various countries of the world, the latest instance being Algeria, where several detector vans have been equipped for this purpose.

Blind Listeners

THE important part played by broadcasting in the lives of blind people is amply illustrated in the recently issued 67th Annual Report of the National Institute for the Blind. Not only do broadcast programmes provide one of the chief recreations of those without sight, but talks and lectures have proved to be valuable educational mediums.

"Wireless has given much encouragement to language study by the blind," says the report. "We are constantly producing Braille books in French, German and Spanish, including pamphlets to accompany the B.B.C. language talks."

Stiffer Tests for Indian Transmitters

COINCIDENT with the general "cleaning-up" of radio matters in India, it is understood that amateur radio transmitters are to undergo stiffer tests. Ability to transmit and receive at sixteen words per minute must be proved, and not only newcomers but existing amateurs must submit to the test at one of the examination centres that have been established.

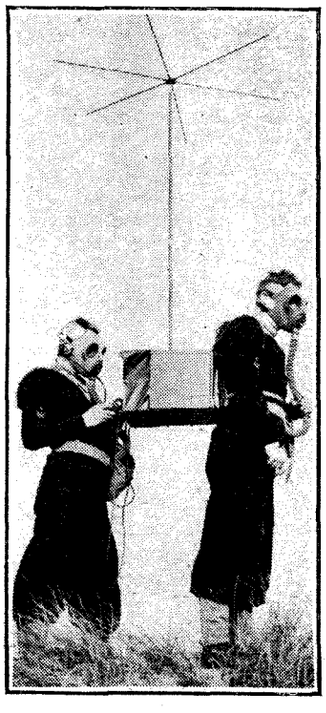
The New Empire Airways

APPROXIMATELY twenty new wireless stations are being established along the Empire Air routes. The technical equipment is being rapidly brought into line with the requirements of the new methods of operation, and particularly to provide the necessary wireless services for night flying.

An Indian "People's Set"?

REPORTS from India would suggest the possible introduction in that country of a standardised receiver to be produced on the same basis as the German "Volksempfänger." It is stated that the first job of Mr. C. W. Goyder, formerly of the B.B.C., and now Chief Engineer of the All-India Radio Service, will be to design a cheap but effective set suitable for the needs of those whom the orator loves to describe as "the toiling millions of India."

Incidentally, the Government of India has now appointed an Advisory Committee to help the Controller of Broadcasting in the working of the Delhi station. Some of the members of the Committee were evidently chosen for their expert knowledge on the choice of material for broadcast programmes, but the larger section may be regarded as holding a watching brief in the interests of various groups of the listening community.



SOUTH COAST "WAR." During the recent manœuvres in Dorset the Navy used portable transmitter-receivers for the landing parties.

Johannesburg Jubilee Contest

AS part of the Jubilee celebrations in Johannesburg, South African amateurs are to hold a transmitting contest during next month. The contest will be open to amateurs in all parts of the world except in countries bordering on the Union.

Extra points will be given to competitors making contact on the ten-metre band, on which so much amateur activity is now concentrated.

Germany Forges Ahead

IT is claimed that since Hitler came into power on January 30th, 1933, the development of broadcasting in Germany has been more rapid than in any other country. This is reflected in the number of licence holders, which has increased from 4,307,722 to 7,430,319, the latter figure being correct for the end of July. This is said to be largely due to the encouragement given by the Führer, who recognises the extreme importance of broadcasting to the welfare of the country.

Unusual Applications of the Cathode-Ray Tube

MORE BY-PRODUCTS OF TELEVISION

By J. H. REYNER, B.Sc., A.M.I.E.E.

THE cathode-ray tube is being used to an increasing extent in industry owing to the ease with which it can be made to give visual indication of various phenomena. The simple analysis of the wave-form of currents or voltages is now almost the least important application.

Let us examine in detail some of the applications. The general principles will be familiar to readers. By an assembly comprising a cathode, grid and one or more anodes a beam of electrons is produced which is projected down the tube on to a fluorescent screen where it impinges with a sharp focus, causing a small spot to appear. Deflector plates located on each side of the beam, shortly after it first emerges from the gun or anode system, cause the beam to deviate in its travel and hence move the spot either horizontally across the screen or vertically up and down. Similar movement of the spot can be obtained by passing current through coils located externally to the tube, and in some circumstances this magnetic deflection is convenient.

TELEVISION has been largely responsible for the rapid development of the cathode-ray tube, which is now a comparatively robust and reliable piece of apparatus with a reasonable "expectation of life," and is consequently finding applications in many new fields.

It is customary to cause the spot to move in a horizontal direction by the application of voltage from a device called a time base. It is interesting to think what this name really implies. It means simply that movement of the spot is proportional to the time which has elapsed since it started to move. If we place on the vertical deflector plates a voltage from an oscillator or similar source of AC the vertical position of the spot at each instant will be proportional to the manner in which the particular voltage is varying. At the same time the spot is being caused to move horizontally at a rate proportional to the time interval so that the variation of the voltage under examination is spread out on a *time base*. As we know, this results in the familiar wave-form, which is quite smooth and regular if the wave-form is pure but contains all sorts of humps and irregularities if the wave-form is distorted, or if made up of more than one component frequency.

Apart from the simple examination of wave-form, there are quite a number of other applications which require a time base. One unusual application is that of echo sounding or depth recording. The art of measuring depth electrically has been brought to a high state of perfection of recent years. The procedure is to generate a sound wave by a diaphragm located in the hull of the ship. This sound wave travels down to the bottom of the sea bed, is reflected back again, and is picked up on a microphone. Since the velocity with which sound travels through water is known, an accurate observation of the time elapsing between the start of the sound and its reception by the microphone gives an immediate indication of the distance which the sound has travelled down to the bottom of the sea bed and back.

It is clear that any equipment of this sort must not involve elaborate calculation, for it has to be used by quite inexperienced operators who will require merely a clear indication of depth without any juggling. The cathode-ray tube offers an immediate solution to this problem. By a suitable time base the spot is caused to move relatively slowly across the screen. It starts its travel at the instant when the sound pulse first leaves the transmitter in the ship's hull. When the reflected sound is picked up by the microphone it causes a deflection on the vertical plates which results in a kink in the wave. The distance of this kink from the starting point indicates the depth, and by mounting the tube behind a transparent screen having a superimposed scale calibrated in fathoms it is possible to see at a glance the depth of the ocean bed over which the ship is moving at the time.

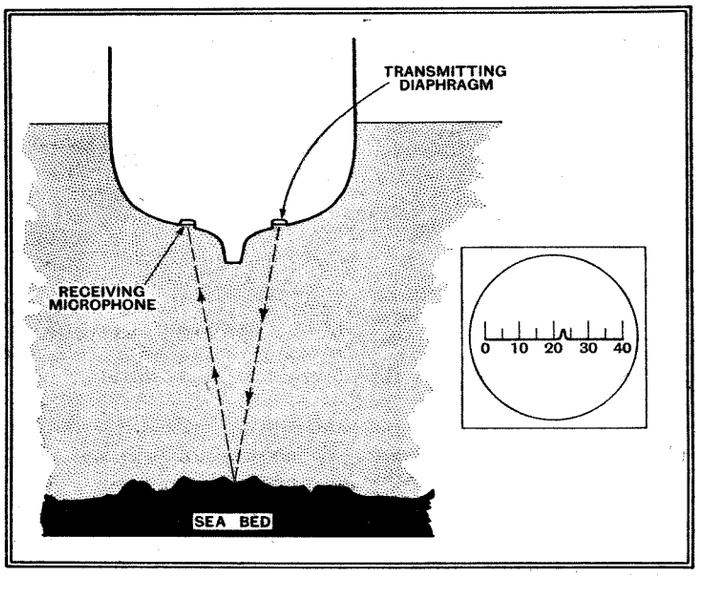


Fig. 1.—Illustrating the principle of the marine echo sounder. Inset: Record of depth as it appears on the tube.

Heart Action Made Visible

Another application requiring a time base is the cardiograph—an electro-medical instrument for observing the action of a patient's heart. The heart's action generates electrical voltages between the extremities of the limbs, and the wave-form of these voltages is a useful clue to the condition of the patient's heart.

Since the heart beats occur 70-80 times a minute under normal conditions, a slow-moving time base is again required which will deflect the spot across the screen once every two or three seconds—sufficient to enable two or three successive heart beats to be observed. This particular application also involves the use of a screen having a long "afterglow"—a point which will be discussed later in this article. Other types of indication, however.

Unusual Applications of the Cathode-Ray Tube—are often required. For example, consider an audio-frequency response curve of an amplifier. Here the vertical movement of the spot would again be proportional to the output voltage, but in this case it has to be related not to a time base but to the frequency of the current at each instant.

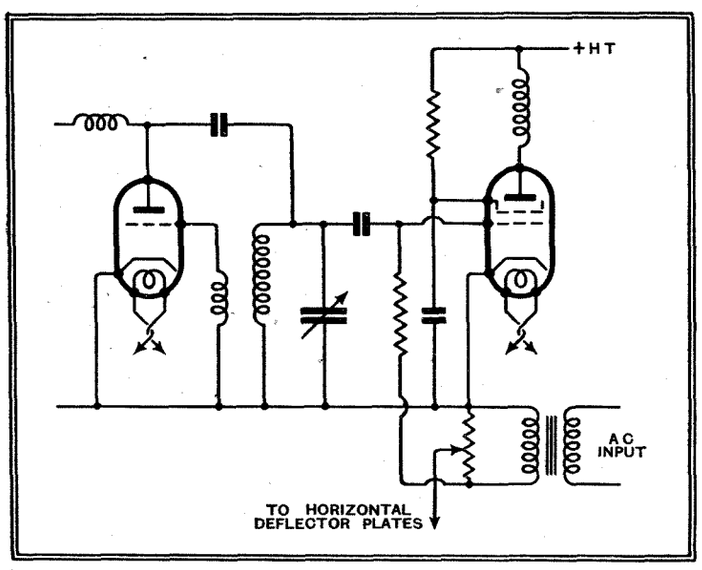


Fig. 2.—Electrical frequency base as used with cathode-ray tubes.

One way of doing this is to use a beat-frequency oscillator so designed that it will cover the whole frequency range required in one complete rotation of a suitable shaft. On the same shaft is mounted a potentiometer from which voltage is tapped off and taken to the horizontal deflector plates of the tube. Thus the voltage actually applied to the plates is proportional to the rotation of the shaft, which again is proportional to the frequency, and hence the tube can be made to plot the actual low-frequency response curve. It will do this at each revolution of the shaft, and if the shaft is revolving fairly rapidly the successive traces will all lie on top of one another and will give the impression of a continuous and steady curve. The effect of altering various constants in the circuit can be observed at once, and the curve can, in fact, be adjusted to acquire any desired shape in a very short time without the necessity for laborious measurements.

Aid to Circuit Alignment

The same idea can be applied to high frequencies, where one often requires to know the resonance curve of the circuit or group of circuits. This is particularly the case with IF transformers, for the modern bandpass transformer is difficult to line up (even with a valve voltmeter), so that the peaks are exactly as they should be.

By having a similar arrangement whereby the rotating shaft alters a small condenser in parallel with the main tuning condenser of a radio-frequency oscillator it is possible to vary the frequency within, say, plus or minus 20 kc/s of the resonant point. As the frequency varies over this range, the output from the IF transformer will rise to its maximum and fall off again, and if the cathode-ray spot is given a horizontal deflection proportional to the frequency by the same method as before the resonance curve will build up on the tube. Simple adjustment of the trimmers is then sufficient to pull the curve into any desired shape, and it is quite easy to adjust them to be of the same height and symmetrically disposed.

It is worth noting that mechanical methods are not essential for producing the variation of frequency required. It is usually practicable to cause a suitable variation in some part of the circuit by electrical means pure and simple. For example, the input capacity of a valve is dependent upon the effective amplification which the valve is delivering at the time. Now the amplification of a valve can easily be controlled by using a variable-mu type and altering the bias. Therefore, by connecting across the oscillating circuit a passenger valve having a suitable anode load and varying the bias on this valve the effective capacity in parallel with the main tuning circuit can be varied within certain limits. The variation of bias on the grid may be accomplished by applying suitable alternating potential from the mains, and the same potential may be used to produce the deflection on the horizontal deflector plates, thus producing a very simple electrical form of frequency base.

There are numerous other forms of frequency base and other ways of achieving the desired results, but we must pass on to yet another form of application, that requiring a voltage base.

A good example of another type of base—the voltage base—is provided by a valve characteristic where we desire to know how the anode current varies according to the voltage on either the grid or the anode. From what has been said already it will be clear that this is comparatively simple to arrange. We require a source of varying voltage which is applied to the grid or anode of the valve, and at the same time to the horizontal deflector plates, so that as the voltage on the valve varies the spot moves from side to side on the cathode-ray tube.

Then by arranging that the vertical deflection of the spot is proportional to the anode current the tube will plot the valve characteristics. The vertical deflection may be obtained magnetically by passing the anode current through suitable coils or by including a small resistance in the anode circuit and using the voltage developed across this resistance, if necessary through an amplifying valve, as described in these columns (May 8th, 1936).

Here, again, the usefulness of the device lies in the fact that any alteration to any of the constants in the circuit causes an immediate alteration in the characteristic which can be seen at once. I have actually turned the characteristic of a screen grid valve inside out by adjustment of the anode and grid potentials!

There is one other application of voltage bases which may be mentioned particularly, as it depends on a most interesting property of cathode-ray tubes: that of afterglow. The spot of light on the screen is caused by the fluorescence of the material under the influence of the electrons. Now, in the ordinary course we require that the luminosity shall cease immediately the electron beam is removed. Otherwise, if the beam is moving rapidly across the screen the spot will leave behind it a little tail like a comet, due to a slight persistence of the luminosity.

This persistence is called the afterglow, and considerable research has been undertaken to reduce it to a minimum. With a normal tube it only exists for a small fraction of a second and is thus barely noticeable, but in television and similar applications the spot has to move at such an extremely rapid rate that an afterglow of a few micro-seconds is sufficient to cause trouble.

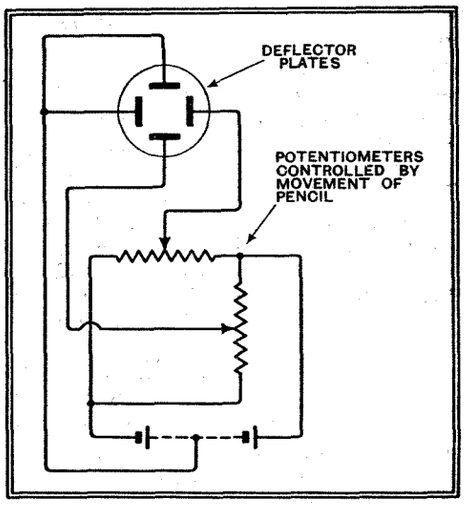


Fig. 3.—Circuit for cathode-ray writing.

On the other hand, there are occasions when an afterglow of this sort is useful, and by working in the opposite direction modern research has now produced tubes having an afterglow of 10-15 seconds and more. This means that if the spot moves across any part of the screen it leaves a trace which will remain glowing, even though the spot has long since ceased to be anywhere near, and may, in fact, be executing a movement in some other part of the screen.

Unusual Applications of the Cathode-Ray Tube—

So pronounced has this afterglow been made that it is possible to make the spot write words on the screen and the trace is visible for a sufficiently long time for the words to be read quite easily. A pencil is used which operates two potentiometers in the form shown in Fig. 3, so that the horizontal and vertical location of the pencil point relative to its frame are immediately translated into voltages which are applied to the deflector plates of the tube and cause the spot to take up an exactly equivalent position on the cathode-ray screen. Then as the pencil is moved the spot on the screen moves in conformity and will write words and even messages. It is possible for something like ten words to appear on the screen at once before the glow dies away, i.e., as the eleventh word is being written the first word is just becoming indistinguishable.

Enough has been said to show that possibilities of the cathode-ray tube are far greater than anyone would have imagined a few short years ago. Even now several quite interesting applications have had to be omitted for lack of space. The ordinary user can take comfort in the thought that the more cathode-ray tubes are used in industry the cheaper they will become, until we can look forward to the time when the tube will cost little more than a super-power valve!

On the Short Waves

NOTES FROM A LISTENER'S LOG

AN interesting article by L. C. Young and E. O. Hulbert appeared in the *Physical Review* for July 1st, 1936, entitled "Radio and the Sunspot Cycle." A great deal of attention has been focused on this aspect of radio communication since T. L. Eckersley first suggested that there was a definite connection between solar sunspot activity and optimum working frequencies about 1927-28. The increase in optimum frequency with the rise to maximum of the solar cycle actually thrust itself on the early short-wave engineers—since it will be remembered by some of us that Poldhu first established world-wide *daylight* communication in October, 1924, on 32 metres (9 Mc/s), although the contract with the Government for the erection of the Marconi beam stations had been signed some months before, namely July 28th, 1924.

Now 1924 was near the sunspot minimum period and it was not, therefore, surprising to read that in 1926, two years closer to the sunspot maximum of 1927-28, that "Unexpected difficulties were met and conquered, and on October 25th, 1926, the Canadian beam circuit was opened on a wavelength of 16.574 metres (17 Mc/s)."

This difficulty was largely due to the fact that the wave for successful daylight working to Canada had been halved in those two years.

Now Young and Hulbert state that the observed optimum frequency "f" for long distance daylight communication averaged over the year during the period from 1923 to 1936 was found to vary with the yearly average relative sunspot number according to the relation:

$$f = 7.8\ (S + 12)^{\frac{1}{2}}.$$

The march of the sunspot curve from 1749 to 1935 suggests the possibility of greater sunspot numbers in coming solar cycles than the value S=78 which occurred at the 1928 maximum. Working out this little sum for S=78 we find that the optimum frequency is 24 Mc/s (12.5 metres), and if we take S to be 160, a possible maximum, we then find that the optimum yearly *average* long distance daylight frequency to be 28 Mc/s (10.5 metres).

It therefore seems possible that the Empire station at Daventry may yet, in the unspecified future, make use of GSK on 26.1 Mc/s (11.49 metres).

It should be borne in mind, however, that a two-fold increase in sunspot activity only increases the optimum frequency from 24 to 28 Mc/s, but on the other hand the "Laws of Physics" cannot be altered to suit British radio manufacturers who persist in designing receivers which only tune up to 15 or 18 Mc/s (19 or 16 metres)!

Turning now to the review of short-wave conditions during the past fortnight, one would like to comment on the noticeably high sunspot activity and general good programme value reception from the U.S. and other stations.

Starting with Thursday, September 10th, conditions were noted as average, with W3XAL on 17.78 Mc/s the best signal, giving 3 watts to the loud speaker easily with just audible noise, even W2XAF was fair, apart from morse interference from EAX Barcelona at 11 p.m.

Conditions seemed a little poorer on the Friday, W3XAL was again good all the afternoon, but W1XAL on 11.79 Mc/s was poor to fair in the evening with W2XAF and LKJ1 alternating on 9.53 Mc/s.

Incidentally, W1XAL now appears to be testing on 15.25 Mc/s in the afternoons about 3 p.m. and has been heterodyned by RIM Tashkent.

Really first-class results were obtained from W8XK on 15.21 Mc/s on Saturday evening, September 12th, at 11 p.m., and at this time W2XAF was exceptionally strong, but subjected to two separate heterodyne whistles.

At midnight on the following Monday, W8XK was again excellent on 15.21 Mc/s, W2XE good on 11.83 Mc/s and W2XAF good, and overriding LKJ1 at R9+ on 9.53 Mc/s.

The Bandoeng transmitter, PMN, on 10.26 Mc/s was good (with slight static crashes), giving a gramophone recital of military marches—probably a prelude to its early morning "physical jerks" programme, in fact, even the U.S. 6 Mc/s group was audible at this period—in particular W3XAL on 6.1 Mc/s was good and quite intelligible, though badly heterodyned.

The Buenos Aires station, LRU, was heard closing down on his 15 Mc/s channel at 10.45 p.m. on Wednesday prior to commencing operations, after a short pause, on LRX, 9.66 Mc/s, the final announcement was made in English.

An excellent relay of the Chalk Farm Salvation Army band was intercepted from DJB, 15.20 Mc/s, at 2.45 p.m. on Thursday afternoon, September 17th, and good results were obtained on Friday evening from the triumvirate W3XAL, W8XK and W2XE on the higher frequencies, with W2XAF particularly good later.

A new station, COCX, Havana, on 11.42 Mc/s, was also fairly well received at 10.40 p.m. on the Friday.

A change—apparently only a temporary one—to autumn conditions was noted on the Saturday evening, and the two 9 Mc/s transmitters W1XK and W2XAF gave the best results to date since the Spring.

The interesting relay from America on Sunday evening, September 20th, between 9 and 9.30 p.m. was taken *via* WKF on 19.22 Mc/s (15.61 metres), which seems to be an abnormally high frequency when compared with the night frequencies of the autumns of 1933-4 and even 1935.

There were so many transmitters taking this relay that it became difficult to identify them quickly.

To conclude these notes it will, perhaps, be interesting to refer to the excellent reception of W2XAD (on European beam?) during the "mailbag programme" at 11.35 p.m. on Tuesday, September 22nd, W2XAF was strong but not so good as W2XAD.

E. S. Darlington, during this broadcast, introduced the manager of WGY (and the other G.E.C. stations), who spoke about the new F.C.C. rulings which were referred to recently in these columns. Incidentally, daylight saving time ceases in the U.S. on September 27th, and the mailbag programme will be heard in this country at 12.35 a.m. until October 4th—on October 6th it will be back again at 11.35 p.m. so far as we are concerned.

ETHACOMBER.

CLUB NEWS

Slade Radio Society

AN extremely successful demonstration of the Voight loud speaker was given before the Society on September 17th. Attendance amounted to eighty people, and everyone was greatly impressed.

Exeter and District Wireless Society

On October 5th a short-wave demonstration is to be given to the Society by Mr. Cholot, of Lissen, Ltd. The meeting, which is open to everyone, will be held at the Y.M.C.A., High Street, Exeter. Further particulars can be obtained from the Hon. Secretary, Mr. W. J. Ching, 9, Sivell Place, Heavitree, Exeter.

West London Radio Society

The five-metre field-day arranged for September 27th has been postponed until Sunday, October 4th. Those who wish to attend should meet outside the Lido Cinema, West Ealing, at 10 a.m.

On Wednesday, October 7th, at 8.30 p.m., there will be a general meeting in Ealing Town Hall to which members, prospective members, and others are cordially invited. An American Army set, claimed to be the most sensitive of its kind in the world, will be demonstrated by the President, Mr. Douglas Walters.

Croydon Radio Society

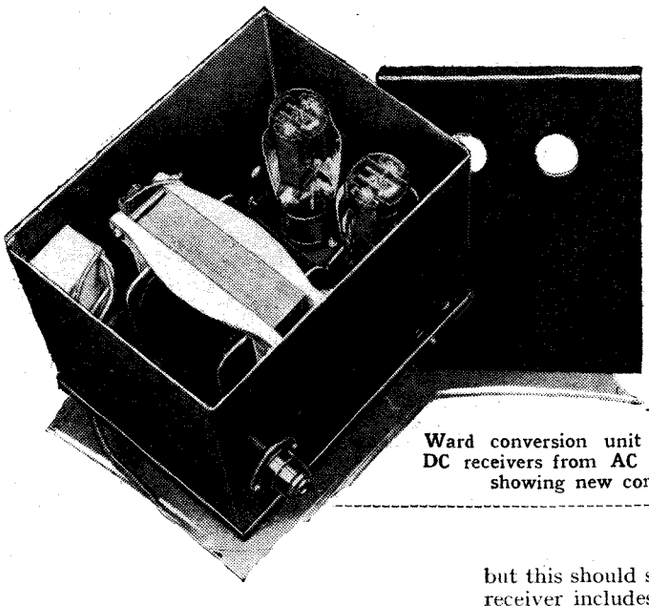
The new session starts on Tuesday, October 6th, when the President, Mr. H. R. Rivers-Moore, will speak on his experiences with microphones and public address equipment.

International Short-wave Club

The new address of the above club is at 100, Adams Gardens Estate, London, S.E.16.

New Apparatus Reviewed

Recent Products of the Manufacturers



Ward conversion unit for operating DC receivers from AC supply mains, showing new container.

WARD AC TO DC CONVERSION UNIT

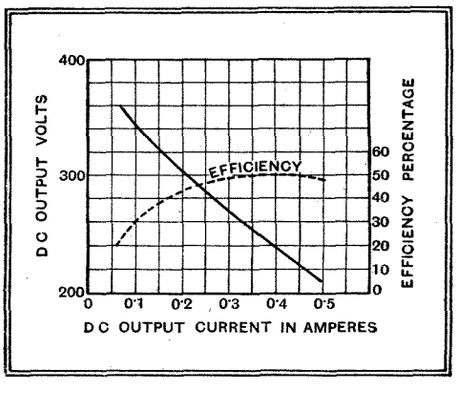
THERE are occasions when it becomes necessary to consider the matter of operating a DC receiver from the AC supply mains. Where this arises due to a change of residence the onus of finding a solution rests with the individual.

It may, therefore, be of interest to know that a compact valve-operated unit designed especially for the purpose is now obtainable from Charles F. Ward, 46, Farringdon Street, London, E.C.4.

The specimen unit sent to us for test was enclosed in a metal case measuring 6½in. cube, but we understand that in order to provide better ventilation it is proposed to employ a case of somewhat larger size.

This unit is intended to give an output of 90 watts, and two American rectifying valves of the 5Z3 type are used. Each of these is rated to give 0.25 amp. of DC so that the pair will supply approximately 0.5 amp., which at 220 volts, for example, represents 110 watts.

Measurements show that the rated output of 90 watts is definitely obtainable, and on this load the unit is working at its highest efficiency. In this respect it compares



Output and efficiency curves of Ward AC to DC conversion unit.

favourably with most other types of rectifier or conversion units of similar capacity as the figure recorded on test was 50 per cent.

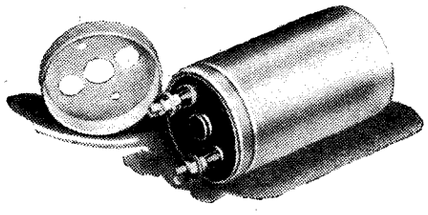
The only smoothing provided in the unit is a large capacity electrolytic condenser, but this should suffice since every DC mains receiver includes chokes and condensers for this purpose. It was found, however, that a good earth connection is desirable to ensure satisfactory operation as a poor "earth" on the receiver may give rise to a certain amount of hum.

The price of this unit is £2 10s. complete.

BULGIN ALL-WAVE HF CHOKE

THE model HF15 is one of a series of new HF chokes recently introduced by A. F. Bulgin and Co., Ltd., Abbey Road, Barking, Essex. These models are described as "sealed" chokes as the winding is enclosed in an hermetically sealed metal case.

The choke is secured to the chassis by means of a shallow holder, and it can be



Bulgin sealed all-wave HF choke, type HF15.

fixed with the terminal end uppermost or with the terminals projecting below. This dual-purpose mounting is a valuable feature, since it is often more convenient to accommodate the component on top of the chassis, even though the wiring connections may be on the underside. It also obviates the use of unnecessarily long leads.

Tests made with the choke show that it is entirely satisfactory for use in all-wave receivers, for over the usual wave-ranges covered by such sets there was no trace of major or minor resonances to be found. Our tests were made with a typical detector circuit and with the customary by-pass condensers.

The specimen sent in for test had a measured resistance of 550 ohms, and the price is 5s.

"CHEMICO" RUBBER TAPE

IT is, perhaps, not generally known that a high grade rubber tape having very good insulating properties is now available for electrical repairs. It is made in 8-oz. rolls giving approximately 7 yards of ¾in. wide tape.

It is self-adhesive and does not require rubber solution for fixing, as the prepared surface is protected by a thin layer of canvas that easily strips off.

One of its main features is that being rubber it is quite plastic and can easily be moulded to form a soundly insulated covering for jointed wires and conductors. It is also shock-proof up to 10,000 volts or more.

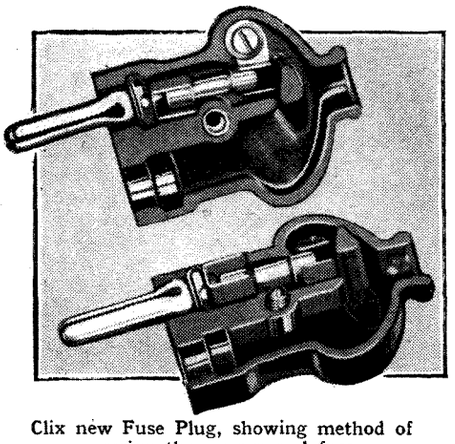
The exposed surface of the tape is free of any adhesive, and being quite clean to handle it can be used for all kinds of temporary repairs. It costs 2s. a roll, and the makers are The County Chemical Co., Ltd., Chemico Works, Birmingham, 5.

CLIX FUSE PLUG

WHERE only one mains power point is available in a room several pieces of electrical apparatus can be operated from it with the aid of an adaptor having two or more entry sockets. Should an accidental short circuit occur on one, the whole, which may possibly include an electric clock, will be put temporarily out of action.

Under these conditions separate fuses in each of the extension circuits are most desirable, and a convenient way of arranging this is made possible by the new Fuse Plug just introduced by Lectro Linx, Ltd., 79a, Rochester Row, London, S.W.1.

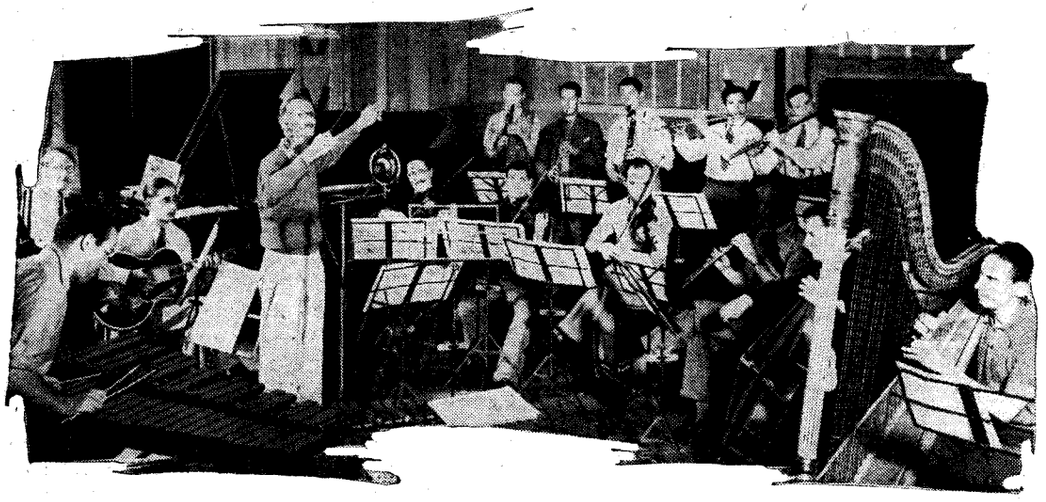
The body of the plug consists of two



Clix new Fuse Plug, showing method of securing the prongs and fuses.

parts moulded in bakelite and joined together by a single screw. One prong is secured to each half of the plug, and between the prongs and the cable connections are miniature cartridge-type fuses. Fuses of either one or five amp. rating can be fitted. Clix special prongs are used, and the price complete is 1s. 8d.

Listeners' Guide for the



VAN PHILLIPS conducting whilst recording for Columbia. With his new two-section rhythm orchestra, which includes many star musicians, he will present in the National programme on Thursday at 8 song hits of to-day by a full orchestra of twenty alternating with a small string orchestra giving favourites of yesterday

THERE is a marked improvement in the programmes during this week. It seems as if the programme planning department has been penned up during the Summer months and now, the first week in October, they have been let loose and a bumper week of really good matter awaits the evening listener.

Many new regular programmes make their début during the week under review. Outstanding among these being the first edition of "Entertainment World," a fortnightly topical review of the world's entertainment. Personalities and news of the stage, screen and radio, the latter being divided into two parts, home and abroad, will be brought into this 40-minute programme.

In the instalment this week, on Monday at 7.20 (Nat.), the radio section will include a transatlantic flash from Radio City, New York, and a review of the highlights of the home programmes during the past fortnight.

Trailers of the three biggest films being shown and of three stage successes at present in production will be given, and it is hoped to bring to the microphone stage and screen personalities. The usual microphone interview, having been "tried and found wanting," will be replaced by the stars, after speaking for a minute or two, giving thumbnail sketches specially written for them and probably based on their latest successes.

A further idea is that Hollywood should be rung up each fortnight and for two stars to talk to each other of the happenings on both sides of the Atlantic.

From these details readers will have some idea of the wide variety of material which will be used in this new and promising fortnightly light entertainment.

BROADCAST TALKS

ON the list of broadcast talks issued by the B.B.C. is the quotation, "Who listens once will listen twice," from Byron's "Mazeppa," and this certainly seems to be the sentiment of those responsible for the planning of the talks.

It is difficult to mention outstanding items as listeners' opinions differ so vastly. However, the following strike me as being noteworthy. The first of the series, "Music and the Ordinary Listener," will be opened by Sir Walford Davies to-night at 6.50.

In the series of talks headed "I Was There," speakers will recount their experiences during memorable, world-famous events. The rising in Johannesburg and the Jameson Raid will be dealt with in the Regional programme at 5.55 on Sunday.

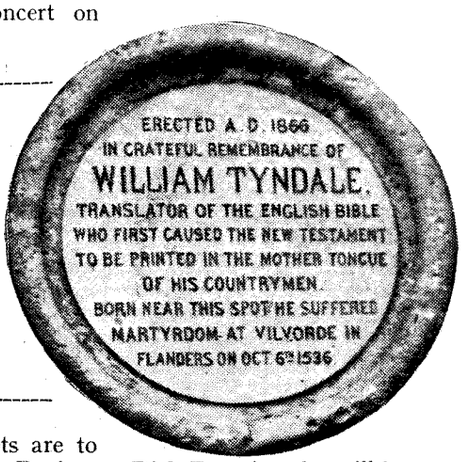
A magazine-type of programme, consisting of short talks on matters of information, travel and opinion, with the title "The World Goes By," makes its first appearance in the National programme on Wednesday at 8.30.

THE PROMS END

THE penultimate concert of the Proms. is represented in the programmes by the broadcasting of Beethoven's Ninth Symphony in D minor (Choral), the chorus work being sung by the B.B.C. Choral Society.

From the last concert on Saturday two excerpts are to be given. The first Regionally at 8.45, when the first performance in England will be given of "Chaconne" for full orchestra (Bach-Casella), also Roy Henderson will sing Vaughan Williams' Songs of Travel. In the second relay at 9.50 (Reg.) Sir Henry Wood's Fantasia on British Sea Songs and Elgar's "Pomp and Circumstance" March No. 1 will be heard. After which comes the National Anthem and round after round of applause which always goes on long after the microphones have been switched out of circuit.

THE VEN. V.F. STORR, Archdeacon of Westminster, will speak on Sunday at 5 (Nat.) on William Tyndale, the translator of the English Bible. The tablet reproduced is on his memorial at Nibley, Glos.



HARVEST

THE Sunday evening services from both the National and Regional stations at 7.55 are Harvest Thanksgivings. That from St. Mary's, Beverley, Yorkshire, is to be heard Nationally and that from Cransley Church, Northamptonshire, Regionally. The latter has been the scene of eight or nine broadcasts, including one for the N.B.C. last Christmas Day. Quite near Kettering, it is secluded in typically English country.

"THE BOY"

THIS musical comedy, which was produced at the Adelphi in 1917 will be heard by listeners to-night (Friday) at 7.20 (Nat.) and to-morrow at 6 (Reg.). The radio adaptation has been carried out by Archie Campbell, who will also be the producer. The original part of the Magistrate, which was taken by W. H. Berry in the Adelphi production, will be played by Dick Francis, who will be supported by a strong cast, including Nora Howard and John Bentley. The Midland Revue Orchestra and Chorus, conducted by Reginald Burston, will be in attendance.

Week — Outstanding Broadcasts at Home and Abroad

HIGHLIGHTS OF THE WEEK

FRIDAY, OCTOBER 2nd.

Nat., 7.20, "The Boy." 8.20, Prom. 10.30, B.B.C. Theatre Orchestra

Reg., 7.30, B.B.C. Orchestra (C) and Alfredo Campoli. 8.25, B.B.C. Dance Orchestra. 9.5, "Sailors of Cattaro." 10.30, Jack Payne and his Band

Abroad.

Strasbourg, 8.45, "Orpheus" (Gluck).

SATURDAY, OCTOBER 3rd.

Nat., 6.50, Theatre Orchestra and Alleyne and Leonhardt. 8.20, Variety. 9.50, Prom.

Reg., 6, "The Boy." 8.15, Violin Recital: Frederick Grinke. 8.45 Prom.

Abroad.

Leipzig, 8.10, "Indigo" (Johann Strauss) relayed from Dresden.

SUNDAY, OCTOBER 4th.

Nat., 4.30, Rawicz and Landauer. 5.20, Theatre Orchestra—the Music of Eduard Künneke, conducted by the composer. 6.30, South Place Sunday Concert Society from Conway Hall, Red Lion Square. 9.45, "The Last Days of Sail."

Reg., 6.15, The Crystal Palace Band. ¶"The Table Under the Tree." 9.5, The London Symphony Orchestra with Henry Holst.

Abroad.

Hamburg, 8, Grand Variety Concert.

MONDAY, OCTOBER 5th.

Nat., 6.40, The Bernard Crook Quintet. 7.20, Entertainment Parade. ¶Pianoforte Recital: Géza Frid.

Reg., 8, B.B.C. Dance Orchestra. 8.45, Talk: Round the World Playing Badminton (J. F. Devlin). 10.25, Grosvenor House Dance Band

Monday, October 5th (*continued*)

Abroad.

Paris, Eiffel Tower, 8.45 Symphony Concert.

TUESDAY, OCTOBER 6th.

Nat., 7, B.B.C. Military Band: Naval Marches. ¶Talk: The Village. 8, Comic Opera Programme—VIII.

Reg. 7.30, Choir of the Gentlemen's Glee Club Manchester, from the Midland Hotel. ¶Eddie Carroll and his Music.

Abroad.

Deutschlandsender, 8.10. "Invitation to the Dance!" Non-stop Dancing Programme.

WEDNESDAY, OCTOBER 7th.

Nat., 7.30, West Country Calendar: Memory of William Barnes (poet). 8, Jack Hylton and his Orchestra. ¶Talk: Living Off the Map. 9.40, Sonata Recital: Lionel Tertis and Solomon.

Reg., 7.30, Carroll Gibbons and The Savoy Hotel Orpheans. 8.30, The World Goes By. 9, Comic Opera Programme—VIII.

Abroad.

Brussels I, 8, Symphony-Concert of the "Contemporary Composers," Series—Milhaud.

THURSDAY, OCTOBER 8th.

Nat., 6.20, Talk: This Way Out (John Hilton). ¶Students' Songs, B.B.C. Men's Chorus and Henry Cummings. 8, Van Phillips and his Two Orchestras. 10.20, "London's Latest."

Reg., 7.30, Symphony Concert from the Town Hall, Birmingham. 8.30, "Cavalcade." 10.25 Ambrose and his Orchestra.

Abroad.

Kalundborg, 8 Third Thursday Concert, from the Odd Fellows' Palace, Copenhagen.

AN ENCORE

IT has been decided, in response to the many requests, to revive Noel Coward's "Cavalcade," which was broadcast in June. This epic of the stage, screen and radio will again be heard on Thursday at 8.30 (Reg.) and Nationally on Friday, October 9th. It is hoped to include the majority of the brilliant cast which took part in the original show.

"LONDON'S LATEST"

REX LONDON for the first time brings a revue to listeners on Thursday at 10.20 (Nat.), and again Regionally on Saturday, October 10th. This high-speed revue, with the above title, is built on original lines, and has a strong cast headed by Rex London and includes Janet Lind, Raymond Newell, Florence Oldham and Miriam Ferris.

THE CHIEF GUIDE, Lady Baden-Powell, with a group of Guides in camp. She will be heard from the Girl Guide Rally at the Albert Hall on Saturday at 3.15 (Nat.). Community singing by Guides will also be a feature of the relay.

REPLACING "FOUNDATIONS"

THE first of the new series of recitals which will replace "The Foundations of Music" will be given on Sunday at 4 (Nat.) and followed by concerts on Monday at 7.30 (Reg.), Tuesday at 9.40 (Reg.), and Thursday at 9.20 (Nat.). The subject for the week will be the music of Rameau, and among those taking part will be Rudolph Dolmetsch, the Boyd Neel String Orchestra and Sophie Wyss (soprano).

A PROTEST

THE loud-speaker nuisance is the subject of a very short programme, "Breaking the Peace," which comes from the National transmitter at 9.25 on Monday. It is given as a protest against this growing annoyance.

Of course, I am not suggesting that *Wireless World* readers are so selfishly thoughtless as those who want the neighbourhood to hear their *quality* receivers, but perhaps if you listen you may get a hint or tip to pass on to the offending neighbour.

MORE COMIC OPERA

THE eighth of the comic opera series of programmes will be broadcast on Tuesday and Wednesday at 8 (Nat.) and 9 (Reg.) respectively. The three operas chosen from which to extract songs and scenas are Planquette's "Paul Jones," Messager's "Mirette," and Jones' "A Greek Slave." Those taking part include Hella Langdon, Margaret Lauder, Morgan Davies, Betty Huntley-Wright and Tomasini, together with the Revue Chorus and Theatre Orchestra.

ON A WINDJAMMER

REAL old salts, each having served in sailing vessels, will take part in the programme "The Last Days of Sail," to be given Regionally on Sunday at 9.45. It will recount the adventures of the *Arunvale*, a British three-masted barque, on a voyage in 1900 from Chile round Cape Horn to London River (the sailor's name for the Thames).

There will be a storm rounding the Horn and real shanty singing by those who sang in the brave old days; in fact, it will be a complete sound picture of life on a windjammer, compiled on authentic information gathered by Peter Belloc, son of Hilaire Belloc, and Alexander Bone.

TWO JACKS

Two well-known and much-liked dance bands will be heard during this week. They are Jack Payne and his Band, who come to the Regional microphone to-night at 10.30, and Jack Hylton and his orchestra, who, with Peggy Dell, will give a programme headed "You Shall Have Music" on Wednesday at 8 (Nat.).

OPERA

FOR its usual Friday opera programme Bucharest has chosen a recorded version by the cast of La Scala, Milan, of Puccini's "Tosca," timed for transmission at 8.15; this will also be relayed by Radio-Romania. A studio production of Gluck's "Orpheus" comes from Strasbourg at 8.45 to-night.

A relay from the Royal Flemish Opera, Antwerp, of Bizet's incomparable "Carmen" will be given by Brussels No. 11 at 8 on Saturday. From Prague at 9.10 on the same evening comes a studio performance of Bendl's ballet, "Czech Wedding Day."

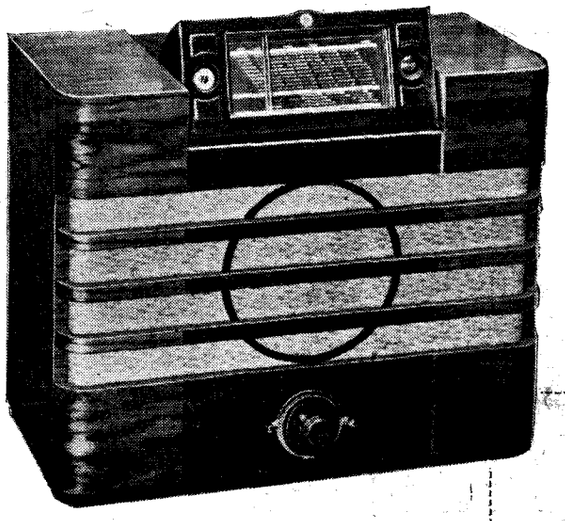
OPERETTA

STRASBOURG gives the only transmission of this type on Friday with Lecocq's opéra-bouffe, "Le Myosotis," at 8.20.

Saturday has a larger selection, commencing with Brussels No. 1 at 6.15, giving records of Planquet's "Les Cloches de Corneville." Leipzig relays Johann Strauss's three-act operetta, "Indigo" (after the "Arabian Nights") from Dresden at 8.10. From Radio-Toulouse at 9.10 comes Léhar's "Frasquita."

The first broadcast of a new operetta entitled "The King of Tippers" will be given from Paris PTT at 8.30 on Thursday. Casadesus is responsible for the music, with Régina Patorni as librettist.

THE AUDITOR.



Philips TYPE 795A

AN ALL-WAVE SUPERHETERODYNE WITH MANY INTERESTING ELECTRICAL AND MECHANICAL FEATURES

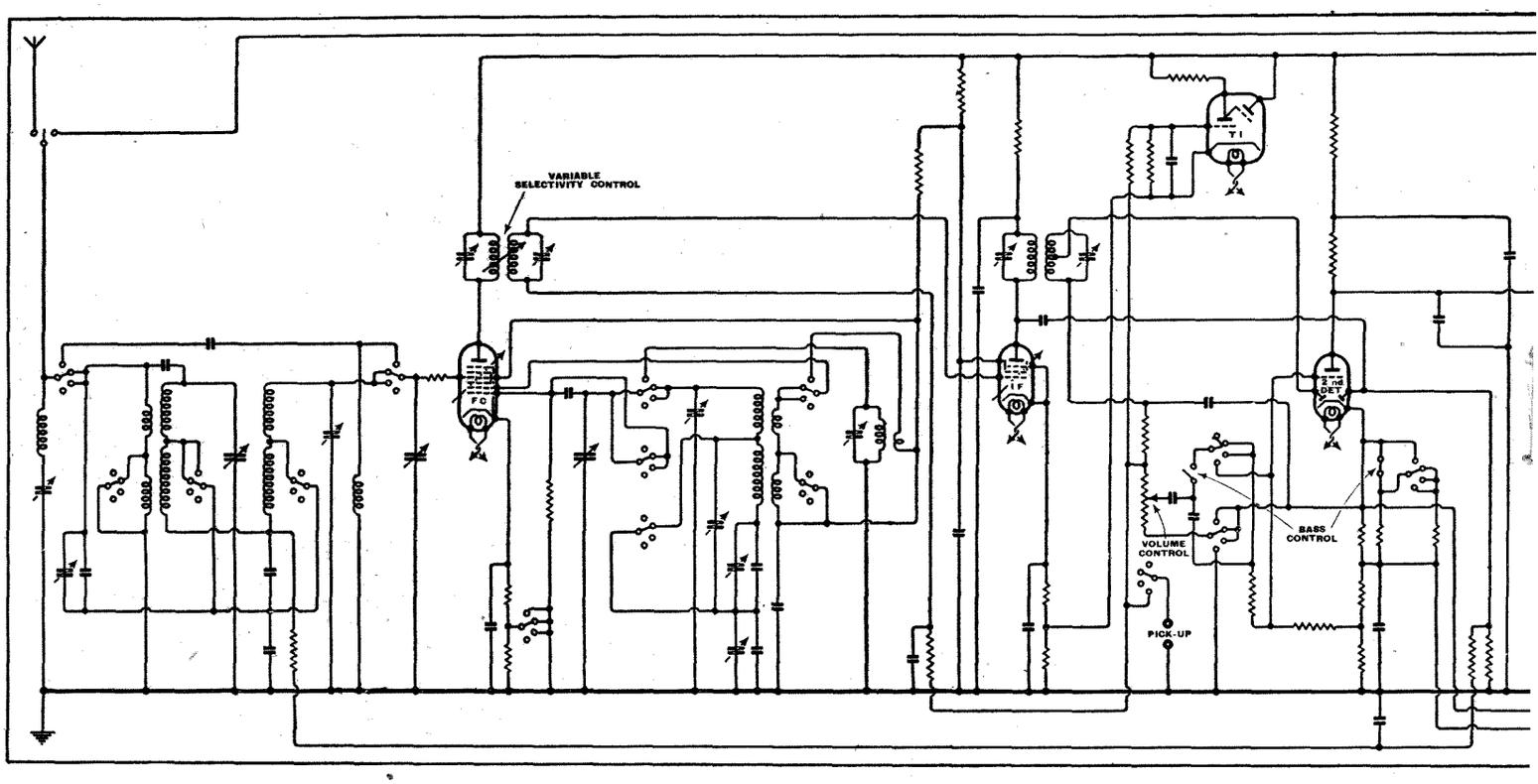
FEATURES.—*Type.*—*All-wave superheterodyne receiver for AC mains.* *Wave-ranges.*—*(1) 16.7-51 metres. (2) 200-585 metres. (3) 725-2,000 metres.* *Circuit.*—*Octode frequency-changer—var.-mu pentode IF amplifier—double-diode-triode second detector—pentode output valve with negative feed-back. Full-wave valve rectifier.* *Controls.*—*"Mono-Knob" control incorporating (1) Tuning. (2) Volume. (3) Tone and selectivity. (4) Wave-range. (5) Radio-gramo switch. (6) Mains on-off.* *Auxiliary Controls.*—*(1) Mains or external aerial switch. (2) Bass response switch. (3) Internal loud speaker switch.* *Price:*—*18 guineas.* *Makers.*—*Philips Lamps Ltd., 145, Charing Cross Road, W.C.2.*

THE range of Philips sets for the forthcoming season is unusually prolific in points of interest and originality, and the present model is sufficient to indicate the immense amount of research and development which has been undertaken in preparing for the new season's programme. Although on the basis of the number and arrangement of valves the Type 795A would seem to fall into the very large category of four-valve superheterodynes, its performance both from the audio- and radio-frequency points of view suggests a circuit of the six- or seven-valve type.

The basic arrangement is an octode frequency-changer followed by a single IF amplifier stage, a double-diode-triode second detector and a pentode output valve. On the medium- and long-wave ranges a band-pass filter precedes the frequency-changer, and in this filter is incorporated a whistle suppression circuit which subsequent experience with the set showed to be extremely efficient. On the short-wave range, however, a single circuit takes the place of the band-pass filter. Both the frequency-changer and the IF amplifier are controlled by AVC bias derived from one of the diodes in the second detector stage. During the reproduction of gramophone records the radio section of the receiver is suppressed by increasing the bias on the frequency-changer.

The first IF transformer has variable coupling which is mechanically linked with the tone control. The second transformer has fixed coupling and the secondary is tapped down to reduce the diode load. The AVC rectifier is connected to the primary winding in the usual way. A tuning indicator of the cathode-ray type with built-in triode amplifier is operated from the AVC line to the IF stage.

In the connections of the output valve and the preceding amplifier portion of the second detector we find what is probably the most interesting feature of the circuit from the electrical point of view. In addition to the normal resistance-capacity coupling there is a certain amount of negative feed-back which is taken from the secondary of the output transformer through a frequency discriminating cir-



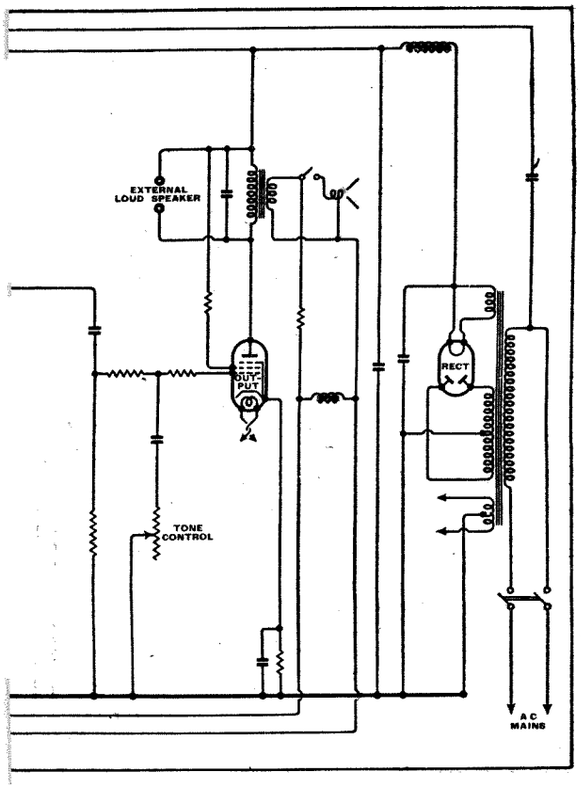
cuit, consisting of a choke and associated resistances, to the cathode circuit of the second detector valve. From the AF point of view this may be regarded as part of the grid circuit of the output pentode, and although the scheme results in some reduction of the effective amplification of the last stage, there is a marked improvement not only in the harmonic content of the $3\frac{1}{2}$ watts output available, but also a levelling of the frequency response, particularly in the bass.

The reaction coupling is automatically disconnected on the short-wave range where high sensitivity is essential, and it is also under the control of a separate switch so that the full bass response, which is of such great benefit to musical reproduction, shall not result in too deep a tone when listening to speech.

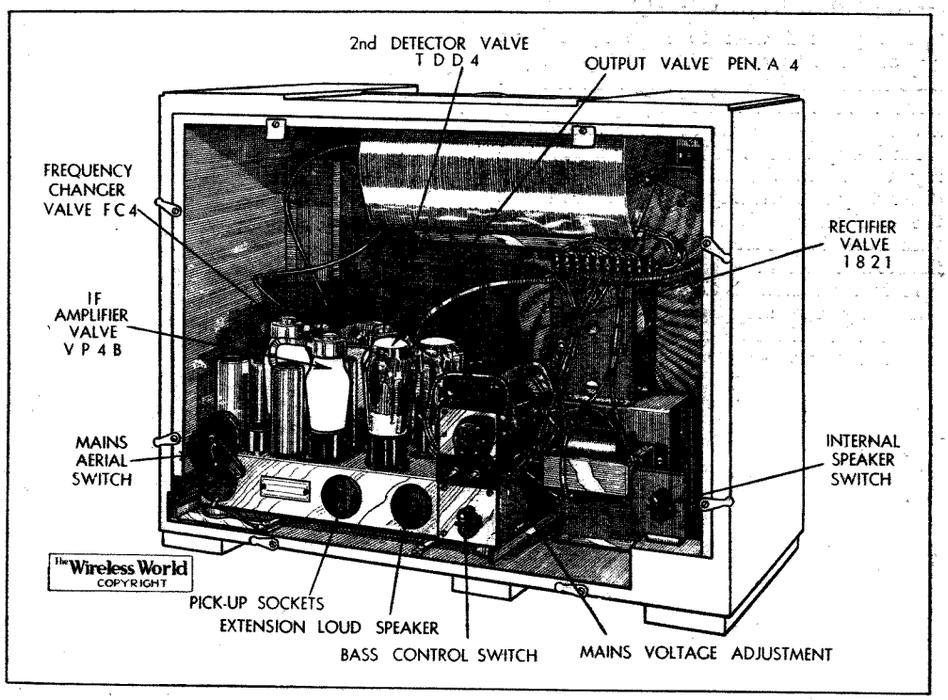
Improved Quality

The quality of reproduction is undoubtedly a great advance on accepted standards for receivers of this type, and has the clarity and freedom from incipient harmonic distortion which one associates with large triode output stages. The breadth of the bass response is, indeed, remarkable in a table model receiver of this size, and the new loud speaker, although of the narrow angle type, is free from focusing effects at high frequencies; indeed, the character of the transmission is notable for its breadth, though whether this is entirely a quality of the loud speaker or partly the psychological effect of the cabinet design it is difficult to say.

The good quality of reproduction is not confined to the local stations, and this receiver has the rare quality of bringing in foreign programmes with a clarity which at first deceives the listener as to their origin. Although no special arrangement is made in this particular model for inter-station noise suppression, the set is remarkably docile in view of its undoubtedly wide range.



One of the most interesting features of the circuit is the negative feed-back which has been provided in the output stage to give improved frequency response and reduced harmonic distortion.



Rear view of cabinet with safety back removed showing positions of valves and auxiliary controls.

As regards selectivity there is no difficulty on the medium-wave band in approaching within one channel on either side of the normal settings of Brookmans Park transmitters when using the set in Central London, and to do this does not appear to involve any really serious loss of high-note response. On the long-wave band the Deutschlandsender can be received clear of Droitwich and Radio-Paris, but here it is necessary to move the combined tone and selectivity control a little nearer to the low tone position.

The short-wave range is extraordinarily lively, and excellent reception was obtained from Schenectady during an afternoon session. This station was sufficiently strong to actuate the electron tuning indication, the fluctuations of which, incidentally, afforded striking proof of the efficiency of the AVC system, for the volume of the American station remained quite steady. As there is only a single tuned circuit preceding the frequency-changer on this range it is only to be expected that each station is received at two points on the scale. This should be borne in mind when trying to identify a transmission from its wavelength, which one is quite entitled to do in view of the accuracy of calibration of the set.

The tuning scale unit is hinged and may be tilted to provide comfortable vision in whatever position the receiver is installed. Control is effected through a series of flexible couplings, and the knife-edge pointer is actuated through a two-speed drive involving only a single knob. The scale may be traversed rapidly in one direction, and as soon as the direction of rotation is reversed the gear ratio is reduced for fine tuning. This condition is maintained for a distance sufficient to cover the various broadcast bands on the short-wave range and also the band width of any of the long-wave stations, and if the tuning knob is rotated still further in the same direction the lower gear re-engages and the search for stations can be continued without further delay.

The tuning knob is mounted in a ball joint giving two degrees of movement in addition to rotation. Vertical movement up or down controls volume, and horizontal movement simultaneously varies both tone and selectivity, the maximum selectivity and the lowest tone being to the left. A chromium-plated annular ring actuates the waverange, radio-gramo. and mains on-off switches. The mechanical design of this "Mono-Knob" control and its associated system of flexible couplings is an outstanding achievement and is certainly justified, not only by the ease with which the optimum operating conditions can be found for any given station, but also by the simplification which it has effected in the external appearance of the cabinet.

In dealing with any minor servicing troubles there is no necessity to disturb the somewhat complicated system of controls associated with the "Mono-Knob." All trimming condensers are readily accessible from the back of the cabinet, and an inspection cover under the base gives access to resistances and fixed condensers.

Letters to the Editor

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

X-Rays and Cathode-Ray Tubes

THE point I wish to raise must have occurred to others besides myself, yet I do not recollect ever having seen it mentioned. It is this: Are X-rays produced by a cathode-ray tube as used for television?

An X-ray tube *is* of necessity a cathode-ray tube. Is the converse true? They differ only in operating voltage, and in that the electron stream is focused on a fixed "anticathode" instead of moving over a fluorescent screen.

It is fundamental that X-rays are produced by the stoppage of a high-speed electron. Is there a critical velocity below which the production ceases entirely or does it fall off gradually? Or do the rays become so "soft" as to be incapable of penetrating to any appreciable distance?

Is it not just possible that over an extended period even the very smallest emission might have an unfortunate effect on a regular "looker-in"?

Brighton. ALFRED K. DAWSON.

[Mr. Dawson is, of course, correct when he says that some of the energy of the stopped electrons will appear as radiant energy. Much, of course, is converted into heat and into the visible light yielded by the fluorescent screen. What proportion remains to produce radiation of X-ray type it would be hard to guess; in any case, it is the frequency which is the most important.

In a cathode-ray tube the electrons have very little energy compared with those in an X-ray tube. Since in such cases the frequency of the radiation emitted is proportional to the energy of the electron stopped (Planck's Law), any radiation emitted will be of such long wavelength compared with X-rays as hardly to fall into the same category as these. Even with very high accelerating voltages, any radiation would only consist of the very softest of X-rays—so soft that they would hardly stand a chance of penetrating the glass of the tube. If they did their range in air would be quite small.

There are many scientific workers, it must be remembered, who have used cathode-ray tubes for years and years, to the tune of far more hours a day than any sane person would give to television, and no ill-effects have yet been reported so far as we are aware.—ED.]

The Ultra-Lightweight Portable

THE recent appearance of really lightweight receivers is a welcome development, but it occurs to me that modifications might make them still more portable and increase their dependability in the hands of the public.

First, is the LT accumulator essential? As the ultra-light portable is likely to be a set for occasional use rather than regular day-in-day-out operation, it seems to me that there is likely to be considerable dissatisfaction among non-technical purchasers if, through neglect, their accumulators die young. This seems quite likely to happen if the set is put away and forgotten in the intervals between holidays and so forth. The alternative source of LT would be dry-cells. They are always ready for use; if not overworked they remain effective for long periods. If the receiver is wanted suddenly, a couple of shillings at any ironmonger's sets it up with 100 hours' supply of LT current.

But are dry-cells practicable with 2-volt valves?

Two cells in series give 3 volts when new. To work 2-volt valves, whether normal or "deaf-aid," from such a supply would make a rheostat essential, and in unskilled hands there would be a grave risk of over-running the filaments to a serious extent.

But would it not be possible to revive the low-consumption 3-volt valves, so popular ten or eleven years ago when battery charging stations were few and far between? These valves, rated at 2.7-3 volts and consuming 0.06 amp., were only slightly over-run on a fresh 2-cell battery, and continued to function well when the dry cells, nearing the end of their life, were giving only 2.3 volts or so on a continuous 0.25-amp. drain.

Perhaps some valve designer could tell us the snags? Would 3-volt 0.05-amp. filaments be suitable for modern multi-electrode valves? DAVID SYMON.

Chorley Wood, Herts.

"The Wireless World Super-Selective Six"

THE following account of one of your star receivers, "The Super-Selective Six, June, 1931," may be of interest.

I constructed this set in the autumn following publication, using all specified parts throughout, together with a double-diaphragm linen cone (since changed to an energised m/c speaker).

It has been in constant use ever since, and failed for the first time a few weeks ago. Deciding that it was worth modernising (since the trouble was nothing more serious than a broken soldered connection), I substituted a double-diode-triode for second detector (for detection and AVC) and an HF pentode in place of original fixed-mu screen-grid IF valve, together with a Bulgin tuning indicator mounted between the two condensers. Results have fully justified the alterations, for although by no means perfect AVC is obtainable from the single controlled stage, it effectively holds all but the worst fading, and quality is greatly improved by the diode detector.

The most remarkable feature of the receiver is that, although designed five years ago, its selectivity is still equal to modern demands, and, used as it is in this district, on a full size outdoor aerial, it is possible to get a good signal from almost every worth-while station with the IF transformer coils opened to maximum, thus giving practically adjacent channel selectivity on the two London stations with only very occasional sideband splash. This remarkable performance is undoubtedly due to the separate oscillator condenser, which, although it might be considered a nuisance in these days of single-knob control, certainly extracts the last ounce of efficiency from the set, and, when once calibrated, the two tuning controls are not troublesome.

May I offer congratulations to *The Wireless World* and to the manufacturers of the various components, etc., as, with the exception of the output choke which broke down through an intermittent connection on an extension speaker, not *one* single part has ever failed, and the only valve replacements have been output pentode, oscillator and rectifier (twice). The receiver must have run literally thousands of hours, averaging three to four hours every day.

Wishing your publication continued success. EDWIN G. SEARS.

Beckenham, Kent.

Random Radiations

By "DIALLIST"

Why Not a Frequency Broadcast?

SOME time ago some very interesting talks on wireless that were broadcast by the B.B.C. included the transmission of various single notes whose frequencies were announced. These gave the owner of a wireless set, whether built or bought, a very good opportunity of determining just what its response was to various parts of the musical scale. *The Wireless World* has often proposed that every now and then the B.B.C. should give us a few minutes of similar frequency broadcasts, sending out notes at, say, 50, 100, 200, 400, 800, 1,200, 2,000, 3,000, 4,000, 5,000 and 6,000 a second? I know, of course, that it would show up some sets pretty badly; but wouldn't that be all to the good? The standard of transmission technique has improved so enormously in recent years that a good receiving set can give wonderful reproduction. The B.B.C., on this account, is always very careful to point out that no station makes such good quality possible as the local. That is perfectly true so long as the receiving set has something to say about the upper audio frequencies; but how many low-priced commercial sets have nowadays? Were frequency broadasts of the kind suggested to take place at intervals they would certainly stimulate improvement in the audio-frequency sides of radio sets.

Criticism from Overseas

A CORRESPONDENT stationed in the Far East sends me an interesting commentary on the short-wave Empire programmes. "We like the news bulletin," he writes, "with their items from all over the world besides the home news. Most welcome of all, perhaps, are the running commentaries on horse races, cricket and rugger matches, motor cycle trials, car races and other big sporting events. But they do seem to waste an awful lot of the pro-

Random Radiations—

gramme time—already too short—over announcements and so on." For instance, he tells me that when there's a fifteen minute ciné organ item the announcer may spend a good five of them giving out the fullest particulars of the wavelengths in use by the transmitters in service at the time. All this information is no doubt very useful, but it should be given as briefly as possible.

B.B.C. Please Note

Another mild grouse is concerned with the waste of time in giving a long, and sometimes rather rambling, account of the evening programme that is to follow. When it's going to last only a couple of hours you don't want any of the time to be spent in preliminaries. Once a week, too, a considerable period is spent in detailing coming events, though, as my correspondent says, everyone has the full week's programmes in the "local rag." Everyone won't see eye to eye with him there, for it's only in favoured places that there is such a thing as a local rag. Still, in the main he's probably right in suggesting that the time devoted to announcements of this kind should be cut down to a minimum and kept there.

Waves and "Bugs"

I WAS interested, but not surpised, to read that radiation of high-frequency has been found effective for destroying a particularly pernicious kind of weevil. Some time ago it was found that certain bacilli, cocci, or other "bugs" in milk were destroyed by something akin to shattering when subjected to oscillations of very high audio frequency, if I remember rightly. There is no question that radiations of different wavelengths have big effects upon the well-being, or otherwise, of both plants and animals. Ultra-short waves of a certain length, for example, can raise human temperatures to a very high point. Some time ago when experiments were toward in an American laboratory it was discovered that men can be kept perfectly warm and comfortable though wearing but the lightest of clothing in an unheated laboratory, whose doors and windows were all open to the bitterly cold atmosphere of mid-winter.

We're getting to know something about the effects of rays on living things. So far we've found some frequencies that are beneficial and some that are harmful. As time goes on it may be found that any particular living thing has a kind of critical frequency and that if it is subjected to intense radiation of this frequency it is simply snuffed out. But whether this will make a "death-ray" possible, except at the shortest of ranges, no one can say.

The Old and the New

THERE are those who won't go in for up-to-date receivers, not because they can't afford to do so, but because they contend stoutly that their present models, which may be three or four years old, perform as well as any you could wish. Others again hold that it is the height of extravagance to discard valves, no matter how ancient they are, so long as they continue to work. I wish that some who hold such views could have been with me the other afternoon when I was visiting two houses not a quarter of a mile apart in a place that has a reputation for being rather poor for radio reception. In the first of these houses really good reception was obtainable in broad daylight from Droitwich, three British Regionals and eight or ten foreign stations on the medium waveband. In the other the *only* station worth listening to even after dark was Droitwich. Other stations could be heard, but as the volume control had to be "full on" to obtain a reasonable sound level, there was a hideously noisy background.

A Contrast

Both set No. 1 and set No. 2 are mains-driven superhets of good make, containing the same number of valves. Each has a good aerial and earth system. The two houses stand at about the same height above sea-level and in neither case does there appear to be anything to cause a "wireless shadow." So far as one could make out, then, reception conditions should be equally good in both homes, and the receiving sets themselves must be mainly responsible for the widely different results obtained.

No. 1 is an up-to-date model; No. 2 is between three and four years old and its original valves are in use to-day. I haven't the smallest doubt that if this latter set were re-valved it would give an altogether different account of itself. But even so, it could not approach the performance of the new model with its greater sensitiveness, its more effective AVC and its far superior AF side. Yes, it *is* worth while to keep your receiving gear up to the mark.

Quality Suggestions

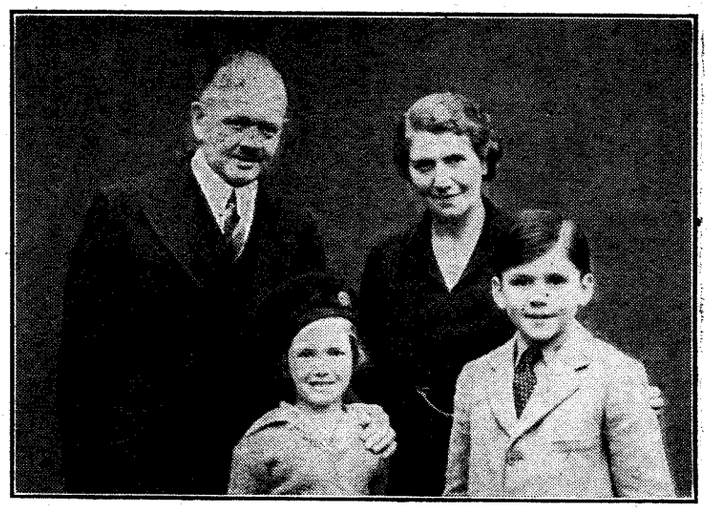
UNTIL a year or two ago the "ordinary listener" was not very critical of quality in reproduction. A loud and cheerful noise was—and still often is—the chief requirement, and a fair amount of distortion of one kind or another passed unnoticed. His first awakening to the fact that the wireless set was capable of better things came with the "bring out the bass" campaign of yester-year. For a long time after that the amount of bass remained for many the criterion of quality. Now I find that listeners are beginning to realise the importance of the high notes more and more and to develop an increasing dislike for the "woomphy" set that used to seem so satisfactory with its booming bass. The receiver with the "mellow tone"—in other words, the one with a complete cut off at about 3,000-4,000 cycles—is making a smaller and smaller appeal to ears that are growing gradually more critical. Set manufacturers will soon have to wake up to the fact that popular taste in quality does not stand still.

The Little More . . .

WHILST staying with friends in the country I have been having great fun with a large and expensive "all-wave" radio-gramophone of the latest type that they have installed, complete with special aerial. It is in most ways a lovely instrument, so sensitive and selective that you can pick up pretty well anything that is going on the long, medium or short waves. The quality is about the best that I've heard from a "commercial" instrument. So far so good. But it has what is to me a poisonous fault. The calibration on the long and medium waves is by station names, with a kilocycle scale as well. On the short waves there is not a kilocycle scale. On none of its ranges is the calibration sufficiently accurate to be of real use. Speaking in kilocycles, it over-reads on every scale. Now I'm quite sure that the man who was prepared to put down the price of this radio-gram wouldn't have minded paying anything up to a fiver extra to have it accurately calibrated by hand. Why don't makers offer this optional "extra" with their de luxe models?

Major Gladstone Murray

THE appointment of Major Gladstone Murray to be General Manager of the Canadian Broadcasting Corporation will scarcely come as a surprise to those who have been associated with broadcasting here and have watched his career since he threw in his lot with broadcasting in the very pioneering days of the B.B.C.



Major and Mrs. Murray photographed with their son and daughter after the announcement of the new appointment.

Major Murray has seen the B.B.C. safely through many difficult situations with which it was confronted in the early stages of its development, when all kinds of interests ranged themselves in opposition. It required infinite tact and resourcefulness to steer a safe course in those days, and Major Murray was well fitted for his task. To-day his talents will be applied once more to pioneering efforts, and he will leave the B.B.C. with satisfaction in the knowledge of having played a prominent part in laying the sure foundations of that great enterprise.

Major Murray's return to Canada must seem to him very like going home, for by birth he is a native of Western Canada, and was a Rhodes Scholar from Quebec. In 1933 he was lent by the B.B.C. to Canada to advise on the general organisation of broadcasting there.

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.
Ankara (Turkey)	153	.....	1961	5
Kaunas (Lithuania)	153	.....	1961	7
Brasov (Radio Romania) (Romania)	160	.....	1875	150
Hilversum No. 1 (Holland) (10 *kW.* till 7.40 p.m. G.M.T.)	160	.....	1875	100
Lahti (Finland)	166	.....	1807	150
Moscow, No. 1, RW1 (Komintern) (U.S.S.R.)	172	.....	1744	500
Paris (Radio Paris) (France)	182	.....	1648	80
Istanbul (Turkey)	185	.....	1622	5
Irkutsk (U.S.S.R.)	187.5	.....	1600	20
Deutschlandsender (Germany)	191	.....	1571	60
Droitwich	200	.....	1500	150
Minsk, RW10 (U.S.S.R.)	208	.....	1442	35
Reykjavik (Iceland)	208	.....	1442	16
Motala (Sweden)	216	.....	1389	150
Novosibirsk, RW76 (U.S.S.R.)	217.5	.....	1379	100
Warsaw, No. 1 (Poland)	224	.....	1339	120
Luxembourg	232	.....	1293	150
Leningrad, No. 1 RW53 (Kolpino) (U.S.S.R.)	232	.....	1293	100
Kalundborg (Denmark)	240	.....	1250	60
Vienna, No. 2 (Austria)	240	.....	1250	0.5
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
Tromsö (Norway)	282	.....	1063.8	10
Tiflis, RW7 (U.S.S.R.)	283	.....	1060	35
Finmark (Norway)	347	.....	864.6	10
Rostov-on-Don, RW12 (U.S.S.R.)	355	.....	845.1	20
Budapest, No. 2 (Hungary)	359.5	.....	834.5	18
Sverdlovsk, RW5 (U.S.S.R.)	375	.....	800	40
Boden (Sweden)	392	.....	765	0.6
Banska-Bystrica (Czechoslovakia)	392	.....	765	100
Geneva (Switzerland)	401	.....	748	1.3
Moscow, No. 3 (RCZ) (U.S.S.R.)	401	.....	748	100
Ostersund (Sweden)	413.5	.....	726	0.6
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
Hamar (Norway)	519	.....	578	0.7
Innsbruck (Austria)	519	.....	578	1
Tartu (Estonia)	522	.....	575	0.5
Ljubljana (Yugoslavia)	527	.....	569.3	6.3
Viipuri (Finland)	527	.....	569.3	10
Bolzano (Italy)	536	.....	559.7	10
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	3
Stuttgart (Germany)	574	.....	522.6	100
Alpes-Grenoble, P.T.T. (France)	583	.....	514.6	15
Riga (Latvia)	583	.....	514.6	15
Vienna No. 1 (Austria)	592	.....	506.8	100
Rabat (Morocco)	601	.....	499.2	30
Sundsvall (Sweden)	601	.....	499.2	10
Florence (Italy)	610	.....	491.8	20
Cairo, No. 1 (Egypt)	620	.....	483.9	20
Brussels, No. 1 (Belgium)	620	.....	483.9	15
Lisbon (Portugal)	629	.....	476.9	15
Tröndelag (Norway)	629	.....	476.9	20
Prague, No. 1 (Czechoslovakia)	638	.....	470.2	120
Lyons, P.T.T. (France)	648	.....	463	100
Petrozavodsk (U.S.S.R.)	648	.....	463	10
Cologne (Germany)	658	.....	455.9	100
North Regional (Slaithwaite)	668	.....	449.1	70
Sottens (Switzerland)	677	.....	443.1	100
Belgrade (Yugoslavia)	686	.....	437.3	2.5
Bodö (Norway)	686	.....	437.3	0.5
Paris, P.T.T. (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	.....	415.4	35
Kharkov, No. 1, RW20 (U.S.S.R.)	722	.....	415.4	10
Tallinn (Estonia)	731	.....	410.4	20
Madrid, EAJ2 (Spain)	731	.....	410.4	3
Seville (Spain)	731	.....	410.4	5.5
Munich (Germany)	740	.....	405.4	100
Marseilles, P.T.T. (France)	749	.....	400.5	90
Pori (Finland)	749	.....	400.5	1
Sortavala (Finland)	749	.....	400.5	0.25
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. (France)	776	.....	386.6	120
Fredrikstad (Norway)	776	.....	386.6	1
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	70
Milan, No. 1 (Italy)	814	.....	368.6	50
Bucharest (Romania)	823	.....	364.5	12
Moscow, No. 4, RW39 (Stalina) (U.S.S.R.)	832	.....	360.6	100
Agen (France)	832	.....	360.6	0.5
Berlin (Germany)	841	.....	356.7	100
Norwegian Relay Stations	850	.....	352.9	—
Sofia (Bulgaria)	850	.....	352.9	1
Valencia (Spain)	850	.....	352.9	3
Simferopol, RW52 (U.S.S.R.)	859	.....	349.2	10
Strasbourg (France)	859	.....	349.2	100
Poznan (Poland)	868	.....	345.6	16
London Regional (Brookmans Park)	877	.....	342.1	50
Linz (Austria)	886	.....	338.6	15
Graz (Austria)	886	.....	338.6	7.5
Helsinki (Finland)	895	.....	335.2	10
Limoges, P.T.T. (France)	895	.....	335.2	1.5
Hamburg (Germany)	904	.....	331.9	100
Dniepropetrovsk (U.S.S.R.)	913	.....	328.6	10
Toulouse (Radio Toulouse) (France)	913	.....	328.6	60
Brno (Czechoslovakia)	922	.....	325.4	32
Brussels, No. 2 (Belgium)	932	.....	321.9	15
Algiers (Algeria)	941	.....	318.8	12
Göteborg (Sweden)	941	.....	318.8	10
Breslau (Germany)	950	.....	315.8	100
Paris (Poste Parisien) (France)	959	.....	312.8	60
Bordeaux-Sud-Ouest (France)	968	.....	309.9	30
Odessa (U.S.S.R.)	968	.....	309.9	10
Northern Ireland Regional (Lisburn)	977	.....	307.1	100
Genoa (Italy)	986	.....	304.3	10
Torun (Poland)	986	.....	304.3	24
Hilversum No. 2 (Holland). (15 *kW.* till 7.40 p.m. G.M.T.)	995	.....	301.5	60
Bratislava (Czechoslovakia)	1004	.....	298.8	13.5
Midland Regional (Droitwich)	1013	.....	296.2	70
Chernigov (U.S.S.R.)	1013	.....	296.2	5
Barcelona, EAJ15 (Spain)	1022	.....	293.5	3
Cracow (Poland)	1022	.....	293.5	2
Oviedo (Spain)	1022	.....	293.5	0.7
Königsberg No. 1 (Heilsberg) (Germany)	1031	.....	291	100
Parede (Portugal)	1031	.....	291	5
Leningrad, No. 2, RW70 (U.S.S.R.)	1040	.....	288.5	10
Rennes-Bretagne (France)	1040	.....	288.5	120
Scottish National (Falkirk)	1050	.....	285.7	50
Bari No. 1 (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-Lafayette (France)	1077	.....	278.6	12
Zagreb (Yugoslavia)	1086	.....	276.2	0.7
Falun (Sweden)	1086	.....	276.2	2
Madrid, EAJ7 (Spain)	1095	.....	274	5
Vinnitsa (U.S.S.R.)	1095	.....	274	10
Madona (Latvia)	1104	.....	271.7	50
Naples (Italy)	1104	.....	271.7	1.5
Moravska-Ostrava (Czechoslovakia)	1113	.....	269.5	11.2
Fécamp (Radio Normandie) (France)	1113	.....	269.5	10
Alexandria, No. 1 (Egypt)	1122	.....	267.4	0.25
Newcastle	1122	.....	267.4	1
Nyiregyhaza (Hungary)	1122	.....	267.4	6.25
Hörby (Sweden)	1131	.....	265.3	10
Turin, No. 1 (Italy)	1140	.....	263.2	7
Trieste (Italy)	1140	.....	263.2	10
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)	1158	.....	259.1	10
Monte Ceneri (Switzerland)	1167	.....	257.1	15
Copenhagen (Denmark)	1176	.....	255.1	10
Kharkov, No. 2, RW4 (U.S.S.R.)	1185	.....	253.2	10
Nice Corse (France)	1185	.....	253.2	60
Frankfurt (*and Relays*) (Germany)	1195	.....	251	25
Prague, No. 2 (Czechoslovakia)	1204	.....	249.2	5
Lille, P.T.T. (France)	1213	.....	247.3	60
Bologna (Radio Marconi) (Italy)	1222	.....	245.5	50
Narvik (Norway)	1222	.....	245.5	0.3
Gleiwitz (Germany)	1231	.....	243.7	5
Cork (Irish Free State)	1240	.....	241.9	1
Saarbrücken (Germany)	1249	.....	240.2	17
Riga (Latvia)	1258	.....	238.5	10
Rome, No. 3 (Italy)	1258	.....	238.5	1
San Sebastian, EAJ8 (Spain)	1258	.....	238.5	1
Nürnberg (Germany)	1267	.....	236.8	2
Juan-les-Pins (Radio Côte d'Azur) (France)	1276	.....	235.1	2.7
Christiansand (Norway)	1276	.....	235.1	0.5
Stavangar (Norway)	1276	.....	235.1	0.5
Dresden (Germany)	1285	.....	233.5	0.25
Aberdeen	1285	.....	233.5	1
Klagenfurt (Austria)	1294	.....	231.8	5
Vorarlberg (Austria)	1294	.....	231.8	5
Danzig	1303	.....	230.2	0.5
Swedish Relay Stations	1312	.....	228.7	—
Magyarovar (Hungary)	1321	.....	227.1	1.25

Station.	kc/s.	Tuning Positions.	Metres.	kW.
German Relay Stations	1330	.....	225.6	—
Montpellier, P.T.T. (France)	1339	.....	224	1.2
Lodz (Poland)	1339	.....	224	2
Dublin (Irish Free State)	1348	.....	222.6	0.5
Rjukan (Norway)	1348	.....	222.6	0.15
Salzburg (Austria)	1348	.....	222.6	2
Tampere (Finland)	1348	.....	222.6	0.7
Cairo No. 2 (Egypt)	1348	.....	222.6	0.5
Königsberg (Germany)	1348	.....	222.6	2
Nottoden (Norway)	1357	.....	221.1	0.15
Italian Relay Stations	1357	.....	221.1	—
L'Ile de France (France)	1366	.....	219.6	0.7
Basle (Switzerland)	1375	.....	218.2	0.5
Berne (Switzerland)	1375	.....	218.2	0.5
Warsaw, No. 2 (Poland)	1384	.....	216.8	2
Lyons (Radio Lyons) (France)	1393	.....	215.4	25
Beziers (Radio Midi) (France)	1429	.....	209.9	0.3
Alexandria, No. 2 (Egypt)	1429	.....	209.9	0.5
Turku (Finland)	1429	.....	209.9	0.5
Miskolc (Hungary)	1438	.....	208.6	1.25
Paris (Eiffel Tower) (France)	1456	.....	206	5
Pecs (Hungary)	1465	.....	204.8	1.25
Antwerp (Belgium)	1465	.....	204.8	0.1
Courtrai (Belgium)	1465	.....	204.8	0.1
Bournemouth	1474	.....	203.5	1
Plymouth	1474	.....	203.5	0.3
Binche (Belgium)	1487	.....	201.7	0.1
Chatelineau (Belgium)	1492	.....	201.1	0.1
Wallonia (Belgium)	1492	.....	201.1	0.1
Nimes (France)	1492	.....	201.1	0.7
Albacete (Spain)	1492	.....	201.1	0.2
Radio Alcoy (Spain)	1492	.....	201.1	0.1
Santiago (Spain)	1492	.....	201.1	0.5
Liege (Radio Cointe) (Belgium)	1500	.....	200	0.1
Verviers (Belgium)	1500	.....	200	0.1
Pietarsaari (Finland)	1500	.....	200	0.25
Radio Alcalá (Spain)	1500	.....	200	0.2
Karlskrona (Sweden)	1530	.....	196	0.2
Liepàja (Latvia)	1737	.....	173	0.1

SHORT-WAVE STATIONS OF THE WORLD

Station.	Call Sign.	kc/s.	Tuning Positions.	Metres.	kW.
Ponta Delgada (Azores)	CT2AJ	4,000	.....	75.00	0.05
Kharbarovsk (Russia)	RV15	4,273	.....	70.20	20
Sourabaya (Java)	YDB	4,470	.....	67.11	1
Caracas (Venezuela)	YV2RC	5,800	.....	51.72	1
San Jose (Costa Rica)	TIX	5,820	.....	51.52	1
Maracaibo (Venezuela)	YV5RMO	5,850	.....	51.28	1
Vatican City (Vatican State)	HVJ	5,969	.....	50.26	10
Trujillo (Domenica)	HIX	5,980	.....	50.16	0.2
Mexico City (Mexico)	XEBT	6,000	.....	50.00	1
Moscow (Russia)	RW59	6,000	.....	50.00	20
Drummondville (Canada)	VE9DN	6,005	.....	49.96	6
Havana (Cuba)	COCO	6,010	.....	49.92	0.5
Singapore (Malaya)	ZH1	6,018	.....	49.85	0.09
Bogota (Colombia)	HJ3ABH	6,018	.....	49.85	1.6
Zeesen (Germany)	DJC	6,020	.....	49.83	5
Panama City (Panama)	HP5B	6,030	.....	49.75	0.1
Calgary (Canada)	VE9CA	6,030	.....	49.75	0.1
Boston (U.S.A.)	W1XAL	6,040	.....	49.67	10
Miami (U.S.A.)	W4XB	6,040	.....	49.67	2.5
Pernambuco (Brazil)	PRA8	6,040	.....	49.67	3
Barranquilla (Colombia)	HJ1ABG	6,042	.....	49.65	0.15
Daventry (Gt. Britain)	GSA	6,050	.....	49.59	15
Cincinnati (U.S.A.)	W8XAL	6,060	.....	49.50	10
Philadelphia (U.S.A.)	W3XAU	6,060	.....	49.50	10
Skamlebaek (Denmark)	OXY	6,060	.....	49.50	0.5
Manizales (Colombia)	HJ4ABL	6,067	.....	49.45	0.15
Vienna (Austria)	OER2	6,072	.....	49.41	1.5
Penang (Malaya)	ZHJ	6,080	.....	49.33	0.05
Chicago (U.S.A.)	W9XAA	6,080	.....	49.33	0.5
Nairobi (Kenya)	VQ7LO	6,083	.....	49.31	0.5
Bowmanville (Canada)	CRCX	6,090	.....	49.26	0.5
Johannesburg (South Africa)	ZTJ	6,097	.....	49.20	5
Bound Brook (U.S.A.)	W3XAL	6,100	.....	49.18	35
Chicago (U.S.A.)	W9XF	6,100	.....	49.18	10
Belgrade (Yugoslavia)	.....	6,100	.....	49.18	1
Manizales (Colombia)	HJ4ABB	6,105	.....	49.15	1
Daventry (Gt. Britain)	GSL	6,110	.....	49.10	15
Calcutta (India)	VUC	6,110	.....	49.10	0.5
Medellin (Colombia)	HJ4ABE	6,110	.....	49.10	1
Wayne (U.S.A.)	W2XE	6,120	.....	49.02	1
Havana (Cuba)	COCD	6,130	.....	48.92	0.25
Halifax (Canada)	VE9HX	6,130	.....	48.92	0.2
Pittsburgh (U.S.A.)	W8XK	6,140	.....	48.86	40
Winnipeg (Canada)	CJRO	6,150	.....	48.78	2
Lisbon (Portugal)	CSL	6,150	.....	48.78	0.51
Caracas (Venezuela)	YV3RC	6,150	.....	48.78	1
Parede (Portugal)	CT1GO	6,198	.....	48.40	5
Trujillo (Domenica)	HIZ	6,316	.....	47.50	1
Caracas (Venezuela)	YV4RC	6,375	.....	47.05	1
San Jose (Costa Rica)	TIPG	6,410	.....	46.86	0.5
Barranquilla (Colombia)	HJ1ABB	6,447	.....	46.52	1
Cali (Colombia)	HJ5ABD	6,490	.....	46.21	0.1
Valencia (Colombia)	YV6RV	6,520	.....	46.00	0.5
Riobamba (Ecuador)	PRADO	6,620	.....	45.31	1
Guayaquil (Ecuador)	HC2RL	6,667	.....	45.00	0.2
British Amateurs	.....	7,000	.....	42.86	0.01
		to		to	
		7,300		41.10	
Georgetown (British Guiana)	VP3MR	7,080	.....	42.36	0.15
Tokio (Japan)	JVP	7,510	.....	39.95	20
Prangins (Radio-Nations) (Switz'l'd)	HBP	7,797	.....	38.48	20
Quito (Ecuador)	HCJB	8,214	.....	36.50	0.25
Hong Kong (China)	ZCK3	8,750	.....	34.29	0.5
Budapest (Hungary)	HAT4	9,125	.....	32.88	5
Havana (Cuba)	COCH	9,428	.....	31.80	1
Rio de Janeiro (Brazil)	PRF5	9,501	.....	31.58	5
Daventry (Gt. Britain)	GSB	9,510	.....	31.55	15
Melbourne (Australia)	VK3ME	9,510	.....	31.55	1.5
Jelöy (Norway)	LKJI	9,530	.....	31.48	1
Schenectady (U.S.A.)	W2XAF	9,530	.....	31.48	30
Zeesen (Germany)	DJN	9,540	.....	31.45	5
Zeesen (Germany)	DJA	9,560	.....	31.38	5
Bombay (India)	VUB	9,565	.....	31.36	4.5
Millis (U.S.A.)	W1XK	9,570	.....	31.35	10
Daventry (Gt. Britain)	GSC	9,580	.....	31.32	15
Lyndhurst (Australia)	VK3LR	9,580	.....	31.32	1
Buenos Aires (Argentina)	LRX	9,580	.....	31.32	5
Philadelphia (U.S.A.)	W3XAU	9,590	.....	31.28	10
Sydney (Australia)	VK2ME	9,590	.....	31.28	20
Eindhoven (Holland)	PCJ	9,590	.....	31.28	20
Prangins (Radio-Nations) (Switz'l'd)	HBL	9,595	.....	31.27	20
Moscow (Russia)	RAN	9,600	.....	31.25	20
Rome (Italy)	2RO	9,635	.....	31.13	25
Lisbon (Portugal)	CT1AA	9,655	.....	31.07	2.5
Lisbon (Portugal)	CT1CT	9,677	.....	31.00	0.5
Madrid (Spain)	EAQ	9,860	.....	30.43	20
Bandoeng (Java)	PMN	10,260	.....	29.24	10
Ruysselede (Belgium)	ORK	10,330	.....	29.04	9
Tokio (Japan)	JVN	10,710	.....	28.01	20
Tokio (Japan)	JVM	10,740	.....	27.93	20
Medellin (Colombia)	HJ4ABA	11,710	.....	25.62	1
Winnipeg (Canada)	CJRX	11,720	.....	25.60	2
Paris (Radio-Colonial) (France)	TPA4	11,720	.....	25.60	12
Daventry (Gt. Britain)	GSD	11,750	.....	25.53	15
Zeesen (Germany)	DJD	11,770	.....	25.49	5
Boston (U.S.A.)	W1XAL	11,790	.....	25.45	10
Rome (Italy)	2RO	11,810	.....	25.40	25
Daventry (Gt. Britain)	GSN	11,820	.....	25.38	15
Wayne (U.S.A.)	W2XE	11,830	.....	25.36	1
Lisbon (Portugal)	CT1AA	11,830	.....	25.36	2
Daventry (Gt. Britain)	GSE	11,860	.....	25.29	15
Pittsburgh (U.S.A.)	W8XK	11,870	.....	25.27	40
Paris (Radio-Colonial) (France)	TPA3	11,880	.....	25.23	12
Moscow (Russia)	RW59	12,000	.....	25.00	20
Lisbon (Portugal)	CT1CT	12,082	.....	24.83	0.5
Reykjavik (Iceland)	TFJ	12,235	.....	24.52	7.5
Parede (Portugal)	CT1GO	12,396	.....	24.20	0.35
Suva (Fiji)	VPD	13,075	.....	22.94	1
Warsaw (Poland)	SPW	13,635	.....	22.00	10
British Amateurs	.....	14,005	.....	21.42	0.01
		to		to	
		14,395		20.84	
Vatican City (Vatican State)	HVJ	15.123	.....	19.84	10
Daventry (Gt. Britain)	GSF	15,140	.....	19.82	10
Daventry (Gt. Britain)	GSO	15,180	.....	19.76	15
Zeesen (Germany)	DJB	15,200	.....	19.74	5
Pittsburgh (U.S.A.)	W8XK	15,210	.....	19.72	40
Eindhoven (Holland)	PCJ	15,220	.....	19.71	20
Paris (Radio-Colonial) (France)	TPA2	15,243	.....	19.68	12
Daventry (Gt. Britain)	GSI	15,260	.....	19.66	10
Wayne (U.S.A.)	W2XE	15,270	.....	19.65	1
Zeesen (Germany)	DJQ	15,280	.....	19.63	5
Buenos Aires (Argentina)	LRU	15,290	.....	19.62	5
Daventry (Gt. Britain)	GSP	15,310	.....	19.60	15
Schenectady (U.S.A.)	W2XAD	15,330	.....	19.57	18
Szekesfehervar (Hungary)	HAS3	15,370	.....	19.52	20
Zeesen (Germany)	DJE	17,760	.....	16.89	5
Wayne (U.S.A.)	W2XE	17,760	.....	16.89	1
Huizen (Holland)	PHI	17,770	.....	16.88	23
Bound Brook (U.S.A.)	W3XAL	17,780	.....	16.87	35
Daventry (Gt. Britain)	GSG	17,790	.....	16.86	10
Bandoeng (Java)	PLE	18,830	.....	15.93	60
Daventry (Gt. Britain)	GSH	21,470	.....	13.97	10
Wayne (U.S.A.)	W2XE	21,520	.....	13.94	1
Daventry (Gt. Britain)	GSJ	21,530	.....	13.93	10
Pittsburgh (U.S.A.)	W8XK	21,540	.....	13.93	40

Recent Inventions

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

FLUORESCENT SCREENS

ZINC or cadmium sulphide as used for the fluorescent screen of a cathode-ray tube is prepared by coating the material with a fine crystalline deposit of aluminium hydroxide. This results in a free-flowing product which is readily made up into a screen and does not "cake." The material so prepared is also free from the usual tendency to "blacken" in the presence of traces of moisture, a defect which impairs its capacity to fluoresce.

A. Carpmael. Application date December 19th, 1934. No. 449392.

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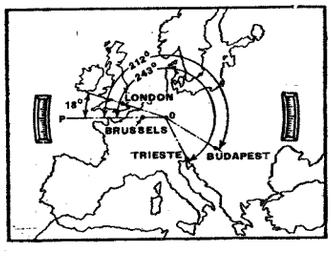
TUNING INDICATORS

THE face of the dial carries a translucent map of Europe marked, as shown, with a selection of the broadcasting stations. Behind the map is an opaque disc,



Tuning dial which indicates the geographical position of the station received.

which is geared to the tuning control and is pierced with holes at certain points, so that when the tuning spindle is turned to the correct setting the station to be received is shown lit up on the map. Instructions are given as to the manner in which the opaque disc must be pierced to secure this result. Long-wave stations are illuminated with a different colour from the short-wave stations. Or a screen may be interposed between the map and the opaque disc, so that, in one position, only the short-wave stations are illuminated, whilst in a second position only the long-wave stations are shown.

G. B. Kemp; L. A. Armstrong; and J. W. Courtman. Application date December 5th, 1934. No. 448268.

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TUNING SYSTEMS

THE tuned input circuit, and the intervalve couplings, of a wireless receiver consist of solenoid coils fitted with adjustable magnetic cores, which are adjusted to resonate so that a standing wave is set up along the length of each coil. According to the invention the distributed capacity across the windings of each coil is supplemented by a shunt condenser which is kept at a fixed value when tuning, though provision is made for "trimming" when the set is installed. The circuit is stated to be highly selective.

S. G. Brown. Application date October 15th, 1934 (divided out as a patent of addition to No. 445252). No. 447387.

AMPLIFIERS

AN amplifier for handling a wide band of radio-frequency signals, extending, say, from 150 to 1,500 kilocycles, consists of a series of valves, each arranged in parallel across one element of a number of series-resonant circuits. The circuits are tuned to sub-frequencies extending at regular intervals over the entire signal band. The arrangement allows selected sub-frequencies to be boosted at will, relatively to the others, so that the amplifier as a whole can be given any desired frequency characteristic. The arrangement is suitable for feeding a large number of radio receivers from a common aerial.

Kolster Brandes, Ltd., and C. W. Earp. Application date November 30th, 1934. No. 448113.

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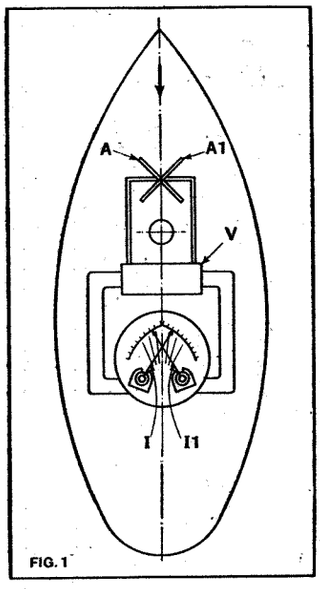
DIRECTION FINDING

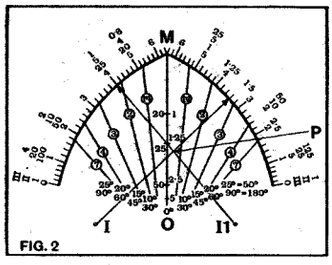
THE bearing of a single beacon station is directly obtained with the aid of a pair of inclined frame aerials, and is continuously recorded as the craft carrying the frame aerials changes its course. As shown in Fig. 1, the two frame aerials A, A1, are mounted in the fore-and-aft line of a ship.



Method of arranging the apparatus for wireless navigation.

The signal pick-up from each aerial is separately amplified at V, and is then separately applied to each one of a pair of ammeter indicators I, I1.

The scale over which these needles move is shown in Fig. 2. If the incoming wave induces equal signal-voltage in each of the frame aerials, the two indicators I, I1 will intersect each other on the centre line O.M. of the scale. But if one aerial is more in line with the distant beacon transmitter than the other, then the indicators will intersect to one side or other of the centre line. In Fig. 2 the point of intersection P shows that the beacon station lies slightly to the right or starboard of the course of the vessel.



The visual indicator showing the type of scale used and the two pointers.

The marginal scale also gives a rough indication of the distance of the ship from the radio beacon.

Radio Navigational Instrument Corporation. Convention date (U.S.A.) November 10th, 1933. No. 447273.

A CONTINUOUSLY ROTATING frame aerial is used to give a direct reading of the direction of a distant beacon station. The pick-up signal from the frame is first combined with that from a vertical aerial so as to produce a heart-shaped curve, free from the usual 180 deg. ambiguity. The resulting current, after amplification, is fed through commutator brushes on the shaft of the frame aerial to a coil of wire mounted between the poles of a horseshoe magnet. A rotary switch, also mounted on the same shaft, periodically reverses the current. This produces a torque in the magnet coil at any position other than the one in which the interrupted current is split into two equal parts. The indicator needle, which is mounted on the magnet-coil, accordingly tends to set itself into the no-torque position, which, since it coincides with the major axis of the heart-shaped curve, automatically indicates the required direction.

Standard Telephones and Cables, Ltd. (Assignees of Le Materiel Telephonique). Convention date (France) May 24th, 1934. No. 450027.

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ELECTRON MULTIPLIERS

AN initially small discharge current, which may be derived by photo-emission from a sensitised electrode, is amplified by successive stages of secondary emission. The electrons first liberated are directed at high velocity against a "target" electrode, where they produce secondary electrons by the force of the impact. The resulting electrons are similarly directed at high velocity against a second target with similar results, and the process is repeated until the desired amplification has been secured. The resulting current is taken off from an output electrode situated between the targets. The amplifier can be used as an "image-dissector" for television.

Television Laboratories, Ltd. Convention date (U.S.A.) October 7th, 1933. No. 450138.

o o o o

MICROPHONES

IN a carbon microphone where the current flows transversely through the carbon granules from one electrode to the other it is difficult to obtain a uniform output, because sound-waves of different frequencies penetrate the granular layer to different depths, and the deeper the penetration the larger the response.

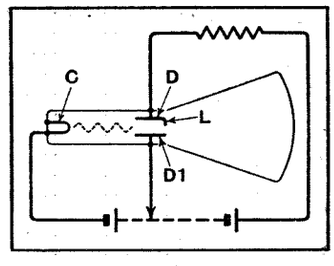
According to the invention this defect is avoided by arranging the carbon granules in a groove which varies gradually in depth, and may also vary gradually in width, in the same sense.

L. H. Paddle. Application date January 2nd, 1935. No. 449950.

o o o o

TELEVISION SYSTEMS

THE saw-toothed voltages used to deflect the electron stream in a cathode-ray tube are usually generated by discharging a condenser through a separate gas-filled valve. The invention consists in making use of the condenser formed by the actual deflecting electrodes mounted inside the cathode-ray tube, the periodical discharge being effected by the electron stream.



Methods of generating scanning potentials in the cathode-ray tube.

As shown in the figure, the two deflecting electrodes D, D1 are charged up from a suitable source of HT. As the stream from the cathode C is deflected or attracted towards the positively charged plate D, it ultimately impinges against a lip L formed at one end of the plate. Here it automatically opens-up a discharge path along the beam back to the cathode C. The operation is repeated indefinitely and so generates the scanning potentials required to operate the cathode-ray tube.

Marconi's Wireless Telegraph Co., Ltd., L. M. Myers, and R. Cadzow. Application date December 21st, 1934. No. 449177.

The Wireless World

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CONTENTS

EDITORIAL COMMENT

Modern Set Design

Need for Variety of Types

PROSPECTIVE purchasers are constantly asking how much they should pay for a wireless set, a question which is by no means easy to answer unless the answer has first been found to a number of other points having a direct bearing on the same problem.

We suppose that the reply might be that the average mains set of to-day costs about twelve guineas, but there are better and worse sets at higher prices, just as there are at prices below this figure. For years manufacturers have been torn between two lines of approach to the problem of marketing sets ; should they cater for the cheapest possible market so as to bring their sets within the means of even the poorest homes in the country, or should new wireless receivers continue to be regarded as something of a luxury, leaving the cheaper market to be supplied with the second-hand sets which make way for the new ones in the homes of those more fortunately placed ?

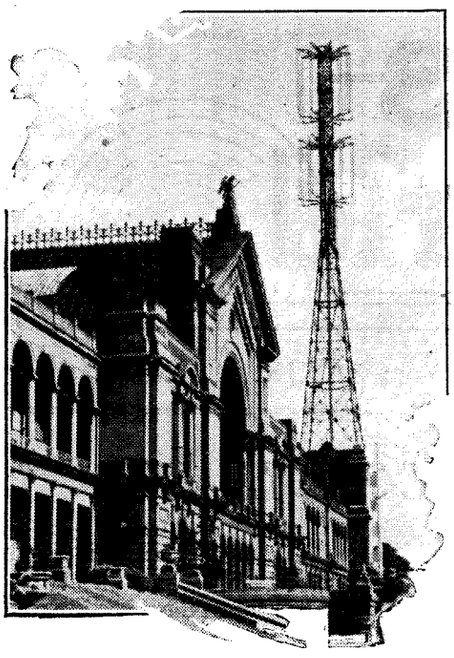
Price "Rings"

Hard things are often said on the subject of associations between manufacturers to control prices, and there have been unfortunate examples in some industries of abuse of positions created by such organised "rings." But a trade association which endeavours to prevent a reckless reduction of prices on a competitive basis more often than not is doing the public user a valuable service, especially where the articles manufactured are of such a nature as wireless sets, requiring that every precaution should be taken to avoid slipshod or over-hasty production. When, too, manufacturers are in cut-throat competition, each trying to produce the cheapest article, the margin of profit to the manufacturer is small and there is nothing left to spend on research and development work to improve the quality and efficiency of the product, and no prospect of anything beyond minimum wages for those employed in manufacture.

"Bottle-neck" Receivers

No one would wish that the public should have to pay more than is strictly necessary for a wireless set, and for this reason the substantial reductions in set prices which have taken place progressively during past years is everywhere welcomed, but it is necessary to look ahead and endeavour to guard against a position which might quite easily arise where the lowest price at which sets are sold would come to be regarded by the public as the highest price they should pay. Better sets with better quality of reproduction, better performance, and of greater durability and dependence, would cease to be the aim of designers and manufacturers, and might even disappear from the market.

There is room to-day for the cheap set as well as the expensive one, and a wide variety of types helps to keep the receiving side elastic. It is highly undesirable that at any time we should reach a position where the majority of the listening public regarded the cheapest set as the standard, and as good enough for the reception of broadcasting. If that time should ever come it will have shown private enterprise in broadcast receiver manufacture as incapable of acting as an auxiliary to the transmissions which, however good, would be brought to the level of performance of the receivers, which are, after all, the bottle-neck of reception quality.



Ultra-Short-Wave

Some Experiments on the Television Signals

THE range of ultra-short-wave signals, and especially the dependable range—in other words, the service area—is still a matter for controversy. This article, written after making a series of observations on television signals from the Alexandra Palace, will help to clear up many misconceptions on the subject.

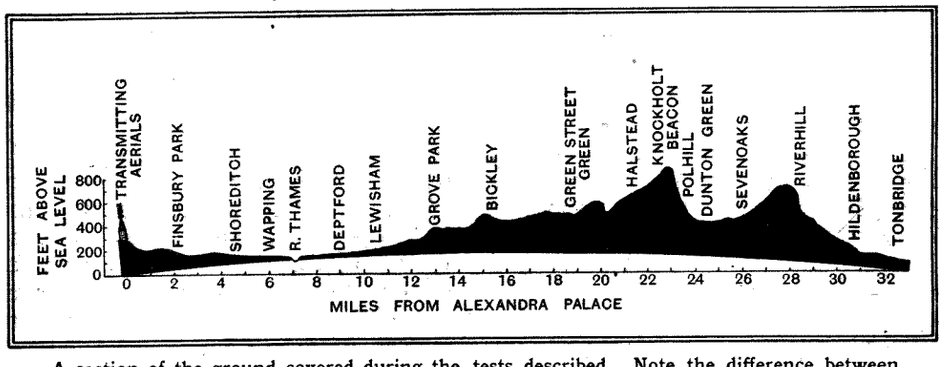
A WEEK or two ago I gave some results of observations made on the preliminary "tuning-up" of the Alexandra Palace television transmissions. The Radio Exhibition schedule made it possible to carry out much more extended tests which may shed some light on the question of the range at which the station may be expected to give a reliable service.

For this purpose it was necessary to have a receiver that was easily portable, did not take long to lash up, and that enabled the strength of the signal to be judged. The loudness of reception is generally a very uncertain guide, as the modulation is constantly changing (the sound programme was used for the tests, being less irritating to listen to for prolonged periods than the vision). The super-regenerative type of receiver might at first thought be considered to be particularly unsuitable because of its almost perfect AVC characteristics, whereby all except very weak signals are brought to a uniform level. But actually it is ideal for the purpose, because the background noise, which is initially very loud, decreases as the *carrier wave* strength increases and gives a useful indication of field strength over a wide range of intensity.

The dipole described in the previous article was a rather cumbersome piece of apparatus for moving about, and did not permit of observations being made while in motion. The tests to be described were made with a simple super-regenerative receiver having wire ends reaching to floor and non-metallic roof of the car. These were later replaced by a telescopic dipole made from tubular camera tripod legs.

The ground covered lay in the direction that presumably is least favourable for reception, having the whole of London lying between it and the Alexandra Palace transmitter. Even the National transmission from Brookmans Park, admittedly some miles farther away, but very much higher in power and wavelength, is known to be absorbed very seriously by this path and diminished to a barely satisfactory field strength within a mere twenty miles. Absorption in built-up areas is agreed to be still more pronounced as the wavelength is shortened. But whether this is serious when the whole of the transmitting aerial is raised well above the level of the city is open to question.

Starting at the south-eastern boundary of London, at Lewisham, the main road was followed as far as Tonbridge. To explain why this route was considered likely to be particularly interesting, a section of the ground between the Alexandra Palace and Tonbridge, 33 miles long, is shown. The vertical scale is, of course, exaggerated; actually about 25 times. But it will be seen to include two hills, or, rather, ridges, of even greater height than the transmitting tower itself. There is also appreciable curvature of the earth, which is shown. The section is along a straight line, but the road happens to follow it fairly closely all the way, and the high ground stretches for considerable distances at right angles to the section.



A section of the ground covered during the tests described. Note the difference between horizontal and vertical scales.

The field strength was very good at the start, the background noise being negligible; but just before actually joining the main road the car had to pass through a deep cutting at right angles to the direction of the transmitter and bordered by large trees. As was expected, reception fell off very badly here, but was still fairly good, except that at more or less uniform intervals there were curious bursts of background noise, corresponding to almost complete extinction of the signal. At first it was supposed that these might occur at the same intervals as the lamp standards, but this was soon found to be wrong. The phenomenon was to be noticed quite often later on.

Local Absorption

Passing through busy streets the reception fluctuated a good deal, and local absorptions were noted, but the severest effects of these were generally confined within limits of a foot or two. Some interference from the ignition systems of passing cars could occasionally be heard, and of course the continuous noise of the car in which the receiver was installed (not fitted with suppressors), but this was not bad enough to render speech hard to follow or to mask the background noise generated by the receiver itself.

An open level stretch of road conformed to expectations in giving excellent reception, but even here a periodical extinction or fluctuation was sometimes observed. Mental calculation based on the speed of the car showed that whenever this effect was observed it was usually at intervals of the order of half a wavelength. This is rather surprising, as the "interference"

Service Area

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

(in the optical sense) between sets of waves converging from directions not widely separate, such as the direct ray and that reflected from the ground, would lead to minima at intervals of a good many wavelengths.

This effect was examined later with improved apparatus, and the intervals between minima estimated to be slightly less than half a wavelength. The idea that standing waves on overhead wires might have some connection with it was disproved when similar results were obtained along roads devoid of overhead wires or metal fencing. Though there seems no doubt that standing-wave "patterns" due to reflections from various objects were responsible, it was not possible to identify these objects in any given situation. The same phenomenon can be demonstrated in acoustics by moving the ear into different positions when listening to a high-pitched note.

A somewhat similar effect takes place when the receiver is stationary and turned so as to obtain a minimum of reception. A vehicle moving past upsets the balance-out of the signal and gives rise to a succession of maxima and minima. It was found possible to detect even a bicycle at 40 feet and an aeroplane at several thousand feet. The moving object reflects a certain amount of the signal (an aeroplane is in a strong field and contains many wires and other parts, some of which may quite possibly resonate) and, when the direct signal is balanced out by the angle at which the receiving aerial is placed, the receiver is at its maximum sensitivity for picking up such stray reflections. As the object moves, the phase of the reflected signal changes periodically, causing fluctuations in reception.

Easily Explained Fluctuations

The screening effect of woods or thick borders of trees close to the road was noticeable; and also that due to buildings or high walls, but perhaps less so than was expected. The contour of the road likewise had its effects; in fact, most, but not all, of the fluctuations in signal strength could be related to the visible surroundings according to known principles.

The descent of the first steep slope carrying the road well below the direct line of the transmitter was awaited with interest. The upper part of the ascent gave excellent signal strength, but rather unexpectedly it fell off very noticeably before the descent of Polhill actually commenced. The fact that trees became fairly numerous at this point seemed hardly to be enough to account for it, but it is possible that the effect was supplemented by a less favourable angle between the radiation and the receiver, and by the cancellation of the direct ray by a reflected ray. Since making this observation it has been found to be in agreement with those of other experimenters.

As the hill was descended the signal declined steadily, and about half-way down, surrounded by trees, was so weak as to enable only occasional words of speech to be distinguished even with the engine stopped. But it must be remembered that the aerial and receiving conditions generally were far from ideal, and even in this exceptionally unfavourable location, 24 miles from the transmitter, a more ambitious receiving system with a raised aerial might achieve fair results. Incidentally, the vision signal on 6.7 metres seemed rather stronger, in so far as such different types of transmission could be compared at all.

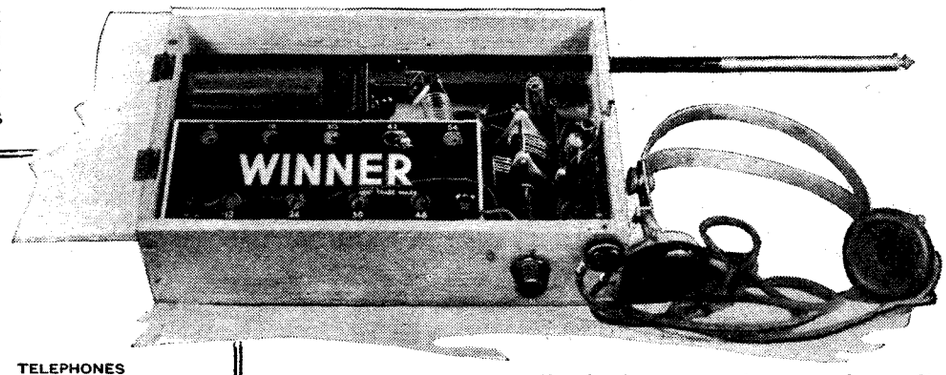
Further descent of the hill, but at an easier gradient, restored a large part of the lost signal strength; and at Dunton Green, 500 feet below the horizon of the transmitting aerial, reception was as good as in the more urban localities at half the range.

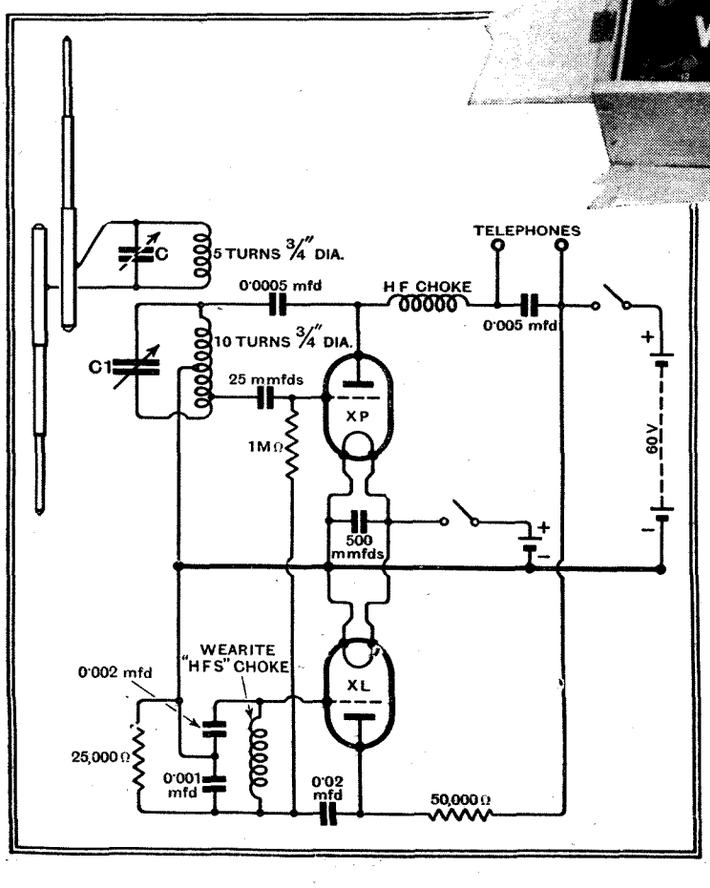
The next big hill, beyond Sevenoaks, again showed a rapid declension of signal very little beyond the crest. Although five miles farther on, and steeper in gradient, the loss of strength was less than at Polhill, and again there was a marked recovery on the lower slopes.

On the very low ground of the Medway Valley, around Tonbridge, reception was undoubtedly a lot weaker than on the rising country before Polhill, but hardly more so than would have been expected in view of the increased distance, let alone the intervention of two ranges of the North Downs.

Some other roads were surveyed without adding materially to the findings already described, except to dispel a faint suspicion that the overhead wires along the main road might have been helping reception.

A justifiable conclusion seems to be that 33 miles need not by any means be regarded as the maximum reliable range, even when the receiver is below the transmitter horizon. In the experiments described there was good reception in places where the radiation would have to turn





Circuit diagram of the super-regenerative portable receiver shown in the accompanying photograph. The aerial circuit condensers C and C1 are of about 100 m-mfds. Quenching is carried out by a separate valve.

Ultra-Short-Wave Service Area—

through an angle of as much as 4 degrees to clear the high ground.

Incidentally, the configuration of the ground in the opposite direction is curiously similar; Aylesbury taking the place of Tonbridge, and the Chilterns corresponding to the North Downs. Elsewhere, except perhaps towards the south-west, the topographical conditions for long range are more favourable. With the development of improved methods of reception, such as directional aerial arrays, considerable ranges are likely to be established. Such aerials are valuable not only for the increased signal reception, but also for reduction in interference when they are properly designed and located. One may also expect a diminution of interference at the source as suppressors become normal practice. It seems likely that the most troublesome factor at the fringe of ultra-short waverange will be fading due to variation in the standing wave patterns set up by objects that divert the radiation, for these are not necessarily stationary.

Since the results already described were obtained, an investigation was made along the Great North Road for a distance of 36 miles from the Alexandra Palace, using the improved telescopic dipole. A photograph and circuit diagram of this receiver are shown. Although the conditions of use while in motion did not permit of more than half of the full 6-foot extension being brought into action, quite strong reception was obtained up to the maximum distance, some miles north of Biggleswade, where the signal was actually received with the aerial completely telescoped and lying horizontally in the bottom of the car—the worst possible conditions. There was appreciable screening just beyond the hill (440 feet) near Stevenage, but otherwise little of interest. In general, the strength of reception over the greater part of the distance was such as to render even the car ignition inaudible.

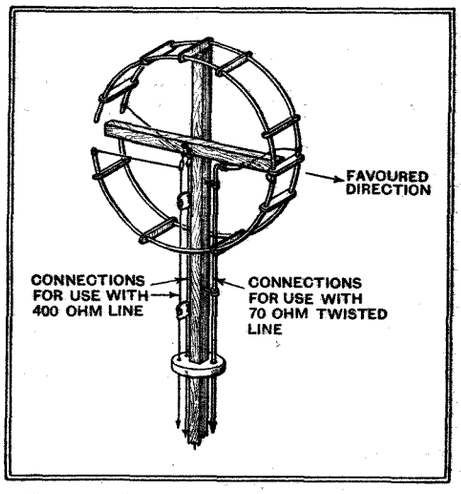
The relationship between strength of reception and orientation of dipole was subject to local variations, but most usually there was a maximum with the aerial vertical, and there was always a very large increase when the apparatus was raised even as little as a foot from the normal position with one end resting on the floor of the car.

Going to still greater distances, the sound programme was heard quite strongly and clearly, though with a fair background of super-regenerative noise, indoors about 100 feet above sea-level at Eastbourne. This is sixty-two miles from the transmitter, and no fewer than 3,000 feet below the horizon. Not only is there considerable earth curvature intervening, but a direct line passes right over Tatsfield, selected by the B.B.C. for a receiving station by virtue of its altitude. Similar results were obtained farther along the South coast at Rye, while out-of-doors, on the top of Beachy Head, the signal was really strong—good enough to suppress all background noise even when unmodulated.

Aerial Efficiency

Designing the Antenna for the Wavelengths to be Used

ONLY a few years ago a really good aerial was almost indispensable for the satisfactory reception of any broadcast station other than the local. Today, owing to the great improvement in receiver design even the poorest of aerials suffice almost anywhere. Actually, there is very little the listener can do to improve the efficiency of an aerial for ordinary broadcast use unless it be in cases where local electrical interference is troublesome. Then it is not the actual efficiency that is considered, but ways and means of improving the signal-to-noise ratio even though this may entail some reduction in the efficiency of the aerial as a collector of signals.



Reinartz Rotary Beam; a compact ultra-short wave directional aerial.

An aerial operates at maximum efficiency only when its length bears a certain relationship to the wavelength on which it is used, but the amount of wire permitted for broadcast use falls far short of the minimum necessary to achieve this object.

On the other hand, very efficient aerials of the resonant type can be employed on the short and ultra-short waves, as one for the 7 Mc/s amateur band, for instance, requires a wire only about 66 feet long. An aerial of this type is also quite efficient at all the harmonics of the wavelength for which it is designed.

The subject of aerial design is of such importance in amateur experimental work that the engineering staff of the American journal *Radio* has produced an 80-page book dealing exclusively with aerials. The *Radio Antenna Handbook*, as it is called, is published by Radio, Ltd., 7460, Beverly Boulevard, Los Angeles, California, U.S.A., and costs 50 cents in the U.S.A. and Canada, 2s. 6d. in the United Kingdom, and 3s. in Australasia.

It deals with the design of all the various types of aerials suitable for amateur use on the short and ultra-short waves, including directional arrays, and also with the design and construction of all-wave aerials of the kind sometimes referred to as the anti-interference type.

An example of a novel type for the ultra-short waves, and which is described in the handbook as the Reinartz Rotary Beam, is illustrated here. It is claimed to give a worth-while gain in signal strength both for transmission and reception in the favoured direction, for the aerial is uni-directional in a plane parallel to the loops and in a direction opposite to the open ends. As it takes up comparatively little space and is far more easy to handle than a dipole for the same wavelength, it should prove very useful for television reception, especially in situations where the maximum efficiency is required.

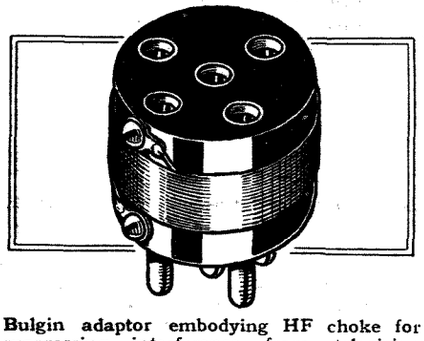
One for 58.5 Mc/s in the amateur band measures only 32ins. in diameter, while for 41.5 Mc/s, the sound accompaniment of television, the size of the loops would be about 45ins.

The book is profusely illustrated and will be found a valuable addition to the amateur's bookshelf. H. B. D.

Suppressing Television Interference

BROADCAST listeners in proximity to Alexandra Palace who may have experienced some interference from the television transmitters will be interested to learn that A. F. Bulgin and Co., Ltd., Abbey Road, Barking, Essex, have produced a special HF choke for suppressing the interference.

In order to be effective it should be joined direct to the grid of the detector valve, and this is arranged by winding the HF choke on a split-grid adaptor, so that, by removing the valve, inserting the adaptor, and then plugging the valve into the adaptor, the choke is included in the circuit without having to disturb a single wire.



Bulgin adaptor embodying HF choke for suppressing interference from television transmitters.

This choke is available at present wound on either a four- or a five-pin adaptor, and is intended chiefly for use in mains or battery sets of the straight type.

We understand that some small HF chokes suitable for inserting in the grid lead of valves with top-plug connectors and for use in superheterodynes will shortly be available.

"Parallel Wires as RF Transformers"

A CORRECTION

IN the above article an error occurred on p. 347, col. 2. Beginning at the 5th line, the sentence should read "mainly upon R_0 and the frequency it is desired to transmit. Naturally, as R_0 becomes *greater* . . ."

Inherent Receiver Noise

1—THE ULTIMATE LIMITS OF SENSITIVITY

By A. L. M. SOWERBY, M.Sc.

THE promise of anti-interference legislation suggests that, with a quieter background, an increase in the average sensitivity of receivers might be worth while. The assumption is reasonable, but inherent noises generated in the receiver put an ultimate limit to the amount of magnification that can be usefully employed; the nature of these noises and their evaluation is explained in this article.

CONTINUAL efforts are being made in all countries to reduce the interference with wireless reception set up by electrical machinery. What with silencing devices on the machinery itself, and "noise-proof" aerials equipped with high-frequency transformers and screened down-leads, there is, perhaps, some hope that, in time, the interference from this type of source will vanish completely. When it does, what then? Shall we be able, by sufficiently enhancing the selectivity of our sets, to pick up even the faintest and most distant stations on a background of perfect silence? Will it be possible to economise by reducing the power of transmitters and making a corresponding increase in the sensitivity of receiving apparatus?

Up to a point this would be possible, perhaps, but there is a definite natural limit to the useful sensitivity of a set. Such fundamental and inescapable things as the ultimate structure of matter and electricity begin to take a hand in the game if a set is made sufficiently sensitive.

In our schooldays most of us were introduced to a topic bearing the imposing title of "The Kinetic Theory of Gases." The term "theory" is perhaps misleading to many people, in that the word is so often used to imply an airy and possibly baseless speculation. In the present connection there is no ghost of such a flavour about it; the theory in question is the only possible interpretation of a huge host of observed facts, for which it accounts not merely in a rough general way but down to the last decimal point of painstaking measurement work.

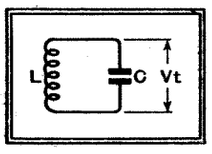


Fig. 1.—Tuned circuit resonating to 500 kc/s. Owing to thermal agitation of the atoms in the wire of the coil the circuit will spontaneously generate high-frequency voltages of a few microvolts across C.

The conclusions summed up in this theory are to the effect that a gas consists of a number of entirely independent particles (atoms or molecules) in extremely rapid movement, and that the apparently steady pressure exerted by a gas on the walls of the vessel in which it is confined is in reality the sum-total of the ceaseless rain of tiny blows given by the countless host of flying particles. By observing the manner in which the pressure of a gas changes with temperature, and interpreting the changes in the light of this theory, it becomes quite evident that the heat-energy put into a gas in warming it eventually goes to increase the kinetic energy of the movement of the particles; that is, it increases their velocity of flight.

It is equally true, though less easily demonstrated, that the atoms or molecules of a solid are also in continual movement. Since a solid retains its shape indefinitely it is clear that the average position of each atom must be fixed; we conclude, therefore, that the movement of the atoms takes place round this fixed position. Once again the movement of the atoms is the ultimate form in which heat energy is stored, so that the movement could only be completely stilled by abstracting all heat from the material—that is, by reducing its temperature to the "absolute zero," which is 273 Centigrade degrees below the freezing point of water. At all temperatures above this there is movement, the movement being faster the higher the temperature.

All this does not seem at first sight to have much connection with wireless. But we know that in a conductor there are free electrons, for it is their movement from atom to atom under the drive of a potential difference that constitutes the electric current. We therefore have to imagine some of these perpetually moving atoms as carrying, even if only momentarily, an extra electron, while others, the suppliers of the extra electrons, are temporarily short of their normal complement. This means that some atoms are negatively, some positively, charged, and the atoms in movement consequently have to be regarded as electric charges in movement.

Over any reasonably prolonged period—a second, for example—the random to-and-fro movements of so huge a host of charges will almost exactly balance, leaving an excess of movements in one direction or the other which is so small as to be negligible in comparison with the enormous total of the number of movements. But it is not difficult to see that on many occasions within that second there will have been instants when the net number of electrons moving one way appreciably exceeded those moving in the contrary direction. If, during the whole of one particular millionth of a second, the number of electrons going upwards in the wire of the coil in Fig. 1 exceeded the number going downwards, the circuit as a whole, if tuned to 500,000 cycles per second, would receive an impulse that would send it momentarily into oscillation. Ignoring resistance, it is clear that this oscillation would persist until chance brought about an exactly equal excess of electrons so accurately timed to match the period of oscillation that the current round the tuned circuit was opposed and wiped out by it. In a practical case, where the circuit would contain resistance, the oscillation would die away slowly unless either killed prematurely in the way suggested or reinforced by a second momentary current.

This mode of looking at the effects of the random movements of electrical charges in a conductor makes clear that they can set up, and so may be said to contain, oscillations at a frequency of 500 kc/s. But there is no special magic in that particular figure; just the same considerations would hold if we had thought of our tuned circuit as resonating to any other frequency.

We can only conclude, then, that the atomic movement due to stored heat-energy in a conductor is equivalent to simultaneous currents of all possible frequencies.

Thermal Agitation

In the circuit of Fig. 1, then, the thermal movements in the wire of which the coil is wound will produce currents of all frequencies. But the impedance of the circuit is high only towards currents of frequencies round about that to which it is tuned, and low to currents of other frequencies; the voltage developed across the circuit will therefore be limited to a band centred on 500 kc/s. If the tuned circuit is part of a receiver this means that the received carrier will be accompanied by thermal voltages at and round the same frequency. Those close to, but not exactly at, the resonant frequency will be heterodyned at the detector by the carrier in just the same way as are the normal sidebands sent out by the transmitter; since all neighbouring frequencies are present, none more than

Inherent Receiver Noise—

another, they will appear in the loud speaker as noise and not as a musical note.

When two voltages at different frequencies are simultaneously applied to a detector the frequency of the output is equal to the difference of the frequencies of the applied voltages, while the magnitude of the output is proportional to the product of their amplitudes. Thermal noise-voltages alone, in the absence of any other received signal, will give a certain output by mutual heterodyning, but on tuning in a carrier of amplitude several times greater than the noise-voltages these will be rectified as sidebands of the carrier and the noise-level will rise. It is this effect that is at least partly responsible for the considerable increase of noise always observed when a carrier is tuned in.

In transmitting a musical programme it is found that the modulation depth required to give the correct aural impression of loudness drops with a rise in frequency of the note being sent out. Noise-voltages, however, are the same (so far as the tuned circuits permit) at all audible frequencies. This accounts for the fact that when aurally estimated noise appears to consist mostly of higher frequencies—taking the words to imply pitch only, and not loudness—we should describe noise as having the characteristics of a "hiss" rather than a "roar."

It is possible to calculate, on purely theoretical grounds, the thermal noise-voltage developed across any circuit. Since the atomic agitation that gives rise to these spontaneous voltages is due to the heat-energy that the atoms contain, the noise will be greater the higher the temperature, and can be made to cease only by cooling the circuit to the absolute zero. A second factor, besides temperature, is the frequency range over which the thermal voltages are to be measured; as we have seen, there are voltages at all frequencies, and the wider the frequency range our receiver includes the greater will be the noise. The third factor is the resistance across which the noise is developed; we must remember that thermal agitation merely produces currents, and that it is only when they

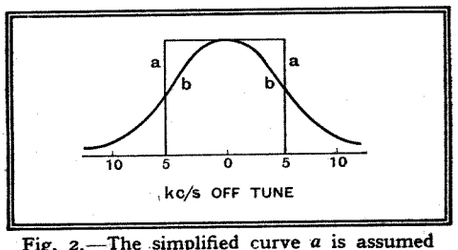


Fig. 2.—The simplified curve *a* is assumed for purposes of approximate evaluation of noise instead of the truer resonance curve *b*.

flow through a resistance that they produce voltages.

At a temperature of T degrees absolute the total noise-voltage within the frequency band f_1 to f_2 that is developed across a resistance R is given by the formula:

$V^2 = 5.5 \times 10^{-23} T(f_1 - f_2)R$ (V in volts).

For the particular temperature 290° absolute (=63° F.), which represents very fairly well that at which wireless sets are generally used, the formula becomes:

$$V = 1.25 \times 10^{-10} \sqrt{R \times F} \text{ volts,}$$

where F stands for the width, in cycles, of the frequency band f_1 to f_2.

In the case of a receiver not of superheterodyne type, and built for the ordinary broadcast band, the interference due to thermal noise-voltages can be estimated quite readily, provided we do not try to do it too accurately. We will suppose that the overall resonance curve of the receiver has the perfectly square-topped form shown at *a* in Fig. 2, making the rather absurd assumption that the tuned circuits pass all frequencies within 5 kc/s on either side of the carrier at undiminished strength, and then cut off suddenly. In a real case, of course, frequencies less than 5 kc/s from the carrier are to some extent attenuated, while frequencies still further out are not entirely eliminated, as indicated by the curve at *b* in Fig. 2. Allowing for all this would be so complicated that the rough-and-ready simplification of replacing curve *b* by curve *a* for purposes of calculation is a very acceptable one.

Noise Level : a Typical Case

If the grid circuit of the first valve of the receiver contains a tuned circuit of dynamic resistance about 80,000 ohms and, as suggested, the set passes signals over a total range of 10 kc/s, the noise-voltage at room temperature works out thus:

$$V = 1.25 \times 10^{-10} \sqrt{R \times F} = 1.25 \times 10^{-10} \sqrt{88{,}000 \times 10{,}000}$$

$$= 1.25 \times 10^{-10} \sqrt{8 \times 10^8} = 1.25 \times 2.8 \times 10^{-6} \text{ volts}$$

$= 3\frac{1}{2}$ microvolts.

As we have seen, this noise-voltage has to be compared not with the carrier but with the sidebands of a received signal. At 10 per cent. modification a signal of carrier amplitude 35 microvolts at the grid of the first valve would give a rectified output in the speaker at the same volume level as the thermal noise. Allowing for a step-up of 10 times in the tuned circuit between aerial and first grid brings us back to $3\frac{1}{2}$ microvolts as the faintest signal that will not be more or less drowned out by thermal noise, while we might hazard, as a pure guess, that a carrier strength of not much less than 50 microvolts at the aerial terminal will be required to provide a programme in which even the quietest parts will rise sufficiently above the noise level to be enjoyable rather than merely intelligible. But this last, evidently, is a matter of opinion rather than of calculation.

If the thermal noise includes voltages up to 10 kc/s away from the carrier, it is clear that after detection they will be represented as speech-frequency currents up to 10,000 cycles per second. Whether the whole of these will eventually reach the listener's ear depends partly on the characteristics of the low-frequency amplifier and partly on the characteristics of the loud speaker and the room in which it is used. This rather complicates the problem. To obtain accurate information as to the interference actually reaching the speaker we have to consider first the mixture of noise, carrier, and sideband voltages at the detector and

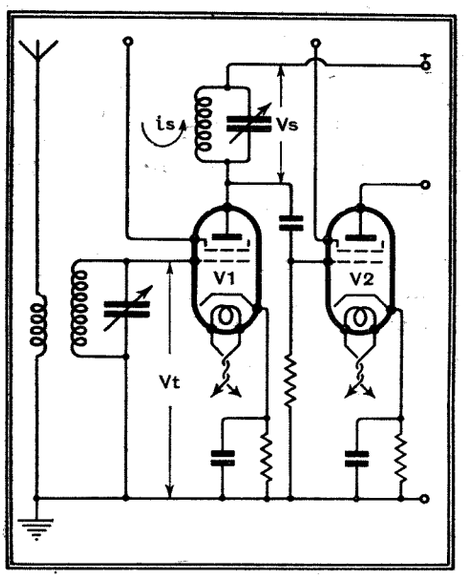


Fig. 3.—Skeleton circuit showing sources of noise. Vt = thermal voltage, *is* = shot-noise current, Vs = shot-noise voltage. Note that Vt appears, amplified, across the tuned anode circuit where Vs originates.

find out, by calculation or measurement, what radio-frequency voltages will result after detection. Of these audio-frequency voltages some will reach the speaker at full amplified strength, some will be much less amplified, and some will be lost entirely. The point of this two-stage working out will be seen when it is realised that two thermal voltages, at 10 and 14 kc/s from the received carrier, can jointly contribute at least a little noise at 4 kc/s after passing the detector; it is therefore not quite safe to disregard these voltages on the grounds that the AF amplifier cuts off at 5,000 cycles.

Inherent Valve Noise

In a wireless receiver there is a second source of irregularity, in nature closely akin to the thermal agitation of which we have been speaking. The current through a valve consists of free electrons arriving individually at the anode, and though the current appears steady when observed over any prolonged period, this is only so because we are unable to perceive directly the separate electrons which make it up. An apparently steady 3 milliamps. of plate current is subject to trifling random variations round this mean value; it is therefore correct to regard it as a direct current on which is superposed a second "noise current" in character exactly like the thermal noise. On account of the fact that this new noise owes its origin to the bombardment of the anode of the valve by the electrons, which pepper it like small shot, the name "shot noise" is used to describe it.

As before, the currents are distributed over all possible frequencies; the magnitude of the shot current therefore depends

Inherent Receiver Noise—

again on the frequency range we have to take into consideration. Further, since the disturbance consists in variations in the number of electrons arriving from instant to instant at the anode, a larger current leads to larger variations. If the average anode current is I amperes, the total of all noise currents lying between the two frequency limits $f1$ and $f2$ is given by:

$i^2 = 3.18 \times 10^{-19}(f1 - f2)I$ (i in amperes)

or, putting F for the frequency range as before.

$$i = 5.54 \times 10^{-10}\sqrt{F \times I} \text{ amperes.}$$

How does this compare in magnitude with the thermal noise? If we make the same assumption of a set passing undiminished all frequencies up to 5 kc/s on either side of the received carrier and then cutting off sharply, and take 3 mA as a likely current for the first valve, we get as shot noise current:

$$i = 5.64 \times 10^{-10}\sqrt{10 \times 3 \times 10} = 5.64 \times 10^{-10}\sqrt{30}$$

$= 3.1 \times 10^{-9}$ amperes, or 3.1×10^{-3} microamps.

This noise current flows through the anode coupling impedance of Fig. 3, and develops it across a voltage depending on the magnitude of that impedance. If we take this as a tuned circuit of dynamic resistance 80,000 ohms (the figure assumed for the grid circuit in which thermal noise was developed) the noise voltage passed to the grid of the second valve will be $3.1 \times 80 = 248$ microvolts.

In practice the voltage found is considerably less than the calculated value, for the calculation is based on the assumption that all the electrons emitted by the cathode reach the anode. It is known that the large space charge round the cathode, consisting of electrons held back by the customary negative voltage on the grid, exerts a very considerable "cushioning" effect, and reduces the current fluctuations producing the noise even below the value proper to the reduced anode current. In such a case as that for which we have worked out the voltage the figure found in a set would not be much over a third of that calculated from the formula. For comparison with the thermal noise we might take the shot noise at 100 μV. at the grid of the second valve; at this figure we shall at least not be underestimating it.

Even this reduced value appears enormous compared with the thermal noise-voltage of $3\frac{1}{2}$ μV. But it must be remembered that this appears a stage earlier in the set than the shot noise, and so is subject to amplification before it reaches the grid of the second valve. If the first valve has a mutual conductance of 2mA/v., and is followed, as assumed, by a tuned circuit of dynamic resistance 80,000 ohms, the stage gain will be approximately $80 \times 2 = 160$ times. The thermal noise at the grid will therefore be amplified up to give $3\frac{1}{2} \times 160 = 560$ μV. at the grid of the second valve. It is this figure that must be compared with the shot noise 100 μV. developed in the anode circuit of the first valve.

These relative figures show that in a set designed for the ordinary broadcast wavelengths, and beginning with a stage of radio-frequency amplification, the limit to usable sensitivity is set by the thermal noise arising in the first grid circuit. By comparison, the shot noise is negligibly small, adding only some $1\frac{1}{2}$ per cent.* to the total noise-voltages in the particular case we have considered

(A concluding instalment will deal with some other aspects of receiver noises.)

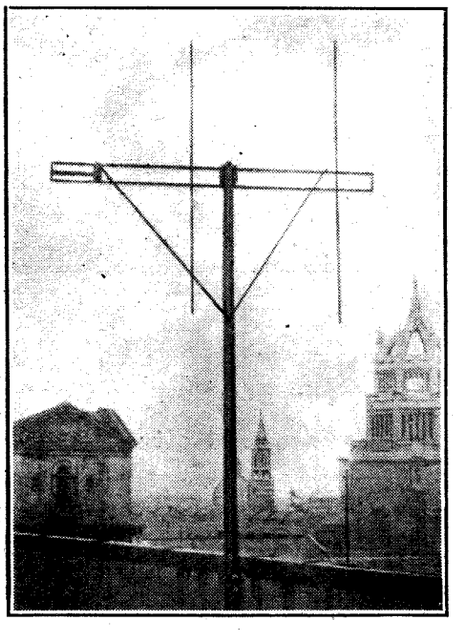
* Noise-voltages, being random in character, have to be added according to rule: $V^2 = V_1^2 + V_2^2$, where V is the total voltage.

DISTANT RECEPTION NOTES

SO far, the general increase in the field strength of the more distant medium-wave stations that has been noticeable during the evenings of early autumn has shown no signs of producing the crop of heterodynes that seemed possible with the coming of the season of shorter days and longer nights. The good work of the I.B.U. is very much in evidence.

On the night before this note was written I went carefully over the medium-wave band between nine and ten o'clock with a modern superhet., keeping a record of the stations that were received well enough and sufficiently free from interference of any kind to have real entertainment value. Had I been asked to guess the number beforehand I should have put it at 30-35. To my surprise it turned out to be 51! And no fewer than twenty of these were on wavelengths below 300 metres.

At first sight, then, the indications appear to suggest that a wonderful season, for European stations at any rate, is before us.



PUBLIC TELEVISION DEMONSTRATIONS.—Special aerial erected at the Science Museum, South Kensington, for reception of the Alexandra Palace transmissions. Demonstrations are being given daily from 11 a.m. to noon and from 3 p.m. to 4 p.m; on Friday and Saturday of last week, they were attended by over 2,000 persons.

Probably it is, but we are not yet so far out of the wood as to justify shouting. Quite a number of stations are due to bring new and far more powerful transmitting plants into action during the next few months. These are almost bound to cause a certain amount of trouble at first, and it may be a little while before the I.B.U. is able to straighten matters out. On the whole, though, I am bold enough to forecast the best autumn and winter for European listening that we have had yet. With a reasonably good set in a reasonably good locality the choice after dark should run to at least forty stations.

About transatlantic listening I am not so sanguine. The main enemy here is the atmospheric. Disturbances have been very bad of late, and, as we approach the sunspot maximum, they are bound to become worse.

With the possible exception of the Russian RED I have always thought that the Japanese JOAK was one of the most appropriately named radio stations. JOAK has become twins, so to speak, during the last few years. No. 1 works on 508 metres, and No. 2 on 345. And something further has happened just lately. Both No. 1 and No. 2 have blossomed out as 150-kilowatt stations. There is every chance that one or other of them may be logged in this country. JOAK, when a singleton of small power, was actually heard here on one memorable evening by many listeners a good many years ago.

These are not the only Japanese stations to be raised to the high-power level. The whole broadcasting system of that progressive country is being overhauled, and several others will be using brand-new plants rated at from 50 to 100 kilowatts before long.

But for the industrial troubles from which France has been suffering, the new Radio-Normandie would have been at work some weeks ago. At it is, delays have been inevitable, and as I write the old plant at Fécamp is still in action. At any time now, though, you may find the new Louvetot transmitter making its *début*.

Speaking of French stations, a correspondent in India tells me that he has lately had excellent reception at Simla of the 0.7-kilowatt *Ile de France*. He could hardly believe his ears until he verified the call sign beyond all possibility of doubt.

Trustworthy Electrical Connectors

A PARTICULARLY well-prepared catalogue has just been issued by Belling and Lee under the title of "Radio and Electrical Accessories." As might be expected, it deals largely with terminals, plugs, sockets and other non-spectacular but none the less vital parts used in the construction of modern wireless apparatus.

The book, which contains clear dimensional drawings as well as perspective illustrations of all the accessories listed, is a valuable source of information on parts for special requirements. Among the more recent and less well-known devices described are screened plugs and sockets, Air Force wander plugs (with a locking device), low-loss bushings, and a valve hood combined with a screened connector. Lastly, there is a summary of suppressor devices which are more fully dealt with in other Belling and Lee publications.

Most of the trade literature reviewed in our pages is issued free, but the present publication is so different from the usual run of small-part catalogues that few will object to the charge of sixpence which is made for it. Copies are obtainable from Belling and Lee, Ltd., Cambridge Arterial Road, Enfield, Middx.

Mixing Circuits

COMBINING THE OUTPUTS OF PICK-UPS AND MICROPHONES

ONE difficulty which always arises in PA equipment is the mixing of the outputs of various pick-ups and microphones. The circuits generally employed are discussed in this article, and it is shown that the only entirely satisfactory method involves the use of an input valve for each channel.

By W. T. COCKING

IN public-address equipment above all there often arises the problem of combining the outputs of several pick-ups and microphones so that they are mixed to any desired degree. It is commonly required, for instance, to reduce the volume on gramophone temporarily so that announcements can be made while retaining a gentle background of music. At first sight there appears to be little difficulty in arranging a circuit which will permit this to be done, but it is actually by no means an easy problem.

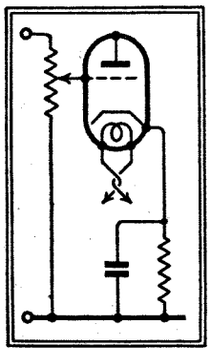


Fig. 1.—The usual volume control circuit for one input channel.

The usual input circuit for a single channel is shown in Fig. 1, and is quite satisfactory under most conditions. Suppose we have two channels, however, we cannot combine them as in Fig. 2, for if we use the arrangement of (*a*) setting one volume control to zero short-circuits the other, while the alternative of (*b*), although it avoids this difficulty, is unsatisfactory because the input impedance changes greatly. This change in impedance has a very bad effect upon the frequency response characteristic. There are, however, two modifications which do permit a much better performance to be obtained. The first of these, Fig. 3 (*a*), is a development of the circuit of Fig. 2 (*a*), and it will be seen that the resistances R2 are introduced in order to prevent the short-circuiting effect of one volume control on the other. It will only do this effectively if R2 is much larger in value than R1; if it is not, an alteration in the setting of one control will have an effect on the volume obtained through the other channel, and it will also have some effect upon the frequency response.

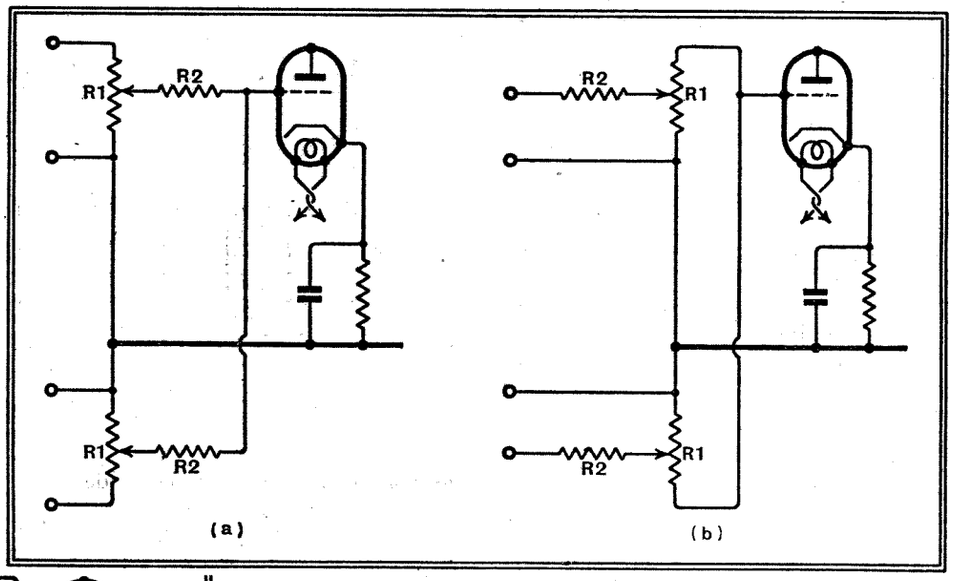


Fig. 2. — (Left) As explained in the text the circuit (*a*) will not work, while (*b*) seriously affects the quality.

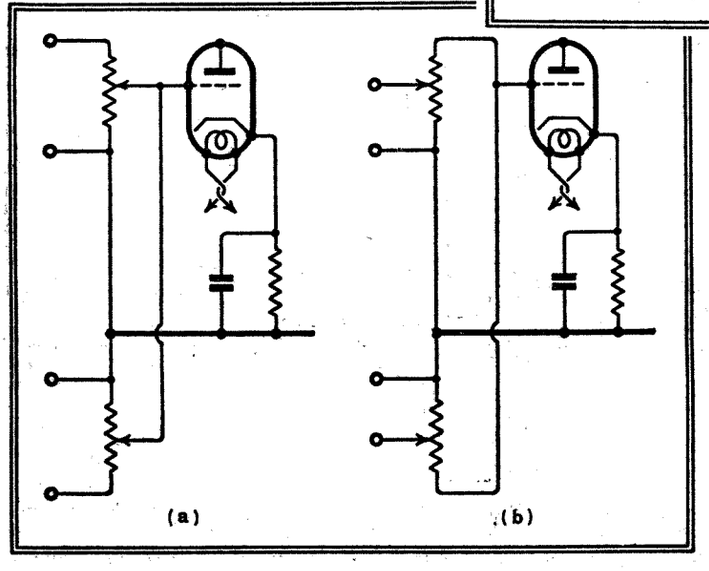


Fig. 3. — (Above) The circuits of Fig. 2 are greatly improved by the addition of the resistances R2. The circuit (*a*) is widely used.

Now, in practice, there are difficulties in making R2 much higher than R1, for the volume control can rarely be of lower resistance than 0.25 megohm, and may have to be higher in order to suit the pick-up. If R2 is of high value, however, the upper audible frequencies will be attenuated because of the input capacity of the valve, which may be as much as 0.0001 mfd. under operating conditions. Even if R2 is no higher than 0.25 megohm, there will be appreciable attenuation.

It is possible similarly to modify the circuit of Fig. 2 (*b*) by introducing resistances R2, as in Fig. 3 (*b*). For satisfactory results R2 must be appreciably larger than R1, and even then the effect on quality is not entirely removed. Furthermore, there is a considerable loss in voltage, and hence increase in the signal to noise ratio.

It can thus be seen that none of these circuits even approaches the ideal, but there is no doubt that the one of Fig. 3 (*a*) is the best, and quite good results can be secured, particularly when the volume controls R1 can be of only moderate value. One method sometimes adopted is to connect the controls in series as in Fig. 4, but this is rarely of much practical use, because the stray capacities are usually quite large, and the operation of one control has a big effect on the quality through the other channel. Serious difficulty is also likely to be found from hum pick-up.

It is not difficult to see that the defects of these methods of mixing are all really due to the input and output impedances of the volume controls not being constant. In Figs. 2 (*a*) and 3 (*a*) the input impedance of each control is the same at all settings, but the output impedance varies

Mixing Circuits—

over a wide range. In Figs. 2 (*b*) and 3 (*b*) the position is reversed, the input impedance being variable and the output impedance constant. To obtain an entirely satisfactory arrangement, therefore, it is necessary to abandon the conventional potentiometer type of volume control and to employ a control having both input and output impedance constant at all settings.

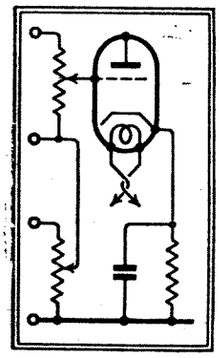


Fig. 4.—A simple mixing circuit which is rarely satisfactory, since the quality is affected and hum pick-up is often serious.

One control of this type is known as the T-attenuator, and it is shown in Fig. 5. It will be seen that three variable resistances, R1, R2, and R3, are used instead of a potentiometer. R1 and R2 are usually equal in value at all settings of the control, and it can be shown that the input resistance is equal to $R1\sqrt{1+2\,R3/R1}$ when it is terminated in a resistance of this value, and that the output resistance is the same when the input is closed through this value of resistance. With two T-attenuators correctly terminated at their input ends the outputs can be paralleled, for each attenuator has the correct output resistance for terminating the other. As the control knob is rotated for increased volume, the values of R1 and R2 decrease while that of R3 increases. With correct design a wide range of control can be secured while maintaining constant impedance relationships.

Attenuators of this nature are widely used in communication engineering, but less commonly in wireless and public address work. One reason for this is that they are quite expensive. The components generally used embody tapped wire-wound resistances, and the control is actually a switch changing the volume in steps of 1 or 2 db. With such a construction it is almost impossible to obtain high-impedance units, and the usual T-attenuator is built for an impedance of 600 ohms, and is consequently unsuitable for use with a pick-up or microphone without matching transformers. It would, of course, be quite possible to build an attenuator by using a three-gang high-value variable resistance of the ordinary compound type, but the units would have to be specially tapered.

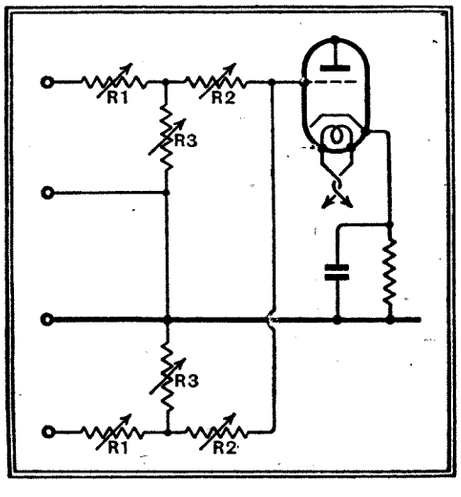


Fig. 5.—The ideal mixing circuit is too expensive for general use, since it involves ganged variable resistances which must be correctly graded. In general, it is only suitable for low-impedance circuits.

In view of this practical drawback of the T-attenuator, it is not very widely used in public-address equipment. This does not mean, however, that we are forced back to one of the circuits already described and which we have already seen to suffer from one defect or another. There is an alternative, and it is one which is becoming more and more widely used in high-class apparatus, particularly in America. This alternative is to retain the simple potentiometer type of volume control, which, as we all know, is very satisfactory on a single input channel, but to provide a separate stage for each channel. Thus in Fig. 6 two channels are shown, and the first stage of amplification is consequently duplicated. It can be seen that the two input circuits are entirely separated, and the volume controls are therefore completely independent, the operation of either having no effect on the volume or quality through the other.

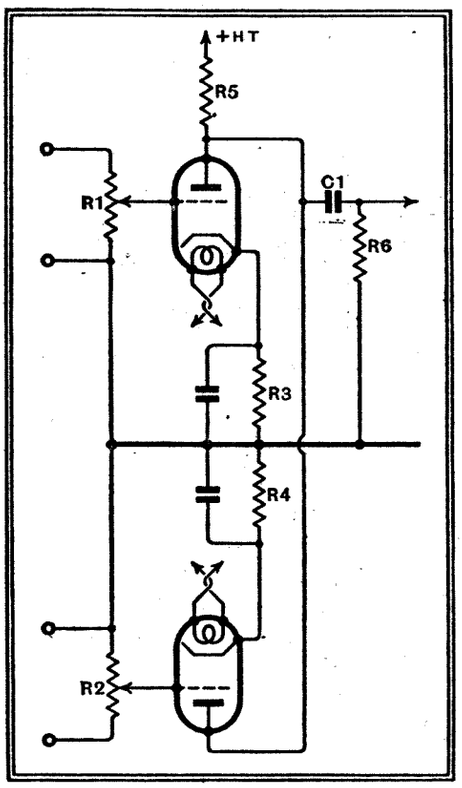


Fig. 6.—A simple and effective mixing circuit employing a separate valve for each channel.

The only point upon which difficulty might arise in design lies in the choice of operating conditions for the valves. If only a single input stage were used the load on the first valve would be R5 in parallel with R6. In general, however, R6 is much larger than R5, so that there is little error in ignoring it and saying that the load is due to the resistance of R5. Using two input valves, however, the load on one valve is R5 in parallel with the AC resistance of the other, and, as both valves will presumably be of the same type, this means that the load on each valve must be less than its own AC resistance. There is consequently a greater risk of harmonic distortion occurring than with the usual arrangement, with which the load on a valve is several times the AC resistance of the valve. It is, therefore, practicable to use this system only when very small signal voltages are involved.

Optimum Operating Conditions

The amplification given by a stage of this type is calculable from the usual formula $A=\mu R/(R+Ra)$, where R is the load resistance, Ra is the AC resistance of the valve, and μ is its amplification factor. With any number of valves of the same type used with common anode connections, as in Fig. 6, $A=\mu R5/(Ra+nR5)$, where n is the number of valves. With the two valves shown in this illustration, $A=\mu R5/(Ra+2\,R5)$.

Now, in general, it will be difficult, on account of the drop of voltage in R5, to make R5 greater than twice Ra. Let us, therefore, decide to adopt this relationship, and let $R5=2Ra$; then $A=2\mu/(1+2n)$. With two channels, as shown in Fig. 6, the amplification is then 0.4μ as compared with 0.66μ for the conventional input system embodying one valve only. This is by no means a great loss, and is

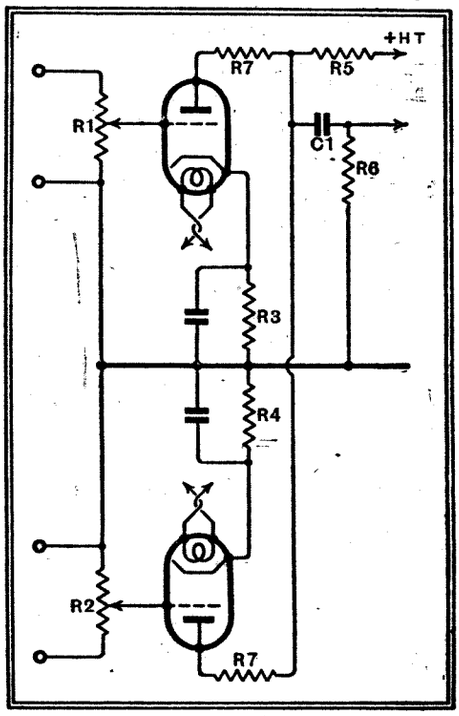


Fig. 7.—The circuit of Fig. 6 is improved by the insertion of the resistances R7, since each valve can then have its correct load impedance.

Mixing Circuits—

in practice not very important. Actually, there is only one objection to this method of mixing, which is that, as the load on the valves is rather small (load = $Ra/(n-0.5) = Ra/1.5$ for two channels), there is an increased risk of amplitude distortion.

This risk may not be serious when only small amplitudes are involved, but there is no doubt that it is present. Fortunately, it is by no means difficult to overcome it, and the arrangement of Fig. 6 can be used if a resistance is inserted in series with each anode lead. This is shown, again for two channels, in Fig. 7, where the resistances are shown at R7. In order to reduce the design to a reasonably simple matter it is necessary to fix some of the relationships arbitrarily; it will accordingly be assumed that R5 equals $2Ra$, and that the load on each valve is to be maintained at twice its AC resistance, a good value for the avoidance of amplitude distortion. The values of the resistances R7 then depend only on the number of channels, and may readily be calculated from the formula $R7 = Ra\,[1-2n+\sqrt{4n^2+12n-15}]/2$. This gives for one channel R7 = 0, which means that it disappears and the circuit becomes the conventional one; when there are two channels, as in Fig. 7, $R7 = Ra$, three channels $R7 = 1.275\,Ra$, and four channels $R7 = 1.42\,Ra$.

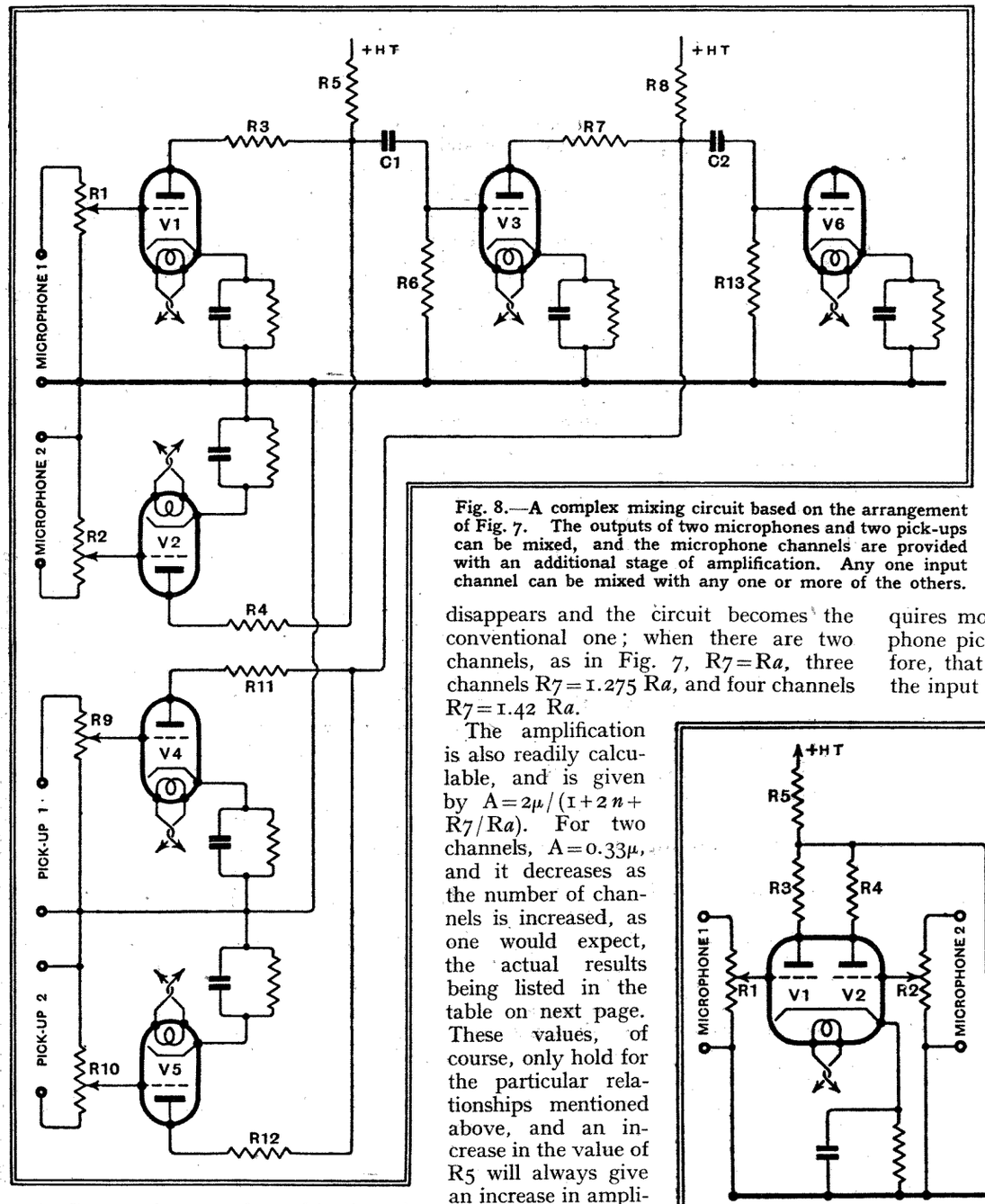


Fig. 8.—A complex mixing circuit based on the arrangement of Fig. 7. The outputs of two microphones and two pick-ups can be mixed, and the microphone channels are provided with an additional stage of amplification. Any one input channel can be mixed with any one or more of the others.

The amplification is also readily calculable, and is given by $A = 2\mu/(1+2n+R7/Ra)$. For two channels, $A = 0.33\mu$, and it decreases as the number of channels is increased, as one would expect, the actual results being listed in the table on next page. These values, of course, only hold for the particular relationships mentioned above, and an increase in the value of R5 will always give an increase in amplification. The gain is, however, very small, and is certainly not worth the increased supply voltage necessary to maintain the anode voltage of the valves.

Now let us compare the results with the simpler circuit of Fig. 6. With two channels the amplification is 0.33μ as compared with 0.4μ, so that the loss is only 1.6 db. With three channels the figures are 0.242μ and 0.286μ, again a loss of only 1.44 db, while with four channels they become 0.192μ and 0.222μ, which means a loss of 1.24 db. The greater the number of channels used the smaller is the difference between the gain given by the two arrangements, but the lower the load on the valves in Fig. 6, and hence the greater the risk of distortion with this arrangement. It follows that the modified circuit of Fig. 7 is most beneficial when many channels are used, but even with only two channels the small decrease in amplification is a worth-while price to pay for the more linear dynamic valve characteristics which are obtained.

Even now we have found a satisfactory method of mixing, our problems are not at an end, for in practice it often happens that the different channels require different degrees of amplification. A microphone, for instance, requires more amplification than a gramophone pick-up. It often happens, therefore, that it is not desired to connect all the input channels to the beginning of the

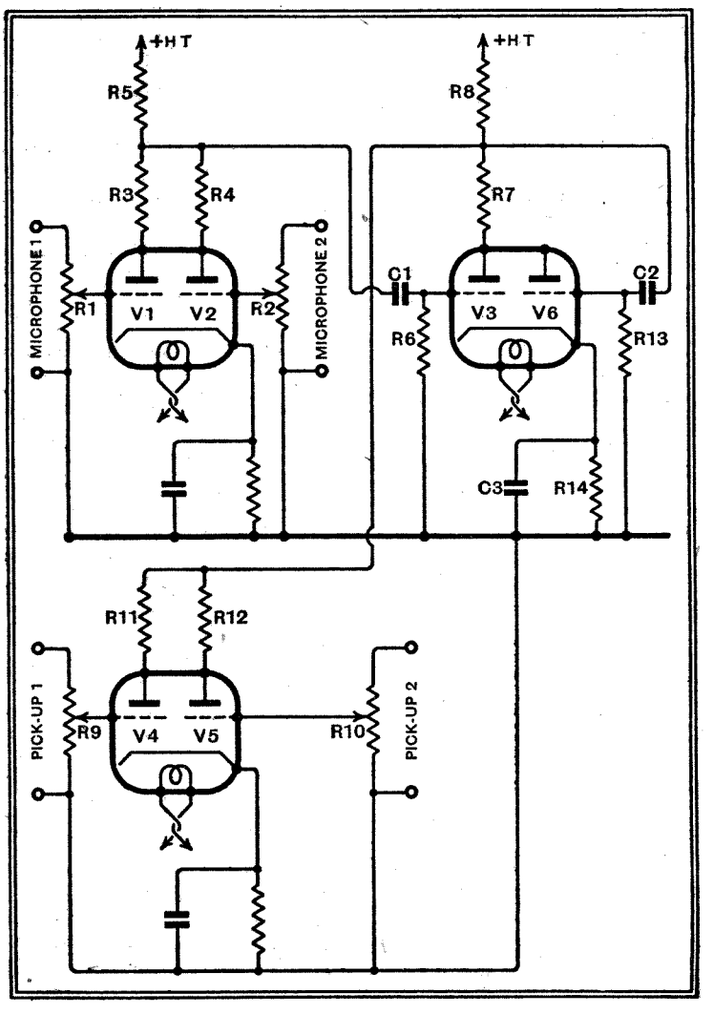


Fig. 9.—A simplified circuit equivalent to that of Fig. 8, but using double-triode valves.

Mixing Circuits—

main amplifier, but to connect some of them only at this point and the others at later stages.

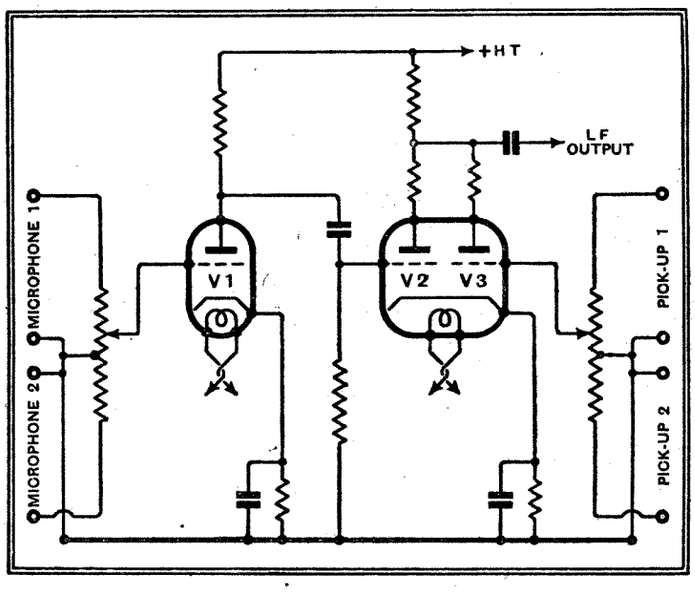


Fig. 10.—A less ambitious arrangement which permits either of the two microphone channels to be mixed with either of the two pick-up channels.

Let us suppose that we are building rather a large mixing unit and amplifier with two microphone and two pick-up channels, and that the microphones require one stage more of amplification than the pick-ups. The first step is to design a two-channel mixer for the microphones using the arrangement of Fig. 7. This is represented in Fig. 8 by that portion of the circuit preceding V3. Valves V1 and V2 must be of the same type, and the volume controls R1 and R2 are chosen to suit the microphones or their transformers. Following the rules already laid down, it will be seen that $R5 = 2Ra$, and $R3 = R4 = Ra$, where Ra is the AC resistance of V1 and V2; C1 and R6 are, of course, chosen according to the usual rules for resistance coupling. The valves V1 and V2 will each give a gain of $0.33\mu_1$ (where μ_1 is their amplification factor).

TABLE
Values of R7 and Amplification

No. of Channels.	R7 =	A =
1	0	0.66μ
2	Ra	0.33μ
3	$1.275\ Ra$	0.242μ
4	$1.42\ Ra$	0.192μ

Now, in the next stage there are the two pick-up channels to be mixed and combined with the output of the microphone mixing stage. A three-stage mixer is consequently needed, and is formed by V3, V4, and V5, which must all three be of the same type, but need not be the same as V1 and V2. The inputs to V4 and V5 are controlled by the individual volume controls R9 and R10, which are chosen to suit the pick-ups. The coupling components in the anode circuits are chosen according to the rules laid down, so that, as there are three channels, $R8 = 2Ra$, and $R7 = R11 = R12 = 1.275\ Ra$, where Ra is the AC resistance of V3, V4, and V5. Each of these valves gives a gain on its own channel of $0.242\mu_2$, where μ_2 is the amplification factor of V3, V4, or V5. Again, C2 and R13 are chosen according to the usual laws of resistance amplifiers, and R13 will often be another volume control potentiometer controlling all channels simultaneously and serving as a master gain control.

It is easy to see that the amplification preceding V6 is $0.242\mu_2$ for the pick-ups, and $0.33\ \mu_1 \times 0242\ \mu_2 = 0.08\ \mu_1\ \mu_2$ for the microphones. One might quite well use similar valves throughout, and the amplification factor might be 40. On gramophone the gain would then be 9.68 times, and on microphone 128 times. As such valves usually have $Ra = 15{,}000$ ohms, typical values for the components would be, $R3 = R4 = 15{,}000$ ohms. $R5 = 30{,}000$ ohms, $R7 = R11 = R12 = 19{,}100$ ohms, $R8 = 30{,}000$ ohms.

Simplifying the Circuit

The method is actually much simpler and less costly than it at first appears, for the arrangement of Fig. 8 can be simplified to quite a large degree without impairing its usefulness. It is not essential to employ individual bias resistances and by-pass condensers for the valves in any mixing stage, and if all the valves are alike a single resistance having a value $1/n$ times that required for one valve with a by-pass condenser of n times that needed for one valve can be used. The second simplification is mechanical, and consists of the use of double-triodes instead of separate valves. In this country the only double-triodes are Class "B" battery valves, and the type requiring negative grid bias can be used if the use of accumulators for the LT supply is not considered objectionable; such valves should be given about one-half the normal grid bias. Indirectly heated double-triodes are available in America, however, and types such as the 79, 53, and 6A6 can be used.

With three such double valves it is possible to use the circuit of Fig. 8 by arranging it as in Fig. 9. Somewhat lower amplification is to be expected from the valves available, but in other respects the results should be entirely satisfactory. It is, however, particularly important that C3 be large enough to by-pass the bias resistance R14 properly, since these components are common to two successive stages of amplification.

In perhaps the majority of cases a less ambitious arrangement will suffice, for one does not often wish to be able to mix as many as four channels. If the requirements are made less stringent, the apparatus can be correspondingly simpler. It is not often necessary, for instance, to mix the outputs from different microphones or from different pick-ups, but only to mix the microphone and pick-up outputs. It would then be possible to use an ordinary fader to control two microphones with another fader to control two pick-ups, and a single two-channel mixing stage will suffice. This arrangement is shown in Fig. 10, and only two valves are needed if one of them is a double-triode. In Fig. 10 the first triode provides amplification for microphone only, while the double-triode gives amplification on both gramophone and microphone, and is the mixer stage.

With the arrangement of controls shown the output of either microphone can be

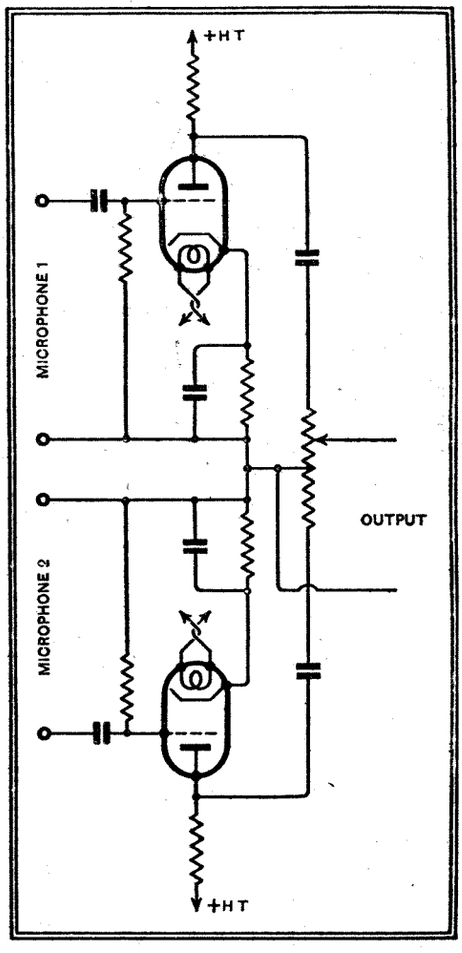


Fig. 11.—With some microphones, it is necessary to provide each with its own pre-amplifier. The circuit can then take this form, a fade-over from one to the other being obtained after initial amplification.

mixed with the output of either pick-up, and by means of the faders either microphone can be faded into the other and

Mixing Circuits—

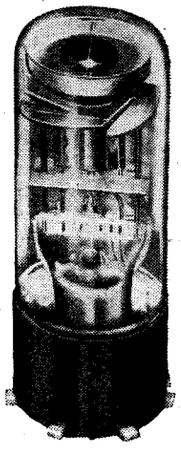
either pick-up into the other. This will probably meet most requirements, but if it is necessary to mix any one of the four channels with any other, or several simultaneously, then the more complex arrangement of Figs. 8 and 9 must be used.

So far, no word has been said about the use of piezo-electric or condenser microphones. For good results these types must be terminated in a very high resistance, and quite high amplification is required. It is consequently not usually permissible to connect a volume control across them. Each microphone must be provided with its own input valve, therefore, and the outputs of these valves mixed. A suitable fading system for two piezo-electric microphones is shown in Fig. 11, and the output can be coupled to the input of V1 or V2 of Fig. 10 according to the degree of amplification necessary. It will be noticed that the fader, which acts as a volume control, is connected after the first valves. This is not objectionable with piezo-electric microphones, since their output is small, and there is little or no risk of the valves being overloaded. It is, indeed, advantageous for the signal to noise ratio is improved. The amplification required with modern high-quality microphones is so high that valve hiss has become an important factor, and it is necessary to take every precaution to obtain the optimum ratio of signal to noise. In some cases special valves are needed.

Cathode-Ray Tuning Indicator

Miniature CR Tube with Triode Amplifier

VARIOUS types of tuning indicator have been produced from time to time, but the meter and the neon indicators have so far held the field. A new indicator has now arrived to challenge their supremacy: this is the Mullard TV4, and it operates upon the cathode-ray principle. It comprises a miniature cathode-ray tube with a triode amplifier built into a single glass envelope; in external appearance it is rather like a valve of unusually small dimensions, and the lower part carries the triode elements. The upper part contains the cathode-ray tube, however, and the indications are seen through the top of the bulb, which must consequently be mounted in a visible position.



The circuit connections recommended by the makers are shown in Fig. 1, and it will be seen that the input to the triode amplifier is derived from the load resistance R1 of the diode detector through a resistance-capacity network comprising R2, R3, R4 and C1. The purpose of R2 and R3 is chiefly to keep the loading on the detector at a minimum while permitting R4 C1 to give good filtering, so that the indicator is not influenced by the modulation on a signal. Maximum indication is secured with only 4 volts input to the triode. The triode-anode is joined to the target of the cathode-ray tube through a 2-megohm resistance R5, and the latter electrode is connected directly to the HT supply which must be not more than 250 volts.

The valve is indirectly heated and consumes 0.3 ampere at 4 volts, and the heater takes 20 seconds to warm up. Under normal operating conditions with no signal, the triode anode current is 120 μA. and the target current 0.29 mA. With a signal giving an input of -4 volts to the triode, and hence full indication, the currents fall to 30 μA. and 0.27 mA. respectively.

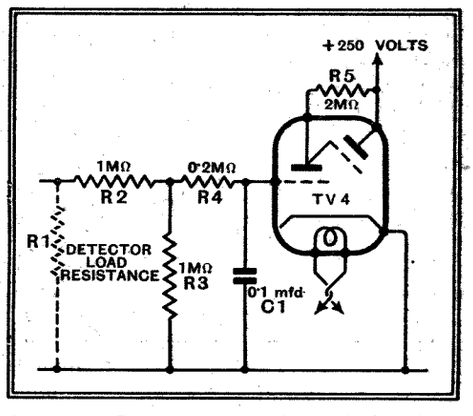


Fig. 1. The recommended circuit for the new tuning indicator. R1 is the load resistance of the diode detector.

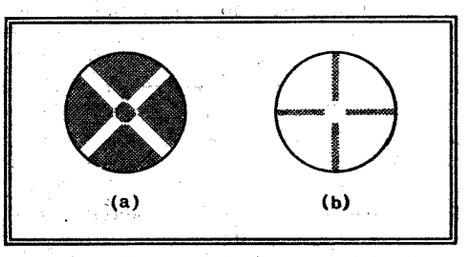


Fig. 2. When no signal is tuned in the indicator shows a green cross on a dark ground (a) but when a signal appears the illumination spreads and the effect is that of a dark cross on a green ground (b).

Certain limits are set by the makers, and it is recommended that the resistance in the grid circuit of the triode should not exceed 2.5 megohms, and that the voltage between heater and cathode should not be greater than 50 volts. Furthermore, the target voltage must never be more than 250 volts, and the tube should be operated under such conditions that full indication is always obtained on a signal.

When the receiver is tuned to no-signal a narrow cross of green light appears at the end of the tube, as shown at (a) in Fig 2. This broadens on tuning in a signal and at first assumes rather the shape of a Maltese cross; eventually, when full indication is secured, almost the whole of the tube is light save for a narrow cross of dark as shown at (b). Actually, there are four segments of light, and the width of the segments increases with signal strength until the limit of indication is reached and practically the whole area is illumined.

The tube must be correctly mounted if even illumination is to be secured, but this is readily arranged by rotating the base correctly. The indicator is fitted with a side-contact base, the connections for which are given in Fig. 3.

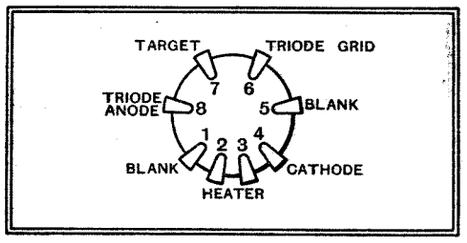


Fig. 3. The base connections of the TV4 indicator.

On test the indicator functioned in a very satisfactory manner and gave a clear-cut image. It proved to be rapid in action and to be unaffected by the modulation of a signal. The appearance is good, and is certainly assists in making the tuning of a receiver easier for the unskilled. The component is priced at 17s. 6d.

NEW BULGIN PUBLICATIONS

A USEFUL 64-page book, the "Bulgin Service Manual," has just been issued by the well-known component manufacturers. The book, which costs 1s., has been written to appeal to the amateur as well as to the professional service man, and so practical descriptions, illustrated by a large number of clearly drawn explanatory sketches, are given of all the details that go to make up the modern receiver.

In the make-up of the book the plan is to give these explanatory notes and sketches on left-hand pages, the facing pages being devoted to a more detailed and theoretical examination of the matter under discussion. A few of the subjects dealt with are: Ganging in Modern Sets, Automatic Volume Control, Aerial Efficiency, and Faults in Receivers. The book can be thoroughly recommended to anyone who wishes to improve his knowledge of radio practice.

Another new Bulgin publication is a second edition of "Radio Progress," which contains constructional details of ten modern receivers and pieces of apparatus, including an all-wave superhet., a "switch-over" local-station set, and a modulated oscillator for AC or DC. This book also costs 1s.; copies are obtainable from A. F. Bulgin and Co., Ltd., Abbey Road, Barking, Essex.

EXTRA SERVICE

A PAMPHLET recently received from Alfred Imhof, Ltd., of 112-116, New Oxford Street, London, W.C.1, describes a free service scheme that has obvious attractions to buyers of receivers. The scheme is quite apart from, and additional to, the manufacturer's guarantee; it is on a definite and clear-cut basis, and contains no nebulous promises that are bound to be unsatisfactory to both buyer and seller.

Briefly, the buyer of a receiver is given three Service Vouchers, valid for either three or six months, each of which entitles him to a free service visit up to 15s. maximum. The conditions under which the vouchers may be used seem eminently fair and equitable; replacement of parts or valves is not included in the free service, but these may, of course, be covered by the maker's guarante

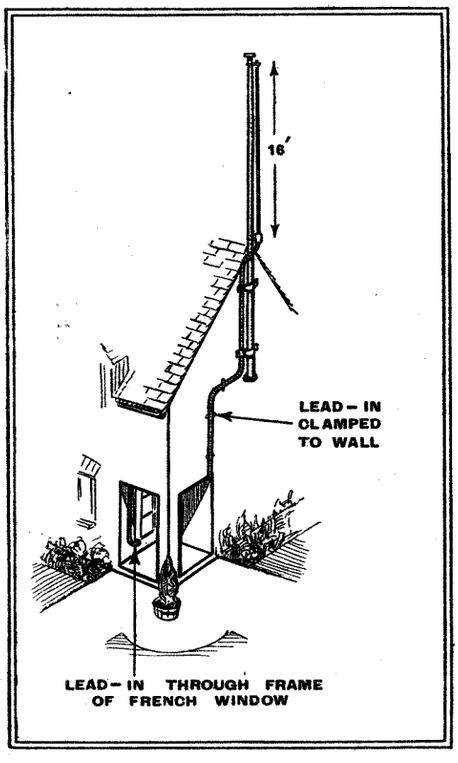
Television at Home

A RECORD OF FIRST IMPRESSIONS

By An "Observer" at Welwyn

DURING next month high-definition television will be launched on the public as a regular experimental B.B.C. service. The possibilities latent in this innovation are at present one big question mark; it may, therefore, be of value to note down how the preliminary programmes from the Alexandra Palace are being received under ordinary home conditions, on a standard production-model receiver.

During and since the hastily devised Radiolympia programmes I have been "looking-in" at my home, 15 miles north of the London television station. It happened that when the Baird service engineer came to instal my receiver the Alexandra Palace was temporarily not radiating, so that I was left to carry out for myself the initial tuning of an instrument which was completely strange to me.



Television aerial as finally installed by the Author.

It proved simpler than I expected. The first time I switched on to the test transmissions I got a picture almost immediately, and had very little difficulty in centring or focusing it. Once this was done, the picture remained stable—in marked contrast to the tuning acrobatics of my last experience of television reception, a few years back, with one of the old 30-line rotating-disc sets.

Expert installation is essential, and the question whether installation costs should be inclusive in the price of the receiver, or charged as an extra, is one upon which the various manufacturers of television sets will no doubt come to an agreement.

The service engineer's first responsibility, of course, is the erection of an efficient aerial. In my case a light temporary aerial was slung outside an upstair window, to keep me going while a permanent fixture was being prepared by a local carpenter. The temporary aerial was a simple dipole with a lead-in of ordinary flex—and signal strength proved to be more than ample. Despite my unfamiliarity with the controls, there was not the slightest difficulty in finding the London station. Tuning, in fact, is fairly flat. Signal strength was such that the sound volume control had to be considerably turned down, and the steadiness of the picture, already noted, is no doubt due to the good strength of the image-signal, with its attendant synchronising impulses.

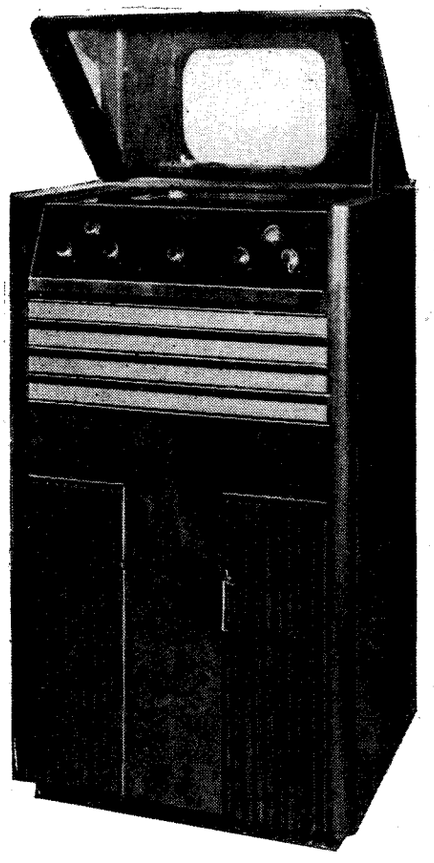
Signal Strength

When the service engineer returned a few days later (the carpenter having completed his construction of the mast) he also was impressed by the signal strength, which augurs well for the range of the station in this northerly direction. At Welwyn we are 350 feet above sea level, and on the "air-line" between us and the Alexandra Palace the ground rises to over 400 feet. The Palace itself is only 300 feet above sea level, but the aerials rise an additional 300 feet.

The permanent receiving aerial which is now erected is of a special anti-interference design of the Baird Comany's. It is a vertical dipole about 16 feet from end to end. To place this aerial in as high and unscreened a position as possible, a 25ft. mast was attached to the end of the house, with 16ft. projecting above the roof-top. Thus the entire aerial is unscreened by the roof.

The lead-in is a low-impedance concentric cable, with the lead covering earthed. This cable was fixed to the wall, down to a room on the ground floor, scrupulous care being taken at bends to avoid any kinking.

By ear and eye one did not observe any great difference in signal strength on the new aerial as compared with the temporary one, but where it did make improvement was in the reduction of interference from motor cars. This is not now serious, unless a motorist stops immediately outside the house and leaves his engine running. The effect is of white flashes horizontally across the screen, with a crackle in the loud-speaker. The aerial is only 20 yards from the road.



A home Televisor, Model T5, made by Bush Radio.

Visitors to my house, as well as my family, enthused about the entertainment value of the transmissions. Personally, I found it rather dull to return to ordinary listening afterwards. After seeing the *whole* of the 1½ hours entertainment directed to Radiolympia, there were no complaints of eyestrain from the home audiences.

Programme Features

The features which drew the greatest appreciation were the outdoor shots at the Alexandra Palace grounds (which never failed to excite the astonishment and wonder of those who had come with no idea of what modern television can do), the variety entertainment in the studio, with its striking use of successive shots from various angles, and, among the films, the news reels and the excerpt from "Show Boat."

On the other hand, in studio programmes, head-and-shoulder views and interviews soon bored the watchers. Frequent change of scene and viewpoint seems to be probably even more important in television than in the cinema. This is where the variety show scored, and although the "Show Boat" excerpt was simply of Paul Robeson singing "Ol' Man River," the film producer has presented this song with such variety of viewpoint, combined with rugged simplicity of masses, and of light and shade, that it

Television at Home—

makes perfect television entertainment. Films with intricate small detail (particularly noticeable in captions) and films which were static, were the least effective.

The lighting of studio scenes seemed to vary considerably, but of course in this, and in the matter of make-up, the television producers will have to feel their way for some time. When the camera moved rapidly towards or away from an artist there was a frequent tendency to go out of focus, evidently because the cameraman has at present no sufficiently positive rapid-focusing device.

The most remarkable effect of television in my house was its enthusiastic adoption by children. They have never shown any great interest in sound broadcasting—even the Children's Hour. But television they watched with rapt attention, and with screams of laughter for the comic horse in the variety show; and not merely once. They insisted on seeing the programme through again and again as it was repeated daily for Radiolympia. They never tired of it, which seems to indicate that it was not the "novelty appeal" of television which was having effect, but real entertainment value.

The receiver used, a Baird "Televisor" model T5, is a 20-valve instrument (including two mains rectifiers). The power consumption from the mains is 240 watts. The image, measuring 12 inches by 9 inches, is reflected from a vertical cathode-ray tube by a mirror inside the lid, held open at 45 degrees. The end of the tube is covered by a window of safety glass, and the tube is guaranteed for 1,000 hours.

The six main controls are mounted on the front of the cabinet:

The Wavelength tuning control tunes-in both vision and sound simultaneously; the peak tuning point is easiest found by ear. The volume of sound may then be adjusted by the *Sound Volume control,* which operates on sound only. *Vision control* is virtually a "Volume Control" for vision—it controls the output from the vision chassis, and once set I find it need rarely be adjusted. If turned up too far it has a "reaction" effect, causing closely-meshed patterns on the screen. *Picture brightness* controls the luminosity, which is such that pleasant reception may be obtained in daytime without fully darkening the room—usually we draw the curtains to avoid reflection of the windows in the mirror. I find it convenient to work this brightness control in conjunction with the *Contrast control,* the effect of which is to vary the black-and-white contrast in the picture. *Focus,* finally, must be carefully adjusted, or a "fuzzy" picture results.

Behind a door in front of the cabinet is concealed the switch for changing over between Baird and Marconi-E.M.I. reception, and also the time-base controls. It was a little more difficult to get the knack of these. As the service engineer would normally set these controls, leaving the owner only to make an occasional vernier adjustment, I do not look upon this as a serious complication, though, of course, it *is* a complication to have to work to a double standard of transmission, and a future elimination of controls is partially bound up with the ultimate standardisation of television transmission.

PYE SERVICE EQUIPMENT

Special Instruments for Tests and Alignment

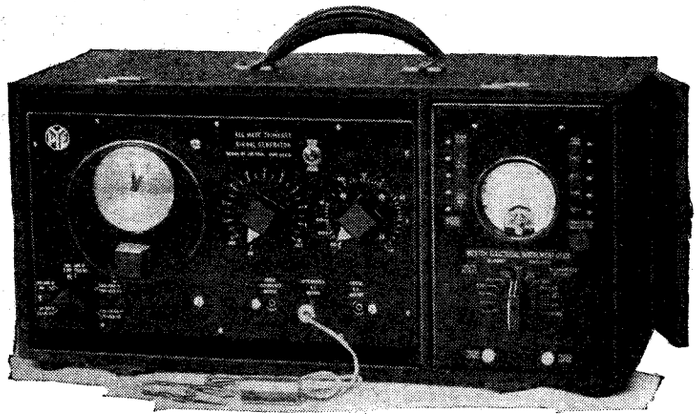
FOR the benefit of agents and their service engineers Pye Radio recently decided to introduce a series of reasonably priced and efficient testing instruments.

Perhaps the most generally useful and technically interesting of the series is the "All-Wave Trimeasy Signal Generator." This oscillator, of which the purpose is self-evident from its title, covers a wave-range of from 12 to 3,000 metres (25 Mc/s to 100 kc/s) in five steps, with switch selection. The radio-frequency output, controlled by an attenuator calibrated in db., ranges from below one microvolt to about 0.1 volt, and is modulated to a depth of 30 per cent. at 400 cycles. There is also a higher output giving an RF signal up to 0.5 volt.

Used as an audio-frequency generator, the instrument gives an output, controllable by an additional attenuator, of 2.3 volts maximum, which is delivered through a separate socket.

The instrument, which is supplied with two dummy aerials and is hand-calibrated, is battery operated; it is stated to be extremely economical in current consumption. A similar generator without short wavebands is also available at a lower price.

If required, the signal generator described above can be combined with a Weston Selective Analyser, the two instruments being mounted in a convenient carrying case and aptly described as the Pye Complete Tester.



Pye All-purpose Tester, combining a signal generator with a multi-range meter.

Another useful instrument for the service engineer is the Pye Valve Tester, which provides for tests of emission and mutual conductance of all types of valves, as well as of inter-electrode insulation; readings are given directly on a 6-inch scale.

Other Pye service equipment includes an output meter calibrated in milliwatts and decibels, a set of trimming tools, and a "kit" of materials—polishes, compounds, etc.—for the renovation and repair of cabinets.

The Wireless World Diary

APART from the diary proper, no fewer than 80 pages of data useful to the wireless enthusiast are contained in the 1937 *Wireless World* Diary, which has just made its appearance.

One of the most helpful features is the inclusion of a table giving the wavelength, frequency and power of all European stations, and a similar table dealing with the short-wave stations of the world. A list of special telephony transmissions—such as those emanating from police cars—together with wavelength details, is also given.

Among the many pages of useful data are to be found formulæ for calculating output transformer ratios, resistance amplifier design, and decibel loss or gain. A table of standardised colour codes forms another valuable feature. Those troubled with interference will find a page of very helpful information. Not the least valuable section of the diary is that containing abacs for the rapid estimation of such information as the wavelength to which a circuit containing a given inductance and capacity will resonate, and for the quick designing of short-wave coils. Constructors and servicemen will find that very helpful diagrams are given, together with explanatory notes, in order to illustrate the correct connections to the sockets of the many types of modern valve base, including American ones, which are available nowadays. Included also will be found the Morse code, the International "Q" code, and a wealth of other information for the keen listener. The diary, which costs eighteenpence, may be obtained through any newsagent, or for 1s. 7d., post free, direct from the publishers, Messrs. Iliffe and Sons Ltd., Dorset House, Stamford Street, London, S.E.1.

The Radio Industry

A 20-PAGE booklet dealing at length with the principles, construction and installation of the "Eliminoise" screened aerial system has just been published by Belling & Lee, Ltd., Cambridge Arterial Road, Enfield, Middx.

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Copies of the new catalogue of Eddystone short-wave components can now be obtained from Stratton & Co., Ltd., Bromsgrove Street, Birmingham. There is also a new edition of the Eddystone Short-Wave Manual (price 1s.), which contains constructional details of several receivers, transmitters and modulated oscillators, as well as other useful information for the short-wave enthusiast.

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Degallier's Ltd. has moved to 18, Connaught Street, Marble Arch, London, W.2. Telephone number is unchanged—Paddington 2745.

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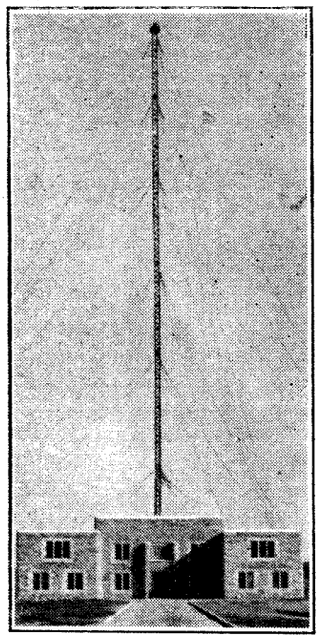
B. J. Round & Sons, 8, 9, and 10, Northampton Street, Birmingham, 18, have just issued a revised edition (price 1s., post free) of their booklet describing the "Epalex" system of electro-plating. A leaflet (free) deals with the protection of aluminium by the "Pylumin" process.



BURGHEAD will be brought into operation on Monday next, October 12th, using the same wavelength as Scottish Regional (391.1 metres.)

BROADCAST BREVITIES

News from Portland Place

Mast Climbing at Droitwich

"DAWN over England" is the title chosen for Kenneth Adam's description of what he sees from the top of the Droitwich mast at 6 a.m. on October 22nd. The actual date of the broadcast is October 23rd, an electrical recording of the talk being broadcast between 8.45 and 9 in the National evening programme. The Recording Department will thus have nearly forty-hours for "sub-editing" purposes.

Something Like a View!

Droitwich happens to be very near the geographical centre of England, and as Mr. Adam will take his stance—a somewhat cold stance, one imagines—about 700 feet above ground level, a very fine prospect should be unfolded.

If the morning is clear the Malvern Hills should be plainly discernible and there should also be a good view of Bredon Hill, the valleys of the Avon and Severn, Worcester Cathedral and the Abberley Hills, with the Shropshire Clees beyond. To the north it should be possible to see the Lickey Hills and perhaps the tower of Birmingham University.

Mr. Adam will also describe his sensations during his climb in the lift.

New "Proms" Scheme for 1937

THE principal source of annoyance to the musically minded has been the tantalising thought that the concerts have been going on night after night, as usual, but have been broadcast only in snippets. If the concerts themselves had been curtailed the complaints might have been fewer.

Meanwhile Dr. Boult and his assistants, overjoyed by this public vindication of the musical side of the B.B.C.'s activities, are quietly planning a better scheme for 1937.

Where Scotland Leads

SCOTSMEN are supposed to be somewhat canny with the postage stamps, which makes it all the more surprising that, if we except Londoners, listeners north of the Tweed are writing more letters to the B.B.C. than their brethren in the South. Next to them come the Welsh.

Of the other provincial regions, the North is the most vocal. Midland and the West of England regions practically tie for the next place. As might be expected, Northern Ireland, with its comparatively small listener population, is a long way behind.

Too Many Organ Recitals?

ARE we to have a glut of organ broadcasts this winter? As already stated in these columns, the new theatre organ in St. George's Hall is to be heard at least twice a week, yet there is apparently no question of reducing the number of recitals on the Concert Hall organ.

The third series of B.B.C. organ recitals opens on Friday, October 23rd, when Dr. Harold Darke, famous for his Bach recitals at St. Michael's, Cornhill, will give a forty-five minute programme of works by Mozart, Bach and Stanford.

Staff Changes at Broadcasting House

THE B.B.C. announces that the resignation of Major Gladstone Murray from the post of Assistant Controller (Programmes) to the B.B.C., following his appointment as General Manager of the Canadian Broadcasting Commission, has involved several staff changes at Broadcasting House. Mr. R. H. Eckersley, who, like Major Gladstone Murray, has been Assistant Controller (Programmes), will take over from Mr. C. A. Siepmann the Directorship of Regional Relations. Mr. Siepmann will succeed Mr. R. E. L. Wellington as Director of Programme Planning, and Mr. Wellington will become Assistant Controller (Programmes).

Quality Transmission from Daventry

GREAT joy in the Empire Department over this tribute in the *Sydney Bulletin:* "One notable circumstance about the B.B.C. transmissions is that while the signal strength may not equal that of other nations, the quality of the transmission excels."

Such praise of a short-wave station from the other side of the globe is rare and refreshing.

Italian Methods in Studio Opera

SPECIAL studio technique is to be employed in broadcasts of Italian opera this autumn and winter.

Gordon McConnel, who has been responsible for the production of such operatic successes as "The Life of Verdi" and "Puccini, the Man and His Music," has paid two visits to Italy to discover the "secrets" of the Italian broadcasting studios, in which opera production has admittedly reached a very high standard.

Improvements on Theatre Broadcasts?

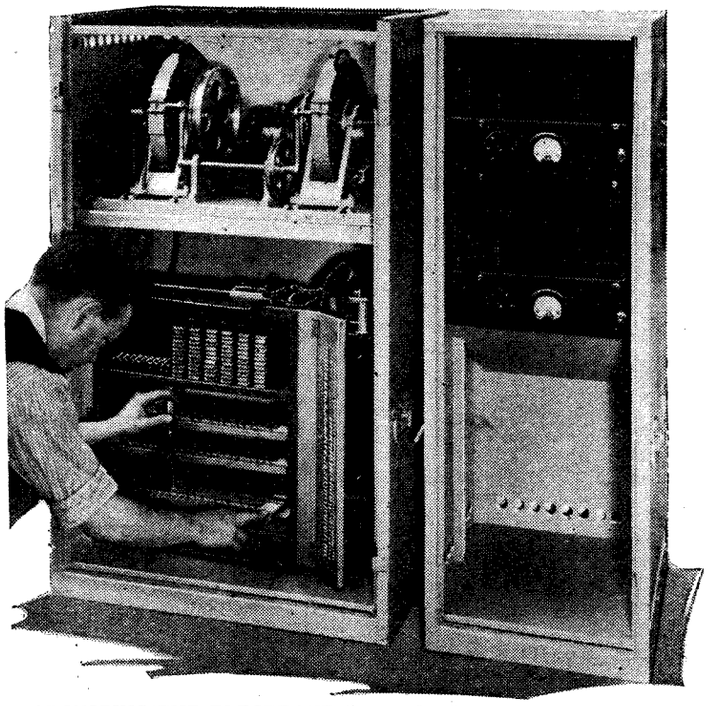
The Italians, in fact, often succeed in making a studio presentation more acceptable than an O.B. from an opera house, the reason being that a typical opera audience in Rome or Naples is almost too vociferous in its applause. Moreover, the Italian engineers seem happier in dealing with studio acoustics than with those of the opera house or theatre.

The B.B.C.'s next operatic programme in the studio will be Act I of Massenet's "Manon," to be given in November.

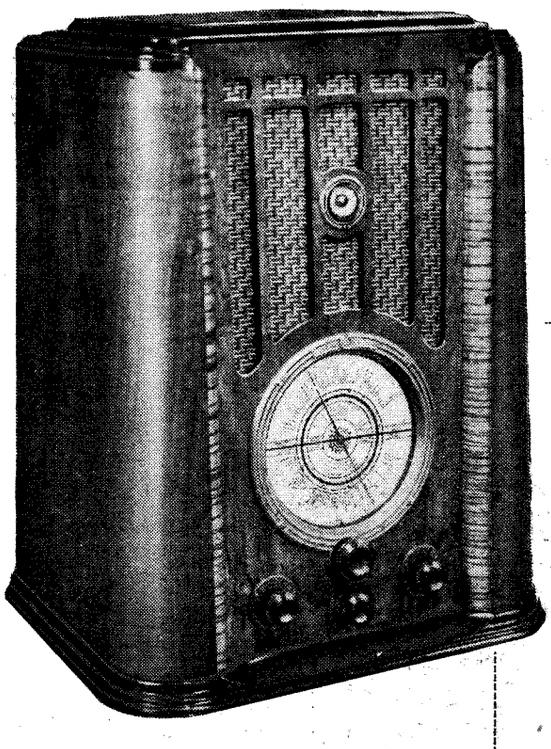
Surprise for the Music Department

THE conclusion of the "Proms" season for 1936 finds the B.B.C. in a reflective mood. Last year there were noisy complaints that the Promenade Concerts were monopolising too much programme time, so the Corporation, bent on pleasing everybody, decided that it would be better to cut down the Queen's Hall relays by half.

The result has been a real eye-opener. If every proof was required that broadcasting has raised the musical tastes of the nation it would be found in the B.B.C. postbag during the past two months. From all quarters letters have poured in condemning the new policy and urging the Corporation to revise its plans for next year.



ADJUSTING THE ELECTRONE for the St. George's Hall organ prior to its installation. The inaugurating broadcast on this masterpiece of organ building will be given Nationally at 8 on Tuesday, October 20th, when four well-known broadcasting organists will demonstrate its capabilities.



Pilot MODEL U650

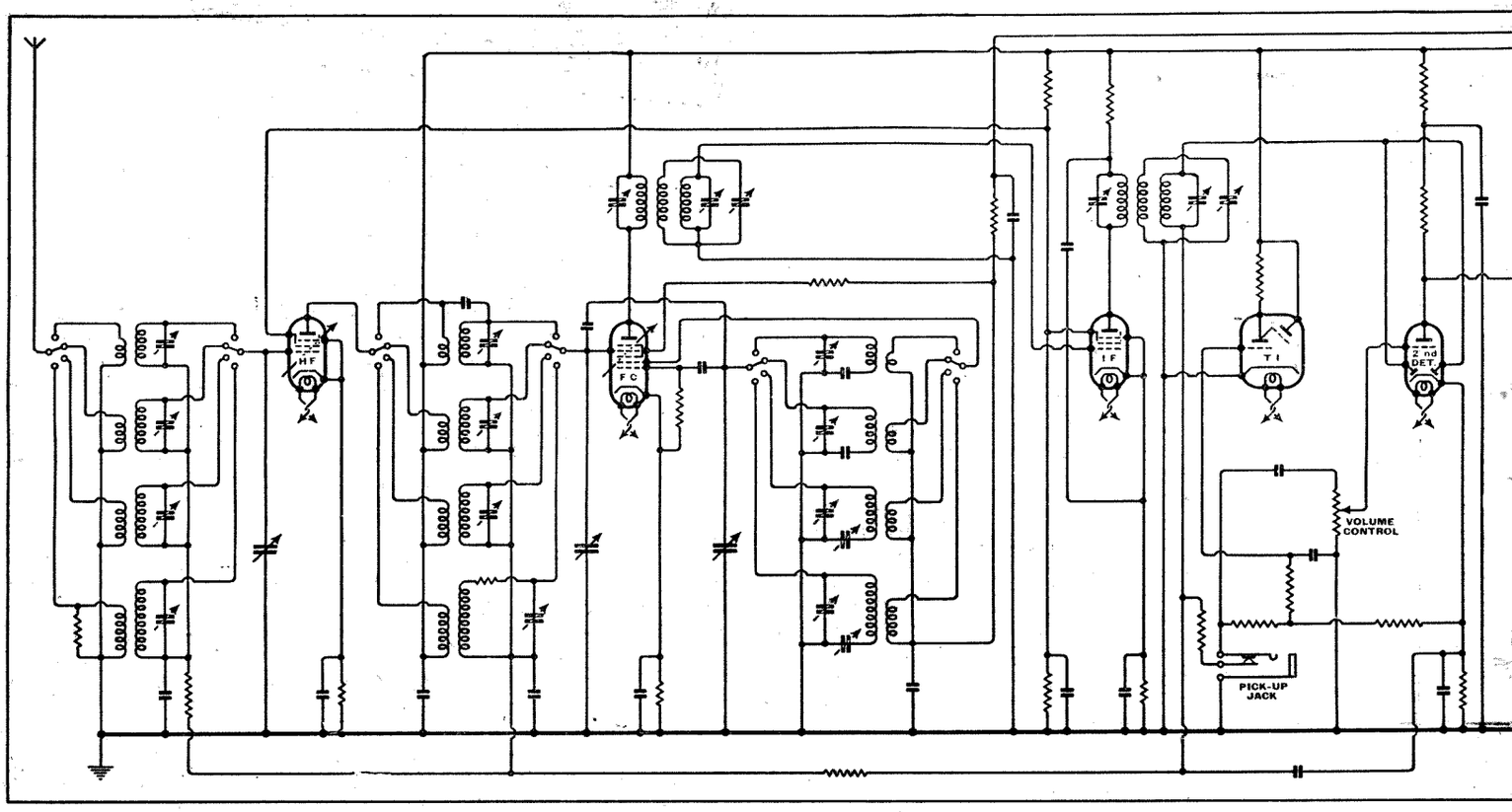
Efficient Performance from an Essentially Simple Circuit

FEATURES. — ***Type.*** — *Table model all-wave superheterodyne for AC mains.* ***Waveranges.***—*(1) 16-52 metres. (2) 48-150 metres. (3) 175-550 metres. (4) 750-2,100 metres.* ***Circuit.***—*Var. mu pentode HF amplifier — heptode frequency-changer — pentode IF amplifier — double-diode-triode second detector — pentode output valve. Full-wave valve rectifier.* ***Controls.***— *(1) Tuning. (2) Volume. (3) Waverange. (4) Tone control and mains on-off switch.* ***Price.***—*16 guineas.* ***Makers.***— *Pilot Radio Ltd., 87, Park Royal Road, London, N.W.10.*

ALTHOUGH the name of this set may be new to many broadcast listeners, short-wave experimenters will already be familiar with the range of Pilot components which had already established a reputation outside their country of origin long before there were any signs of the present popular interest in all-wave receivers. The accumulated experience gained as a result of serving experimenters in the early stages of the short-wave art has now been incorporated in a series of complete receivers, and a factory has been set up for their manufacture in this country.

Before one has traversed more than a few degrees of the dial on the 16-52-metre band it becomes apparent that the performance on short waves is something quite out of the ordinary. The crisp response and excellent signal-to-noise ratio are only two of the qualities which mark this set out as a thoroughbred. Reception of W2XAD at 4 o'clock in the afternoon was perfectly steady, and the volume was such that the control had to be turned down to permit telephone conversations in the same room. One virtue of the high signal-to-noise ratio is that the receiver seemed much less susceptible to the prevailing local interference, and as a result the tone control could be turned much more than usual towards the high position with a consequent improvement in quality. There was no trace of second-channel interference and double tuning points.

It is interesting to find in view of the outstandingly good short-wave performance that the circuit is remarkably simple and free from "frills." Where other makers have added extra valves and circuits in an effort to improve performance the designers of the U650 appear to have worked inwards and made sure of obtaining the maximum efficiency from each component in an essentially simple circuit. The first valve is a variable-mu pentode RF amplifier which functions on all wave bands. Simple transformer coupling is employed in the aerial circuit and between the RF amplifier and the frequency-changer, the only deviation from medium-frequency broadcast practice being in the



addition of some top-end capacity coupling on the shortest waveband. The heptode frequency-changer is followed by a single IF stage, which is interesting for the fact that triple tuned circuits are used in each of the two associated transformers. The IF valve, incidentally, is not controlled from the AVC line, which supplies bias only to the RF and frequency-changer valves. A double-diode-triode, in which both diode anodes are strapped together, occupies the second detector stage, and there is a cathode-ray tuning indicator controlled from a tapping on the diode load resistance.

The resistance coupling between the triode portion of the second detector and the pentode output valve is of the simplest possible type. The output valve is designed to give an undistorted output of three watts, and tone control is effected by the usual condenser and variable resistance in parallel with the primary of the output transformer. The external loud-speaker sockets are also connected at this point, so that a suitable output transformer will be required in the external loud speaker unit.

The quality of reproduction is bright, and fully in keeping with the lively performance of the receiver. The speaker has a rather generous reserve of response in the upper middle register, and except in a few cases the bass response is balanced with the tone control approximately in the mid-position.

As regards the performance on the other wavebands the 48-150-metre band was not productive of any specially interesting transmissions at the time of the test, but the medium-wave band maintained the high standard of performance found on the lower wave ranges.

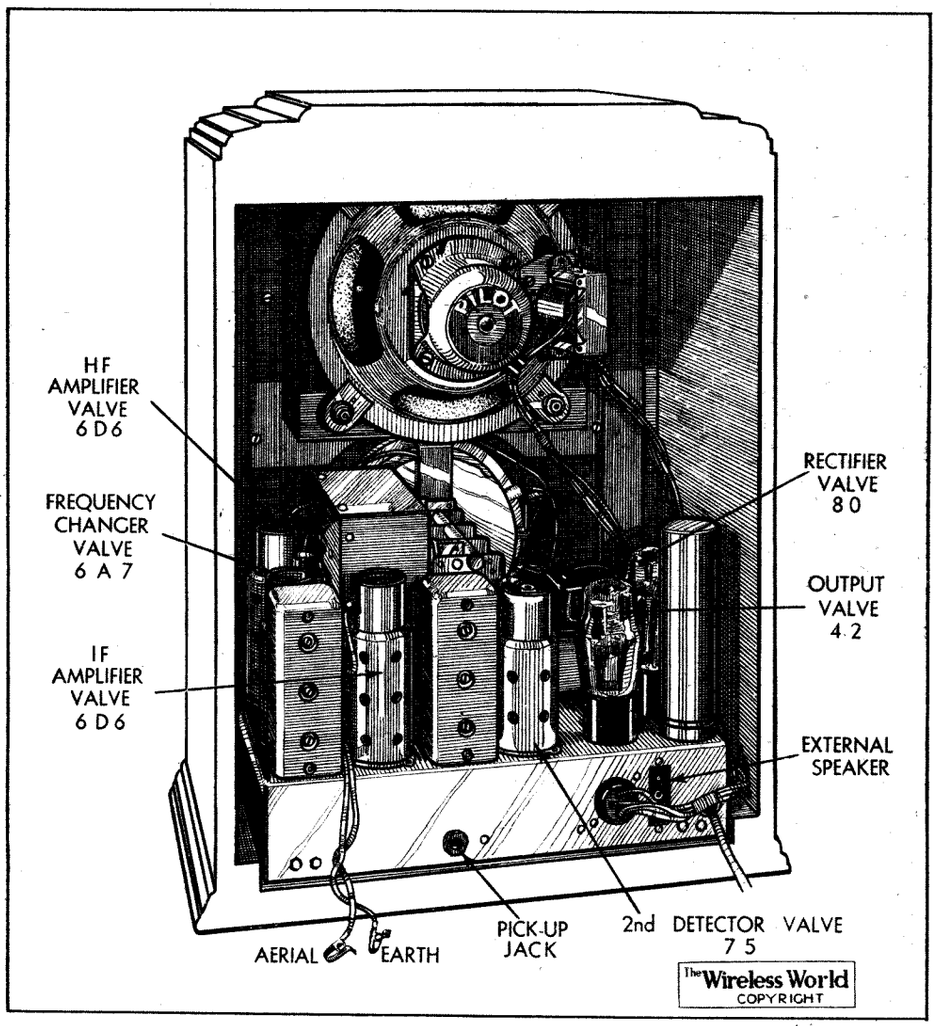
Selectivity on the medium-wave band is such that the Brookmans Park transmitters can be approached within 1½ channels on either side of their normal settings when using the set in Central London. Some difficulty was experienced, however, in finding the Deutschlandsender between Radio-Paris and Droitwich. This is no doubt accounted for by the damping which the circuit shows to have been deliberately introduced on the long-wave band, but if this has resulted in some slight loss of selectivity there is no appreciable diminution of range on long waves by comparison with any of the other wavebands.

The receiver incorporates the conventional type of clock-face dial, but in this case it is of really useful diameter and permits a larger proportion of the number of stations within the range of the set to be marked on the dial. The calibration, incidentally, is remarkably accurate on all four wavebands, so that the wavelength settings may serve as a useful guide in the identification of unknown stations. The pointer is driven by a single knob through a choice of two reduction gears with ratios of 12½ : 1 and 95 : 1; the latter gear for fine tuning being brought into operation by pulling out the knob.

The cathode-ray tuning indicator is mounted in the centre of the loud speaker grille and the valve-holder is carried on a metal "spider" which is clamped underneath the rim of the loud speaker chassis. To replace the tuning indicator, therefore, it will be necessary to remove the loud speaker, but this is really quite a simple matter.

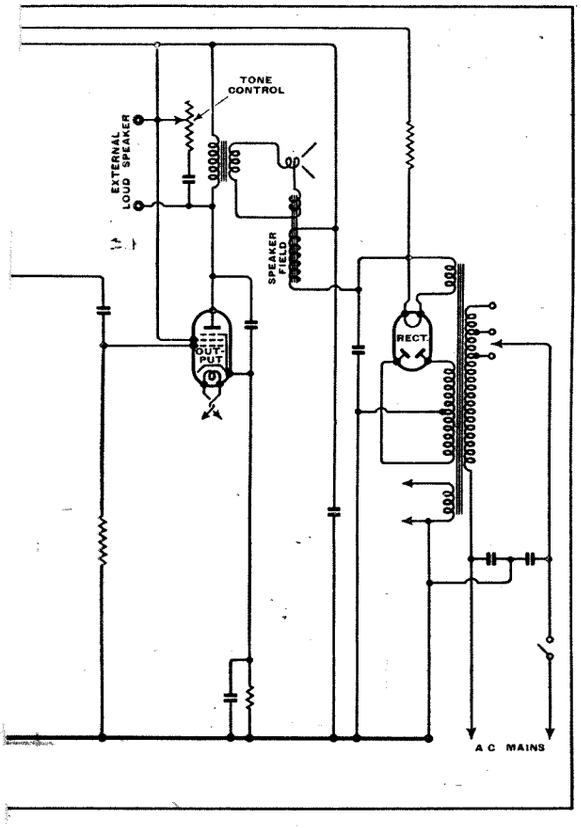
At the back of the chassis a jack has been provided for gramophone pick-up connections, and it is interesting to note that flexible leads with spring clips take the place of the usual aerial and earth terminals or sockets.

Although we have stressed the short-wave performance of this model it should not be inferred that the normal broadcast bands suffer by comparison, and from every point of view we regard the U650 as a well-balanced design.



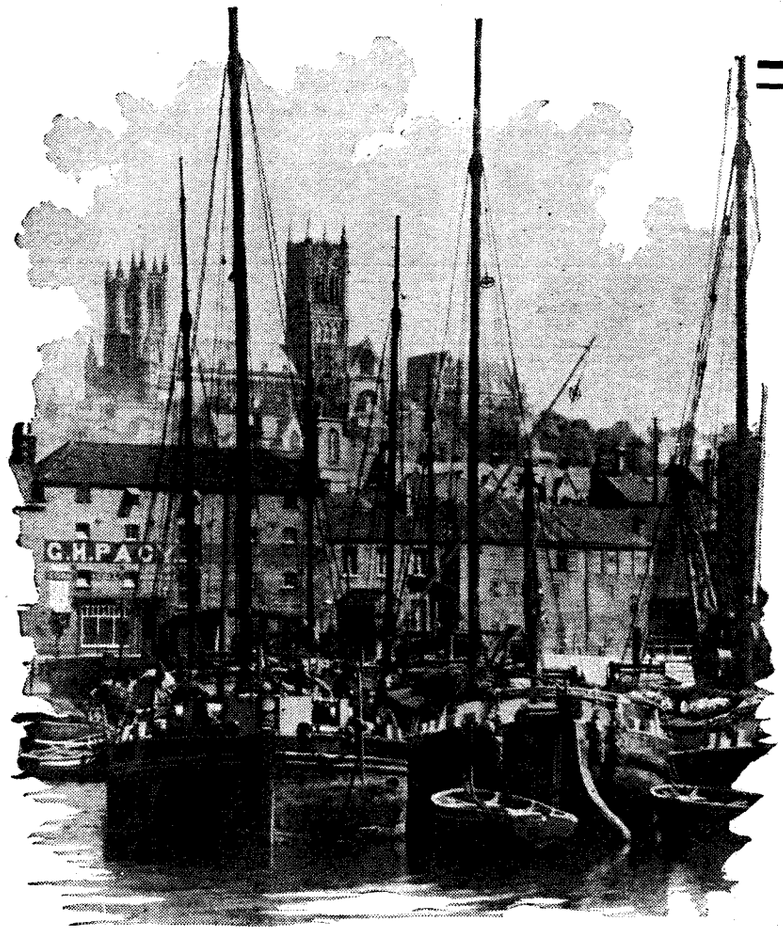
The loud speaker is spaced from the front of the cabinet by a wood block to give space for mounting the cathode-ray tuning indicator in the centre of the loud speaker grille.

Simplicity is the key-note of the circuit, the only important deviation from standard practice being the use of triple tuned circuits in the IF couplings.



Listeners'

Outstanding Broadcasts at H



LINCOLN CATHEDRAL seen from Brayford through the rigging of coasting craft. The cathedral choir will be heard in a programme of Byrd's music tonight (Friday) at 9.0 (Reg.).

THIS week brings to the listener a very varied bill of good music: by "good" I mean classical.

The choir of Lincoln Cathedral with the strings of the B.B.C. Northern Orchestra conducted by Gordon Slater, organist and Master of the Choristers, will be giving a recital of the music of William Byrd (1543-1623), which will be broadcast Regionally tonight from 9 to 10. The first part will be rendered in the vestibule of the Chapter House; this will be followed by an organ solo, and then the second part will be heard from the Minster Choir.

The B.B.C. Symphony Orchestra, comprising 119 players, pays a visit to Hanley, Stoke-on-Trent, this week, and the concert, which will be given in Victoria Hall under the direction of Dr. Adrian Boult, is to be broadcast Nationally on Wednesday from 8 to 9 and 9.20 to 10.5.

On the following evening (Thursday) the London Philharmonic Orchestra, conducted by Sir Thomas Beecham, will be heard during the Royal Philharmonic Society's concert at the Queen's Hall from 8.15 to 9.35 and 9.50 to 10.30.

The works of Richard Dering are chosen for this week's music series. Motets and canzonets will be sung by the B.B.C. Singers conducted by Sir Richard Terry. The first concert is on Sunday at 4 (Nat.), and the succeeding concerts on Monday at 6.55 (Nat.), Tuesday at 9.40 (Nat.), and Thursday at 7.45 (Reg.), also a talk on the music of Dering will be given by Sir Richard Terry at 6.40, preceding Monday's concert.

BEST SELLERS

A NEW and interesting idea has been hit upon by Geraldo, who will bring the first instalment of this broadcast, which is to be a fortnightly feature, to National listeners on Monday at 7.20. Under the heading "The Music Shop," with his orchestra he will play the song hits that have been best sellers during the past fortnight. In this way personal choice will be ruled out. It will be interesting for those keen on dance tunes to see the rise and fall in popularity of "hits" from fortnight to fortnight.

"LOTS OF LOVE"

ALTHOUGH broadcast as recently as last March this story by Holt Marvell (words) and Jack Strachey (music) which is of a modern Don Juan who falls in love with a girl whilst staying on the Côte d'Azur, will be heard again on Monday at 6 (Reg.) and Tuesday at 8 (Nat.). Only a few of the original cast will be available. Of these Nora Howard will again play Minnie. Newcomers to the cast include Joan Carr, Valerie Taylor and Richard Ainley. The music will be in the hands of the Television Orchestra, and the soloists are Anne Ziegler (soprano), John Ticehurst (harpsichord), Marie Goossens (harp), John McKenna (tenor), and Jim Hands (accordion).

"IN TOWN TO-NIGHT"

A. W. (BILL) HANSON brings this popular favourite back into the programmes again on Saturday at 7.30. It will be on similar lines to last season's except that it will not include the serial thriller which will be given as a separate item at 8. "The Palaver is Finished" is the title of the story chosen, which is on the adventures of Commissioner Sanders and Lt. "Bones," and is adapted from the Edgar Wallace story. Each instalment will be complete in itself.

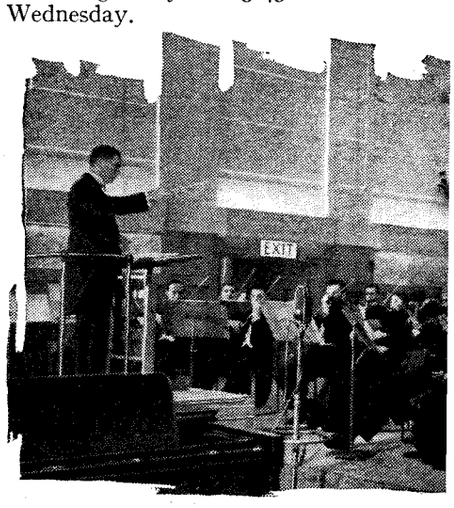
SADLER'S WELLS

WE hear so little opera in this country that when a relay is provided it is welcomed by opera lovers. From Sadler's Wells on Saturday listeners to the Regional programme will be treated to the second act of Wagner's "Lohengrin" at 9, preceded by a five-minute introductory talk. The scene of this act is laid in the Palace courtyard at night. The title-rôle will be filled by Tudor Davies and that of Elsa by Joan Cross.

SPORT

COMMENTARIES on three different sporting events will be given during the current week. On Saturday at 3.15 (Reg.) Captain H. B. T. Wakelam will give a running commentary on part of the Rugby football match between Blackheath and Newport from the Rectory Field, Blackheath. Immediately after this, at approximately 3.40, a much less boisterous contest, a snooker match, will be the subject of a commentary by Willie Smith from Thurston's Hall. H. Lindrum and Newman will be the contestants in the *Daily Mail* Gold Cup Sealed Handicap Tournament.

The International Association Football Match between Scotland and Germany at Ibrox Park, Glasgow, will be the scene of a running commentary which will be broadcast Regionally at 3.45 on Wednesday.



ERIC FOGG conducting the B.B.C. Empire Orchestra in the Concert Hall at Broadcasting House. Isobel Baillie (soprano) will be heard with the orchestra in an hour's programme on Thursday.

Guide for the Week

ome and Abroad

TRAILERS

THE B.B.C. are following the procedure of cinemas in giving trailers of forthcoming events. The first to be given will be on Thursday at 9.20 (Nat.) and is of the Greek drama, "Hippolytus" of Euripedes, which will be produced in the National programme on Sunday, October 18th. This idea should prove quite useful in enabling listeners to "taste and see" and then to make a note of forthcoming worthwhile programmes.

CABARET

A LATE-NIGHT cabaret half-hour, "Stepping Out," will be presented by Brian Michie (compère) and Ernest Longstaffe (producer) to National listeners at 10.5 on Wednesday. They will introduce into the programme a new and ultra-modern "swing" band, Phil Green and his Ballyhooligans, leading exponents of "swing" dance music. Also billed for this show are Marjorie Holmes and Ray Meux, a comparatively new find among comedians.

ALL WOMEN

THE play by Aimée and Philip Stuart, "Nine till Six," which was produced in London in 1930, has been adapted for radio by Aimée Stuart and will be produced by Barbara Burnham twice during the present week, on Monday and Tuesday at 9.35 (Nat.) and 6 (Reg.) respectively. The cast is entirely feminine and comes as a contrast to the all-male show "Eight Bells." It is set in a dressmaker's establishment—Business Hours: Nine till Six—the proprietress of which will be played by Gladys Young.

MOLLY, MARY AND MARIE, the Three Sisters, who broadcast with Henry Hall and the B.B.C. Dance Orchestra, and will again be heard in Henry Hall's Hour on Saturday. They are named here in the order from top to bottom.

SAILORS ALL

THE third edition of Mungo Dewar's "Eight Bells" will be given to Regional listeners at 8.15 on Wednesday. The characters will be the same as before plus one or two new ones, and the programme promises to be as breezy as ever. The stokers, Boyle and Shovell, will be well to the fore.

OPERA FROM ABROAD

ONE of the later works of Respighi, who died in April this year, will be given from Milan at 7.45 on Saturday: it is his "La fiamma."

Two almost simultaneous public performances of Rossini's "Barber of Seville" are announced in the German programmes; one comes from the National Theatre, Munich, and will be heard from Munich at 7, while the other, timed for ten minutes later, takes place at the Municipal Theatre, Freiburg, and will be relayed by Frankfurt. Thursday brings an important relay from Warsaw at 7.10 with the Grand Theatre performance of Moniuszko's "The Haunted Castle" for the opening of Warsaw's Opera Season.

OPERETTA

A NEW operetta "Der Verliebte Wauwau" by Goetze, one of the ultra-modern German composers of light music, will be given by Munich at 7.10 on Saturday.

In an interesting programme from Radio-Paris on Tuesday at 9.15 which consists of works of Vorcet is included a three-act operetta for radio entitled "Miss Cacahuette."

HIGHLIGHTS OF THE WEEK

FRIDAY, OCTOBER 9th.
Nat., 7.30, "Cavalcade." 9.40, "Mincing Lane," London's Tea and Spice Market. 11.15, Jack Payne and his Band.
Reg., 8.15, Eddie Carroll and his Music. 9, Relay from Lincoln Cathedral.
Abroad.
Radio-Paris, 8.45, "Madame Favart," Opéra-comique (Offenbach).

SATURDAY, OCTOBER 10th.
Nat., 7.30, "In Town To-night." 8.15, B.B.C. Orchestra (D). 9.20, Music Hall.
Reg., 4.15, Rex London's "London's Latest." ¶"Legends of the Peak"; Tale and Tradition from the Derbyshire Hills. 9, Sadler's Wells Relay. 10.25, Henry Hall's Hour.
Abroad.
Vienna, 7.5, Bruckner Festival.

SUNDAY, OCTOBER 11th.
Nat., 5.20, The Brosa String Quartet and John McKenna. 7.55, Service from St. Martin-in-the-Fields. 9.50, B.B.C. Orchestra (D).
Reg., 5.45, Edward German Programme; B.B.C. Orchestra (E), B.B.C. Singers and Raymond Newell. 6.45, Mr. Pickwick Still Going Strong. ¶Victorian Melodies, No. VIII.
Abroad.
Königsburg, 8, Bach Festival, the St. John Passion.

MONDAY, OCTOBER 12th.
Nat., 7.20, "The Music Shop." ¶Recital: Muriel Brunskill and Anthony Collins (viola). 9.30, "Nine Till Six."
Reg., 6, "Lots of Love." 9, B.B.C. Orchestra (E) and Isolde Menges. 10.25, The Grosvenor House Dance Band.

Monday, October 12th (*continued*)
Abroad.
Frankfurt, 7.10, Niemann Concert for his Sixtieth Birthday; the composer at the piano.

TUESDAY, OCTOBER 13th.
Nat., 6.25, The Orpheus Trio. ¶H. Robinson Cleaver at the Organ of the Regal Cinema, Bexley Heath. 8, "Lots of Love."
Reg., 6, "Nine Till Six." ¶"The Everlasting Waltz"; B.B.C. Dance Orchestra. 8, Sonata Recital, Adolf Busch and Rudolf Serkin.
Abroad.
Luxembourg, 8.50, Operetta-Revue from the Théâtre des Variétés, Paris.

WEDNESDAY, OCTOBER 14th.
Nat., 6.40, Falkman and his Apache Band. ¶Van Phillips and his Two Orchestras. 8 and 9.20, B.B.C. Symphony Orchestra at Hanley. 10.5, "Stepping Out": Cabaret.
Reg., 8.15, "Eight Bells." ¶"Bigger Business": Claude Hulbert and Bobbie Comber. 10.25, Bram Martin and his Dance Orchestra.
Abroad.
Strasbourg, 8.30, Concert from the Palais des Fêtes.

THURSDAY, OCTOBER 15th.
Nat., 6.40, Empire Orchestra and Isobel Baillie. 9.40, Variety. 10.20, Lew Stone and his Band.
Reg., 6.40, From the London Theatre. 8.15 and 9.50, London Philharmonic Orchestra at the Queen's Hall.
Abroad.
Warsaw, 7.10, "The Haunted Castle" (Moniuszko) from the Grand Theatre.

PAUL BEARD, leader of the B.B.C. Symphony Orchestra. The first public appearance of the orchestra with its new leader since its European Tour last April will be at Hanley on Wednesday.

TUNE IN THIS

LUXEMBOURG'S 9 o'clock transmission on Wednesday has the intriguing title "Music Hall—A Neapolitan Soirée in 1900." This should be well worth tuning in.

THE AUDITOR.

Letters to the Editor

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

Biasing the Output Valve

I WAS interested to read Mr. H. Wightman Harris' letter in which he states that as a result of the temporary leakage of the electrolytic bias condenser, he abandoned auto-bias in favour of a separate bias system.

This is easily remedied if a resistor is connected between the positive end of the bias resistance and HT+, thus partly charging the bias condenser before the output valve takes any anode current.

The bias resistance naturally has to be reduced in accordance with the extra current passed through it, and I have found that with a DO/25, a bias resistance of 1,200 ohms, and a condenser charging resistance of 80,000 ohms is suitable for an HT supply of 400 volts. This develops approximately 6 volts, which I found to be ample for the initial polarisation of the bias condenser.

London, N.12. N. L. BOLLAND.

Local SW Interference

WITH reference to Mr. Browning's letter, which appeared in *The Wireless World* dated August 28th, the experience of receiving a nearby short-wave transmitter on a receiver tuned to the normal broadcast bands is by no means an uncommon one, and has occurred in several instances within the writer's experience. In most cases it is found that the presence of an HF stage greatly accentuates the interference from the short-wave station.

The effect is due to several causes either acting together or separately. The most obvious of these is cross-modulation due to the fact that the high-frequency valve is being operated on the wrong part of its characteristic, so that rectification takes place. This effect is increased on account of the valve being effectively overloaded by the interfering short-wave signal; this tending to produce grid current. The short-wave signal is enabled to reach the grid of the HF valve, since in the majority of cases the medium-wave tuned input circuit exhibits subsidiary or parasitic resonances which are frequently set up or increased by tappings, transformer windings, etc., which generally form an integral part of the tuning coil. Several of these resonances may occur and at frequencies corresponding to both short and ultra-short wavelengths. Alternatively, the medium-wave coils may act as chokes on the short wavelengths, so that aperiodic circuits are formed, and so enable the powerful short-wave signals to reach the grid of the HF valve. Here, assuming the conditions of operation referred to as holding good, the modulation of the short-wave signal is transferred to the medium-wave carrier, obliterating the modulation of the latter on account of the relative strengths of the signals, and so being passed to the loud speaker.

This effect, however, is almost certainly not the cause of the effect to which Mr. Browning refers, since cross-modulation depends on the existence of a carrier on the broadcast band and Mr. Browning states that the interference persists over the whole of the tuning dial. Cross-modulation is, however, mentioned as of general interest, as being some times responsible for a short-wave signal being superimposed on a medium- or long-wave station.

The interference in the present case is most probably produced by the tuned medium-wave input and output circuits of the HF amplifier, acting aperiodically, i.e., as chokes to the powerful ultra-short wave signal, so that the effect is independent of the setting of the tuning condenser. On the other hand, subsidiary resonances in the tuning coils or aerial at the ultra-short wave frequency would effectively produce a stage of ultra-short wave amplification in addition to that produced on the medium waves by the normal action of the tuned circuits, this giving a ready passage for the interfering signal. If, due to this cause, the effect would occur at all settings of the dials, as Mr. Browning describes, it would incidentally be greatly increased by stray parasitic back couplings from the output to the input circuits of the HF amplifier, either externally or through the residual inter-electrode capacity of the valve, these stray back couplings thereby forming a tuned reaction circuit at the parasitic or ultra-short wave frequencies. As designers know, one of the greatest drawbacks to high gain amplifiers employing specially tapped coils is parasitic oscilation, which often consists of frequencies corresponding to the ultra-short waves.

The reason for the interfering signal being nearly inaudible on the det-LF receiver to which Mr. Browning refers is most probably due to the absence of stray reaction effects brought about by the inherent simplicity of the circuit; the different type of coil, and the use of a long aerial. It is probable that the construction of the coil is such that subsidiary resonances on the ultra-short wave band do not occur. Further, the reaction circuit may be so arranged on the det-LF receiver as to suppress or reject ultra-short wave resonances, while reinforcing the desired medium-wave frequency.

Another possible explanation is that the 35ft. indoor aerial of which Mr. Browning speaks in the case of the HF set, resonates with the aerial coupling circuit (which may consist of a series condenser and/or tappings or transformer) at a frequency within the ultra-short wave band. In the case of the det-LF set, however, the use of a longer aerial than in the case of the HF set, together with a probably tighter degree of coupling between the aerial and the tuned circuit, would tend to produce an aerial circuit resonance of much longer wavelength, which would, in effect, greatly reduce the response to the ultra-short wave signal.

Grantham, Lincs. E. P. RUDKIN.

Home Recording

THE article on "Experiments in Home Recording," by Robert W. Bradford, in the September 25th issue of *The Wireless World*, is a useful addition to the scanty literature available on a subject which is now receiving widespread attention.

I have given much time to research on this work, especially in an effort to produce a suitable recording blank, during which an investigation was carried out as to the possibilities of employing blanks made of pure aluminium, aluminium-alloy, tin, zinc, bakelite, gelatine, aldehyde resins, celluloid, celluloid esters, cellulose acetate, cellulose nitrate, all the "plastics," silica, tar, hydrates, and various waxes. These materials were tried unbacked, or flexible; rigid, i.e., backed with a base or carrier of cardboard, metal or glass, and also as applied surface coatings.

Other experiments included the use of mouldings, pressings, case-hardening surfaces, hardening surfaces by baking, and softening surfaces (before cutting), then subsequently hardening and polishing by chemical solutions. In addition, all commercial blanks obtainable in England, and several types from America and the Continent, were tested.

After this exhaustive consideration of all recording materials, I would like to corroborate Mr. Bradford's statement that the "Simplat" glass disc is the best for direct, or instantaneous recording. There are two or three other blanks purchasable that are very good, and cheaper in cost than the "Simplat," but I find the latter successful from all technical viewpoints.

The "Simplat" surface cuts cleanly, it will permanently "hold" a wide frequency response, it will carry transients well, it has a long playing life, and the surface-noise can be less than that on the average professional solid stock record.

To conclude, may I correct Mr. Bradford's impression, as mentioned in his article, that the surface covering on the "Simplat" disc is of cellulose? The coating is gelatine, mixed with a water soluble oil, plus a colouring dye; the hardening fluid is formaldehyde, and the polishing fluid a compound of waxes.

Ilford, Essex. D. ALDOUS.

"Inter-line" Synchronising

IN von Ardenne's book "Television Reception," just issued, he attributes the present television synchronising system by which a signal is interposed between every line traversed to Dr. Schriever in June, 1933. In fairness, it should not be forgotten that "inter-line synchronising" received its first mention in your issue of July 3rd, 1929, where the statement appears "To interpose a synchronising signal between each successive traverse of the object at the transmitter is a logical suggestion." Prior to this, television had no system of synchronising and without synchronising there could be no television. The proposal contained in the article was quickly acted upon, for shortly afterwards it was adopted by the Baird Company in their arrangement whereby the inter-line synchronising signal was applied to a phonic wheel, and the effect of this was that their system at once became a working proposition. To use such a signal in conjunction with a cathode ray tube embodies even less novelty, as cathode-ray time bases have invariably adopted circuits wherein provision is made for injecting a synchronising beat. To *The Wireless World* and its contributor, F. H. Haynes, therefore, goes the credit of inter-line synchronising, by which the present vogue of television was made possible.

London, N.15. B. RUDDER.

UNBIASED

By FREE GRID

SOS

I WONDER if any of you who are gardening experts could spare the time to give me a little advice concerning this hobby in return for the many valuable wireless hints and tips that I have conveyed to you in these columns? Although it is horticultural advice that I need, my problem is really of a radio nature.

Briefly, my trouble is that I am haunted by mistletoe, which is slowly and surely strangling my wireless mast to death. I don't know why it possesses such an affinity for my mast, although I am told it is because the latter consists of the trunk of an old apple tree which was flourishing at the bottom of the garden when I took the house. This tree was of considerable age and had an exceptionally tall trunk, and so it was a simple matter for me to saw off all the boughs and thus possess myself of a mast which was really and truly rooted in the ground and therefore not likely to collapse by reason of the base rotting.

This answered my purpose very well, although I well remember that at the time there was a great outcry among sentimentalists in the neighbourhood, who quoted nauseous rubbish about "the shade of the old apple tree" and similar poetic nonsense. All went well until Mrs. Free Grid was foolish enough to dump the remnants of the Christmas decorations at the base of the pole, and apparently the mistletoe among them, revived by the near presence of the ex-apple tree, took heart and started to commence life afresh.

At first I remember I foolishly thought that the mistletoe-entwined pole looked rather pleasant and I let it go on until it began seriously to affect the efficiency of my reception, when I did some vigorous pruning. Unfortunately, however, I had let things go too far and the mistletoe had got a firm hold on life, and even though I prune it regularly every week-end it has been slowly gaining on me for some months past and things have now come to a pretty pass, as you can see by the accompanying photograph.

A few weeks ago I determined on drastic measures and obtained a generous supply of arsenic, although not without much signing of poisons books and a suspicious look on the part of the chemist, who seemed reluctant to supply my needs. Unfortunately, however, the arsenic has proved a complete failure, since not only is the mistletoe still hale and hearty, but I regret to say that Mrs. Free Grid's most cherished chrysanthemums have passed into a coma and are almost beyond the aid of artificial respiration. Furthermore, the trouble seems to be spreading rapidly, as some Michaelmas daisies in an adjoining bed are looking distinctly pale, while the cat has gone off its feed.

You will understand the desperate nature of my plight when I tell you that Mrs. Free Grid, who is spending a week or two at the seaside and knows nothing of the illness afflicting her wretched plants, may be back at any moment. I hope, however, by the despatch of money, to keep her on holiday until such time as the horticultural experts among you can assist me with advice as to the best methods to adopt in order to counteract the effects of arsenic. Needless to say, I should also welcome advice on how to keep the mistletoe in check, for, as mentioned above, it is choking the life out of my wireless pole, and soon I shall be entirely bereft of any wireless entertainment. In order to lend wings to your pens, I may mention that I am not feeling any too well myself.

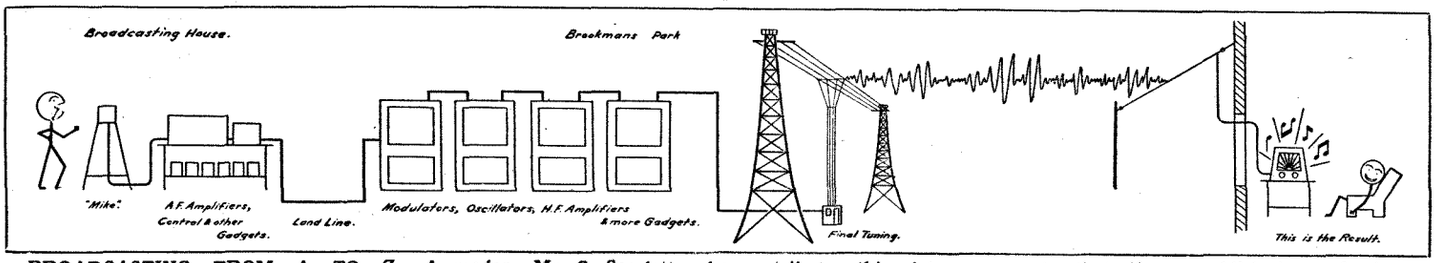
As you can see here, things have now come to a pretty pass.

More Teletroubles

I SEE that there is a great deal of speculation concerning the precise form which should be taken by the television interval signal when the regular programmes start. There was quite enough ado about the interval signal for ordinary broadcasting, and even now many people are far from being satisfied with the sound of Bow Bells. I gather, however, that this will pale into insignificance in comparison with the rumpus that is likely to arise over the visual signal.

It is quite obvious, of course, that something will have to be caused to appear on our television screens during the intervals between the various programme items. If our screens are simply left blank many people will be apt to jump to the conclusion that their television set has broken down and forthwith proceed to disembowel it. So far, I understand, the B.B.C. have hit upon no original ideas, but are proposing to show something which is placid and likely to inspire confidence, such, for instance, as the image of the director-general. The obvious objection to that is, of course, that as in the case of the cinema, the very essence of a television show is life and movement rather than placidity.

It would be quite easy, of course, to send a moving picture of Bow Bells ringing, this being derived from a record—or, in other words, a film—just as the sound one is. I cannot help thinking, however, that this would be exceedingly tame and that something more exciting is called for, but for the life of me I cannot offer any suggestions at the moment. There must surely be some of you, however, who can think of something to help the B.B.C. out of its trouble. Remember that the "signal" can be as complicated as you like, since it will, of course, be recorded on a cinema film. You should, when sending your suggestions to the B.B.C., not omit mention of my name as, if you do this, you will, I assure you, receive special attention.



BROADCASTING FROM A TO Z.—A reader, Mr. C. Scarlett, who contributes this picture, suggests that if we publish it no further articles on Broadcast Transmission will be necessary.

Current Topics

EVENTS OF THE WEEK IN BRIEF REVIEW

Royal Radio Amateur

PRINCE Mohammed Abdul Monnen of Egypt has just passed the French test for amateur transmitters and has received his licence for the operation of a short-wave station.

New Short-wave Station

THE Czechoslovakian broadcasting authorities have been very busy erecting a new short-wave transmitter at Podiebrad, the famous bathing resort. At present the station is not open for public service, but is experimenting with wavelengths of 10.06, 25.51 and 49.05 metres.

South African B.B.C.

AS in the case of the B.B.C., the privately owned company which has been hitherto responsible for South African broadcasting is to pass into the hands of a public-utility corporation. The corporation has acquired all the assets of the private company for £150,000, this sum being fixed by arbitration. Although the corporation has been founded by Act of Parliament, it is stated to be completely free of Government control.

Mayor Appointed Announcer

SO far as is known, no man has yet combined the posts of wireless announcer and mayor of a town. This honour will now fall to the Mayor of Ercé, a town of 2,600 inhabitants in France, who has recently been appointed as an announcer on the staff of the P.T.T. Thus the voice of the mayor of this small town will be heard throughout France, a distinction of which the mayors of many of the largest cities cannot boast.

I.E.E. Wireless Meetings

THE following are the dates of the meetings of the I.E.E. Wireless Section for the 1936-37 session: November 4th, December 2nd, January 6th, February 3rd, March 3rd, April 7th, May 5th. It should be noted that the meetings are always on a Wednesday.

Taxi Radio Slump in France

LAST year there was a tremendous boom in wireless sets for French taxis, but this seems to have been purely a passing phase, as 3,000 of the licences have not been renewed this year. This state of affairs is thought to be the reason why in certain parts of France the net increase in the total number of wireless licences has been exceptionally small during the past few weeks.

Austrian Licences

THE numbers of listeners in Austria has now risen to 357,465. The powers that be are far from satisfied with these figures, however, and are making a great effort to increase the number to half a million by Christmas.

India Anxious for Wireless Progress

A PROPOSAL has been made to form an Indian Radio Relay League, its constitution being based on the American Radio Relay League. It is complained that India has not kept abreast of other countries in the matter of wireless progress, and that this has been due to the absence of any proper organisation for furthering amateur wireless interest.

Craftsmanship Competition

THE Physical Society announces that the eighth annual craftsmanship and draughtsmanship competition will be held, as usual, in conjunction with its annual exhibition of scientific instruments and apparatus in January next. Competitors must be in the regular employ of a firm or institution which will be exhibiting or has exhibited at least once during the previous three years.

Football Commentaries and Gate Money

FOR some time there has been a dispute in Italy concerning the broadcasting of running commentaries on football matches. The football authorities complain, as has been the case elsewhere, that if a commentary is broadcast the gate-money is seriously reduced, as many people who originally intended to be present at the particular match broadcast prefer to listen-in at home. An agreement has now been reached whereby one football match is allowed to be broadcast every Sunday afternoon. No announcement is to be made in advance as to which particular match is to be dealt with, and it is hoped that by this means no detrimental effect will be had on the attendance figures.

French Radio Film

A SPECIAL film dealing with "The Mystery and Glory of Radio" has been prepared in Paris with a view to popularising wireless. It has been done by a well-known film company in conjunction with a famous French radio factory and a popular broadcasting station. Names are not disclosed. Leading broadcasting artistes appear in it, and apart from this there is a section dealing with the assembly of a wireless receiver in the factory and the technical processes in a broadcasting station.

Morse Mangling

AMATEUR transmitters are justly renowned for their technical knowledge, while their operating skill is of no mean order. In respect to the latter ability, however, there are a few morse manglers who are apparently in the habit of sending with their foot, as it is difficult for a skilled listener to distinguish some of their dots from their dashes. A well-known short-wave listener is said to have conceived the idea of taking a tape recording of the sending of certain offenders and forwarding it to them. It seems highly probable, however, that this will prove merely a waste of time and money, since such offenders have usually proved quite impervious to repeated complaints in the past.

Another Death-ray ?

REMARKABLE happenings are reported from Archangel, where cars are said to be breaking down with monotonous regularity in the vicinity of a wayside garage. All efforts to restart the engine are unavailing, and cars have to be towed into the garage, where engine power seems to be miraculously restored without any actual adjustments being carried out. The matter has been investigated by the authorities, who lay the blame on "a peculiar effect of terrestrial magnetism which apparently affects the ignition." Other explanations suggest themselves when it is remembered that as far back as 1920 or thereabouts a "death-ray" inventor successfully demonstrated that it was possible to stop a petrol engine at distances of a few feet by means of ultra-short-wave transmissions of a special nature.

Sydney "Sun" Photo.

AUSTRALIA'S BIGGEST "S.B."—When the Rt. Hon. J. A. Lyons, Prime Minister of Australia, recently spoke on the trade situation with Japan his voice was broadcast over the vast area of the Commonwealth through 95 government and commercial stations, linked by over 18,000 miles of telephone line.

Back to 1922

A WELL-KNOWN London firm of loud speaker manufacturers recently received an enquiry which read as follows: "Can you supply and fit a loud speaker to my portable wireless set which, since the alteration in wavelength, is no longer satisfactory?" We thought that this sort of thing had died out long ago.

Wireless Fans Flames

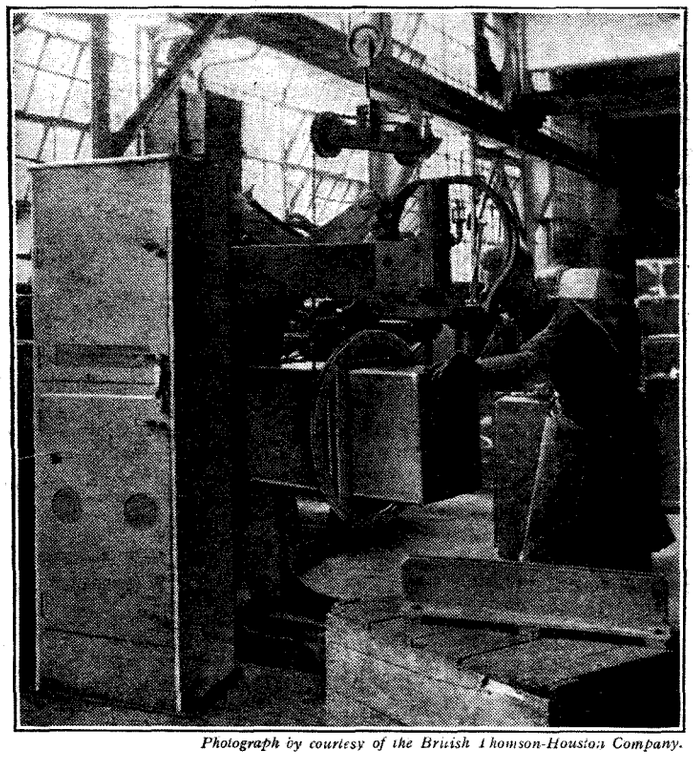
A GROUP of scientists who have been experimenting with the effect of Hertzian waves on flames originating through gaseous mixtures, are reported to have made some remarkable discoveries. It is stated that under the influence of a five-hundred-metre wavelength an oxygen-acetylene flame is greatly increased in intensity, a given quantity of gas being consumed in half the normal time. At 20 metres the effect disappears entirely, but reappears at 8.8 metres. The research workers attribute this effect to "the agitation of the molecules of the gas by ionisation due to the passage of the waves." They do not, however, offer any reason for the phenomenon only occurring at certain critical wavelengths.

THE special issue of *The Autocar*, on sale to-day (October 9th), is the first of three special numbers dealing with the Motor Show. A complete show report will appear on October 16th and a review of progress on October 23rd.

Welding with Thyratron Control

ELIMINATING ERRORS DUE TO THE HUMAN ELEMENT

By HARLEY CARTER



A continuous welding machine in which the current is controlled by Thyratrons.

Photograph by courtesy of the British Thomson-Houston Company.

THE radio engineer, accustomed to think in terms of frequencies ranging up to many millions of cycles per second, and realising that thermionic tubes can respond to such frequencies with great accuracy, is apt to overlook the fact that his brother, the mechanical engineer, while normally dealing with time-cycles of much longer duration, sometimes has to face problems involving periodic operations which, although far below radio frequency, are too rapid to be controlled purely mechanically. To an ever-increasing extent thermionic tubes are being used to assist the heavy engineer in such cases.

One such application is in resistance welding, in which the metals to be joined are pressed together and a low-voltage AC source applied across the work, the comparatively high resistance at the point of contact generating sufficient heat to raise the metal to welding temperature. There are three main types of resistance weld—the spot weld, in which the work is positioned between two heavy copper electrodes which close on to the joint on the depression of a pedal by the operator; the continuous seam weld, in which the work is passed between two disc electrodes; and the intermittent seam weld, which employs a similar machine, but the welding current is interrupted regularly to give a series of overlapping spot welds. The latter is preferable to continuous seam welding because it reduces the risk of overheating and burning the work.

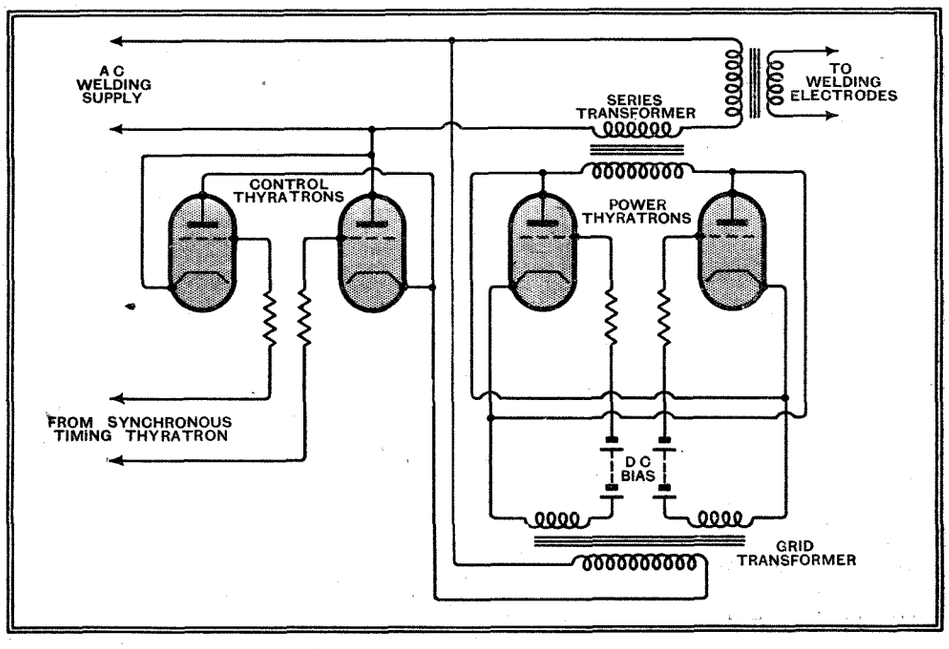
In both spot and intermittent seam welding, accurate control of the time during which the welding current is "on" is essential to ensure good quality work, and it must be adjusted to suit the section of the material being welded. This period can be accurately controlled by Thyratron tubes.

The simplest application is for spot welding in which the welding contacts are applied by pressure upon a pedal. In uncontrolled welding, the duration of the welding current is determined by the length of time for which the operator keeps his foot on the pedal. The human element can be avoided by a circuit in which the operating pedal not only closes the welding current contactor, but also opens a second contactor which permits the grid of a thyratron, previously held at a definite negative bias, to build up to the critical voltage at which the thyratron will pass current, the time taken to reach this voltage being accurately adjustable by varying the grid leak resistance. In the anode circuit is inserted the trip coil of the welding contactor, and when the Thyratron becomes conducting, the welding contactor opens.

For more accurate timing, such as that required in high-speed intermittent seam welding, contactors are dispensed with, the welding control being synchronised with the periodicity of the AC supply.

The basis of the control is a "synchronising unit," which is a single Thyratron adjusted to become conducting at regular intervals at a certain point on the voltage wave of the AC supply, the range of adjustment including an almost endless variety of combination, such as one cycle "on" and one cycle "off"; three cycles on and six cycles off; and so forth.

The synchronous timer regulates the main circuit, which is shown diagrammatically in the figure. The synchronising unit controls the grid circuits of two small Thyratrons, whose anode circuit is completed through the primary of a transformer having two secondaries, one connected in the grid circuit of each of two main power Thyratrons and working in series with a pre-adjusted negative DC biasing supply. At those times when the small control Thyratrons are conducting, the voltages developed in the grid transformer secondaries render the grids of the power Thyratrons positive at a definite point in the voltage wave, and the power Thyratrons become conductive so long as this positive voltage appears every cycle. During the period when these tubes are conducting they act as a short circuit across the secondary of a series transformer, the primary of which is included in the welding supply, and therefore practically the whole of the line voltage becomes available across the primary of the welding transformer, permitted a weld to be made. When, however, the power Thyratrons are rendered non-conducting, the secondary of the series transformer is, in effect, open-circuited, and the primary, acting as a choke, reduces the voltage across the welding transformed primary to a negligible value, while grid control of the power tubes also controls the welding current.



Basic circuit for Thyratron control of welding current "duty-cycle."

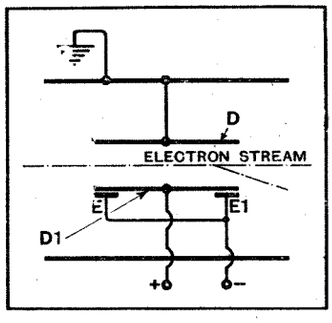
Recent Inventions

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

CATHODE-RAY TUBES

THE electron stream through a cathode-ray tube may be undesirably influenced by the marginal fields set up near the ends of the usual deflecting-electrodes. To offset this tendency, one or more auxiliary electrodes are arranged so as to neutralise the fields in question.

For instance, if the upper electrode D is anchored to earth, disturbing "transverse" fields are likely to occur near the two outer



Arrangement of special electrodes in cathode-ray tube described in Patent No. 449245

margins of the condenser formed by the two electrodes D, D1. According to the invention, such fields are counterbalanced by arranging two suitably charged plates E, E1 in the positions shown in the drawing.

Radio-Akt D. S. Loewe. Convention date (Germany) October 23rd, 1933. No. 449245.

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MOUNTING "ACORN" VALVES

IN the so-called "Acorn" type of valve used for ultra-short-wave working, the top and bottom of the glass bulb are both sealed off in a "pip," and the leads to the electrodes are brought out radially, as shown, for instance, at T, T1, in Fig. 1, from a central flange F. In order to reduce the external inductance and capacity to a minimum, the valve is mounted in a holder consisting of a baseplate B fitted with a number of U-shaped spring contacts S, shown enlarged in Fig. 2. The baseplate is fitted with an upper protecting plate P of insulating material formed with a series of slots Q. The radial leads T are first inserted through the slots Q, and the valve pushed down into contact with the baseplate. It is then given a slight turn or twist so as to force the leads under the flanges of the spring contacts S.

Marconi's Wireless Telegraph Co., Ltd. (Assignees of B. Selzberg). Convention date (U.S.A.) September 12th, 1934. No. 447461.

o o o o

FINE TUNING

ANY initial mistuning of the circuits of a wireless receiver is automatically adjusted by virtue of the fact that a change in the bias on the outer grid of a hexode valve automatically alters the reflected capacity across the input circuit of that valve. The capacity in question is arranged in shunt with the tuning-condenser of the local oscillator valve, which is, in consequence, readjusted to bring the receiver accurately into step with the incoming signal wave.

As shown in the drawing, the output circuit of the intermediate-frequency valve V consists of a series-tuned circuit L, C. The voltage across the inductance L is applied to one, and the voltage across the capacity C to the second of the two diodes of a rectifier D. Should the set be correctly tuned, there will be no resultant voltage across the two load resistances R, R1, since these are arranged in opposition. Any initial mistuning, however, upsets the balance and so applies an additional bias to the grid G of the hexode control valve V1. This, in turn, will alter the effective capacity of the input circuit of that valve, which, being in shunt with the tuning condenser C1 of the local oscillator circuit, automatically brings about the desired adjustment.

R. E. Spencer. Application date December 14th, 1934. No. 449391.

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TELEVISION

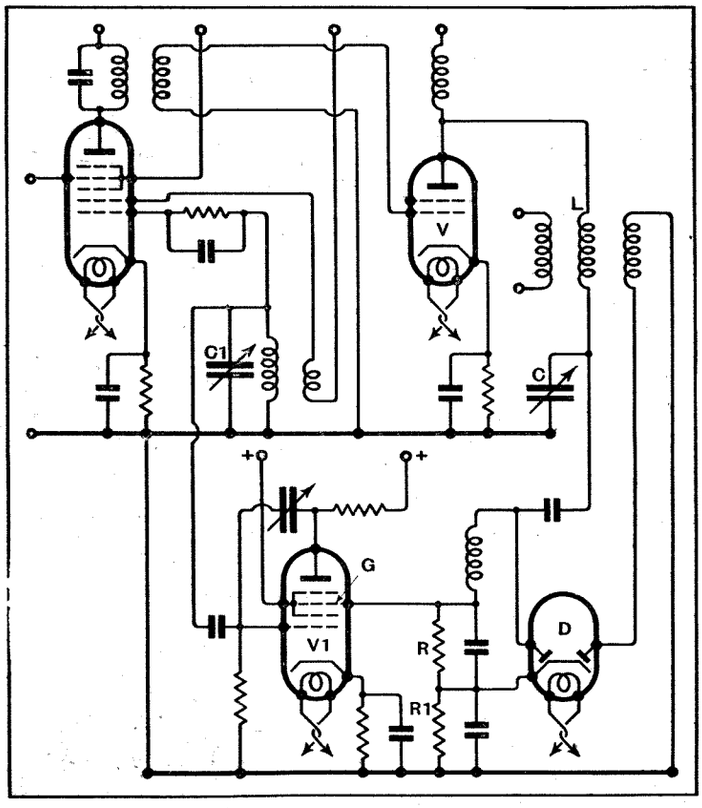
FOR televising a local event at some point distant from the main transmitter, it is desirable that the portable "pick-up" apparatus should be kept as light and compact as possible. The usual time-base circuits for synchronising are accordingly dispensed with. In their place, synchronising signals are radiated from the main transmitter and are picked up by a suitable receiver included with the portable gear. The signals are then amplified and applied to control the working of the portable television camera or "pick-up" apparatus. The final signals, including the synchronising impulses, are either fed by line or radiated back to the main transmitter.

Telefunken Ges. fur Drahtlose Telegraphie m.b.H. Convention date (Germany) March 26th, 1935. No. 450303.

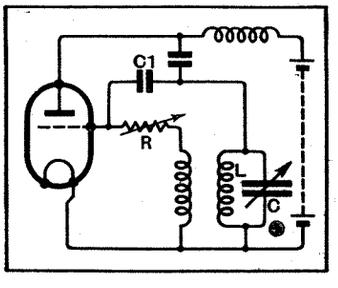
VALVE OSCILLATORS

THE circuit shown is designed to offset the effect of valve-curvature and other factors, such as a fluctuating supply-voltage on the frequency-stability of a back-coupled valve. This is ensured by providing, in addition to the tuned back-coupling circuit L, C, an "anti-reaction" condenser C1, which feeds back energy from the anode to the grid in the sense opposing self-oscillation. The impedance of the condenser C1 decreases with increasing frequency, so that it is particularly effective in offsetting any tendency to produce harmonics. In addition a variable resistance R is used to control the amplitude of the generated oscillations until only the fundamental frequency persists; it also limits the effect of the capacity C1 upon the frequency-determining circuit L, C.

L. H. Paddle. Application date January 2nd, 1935. No. 449871.



Circuit for automatic tuning correction



Method of obtaining good frequency stability in a valve oscillator.

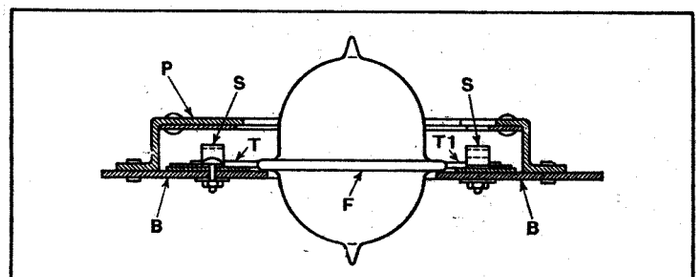


Fig. 1

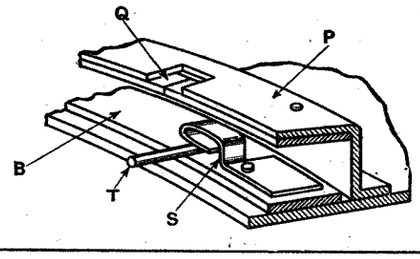


Fig. 2

Fig. 1.—Low-capacity holder for "Acorn" valves. Fig. 2.—Enlarged view of one of the spring contacts.

The Wireless World

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CONTENTS

EDITORIAL COMMENT

The Broadcast Licence

Relation to Television Expenditure

CRITICISM is already beginning to break out on the subject of expenditure on television stations and programmes. Letters are appearing in the Press and there has, in addition, been a certain amount of agitation with a view to opposing expenditure of B.B.C. revenue in this direction.

The reasons given for objecting to the inroads which television is making into B.B.C. finances are that it is the listeners' money which is being used and diverted from the sound programmes as a whole to provide television transmissions in a restricted area and for a potentially limited number of users.

We think it is very desirable to do what is possible to check the growth of this feeling of discontent before it spreads. The achievement of television and its development as a regular service is something for this country to be proud of, and whether or not television attains popularity at once must depend upon the attractions of the programmes transmitted. When the public recognises the value of the entertainment, then we may hope that sets will be sold in increasing numbers and may as time goes on be available at lower prices than those which rule to-day. But this goal will never be achieved unless the B.B.C. is courageous enough to be unstinting in efforts to provide the right material for the programme service.

It is altogether wrong to talk of the revenue of the B.B.C. as listeners' money, as if it were in the nature of payment for a theatre or concert ticket. The 10s. is payable as a licence fee for the use of a wireless receiver and, as such, it comes under the same category as a dog licence, which carries with it no promise as to the behaviour of the dog.

It is, perhaps, unfortunate that so much publicity has been given to the fact that the B.B.C. revenue is based upon the licence receipts. If the 10s. licence had been regarded as on the same basis as a dog licence and broadcasting financed by a Government grant, these arguments might never have arisen. It has, no doubt, been convenient to arrange for the B.B.C. revenue to be in proportion to the licence fees collected, but apart from this the payment of the annual licence ought not to be mixed up with arguments as to what the listener is entitled to expect by way of programmes.

Aerials

Special SW Types

FOR many years now the wireless aerial for broadcast reception has been a necessary but rather uninteresting accessory to reception. Beyond seeing that the aerial wire was laid out on approved lines and kept free from rubbing contacts and bad joints, there was little more that could be done with it.

With the coming of short-wave reception there has been a general revival in interest in aerial design, and for television reception, in particular, special aerial designs have important advantages, particularly in the direction of reducing interference from local causes. The dipole arrangement, favoured for ultra short-wave reception, is discussed in articles in this issue.

The ideal condition for employing a dipole aerial is where one transmission on a fixed frequency is to be received, as in the case of the television broadcasts. The complications arising when an aerial of this type is required to provide for reception on a number of different wavelengths limit its usefulness in such circumstances.

Experiments with Television

EFFECT OF HEIGHT—MOTOR CAR INTERFERENCE—HORIZONTAL OR VERTICAL?

THIS article contains valuable information on the use of doublet or dipole aerials for television reception. The advantages of height, both for signal strength and reduction of interference, are shown, and the relative effectiveness of horizontal and vertical arrangements is discussed.

RECENT transmissions of television pictures and sound from the Alexandra Palace to Radiolympia have afforded an excellent opportunity for carrying out certain fundamental and important measurements with television aerial systems. M. G. Scroggie, in his article "Television and the Aerial,"* has shown the necessity for certain investigations into the properties of television aerials, and this article is intended to follow up his excellent introductory work on this subject.

It is not an over-statement to say that the aerial for television reception requires more careful design and consideration than that required for broadcast reception on the medium and long waves. In the first place, ultra-short waves are much more rapidly attenuated than long waves in their passage over the earth's surface. Secondly, high transmitting power is not so readily available from both technical and economic considerations.

These two factors result in a lower average field strength in the vicinity of the receiving aerial, and a consequently lower signal input to the receiver itself. Furthermore, the presence of neighbouring conductors or semi-conductors vastly influences the field strength, and in most cases causes a further reduction, although an increase is sometimes noted when certain conditions are fortuitously present.

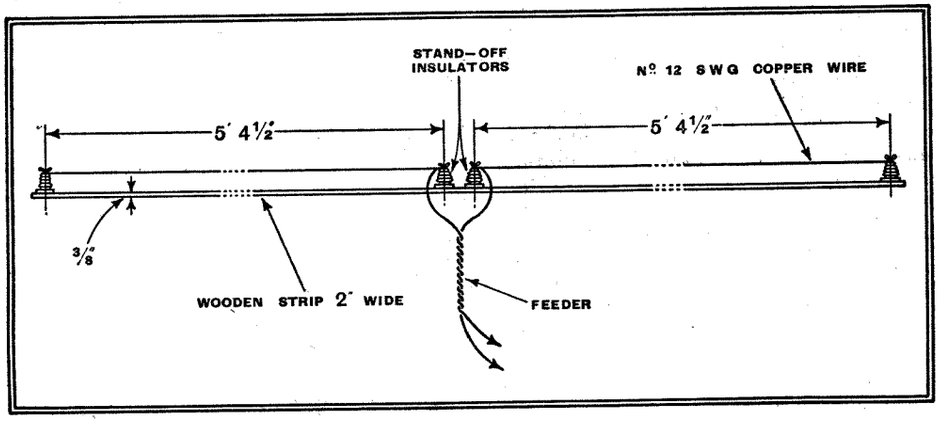


Fig. 1.—Construction and dimensions of the half-wave doublet aerial used for the experiments.

If electrical interference were completely non-existent, then receivers might be built with increased gain to compensate for these inadequacies of field strength, but this is not a practical basis on which to work. Electrical interference from the ignition systems of motor vehicles affects television reception in many areas, the electrical disturbances being mainly due to the sequential sparking at the plug points. The characteristic clicking noises vary with engine speed, and may be heard when listening on and around 7 metres in the vicinity of any main road. The effect on a high-definition television picture is to superimpose upon it numerous small scintillations of night sky appearance.

Directional Advantages

Fortunately this form of interference may be reduced in most cases by arranging the aerial system so that it is more effective in picking up the required transmission than the unwanted electrical noise.

The exhaustive experiments to be described were made in order to ascertain what performance could be reasonably expected from the simplest form of efficient aerial system, and how it should be placed with respect to the ground to obtain a maximum signal-to-noise ratio.

The aerial used for the experiments comprised a half-wave doublet, suitably matched to a low-impedance transmission line, approximately 100ft. in length. The dimensions of the doublet are given in Fig. 1, together with a sketch of the general arrangements.

The aerial was so arranged that it could be erected in a vertical position with respect to the ground, and could be raised or lowered through a total height of 33ft., corresponding to approximately one and a half wavelengths of the received transmission. The measuring apparatus consisted of a suitable input system and frequency changer feeding into an IF amplifier, the frequency of which was 1.6 megacycles, and the gain of which was adjustable in suitable decibel steps. This amplifier was followed by a valve voltmeter, of which the input time constants were adjusted so that the indications (in the case of electrical noise) more closely corresponded to the annoyance factor than to peak or RMS values.

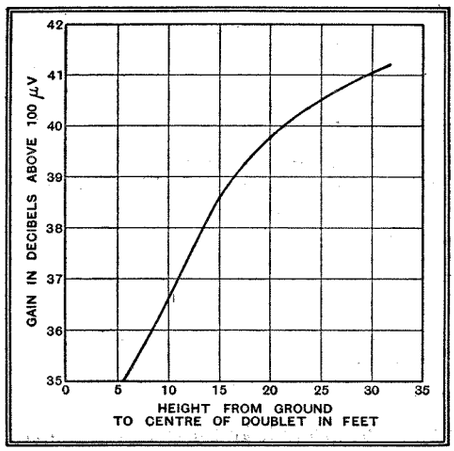


Fig. 2a.—Curve showing variation of signal strength with height above ground of the vertical half-wave doublet.

The whole apparatus was well built and screened, and was very stable in operation. Although the absolute sensitivity in microvolts input for full scale deflection was not exactly known at the television wavelengths, the relative inputs in decibels were known to within + or −0.5 db., and, of course, relative values are of major importance for the experiments to be made. Preliminary calibrations, however, were made and the input in microvolts required to give a full voltmeter deflection at maximum gain in the system was estimated to be of the order of 100 microvolts.

The curves showing the results of these

* *Wireless World*, August 28th, 1936.

Aerials

By F. R. W. STRAFFORD

(Research Dept., Belling and Lee, Ltd.)

experiments are thus relative to 100 microvolts, so that 40 db. represents $100 \times 100 = 10{,}000$ microvolts, 6.0 db. $= 100 \times 2 = 200$ microvolts, and so on.

The tower of Alexandra Palace is at a distance of approximately 5.3 miles from the point at which the aerial was erected, and was visible from ground level. The route is thus an optical one, and the

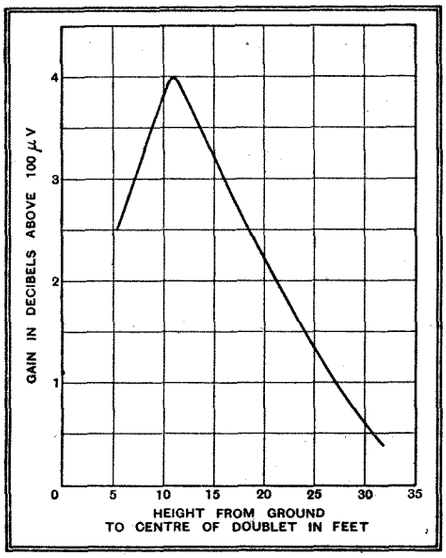


Fig. 2b.—Variation of ignition interference strength with height above ground (vertical aerial).

receiving aerial system already described was located in a field over 100ft. from the nearest buildings.

Fig. *2a* shows how the field strength increased with the height of the aerial above the ground, and it is at once apparent that in a location free from surrounding buildings this increase is very rapid. Converting from decibels: at the ground level the signal produced an input of 5.6 millivolts, while at one wavelength height

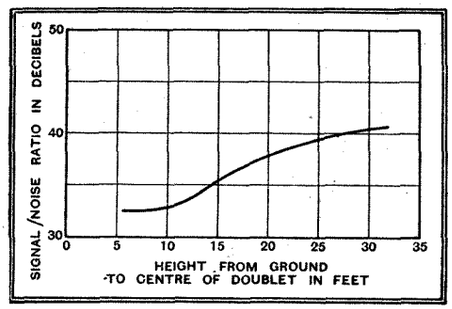


Fig. 2c.—Resultant variation of signal/noise ratio with height above ground (derived from curves 2a and 2b).

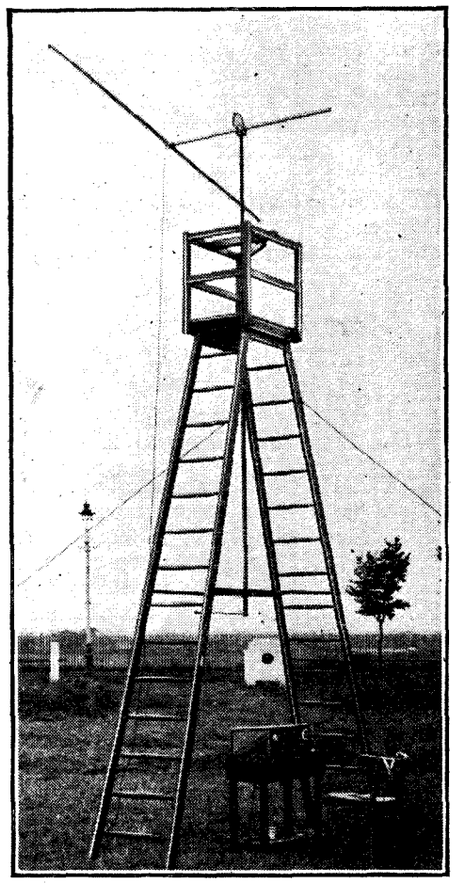


Fig. 3.—Receiving aerial and measuring equipment.

(22ft.) this is increased to 10.25 millivolts.

It was now necessary to determine the manner in which the aerial responded to a typical source of ignition interference. A saloon 8 h.p. car of a popular make was located at a distance of 50ft. from the aerial when at ground level. The engine throttle was pre-set so that the revolutions would closely correspond to a road speed of 30 m.p.h. Fig. *2b* shows the results, from which a very interesting fact arises. An optimum height apparently exists at which the ignition interference is at a maximum. This was confirmed by testing with other cars, identical results being noted. Fig. *2c* was obtained by subtracting the curve of Fig. *2b* from *2a*, and thus indicates the signal-to-noise ratio in decibels against the height of the aerial.

In its decibel form this curve looks rather flat, and it might be thought that very little improvement in signal-to-noise ratio resulted from placing the aerial well above ground level. By converting these decibels to ratios the picture is changed somewhat. Up to a distance of about 10ft. from the ground the ratio is of the order of 40: 1, but at a height of about 20ft. this increases to 90: 1. It is thus apparent that in order to secure a reasonable value of signal-to-noise ratio with a vertical aerial it is necessary that the lowest portion should be at least 15ft. from ground level, particularly if the source of ignition interference is at a distance of 50ft. or less. It is believed that the signal-to-noise ratio should be at least 60: 1 in order that interference-free reception of television pictures may be obtained.

These experiments immediately indicated the need for a comparison of vertical with horizontal aerials, and accordingly a structure was built upon which was located, at 16ft. from the ground, an identical aerial system, excepting that it was adjustable in either a vertical or horizontal plane with respect to the ground by known angular increments.

A photograph of the arrangement of the measuring apparatus and the aerial system is shown in Fig. 3.

Vertical Aerials Best

Some very interesting results and curves were obtained by this very flexible arrangement. Of principal note is the great variation of the received signal strength when the aerial is rotated from a vertical to a horizontal position, particularly when the horizontal position is such that the station is at 90° with respect to the centre of the aerial. The difference here was 23 db., a ratio of nearly 14: 1.

When the aerial was rotated from vertical to horizontal, so that the ends pointed to the Alexandra Palace, the difference was only 15 db., or 5.6: 1. It is obvious that when located in fairly open surroundings, and with a clear view of the transmitting site, the wave retains its vertical polarisation to a marked degree, even close to the earth's surface. If the experiments had been conducted at a much greater height, it would be expected that the decibel differences between the vertical and horizontal aerial would be even greater still. The experiments suffice to show the pronounced superiority of a vertical over a

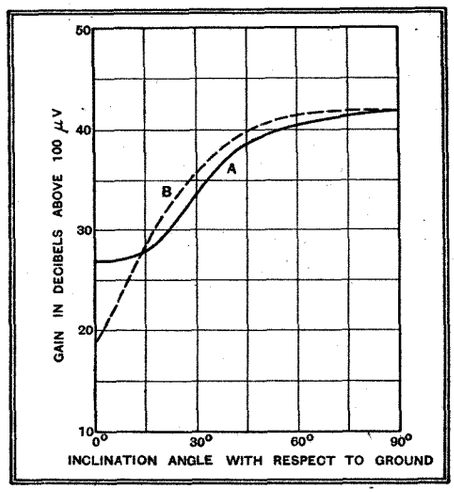


Fig. 4.—Variation of signal strength with aerial inclination in two vertical planes. A, aerial pointing towards Alexandra Palace; B, at right angles to it.

horizontal aerial system in so far as the magnitude of the received signal is concerned. The curves in Fig. 4 show that slight departures from the vertical position are permissible, since only small changes of received field strengths occur. It is when the angle is less than 50° with respect to the ground (vertical = 90°) that the

Experiments with Television Aerials—

signal falls off so markedly. When the aerial was in the horizontal position there was quite an appreciable change in signal strength when pointing at the transmitter, as compared with the transmitter bearing at right angles, the difference being 8 db. If it is impossible to erect a vertical aerial, it thus seems necessary to point the horizontal aerial to the station in order to obtain maximum signal strength.

The manner in which car ignition interference varies with distance from a horizontal half-wave aerial at 0° and 90° bearing upon the car respectively, is shown in Fig. 5. It can be seen by reference to

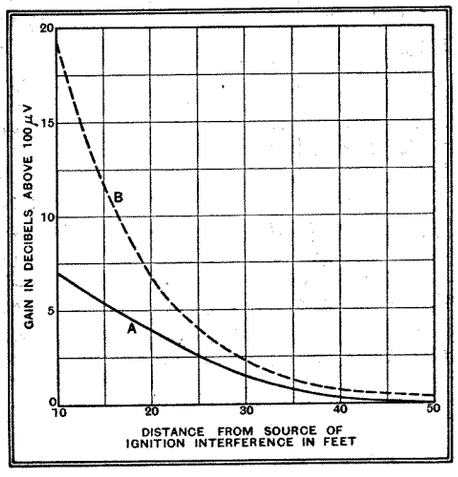


Fig. 5.—Variation of ignition interference with distance; horizontal aerial 16 feet above ground, aerial at right angles to source of interference for curve A and pointing towards it for Curve B.

curves A and B that with a horizontal aerial located 50ft. from the car, and half a wavelength in height from the ground, the signal-to-noise ratio will be approximately 26 db., as compared with the vertical aerial ratio of 36 db. This figure is that obtained when the horizontal aerial is in its best receiving condition, namely, pointing towards the transmitter. It might be noted here that the normal polar reception distribution of a half-wave aerial shows the maxima at right angles to the aerial, and zero at the ends. It must be remembered, however, that this implies horizontally polarised transmitted waves, and not vertically as in the case of the television transmission. This probably accounts for the complete reversal of the directivity of the half-wave aerial in these experiments.

Reverting to signal-to-noise ratio: the vertical aerial is thus 10 db. better than a correctly bearing horizontal aerial of the same height. If circumstances are such that the transmission emanates from a position at right angles to the aerial, the vertical is then 17 db. better on signal-to-noise ratio. It is quite obvious from the foregoing that in all respects horizontal aerials are to be deprecated and vertical systems to be recommended wherever possible. An excellent plan is to mount the aerial by stand-off insulators on a suitably impregnated and varnished lath, and suspend it from a rope, taking care to anchor the lower end to prevent it gyrating in breeze. The aerial should be erected as far as possible from the road, and as high as circumstances will permit.

Since writing the main part of this article further measurements have been made at the writer's residence, which is located at the edge of Epping Forest in the northern vicinity of Loughton, the distance being 9.25 miles. There is much intervening forest and high land, and although one would expect a slight departure from vertical polarisation of the received waves in this location, a vertical aerial was found to be 6 to 10 db. better than a horizontal, at a distance from the ground varying from a few feet to 25ft.

It is hoped to deal in a further article with the effect of directional vertical aerials in which reflectors and directors are employed, and the measurements for this work are now being made.

Television at Thirty Miles

By ERNEST H. ROBINSON

RECEPTION of both sound and vision signals from places as remote as Cambridge, Ely, Bournemouth, and Southend have been reported, but, so far, there is little information as to the limits of the real service area of the new station. Field strength contour lines are, of course, very irregular, depending upon the height of the receiving station and the intervention of high ground between transmitter and receiver. In one locality at least, thirty miles south-west of Alexandra Palace, pictures can be received of a quality which compares very favourably with that which can be had five miles from the transmitting station.

The receiver is a standard Baird Televisor which came straight from the Radiolympia Exhibition without any "vetting" or hotting-up. The aerial, erected on a mast on the roof of the house, the top of the mast being about two hundred and fifty feet above sea level, is also standard Baird equipment, and is a half-wave di-pole, transformer matched (see *The Wireless World*, October 2nd, page 348), the signals being fed to the receiver through lead-covered co-axial cable. The distance between transmitter and receiver is almost exactly thirty miles, and between them is no ground substantially higher than the aerials.

At this distance the only real differences from the pictures received in the London area are a kind of grain on the background due to the low signal-to-noise ratio, and almost constant "flash" interference, caused by motor car and aeroplane ignition, due to the sensitivity of the vision portion having to be pressed to its utmost. The receiver is a hundred yards from the nearest road, and along that road traffic is light.

The "grainy" background seems to take some sharpness from the pictures, but is not in any way distressing. The white flares due to motor car ignition are occasionally annoying.

Before any pictures were received, it was thought that the major difficulty due to distance might be in the holding of synchronisation. With pictures received on the Baird system there is no difficulty at all in this respect, but very dark pictures received on the Marconi-E.M.I. system are inclined to slip a cog or two, but they come into step immediately more light is transmitted.

The C.R. Tube controls seem to need much more accurate and careful setting than when the instrument is nearer town. The setting of the control of output from the vision amplifier circuit is critical. This has not been noticed in Baird instruments nearer the transmitter.

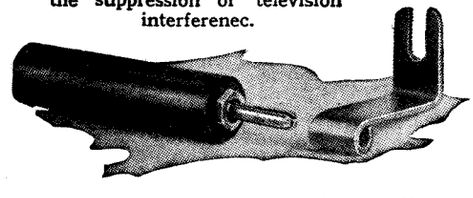
The cathode-ray tube in the Televisor, which gives pictures about ten by eight inches, is conservatively used, and there is little of the familiar barrel distortion due to curvature of the tube end. The colour is a softish black and white, and is most attractive. The light is excellent, and the drawing of thin curtains across the windows is all that is necessary for very good reception. Contrast is also good. Sound volume "full on" is ample for a medium-sized room.

Interference from "A.P."

A Simple Cure

IT now seems certain that reports in lay newspapers have hardly exaggerated the seriousness of the interference from which North London broadcast listeners have suffered (on both National and Regional wavelengths) during the experimental television transmissions from Alexandra Palace. The matter has been touched upon from a technical point of view in our Correspondence columns and now the Research Department of Belling and Lee expresses the opinion that break-through of the sound accompanying television may cause trouble anywhere within a radius of four miles from the Palace.

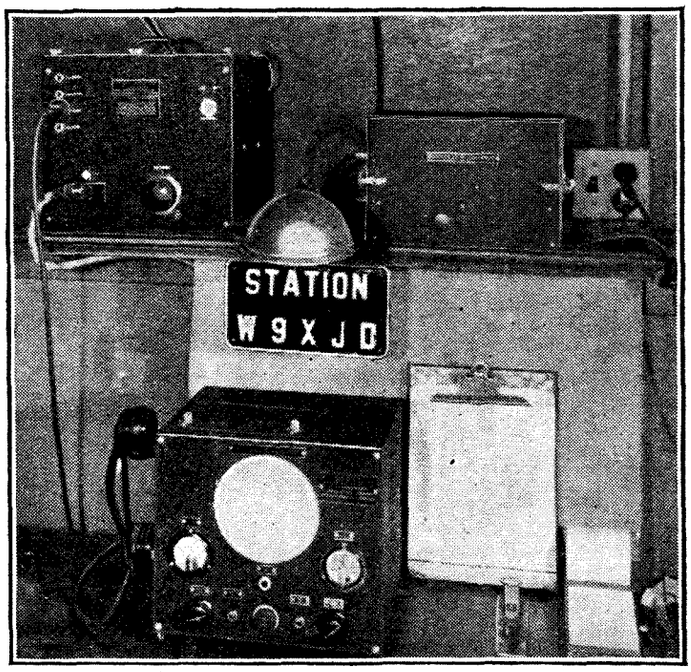
A Belling-Lee ¼-wave choke for the suppression of television interferenec.



A cure has been sought, and, according to the Belling-Lee engineers, the most satisfactory remedy is afforded by the insertion of a ¼-wave choke, usually in the aerial lead, but, in exceptionally difficult cases, in every lead over six feet long that enters the receiver. A midget choke of compact and convenient design has accordingly been produced; this is now commercially available at the cost of 2s.

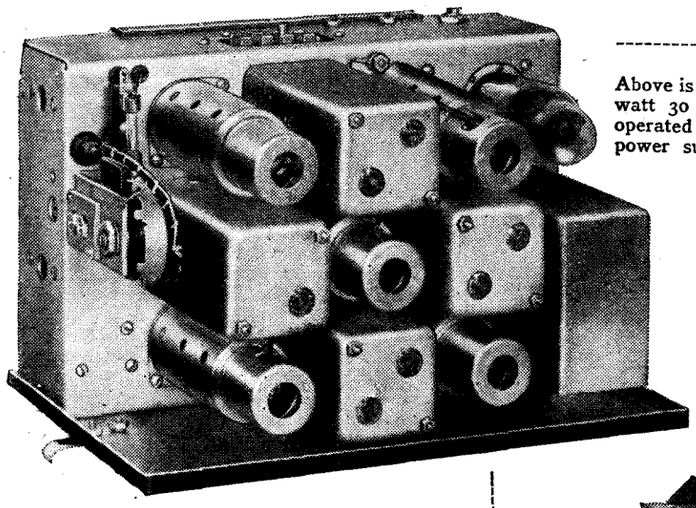
American Police Wireless

AN INTERESTING NEW DEVELOPMENT IN EQUIPMENT OF THE ULTRA-HIGH-FREQUENCY TYPE

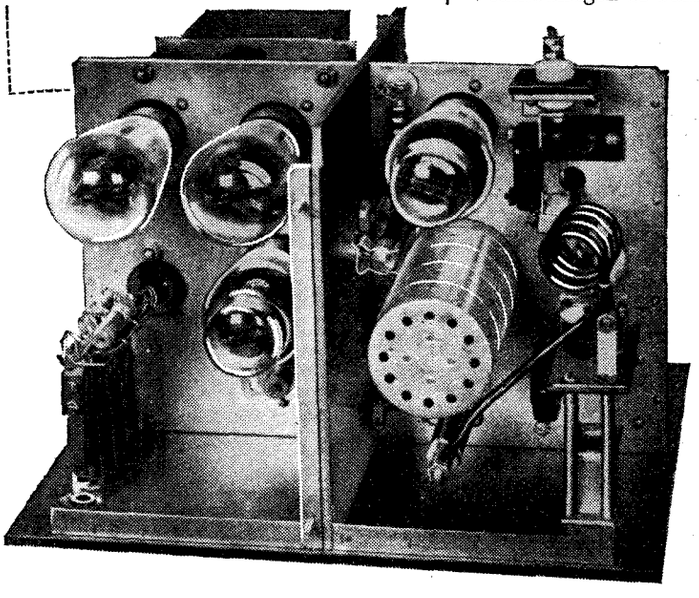


IN America, where for many years now wireless has been such an essential part of the various municipal police systems, very considerable progress has been made in the development of this rather specialised type of mobile equipment. Long ago radio telephony was adopted as being generally more convenient than telegraphy for communication with the patrol cars, since it does not require a skilled operator in the crew of each vehicle.

The single-way working system, whereby the patrols could only receive messages and not reply, was found to be unsatisfactory in many respects, though even this limited form of communication was an invaluable asset. More recently attention has been given to the development of the two-way, or simplex, system, thus enabling the patrol cars both to send and receive messages, and the great advantages this has afforded have now induced the designers of police wireless equipment to advance still one step further and evolve equipment of the true duplex type, which enables the recipient of a message to break-in, as in the case of the ordinary telephone, either for acknowledgment or to ask for more details on any point not clearly understood.



Above is seen a receiver and 15-watt 30 to 42 Mc/s transmitter operated from a common AC power supply unit and a single aerial, and to the left a superheterodyne-super-regenerative receiver used by American police cars and also at the headquarters station. The picture below shows the arrangement of a 15-watt 30 to 42 Mc/s mobile transmitter with the modulation amplifier on the left and the power amplifier on the right.



Wavelengths allocated

With the simplex system the sender of the message has no means of knowing whether it is received and correctly understood until the finish, when a manual change-over to receive, or transmit as the case may be, has to be made for an acknowledgment or to request more details. Obviously much valuable time is saved by the duplex method of working.

Since, in most cases, quite a limited range suffices for municipal police work, the U.S. Federal Communication Commission has allocated a channel in the ultra-short-wave region for this type of service, the actual frequency band being from 30 to 42 megacycles, i.e. 10 to 7.14 metres.

Some interesting equipment of the duplex type and for use on these wavelengths has been developed by the General Electric Company of America of which a brief description can be given.

Duplex working from a car presented many problems, not the least of which was the matter of an aerial, or aerials. Low height, for the wireless may often be used when the car is travelling at high speed, does not make for good efficiency, especially when transmitting. Several types have been tried, including short fixed vertical rods, telescopic masts and aerials camouflaged as bumpers, while roof aerials have been employed in saloon cars for reception purposes only.

The vertical aerial has been found greatly superior to most of the other types, and schemes have been evolved for using the same vertical aerial for both transmitting and receiving even with the duplex system. For this purpose the General Electric Company of America has developed a filter for interposing between the transmitter and the receiver which makes use of a section of transmission line, the attenuation characteristics of which are so good that it is possible to obtain satisfactory reception

American Police Wireless—

with the aerial radiating signals from a 15-watt transmitter and with only about four per cent. difference in frequency.

For this class of work the receiver must be very sturdy, since it is subjected to considerable vibration, and it must be capable of giving reliable reception under very adverse conditions. To function satisfactorily in any large city, with its mass of steel-constructed buildings where, within a distance of a few yards, the signal strength may change enormously, very rapid and efficient AVC action is essential to maintain the signal at a reasonably constant level. The sensitivity must also be high and, in addition, the receiver must be capable of giving good rejection to electrical interference.

It is a well-known fact that the super-regenerative circuit possesses these desirable characteristics, but it lacks selectivity, and it can cause considerable interference to other receivers owing to radiation from its aerial.

A receiver was eventually evolved by the G.E.Co., that possessed the good features of the super-regenerative system but without its disadvantages, the solution of the problem being found by combining the super-regenerative and superheterodyne circuits, the former system being employed for the second detector.

The superheterodyne portion gave the required selectivity and acted as a buffer to aerial radiation from the super-regenerative detector.

From the details available it appears that one signal frequency HF amplifier, using a Type 78 valve, is employed before a triode-pentode frequency changer. Then follows a 6B7 duo-diode pentode, the pentode portion being employed as an IF amplifier and its diodes for conventional AVC. The second IF stage is the pentode section of a 6F7 triode-pentode, the triode being used as a super-regenerative second detector. This is followed by a Type 79 double triode, one section of which supplies the quenching oscillations and the other functions as an intermediate LF amplifier for a Type 41 output pentode.

The quench frequency is about 20,000 c/s and the intermediate frequency is 9 Mc/s.

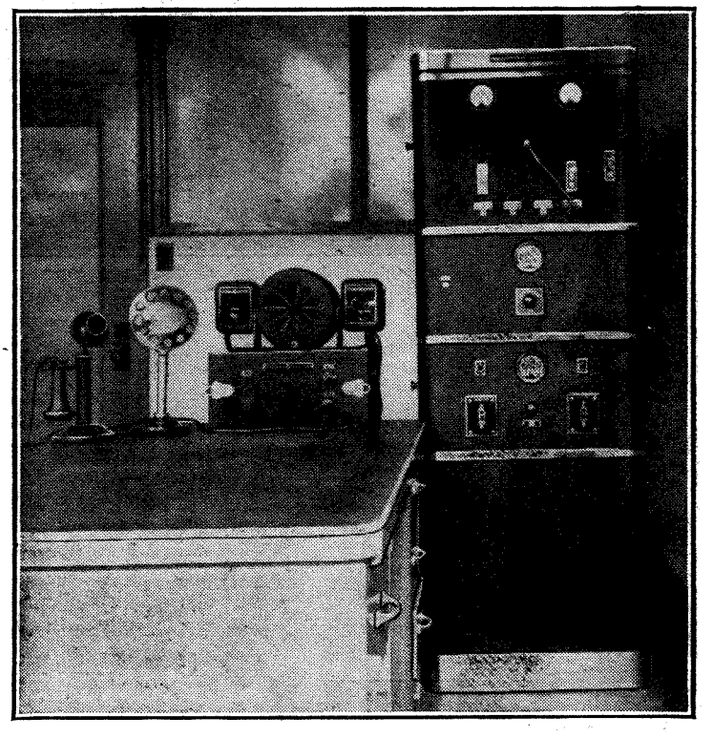
The best adjustment of a super-regenerative detector produces a certain amount of hiss, though, of course, this practically disappears when a carrier wave is present. On police patrol duty the receiver is kept switched on for most of the time and, in order to minimise the annoyance caused by the heavy background of the receiver while standing-by for messages, the G.E.Co., has incorporated a noise-suppression circuit operated by the carrier wave.

When a signal is applied to the grid of a super-regenerative detector its anode current falls and this change is utilised to reduce the grid bias on the LF amplifier, which in the quiescent state is biased to current cut-off.

In order to simplify the handling of the wireless equipment, the receiver is pre-tuned and operated by remote control.

Robust construction, reliability and good frequency stability under very adverse conditions are essential features of the mobile transmitter designed for this class of work. It cannot be kept switched on the whole time, yet it must be ready for use at any moment. Since only a few seconds can be allowed for the valves to warm up, frequency stability is of paramount importance. Five valves are used in the G.E. Co.'s transmitter, three in the modulating amplifier and two in the HF generator. A double-button carbon microphone is employed, its output being amplified by a Type 47 valve which drives two 46's in class B push-pull. These modulate a 2A3 power amplifier which is excited by a similar valve used as a master oscillator.

The transmitter is assembled on a four-section chassis arranged in the form of a cross. The modulator occupies one section, all transformers and chokes are in another, while the master oscillator and power amplifier each has a separate compartment. The power output of the two Type 2A3 valves is 15 watts.



A 75/150 watt ultra-short-wave transmitter and superheterodyne-super-regenerative receiver arranged for use with two separate aerials.

The requirements of the police headquarters wireless equipment will most likely vary in different localities, but standardisation has been allowed for where a 15-watt transmitter will give the required service range. When used as a headquarters transmitter, the 15-watt set can be operated entirely from the AC mains, though otherwise it is identical with the car sets.

A range of transmitters from 15 watts to 1.5 kilowatts has been developed for the main control station, and the higher-powered sets are mostly crystal controlled.

CLUB NEWS

Ipswich Radio Society

It has been decided that the old Ipswich Radio Society shall be revived, and the first meeting for the election of officials has already taken place. Meetings are to be held on the second Tuesday in each month, an additional meeting being held on the fourth Tuesday during the winter. The Society has already enrolled several transmitters in its ranks. All interested should get in touch with the Secretary at Radio House, St. Peter's Street, Ipswich.

The Irish Short-wave Club

A long-felt want has been filled by the inauguration of a short-wave club in Dublin. At the outset work will be confined to reception, but later on a transmitter will be erected for the benefit of members. The services of two well-known Dublin amateurs, EI2F and EI8D, have been secured for lecture work.

There is an entrance fee of 2s. and a weekly subscription of 6d.; country members 5s. per annum. Meetings are held at 8 every Tuesday evening in the Club's temporary premises at 47, Dolphins Barn Street, Dublin. Full details of the club can be obtained from the Secretary, 3, Clare Lane, Dublin.

Scottish Short-wave Radio and Television League (Glasgow Branch)

The above club, sponsored by the *Daily Record* of Glasgow, holds its meetings at Newspaper House, Hope Street, Glasgow, on Friday evenings at 7.45. Arrangements for the present session include lectures on television and on short-wave work. Morse classes are also being held. Arrangements have been made for conducted parties to visit the Scottish transmitter at Westerglen on Saturdays. Full particulars of the society can be obtained from the Secretary at 14, Bolivar Terrace, Glasgow, S.2.

The Cambridge Short-wave Club

This society is to hold meetings on alternate Wednesdays, commencing on October 21st. The meetings will be held at 13A, Ram Yard, Cambridge, and all who are interested are invited to write to the Hon. Secretary at 19, Trafalgar Street, Cambridge, for further details.

The Croydon Radio Society

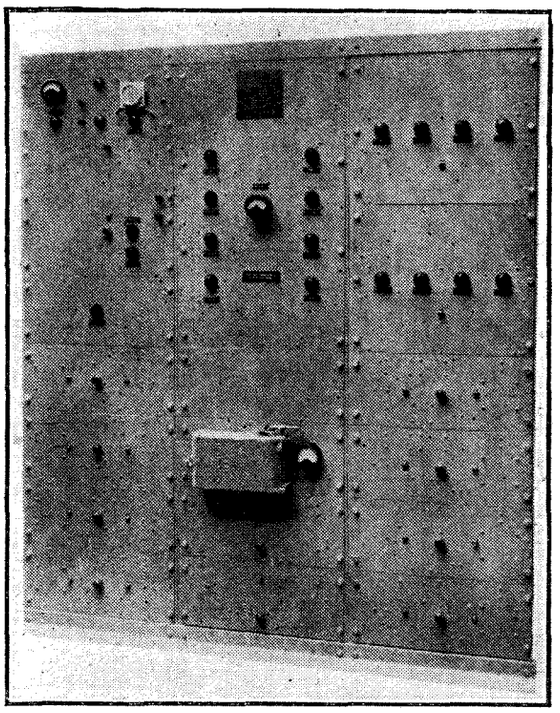
The syllabus of the meetings for the first half of the winter session has now been issued by the above society. Meetings are held every Tuesday evening at 8 at St. Peter's Hall, Ledbury Road, South Croydon. Next Tuesday (October 20th) Mr. B. R. Bettridge, of the Marconiphone Co., Ltd., is to give a talk entitled "Valves and Recent Developments in Ultra-short-wave Work," while the following Tuesday evening is to be devoted to gramophone pick-ups, all members being requested to bring their models for testing and comparison. Full details of the society can be obtained from the Hon. Pub. Secretary, Mr. E. L. Cumbers, at 14, Campden Road, South Croydon.

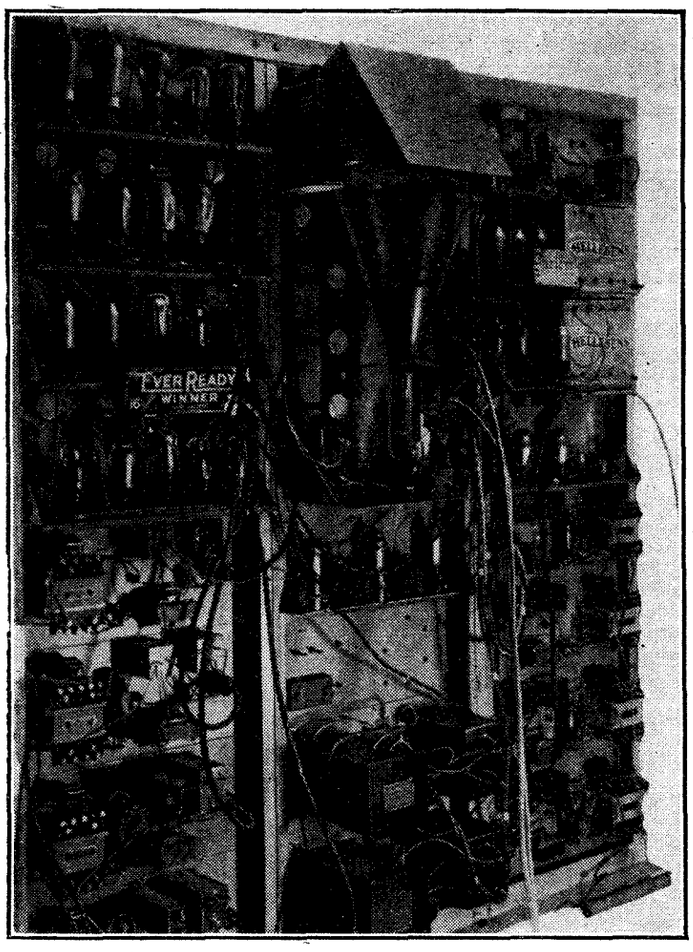
Television at the Empire Exhibition

HOW THE NEW ART WAS INTRODUCED TO SOUTH AFRICA

By J. H. REYNER, B.Sc., A.M.I.E.E.

AS a result of a record hustle visitors to the South African Exhibition at Johannesburg are being able to see for themselves cathode-ray television both as regards transmission and reception. During the first few days of August a telephone enquiry was received by the author from Johannesburg as to the possibility of installing television at the Exhibition. A conference was hurriedly held, with the result that the contract was arranged and work had commenced within a few days from the initial enquiry. The only available boat which would enable the apparatus to arrive in time for the opening on September 15th was due to sail on August 25th, which left rather less than three weeks in which to complete the equipment, but by dint of almost continuous work the contract was completed on time.





Front and back views of the rack carrying the amplifiers, time-base units, power supply units and cathode-ray equipment.

The apparatus comprises a direct-vision transmitter scanning head-and-shoulders subjects with a definition of ninety lines. This feeds five 10in. Ediswan cathode-ray receivers, all operating in unison. The transmitter, spot-lights, time-bases, amplifiers and power units are all mounted on the stage, while the receivers are located at various intervals about the auditorium. The audience, therefore, is able to see at least one of these receivers from any part of the hall and is also able at the same time to see the person actually being televised. This novel feature adds considerably to the interest of the demonstration, particularly as members of the audience themselves may pass up on to the stage and be televised if they so wish.

Most of the electrical equipment is housed on one large steel rack some 6ft. square. The photographs show front and rear views of this rack, and all the important apparatus is in duplicate. Looking at the rear view, the main vision amplifier is on the right, with the sound amplifier immediately underneath. On the left are two amplified time-base units, while in the centre is a monitor cathode-ray receiver in parallel with the five auditorium receivers. Immediately underneath is the synchronising amplifier.

The remainder of the panels, as will be seen, are power supply units, delivering 4,000, 1,000 and 300 volts, suitable spares of each type being provided.

An interesting feature is that the focusing of the lens on the scanning disc housing is operated by remote control from the front of the rack so that the demonstrator can focus the subject while actually looking at the picture on the monitor receiver. A similar arrangement operating through a periscope enables the sitter to be suitably centralised, and the remote control cables from the panel can be seen in the centre of the picture.

Two-way sound is provided so that the demonstrator can speak to the person being televised, while a reply can be reproduced on loud speakers at each of the receivers. The microphone for the former channel can be seen on the left. A further interesting point is the inclusion of a test panel, which comprises a signal generator with attenuator and valve voltmeter so that the vision amplifier can be checked in part or as a whole at any time.

All the apparatus arrived satisfactorily and is actually running at the moment. The audiences are showing an increasing interest, the attendance being greater each day, and South Africa is rapidly becoming "television-minded."

THE RADIO INDUSTRY

COSSOR receiving equipment is being used for the public television demonstrations at the Science Museum, South Kensington, which, as mentioned last week, are to continue until further notice.

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The names of the sets for which the various Exide LT cells are suitable will, in future, be printed on the labels.

Microphone Pre-Amplifier

WHY IT IS NEEDED WHEN A MICROPHONE IS USED WITH A BROADCAST RECEIVER

THE idea of using the AF stages in a broadcast receiver as a microphone amplifier by connecting the microphone to the gramophone pick-up terminals is not new, and has, indeed, been done quite effectively in the past for entertainment purposes, and also for carrying out experiments in home recording.

If a suitable microphone is used quite good results can be obtained in this way, but there are quite a number of people who, having acquired a modern instrument, such as a transverse-current microphone, find that only a mere whisper of sound is emitted from the loud speaker. The first thought is that a wrong connection has been made, or that the microphone is faulty, for, as we are often told by those who consult our Information Bureau, the receiver works quite satisfactorily with a gramophone pick-up!

In the majority of cases there is nothing wrong with the set, or with the microphone, or in its method of connection, the real explanation being that the output from the microphone is so small that the AF stages, or single stage only where one of the high efficiency pentodes is fitted, do not provide sufficient amplification.

With the majority of sets an input of between 0.25 and 0.75 volt is required at the pick-up terminals to fully load the output stage, but a microphone of the transverse-current type, such as that described in *The Wireless World* of January 11th, 1935, gives on an average something less than 0.1 volt; possibly 0.05 volt would be a more accurate figure. This is just about one-tenth of the output from the average type of gramophone pick-up.

Thus to obtain a comparable sound output from the loud speaker an additional amplifying stage giving a gain of about ten times is needed.

For various reasons it is not practical to place the extra valve after the final stage in the set. Apart from the fact that if the additional amplification is attempted at this point a large power valve operated at a comparatively high voltage is required, there would be involved, also, the bother of arranging switches to cut out the extra valve for radio reception.

The most satisfactory way of obtaining the additional amplification is between the microphone and the receiver. The gain of this stage can then be adjusted so that the actual input to the gramophone terminals is about the same as that of the pick-up normally used with the particular set.

A stage gain of the order required can quite easily be obtained from a small battery triode operated with an anode potential of from 60 to 80 volts.

The use of a mains valve is not recommended since it is almost certain to introduce hum unless very special care is taken and some extra smoothing chokes and condensers are used.

One advantage of employing batteries is that the whole of the extra parts can be assembled as a self-contained unit, and two wires only will then suffice to join it to the receiver.

The circuit in Fig. 1 shows the general lay-out of a suitable unit for use with any carbon microphone of the type mentioned.

The two transformers T1 and T2 are microphone and intervalve AF transformers respectively. If T1 has a ratio of about 1 : 10 the volume control potentiometer, R, should be 50,000 ohms. Transformer T2 need have only a small step-up ratio, and a 1 : 2 component will serve quite well. Any general purpose two-volt valve can be used, though its rated amplification factor should not be less than about 10. A Hivac type XL or a Marconi or Osram L11 are typical examples of midget valves suitable for use in this position.

In order to obviate including a separate battery for supplying the microphone polarising voltage either the LT accumulator or a part of the HT battery may be used.

Some microphones will be quite sensitive on two volts, while others may need six or more volts to give the best results.

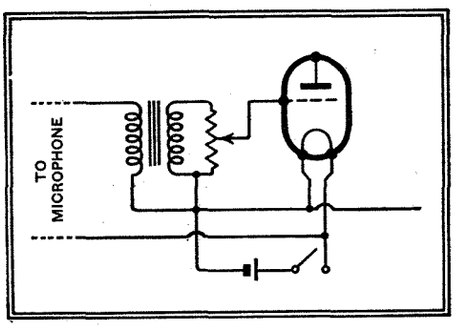


Fig. 2.—Sometimes it is possible to simplify the unit by using the filament battery for the microphone, the modifications required being shown above.

When the microphone takes its voltage from the HT battery the smallest potential that will give good results should always be used. This style of microphone has a resistance of about 300 to 400 ohms so that on 10 volts, for example, it will pass 25 mA or so. On 6 volts, which is usually the lowest voltage tapping available, the current flowing will be of the order of 10 to 12 mA.

From this it will be seen that whenever possible the microphone should be operated from the LT accumulator as the smaller sizes of HT battery are not intended to be discharged much in excess of 7 to 8 mA.

The circuit in Fig. 2 shows the connections and switching for operating the microphone from the filament battery.

It would, of course, be quite a simple matter to arrange the circuit so that a separate microphone battery is used.

H. B. D.

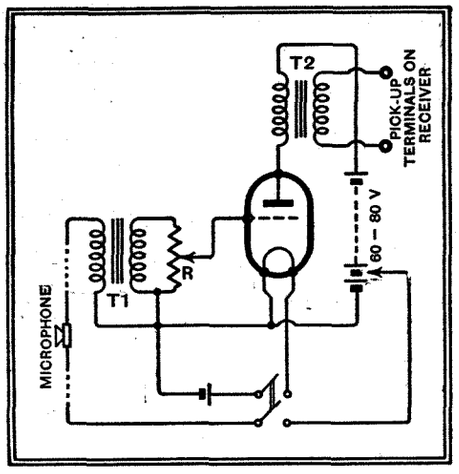
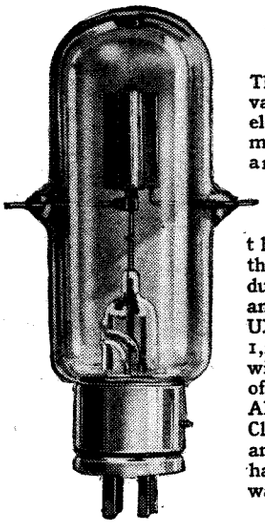


Fig. 1.—Pre-amplifier circuit with battery operation that enables a transverse-current microphone to be used with any broadcast set having pick-up terminals.

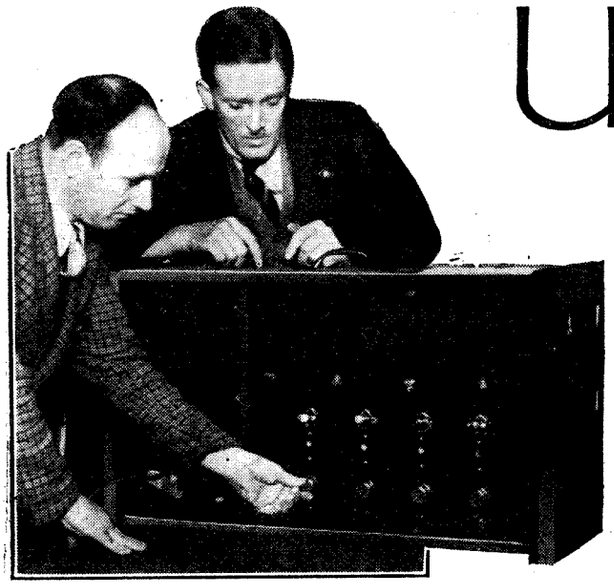


AMERICAN TRANSMITTING VALVE.

The Gammation 154 valve has tantalum electrodes and a filament consuming 6.5 amperes at 5.0 volts. The grid and anode are brought out through the sides of the bulb, thus reducing the capacity, and a standard 4-pin UX base is used. At 1,250 volts the valve will give an output of 15.5 watts as an AF amplifier under Class A conditions, and at 1,500 volts it has an output of 200 watts as a Class C RF amplifier.

UNBIASED

By FREE GRID



Here you see the recently exhibited cineolfactor in action.

ACCUSTOMED as I am to the baseness and black ingratitude of human nature, I must confess that I was considerably taken aback when strolling through the recently held Exhibition of Inventions, to come across one of my own brain children with absolutely nothing on it to indicate its parentage. I refer, of course, to the device for providing the necessary smell accompaniment to our radio and television programmes, and to ordinary cinema films.

Although it is quite true that in my original idea as published in *The Wireless World* I suggested the application of smell to radio programmes and did not specifically deal with the question of converting the talkies into the smellies by the application of locally-generated odours I am, I consider, perfectly justified in thinking some little credit is due to me for imparting the basic idea. Should any of you be in any doubts concerning this I invite you to turn up the specifications of my invention on page 587 of the December 6th, 1935, issue of *The Wireless World* and see for yourselves.

The Smellies

My idea of smellievision, or Radiolfaction as I preferred to call it, went considerably further than this present device since the smells were to be controlled by wireless waves, and had it not been for an unfortunate oversight on my part I, rather than others, might have occupied the limelight at the exhibition. As it was, I failed to find the slightest recognition given to my pioneering work in any of the literature which I have brought away with me from the show. If, therefore, before very long you detect an unusual odour while enjoying the programme in your local cinema I would ask you to spare a kindly thought for me as being the person who put over the idea. I am now conducting preliminary experiments with a view to adding still further to your cinema enjoyment by bringing out the "feelies," but I am finding it difficult to secure the necessary delicacy to the impression of touch with my present crude apparatus.

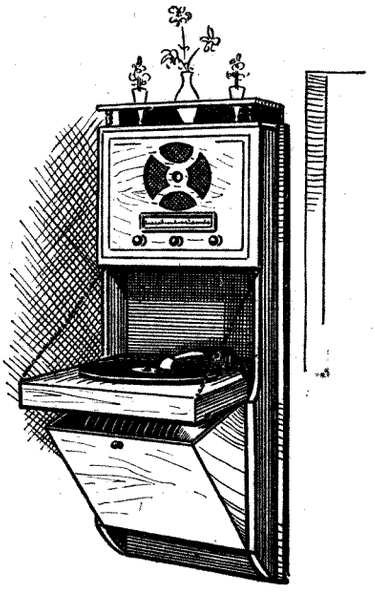
Love's Problems

I HAVE had some fairly tough wireless problems in my time but I must confess that the particular one which I have recently tackled has beaten them all, and before starting the practical work I should be glad to know if any of you can suggest any improvements to my ideas. The problem was brought to my notice by one of the older of the little Grid Leaks (female species) whose friend has recently enticed some man, in a weak moment, into marrying her. It appears that the unfortunate young man is not very well blessed with this world's goods and they propose, therefore, to try the old foolishness of living on love in a cottage. It will not be long, of course, before they find as I did long ago, that love is a far from satisfactory diet and is no substitute for roast beef and Yorkshire. This is, however, no concern of yours or mine, but it has been necessary for me to mention the fact to you in order that you may be in a position to understand my difficulties.

The "cottage" is one of those ultra-modern rabbit hutches which are springing up like mushrooms outside our large cities; I mean the type in which you have to open the window and door if you want to stretch yourself upon getting out of bed in the morning. Despite all these drawbacks the intending Benedicts very sensibly do not intend to forgo the pleasures of radio, and, furthermore, are desirous of having a radiogram. Unfortunately there is simply no room for the ordinary type of radiogram, and it has, therefore, fallen to my lot to design a special instrument for them.

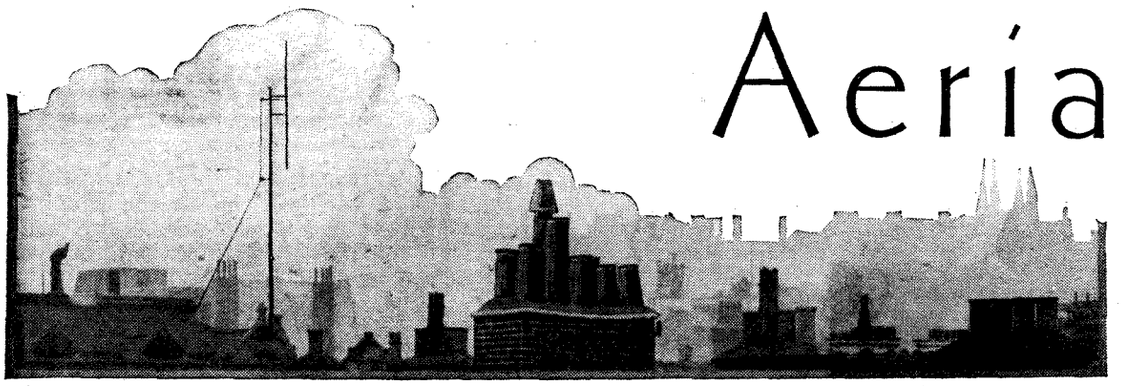
The room in which it is desired to house the instrument is literally not large enough to swing a cat, although, as the estate agent pointed out to me rather coldly, when I complained about it, there are not many people who indulge in this particular pastime nowadays owing to the activities of the R.S.P.C.A. I propose to solve the problem by building a receiver into an old ship's "compactum" washstand, which I find I can pick up cheaply from the premises of a marine-store dealer, and I append my drawing herewith for your comments and criticisms.

These compactums, as some of you may be aware, are frequently to be found in the cabins of cargo boats and other vessels not piped for running water. As their name implies they are, of course, built for compactness, and a basin is fixed to a small platform which folds vertically into the apparatus when not in use. I propose to replace the basin by a "playing desk" as you see in my drawing. These compactums usually possess a mirror behind which is a water storage tank, and I am replacing the mirror by the loud speaker fret and a horizontal tuning dial together with the necessary control knobs, while the works will fit into the erstwhile tank at the back. At the top of the instrument there is usually a rack for a water jug and tumblers, and these will be ideal for placing the wretched flowers which all women will insist on sticking on every available piece of furniture. The lower compartment, usually occupied by the waste-water tank, I propose to convert into a record storage cabinet.



The newly-weds' radiogram.

As I have said before, if any of you have any better ideas—more especially those of you who may have tried this love-in-a-cottage stunt—please let me know of it before I commence my labours. Please don't make the obvious suggestion of incorporating an autochanger, but tackle the box-resonance question. Would it suffice to refrain from boarding-in the top and bottom of the loud speaker compartment or must I put in fretwork sides also? This is important.



Aerials

By "CATHODE RAY"

Special Short-wave Types Compared with the Ordinary Domestic Collector of Signals

I HAVE had several requests to do some explaining about aerials. Until recently it has not been necessary for radio users to know the least thing about how aerials work. A few rules of thumb, such as putting the wire up as high as possible, keeping it away from walls, avoiding tramway standards as supports, soldering all joints (but better still have no joints at all), and cleaning the insulators with a stiff toothbrush twice yearly, were enough basis for a reputation as a "wireless expert." A similar set of rules covered the installation of the "earth"—use thick unjointed copper wire, avoid long runs, bury vast areas of metal in "damp subsoil" (if any), and water nightly during droughts, or connect to a *main* water (but not gas) pipe.

All this may be very sound and useful practical knowledge, enough to carry most people quite happily through life (so far as the subject in question is concerned); but the man who really knows what he is doing may have still better reasons for breaking nearly all of these rules. Now that screened aerials, transmission lines, short-wave and ultra-short-wave aerials are coming into general use, the limitations of the rule-of-thumb "expert" are shown up rather painfully.

Not that I propose to embark on the complete theory, in full textbook dress. But one ought to have a slightly better idea of things than that the aerial is a sort of feeler that picks up the waves. Because, presumably, the more the feeler sticks out the more responsive it is, and that is hopelessly wrong where short waves are concerned.

Perhaps the easiest way to get some sort of mental picture of what takes place invisibly and inaudibly among the aerials that now disfigure the world's landscapes is to consider stringed musical instruments. One can feel and hear them vibrating, and having noted how they do it there is not quite so much difficulty in imagining how similar phenomena can take place in the electrical world which is outside our senses.

Let AB in Fig. 1*a* represent any string of a piano, violin, ukulele, or other instrument. It is caused to transmit sound waves through the adjacent air by striking, scraping, or plucking it, thus making it vibrate from side to side as suggested by the dotted lines. By doing so it alternately compresses and rarifies the air around it, causing waves to spread out. The frequency (more commonly known among musicians as pitch) depends on the length, weight, elasticity, and tautness of the string.

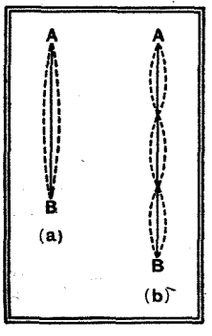


Fig. 1.—A musical instrument string vibrating at its fundamental frequency and at its third harmonic.

This system corresponds roughly to a radio transmitting aerial of the very simple type known as the dipole, used by Hertz about half a century ago, abandoned, and now revived for short-wave work. Amplitude of motion corresponds to current (*amps*, but not so named for that reason), and it is seen that vibration (or oscillation) of the string is set up by communicating motion to it somewhere about the middle, the ends being fixed. In the early days of radio an aerial was struck or banged into oscillation by pulling it and letting go (that is to say, by starting a sudden surge of current in it), allowing the oscillation to die away gradually, just as a piano string vibration dies away slowly when the key or pedal is held down. But now there are ways of feeding a continuous oscillation of the right frequency into an aerial, keeping it going all the time. But note that it must be fed at the middle or thereabouts; not at the end. Current can no more flow in and out of the end of a wire than the fixed end of a string can move backwards and forwards. The distance from any point on AB to the dotted lines in Fig. 1*a* represents not only the limits of vibration of a string, but also the current at each point in an aerial.

The frequency of the radio transmitter is decided by the elasticity (capacity) and weight (inductance) of the aerial, both of which depend on the length. A low frequency (long wavelength) usually necessitates a long aerial, but quite a short aerial can be used if it is weighted in the middle with an inductance coil, in the same way as low notes are obtained within a reasonable size of piano frame by weighting the strings with copper. But the result is not so good in either case.

Fundamental Wavelength and Harmonics

Wavelength, of course, is just the speed of the waves divided by the frequency. Sound travels at about 1,100 feet per second, so the wavelength of middle C, which has a frequency of 261, is 4.38 feet, or 1.33 metre.

When a violinist wants to get that amazingly high note with which his solo often ends he touches the string with his finger (producing another point of *no* vibration, technically termed a *node*—again a fortuitous pun) and obliges the string to vibrate at a higher frequency that it otherwise would (Fig. 1*b*). These are harmonics, which must always be a multiple of the original or fundamental frequency. Similarly, an aerial that naturally oscillates at, say, 1,500 kc/s can be made to oscillate at 3,000, 4,500, 6,000, etc.

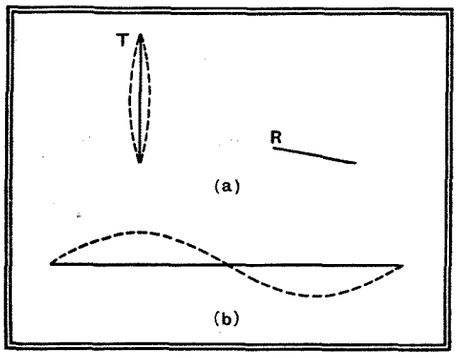


Fig. 2.—A receiving aerial R directed towards the transmitting aerial T is unresponsive. For maximum response it should be parallel, with its axis at right angles to the line joining the two. Diagram *b* represents a current wave; the amplitude of current at any distance along the axis corresponds to the amplitude of movement at any point along a vibrating string.

So much for the transmitting end. Suppose you have two pianos (or harps, or banjos) and play one note. The corresponding string in the other instrument, if

Aerials—

accurately tuned, begins to vibrate; but its faint sound is overwhelmed by the first. However, it can actually be observed if the experiment is done with tuning forks. The wave travelling through the air strikes the "receiving" string, and if it is tuned correctly sets it going too. The radio equivalent is obvious. But note that a long-wave aerial may respond to a short wave that happens to be a harmonic. There is another point about reception. It will not do to have the receiving aerial pointing any old way. If a receiving aerial (R in Fig. 2*a*) is pointing straight at the transmitting aerial T, there is nothing doing. The maximum results occur when the two are parallel. This rule is liable to be upset by reflections from the ground, and other disturbing effects.

Remember that all this time I am referring to dipole aerials. The ordinary pole-and-wire aerial of the backyard is a more complicated arrangement that has yet to be dealt with. In the meantime this discussion chiefly concerns ultra-short-wave radio, for a reason that is now to be revealed.

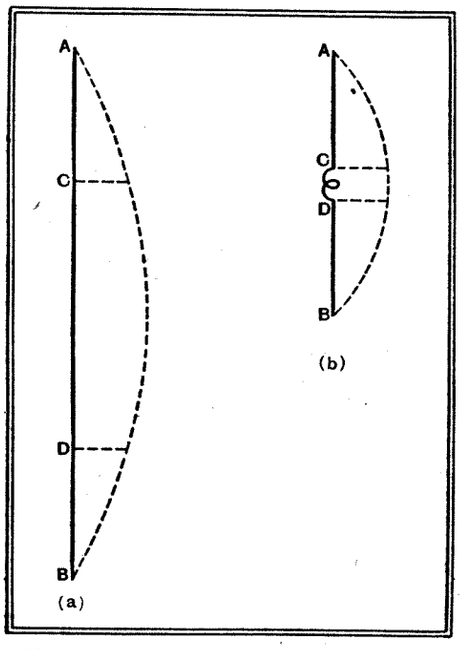


Fig. 3.—When a coil is inserted at the centre of a dipole aerial, its inductance takes the place of part of the aerial, which must be shortened to respond to the same wavelength. The dotted lines show the amplitude of current along the aerial.

I have already mentioned that there is some connection between the length of an aerial and the frequency—and hence the wavelength—to which it tunes. The connection is a rather uncertain one, because aerials are usually—one may say almost invariably—complicated by coils and condensers put there (1) for feeding in or drawing out the oscillations, and (2) for varying the tuning in a more convenient manner than by altering the length of the aerial itself. But if the aerial consists of a plain straight wire or rod, with nothing else anywhere near it, *the natural fundamental wavelength is double its own length*. So it is called a half-wave aerial.

If you draw a diagram of a wave of current (Fig. 2*b*) you will see that half of this is the same as the diagram showing the current at each point along the length of an aerial. And if a simple aerial is oscillating at the third harmonic, it accommodates three times as much wave (Fig. 1*b*), so it is a $\frac{3}{2}$-wave aerial, and there is a similar correspondence between the current diagram and the diagram of the waves themselves.

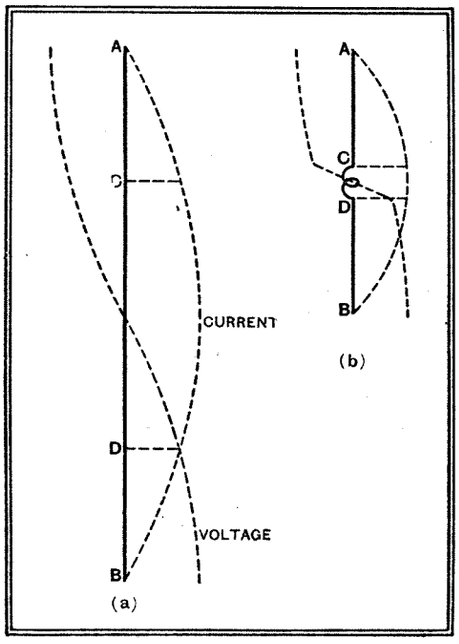


Fig. 4.—The same as Fig. 3, with the addition of voltage lines, showing that at any part of the aerial where there is zero current there is maximum voltage, and vice versa. There is obviously a comparatively high voltage across the terminals of the coil.

Practical example: What is the length of a dipole aerial to resonate fundamentally to Droitwich (1,500 metres)? Answer: $\frac{1,500}{2}$, or 750 metres, or 2,280 feet. Which is absurd (from a practical point of view), especially when it is remembered that it ought to be spaced several times its own length from all other objects, such as the earth.

Another example: What is the length of a dipole to tune to the Alexandra Palace sound channel (7.2 metres)? Answer: 11 feet, which is reasonable, especially as owing to the necessity for coupling and tuning the aerial by means of coils and/or condensers, it is always rather shorter than half a wavelength.

Fig. 3*a* shows the current diagram of a half-wave unloaded aerial. When a coil is used, the inductance of the aerial must be correspondingly reduced by cutting a chunk CD out of the middle, and as the coil is a "concentrated" part of the circuit it is relatively ineffective as an aerial. The reception is reduced, as suggested by Fig. 3*b*.

On the other hand, an enthusiast situated on a larger plot than the average modern dwelling might feel that he had room for more than a mere 11 feet of dipole. But reference to the diagrams shows that the current does not keep on increasing as the aerial is made longer; on the contrary, in a full-wavelength aerial the current at the centre is nil! At long wavelengths nearly all the inductance resides in the tuning coil, so that the active portions AC and DB (Fig. 3*a*) are minute parts of the whole, and any increase in them is well rewarded.

Before objecting that dipoles, even of the heavily loaded sort, are never used for long-wave reception, bear with me a little longer while I dispose of short waves first.

Minimum Current: Maximum Voltage

An important addition to the current diagram is a voltage curve, which can be drawn in by remembering that maximum current is minimum voltage and vice versa. Theoretically you could touch the exact centre of a well-balanced high-power transmitting aerial, where the maximum current is flowing, without burning the end of your finger. But the ends of the aerial must be well insulated, for they take the full voltage. Fig. 4 is the same as Fig. 3 but with the voltage curves added. There are methods of coupling a dipole aerial by voltage, and they obviously must be applied at or near an end.

It is all very well to talk about coupling to an aerial, but when for effectiveness it is suspended in mid-air it is asking something. An ordinary lead-in would add to the length of the aerial and upset the calculation entirely. But it has been found that if two parallel wires, or concentric tubes, are used, the same voltage and current relations along the length hold good; and that if the wires are close together they do not act as an aerial to any great extent. The diagrams show that although current and voltage change as one moves along the wire, after half a wavelength they come back to the original conditions. So a feeder consisting of any number of half-wavelengths can be inserted without making any difference,

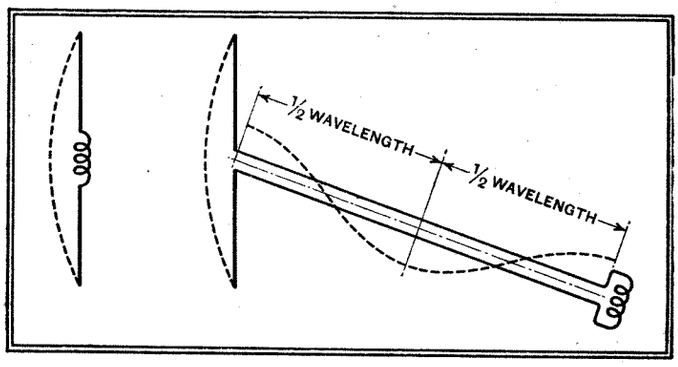


Fig. 5.—It is generally awkward to instal the receiving apparatus at the centre of the aerial. A parallel line of a multiple of half the wavelength enables it to be located any reasonable distance away.

Aerials—

other than a slight loss. Fig. 5 shows how a coupling coil can be located more conveniently by this means. In transmitting stations, for example, a great many half-wavelengths have to be inserted to bridge the distance from the oscillator to the aerial. And the same methods are used in short-wave and ultra-short-wave reception. Actually, there is a great deal more "to it" than I have mentioned—impedance matching, tuned and untuned feeders, and so forth; mostly with a view to getting every bit of efficiency possible. But the foregoing may serve to introduce the subject.

Earthed Aerials

The reader who is accustomed only to the "ordinary" aerial will no doubt have been surprised at the complete absence above of any reference to earth, except indirectly as something to be got away from as far as possible. The earth is, historically, a subsequent complication. It was found that if half a dipole were stuck vertically out of the ground, making good electrical contact with the earth, it behaved very much as if the other half were below the surface (Fig. 6). Ground level marks the middle of the dipole. This is a good deal more convenient for many purposes, particularly for long waves. A vertical aerial in its simplest and truest form is comparatively rare. The height is nearly a quarter of a wavelength (over 1,000 feet in the case of Droitwich), less that replaced by the coupling coil. For domestic reception it is usually very troublesome to raise the aerial more than about thirty feet. And the "effective height" is greatly reduced by the presence of adjacent buildings and other obstructions.

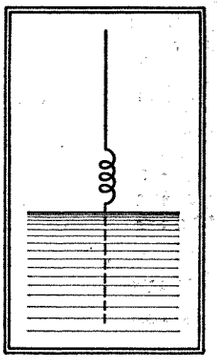


Fig. 6.—The "ordinary" aerial, with the earth connection, may be looked on as a half-buried dipole.

The inverted L aerial lends itself much better to a domestic environment. The horizontal portion, or "flat top," adds nothing to the voltage generated by the passage of the radio waves, assuming perfectly level ground with no excrescences such as houses; but in actual situations there is no doubt that it does help. This is proved by the reception that is obtained when the downlead is screened to reduce interference. And in any case it increases the current set up in the aerial by a given voltage, by reason of the much greater capacity. It forms, in fact, one plate of a condenser, the other being the earth.

The subject of the screened-downlead aerial for excluding interference has been very frequently explained. It furnishes an example of how the old rule against bringing the downlead very close to earthed objects may be successfully defied, provided that there is a transformer to step down the voltage and impedance.

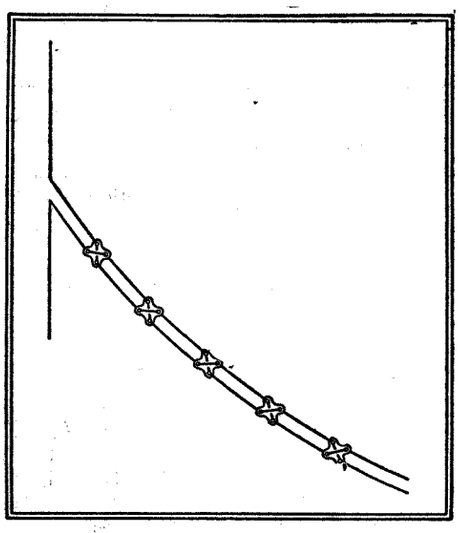


Fig. 7.—To minimise the already small amount picked up by a parallel-wire downlead, the wires are crossed over at intervals.

The twin wire feeder, used for short-wave dipole aerials, also serves as an anti-interference system, but as for efficiency there is a spacing of several inches the pick-up is not negligible. It can be made so, however, by reversing the wires at intervals with special insulators (Fig. 7); any voltage picked up by one section is opposed and neutralised by the next.

On the Short Waves

IN discussing my last notes with G2MV, it became apparent that a little further explanation of the point dealing with the march of the sunspot cycle from 1749 to 1936 might be welcome.

The point which it was desired to emphasise was that, although we have a continuous record of sunspot activity from 1749 to date, we have only experienced one sunspot maximum period, *i.e.*, 1927-28, from the short-wave communication standpoint.

Moreover, the maximum of 1927-28 was not a particularly large one when compared with some of those which preceded it during the period over which we have records.

In fact, when one examines the continuous curve from 1749 it can be seen that during some of the maximum periods, which occur at approximately every eleven years, the activity reached almost twice that of the first radio maximum in 1927-28.

It therefore follows that the coming sunspot maximum in 1938-39 may be either smaller or greater in intensity than its immediate predecessor, and at the moment it looks as if it will be greater, which means higher frequencies, or still shorter waves. Nobody, from a study of short-wave conditions in October of last year, would have thought that the optimum frequency for evening transmission from New York would, this year, be as high as it is at the moment, *i.e.*, 17 Mc/s (16 m.).

Due to the increased solar activity, therefore, the tendency is to make use of the higher, or daylight, frequencies for a much greater percentage of the day (even in winter) than we would do during the sunspot minimum years. Quite apart from changing propagation conditions, too, improvements in aerial and transmitter technique are also increasing the higher limiting frequency for any given circuit, so that even given equal intensities in the maximum of '27-'28 and '38-'39 we may expect to see even higher frequencies used in the latter.

A final reference to sunspots might be to remark that signals generally improve in strength during the maximum years because a greater proportion of the high-angled radiation is bent and returned to the earth; less of the energy radiated in this manner being lost to outer space.

Before turning to the review of conditions, a reference must be made to the return of 28 Mc/s (10-metre) activity during the last week in September, and some of the U.S. group really gave outstanding results on the loud speaker as late as 7 p.m. G.M.T.

Among the best signals were WIHQN using 150 watts into a horizontal wire 7 half-waves long and running east and west, W2HFS, W2JKV and W5CEE. On 32 Mc/s (9 metres) several police transmitters have again been well received on a domestic all-wave receiver, the best being W2XCN.

From My Log

My notes for the period under review begin on Thursday, September 24th, and at 7 p.m. G.M.T. conditions were active up to 20 Mc/s (14 metres) at least, and on 15 Mc/s W2XAD, using his European beam, was a local station signal.

Active conditions were noted on 28 Mc/s on Friday, September 25th, the half-wave of WQP being particularly strong.

At midnight both W8XK on 15 Mc/s and W2XE on 11 Mc/s were very good, as also were W1XK and W2XAF on 9 Mc/s; whilst even W3XAL on 6 Mc/s was fair. VP3MR, Georgetown, was good in this band.

Some surprisingly good signals from the U.S. amateurs on 14 Mc/s were intercepted on Sunday evening, and in particular the performance of W3APO on this occasion was better than the best heard from any U.S. commercial station.

Conditions remained similar to the above over the week from September 28th to Friday, October 2nd, W3XAL on 17 Mc/s being a consistently good signal during the evening till close down (11 p.m. B.S.T. during the week in question).

Round the world echo was noted on the Empire transmitters GSG (17.79 Mc/s) and GSH (21.47 Mc/s) at midday, Saturday, October 3rd, and during the morning and afternoon very strong signals were received from Alexandra Palace on both the sound and vision frequencies.

Later Saturday afternoon fair signals were obtained from Bandoeng PMH on 15.15 Mc/s (next to GSF).

At 11.30 p.m. on Sunday W2XAF, W1XK and COCH were all fair to good on 9 Mc/s, also conditions seemed more favourable than usual on 28 Mc/s.

Since September 1st W2XAF has been using a horizontal dipole for all transmissions, which no doubt accounts for the increased strength lately. W2XAD, too, has been using a European beam regularly and will probably change to low-power modulation in the near future.

ETHACOMBER.

Broadcast Brevities

NEWS FROM PORTLAND PLACE

Start of the Television Service

MONDAY, November 2nd, will see the start of the B.B.C.'s regular television service from Alexandra Palace. That the "send-off" will be appropriately auspicious need not be doubted.

The programme on the opening day will not be too ambitious. The inaugural ceremony at 3 p.m. is expected to last some fifteen minutes, and will be followed by a news reel and a variety show.

In the evening will be presented another edition of "Picture Page," one of the most successful programme ideas yet exploited in television.

Prominent personalities and stars of the stage and screen will be featured in the programme from the very beginning.

High Speed Make-Up

Mary Allan, the make-up expert, is among the heroines of these early days of television. Unaided, she made beautiful all the members of Henry Hall's Band in one hectic hour before they appeared last week in what was generally considered to be among the best programmes of the tests.

The roll of honour must also include D. H. Munro, Productions Manager, who keeps things humming and oscillates so rapidly between studio floor and office tower that he has been seen in both places at once. D. C. Birkinshaw, Engineer-in-Charge, who supervises Marconi-E.M.I. and Baird operations with the tact and patience of a traffic policeman; Dallas Bower, who combines elaborate programme production with film supervision in his spare moments; Cecil Madden, deviser of "Picture Page"—in fact, the list could justly include the whole staff, everyone being fired with the determination to make television a success.

Surprise for the Conductor

Hyam Greenbaum experienced a shock on the second day of the tests. Having conducted the Television Orchestra in the closing cadence of a tune for the film "Television Comes to London," he stepped back to note how the orchestra appeared on the screen of the check receiver in a darkened corner of the studio. He rubbed his eyes in amazement at an apparent miracle, for the orchestra's official red jackets had been strangely transformed into the flowing garments of a gypsy band.

It took him a few feverish seconds to realise that the transmission had been rapidly faded over to Younkmann's Czardas Band in the Exhibition Hall of Alexandra Palace.

Study in Contrasts

THE "Saturday Contrast" programmes are not belying their title.

It is a far cry from the banks of the Thames in the heart of London to the banks of a quiet Warwickshire canal—the two spots from which the Saturday Contrasts are to be radiated on the afternoon of October 24th.

The London affair will be a sound picture, with running commentary by Capt. E. H. Robinson, on a small bore rifle contest at Shell-Mex House, Victoria Embankment, between Lensbury and Britannic House (the national champions) and the London district teams.

From Warwick will come a description ("running commentary" would hardly apply in this case) of coarse fishing in the canal at Lowsonford. Mr. G. H. P. Higginson will take the microphone to the canal bank.

It is hoped that the fish will rise to the occasion.

Points About the Pips

HOW many listeners realise that the Greenwich pips are not always precisely punctual? The B.B.C., which always prefers truth to romance, confesses to enquirers that the last of the six pips is sometimes as much as one-twentieth of a second late. Occasionally, let it be whispered the pip is correspondingly early.

Time Signals v. Artistic Effect

Although the Greenwich time signals are radiated at frequent intervals during the day, they are occasionally suppressed if likely to interfere with the artistic presentation of a programme. (In concerts of modern music the pips sometimes enhance the general effect.)

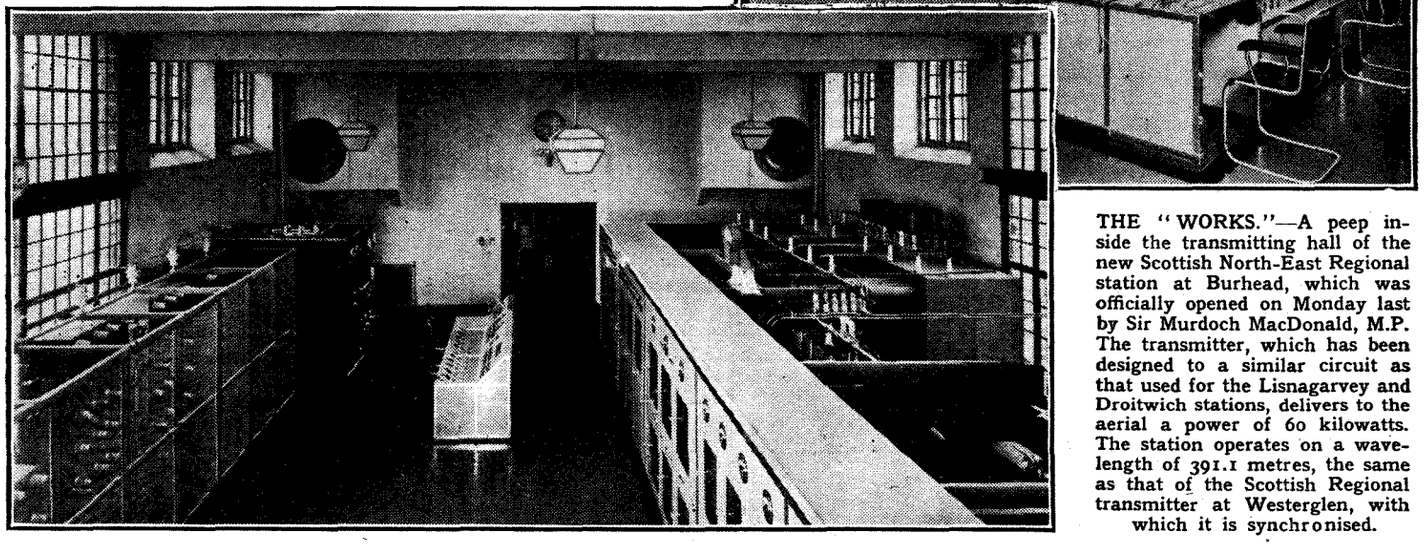
When a time signal is suppressed it is usually radiated at the next available quarter. Two signals—those at 10.30 a.m. and 6 p.m.—are inviolate, as these are relied upon by shipping for the setting of chronometers.

Broadcasting Two Naval Battles

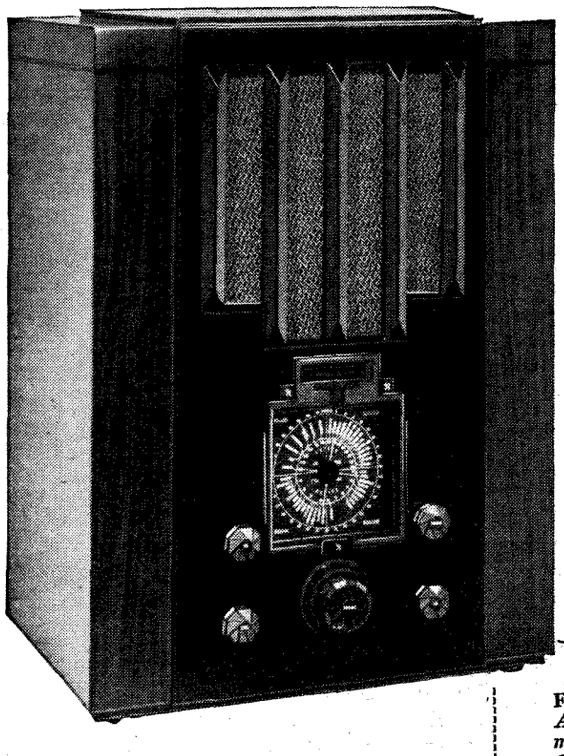
FEW sea "dramas" in fiction or real life are rounded off with the completeness that makes the sea battles of Coronel and the Falkland Islands stand out in history.

On November 1st, 1914, Rear-Admiral Craddock's cruiser squadron was defeated and partly destroyed by the German Admiral Von Spee's armoured cruisers off the coast of Chili. Five weeks later Admiral Sturdee, with *Invincible* and *Inflexible*, accomplished the task set him by the British Admiralty. Von Spee's squadron, fighting to the last, was sent to the bottom near the Falkland Isles.

The story will be retold in a graphic broadcast in the National programme on Sunday, November 1st.



THE "WORKS."—A peep inside the transmitting hall of the new Scottish North-East Regional station at Burhead, which was officially opened on Monday last by Sir Murdoch MacDonald, M.P. The transmitter, which has been designed to a similar circuit as that used for the Lisnagarvey and Droitwich stations, delivers to the aerial a power of 60 kilowatts. The station operates on a wavelength of 391.1 metres, the same as that of the Scottish Regional transmitter at Westerglen, with which it is synchronised.



Pye —MODEL T10—

AN ALL-WAVE RECEIVER OF HIGH OVER-ALL EFFICIENCY

FEATURES.—*Type.*—*Table model superheterodyne for AC mains.* *Wave ranges.*—*(1) 13-33 metres. (2) 30-82 metres. (3) 198-560 metres. (4) 900-2,000 metres.* *Circuit.*—*RF amplifier (on short waves only)—octode 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) Variable selectivity. (4) Sensitivity. (5) Wave range. (6) Mains on-off switch.* *Price.*—*18 guineas.* *Makers.*—*Pye Radio Ltd., Radio Works, Cambridge.*

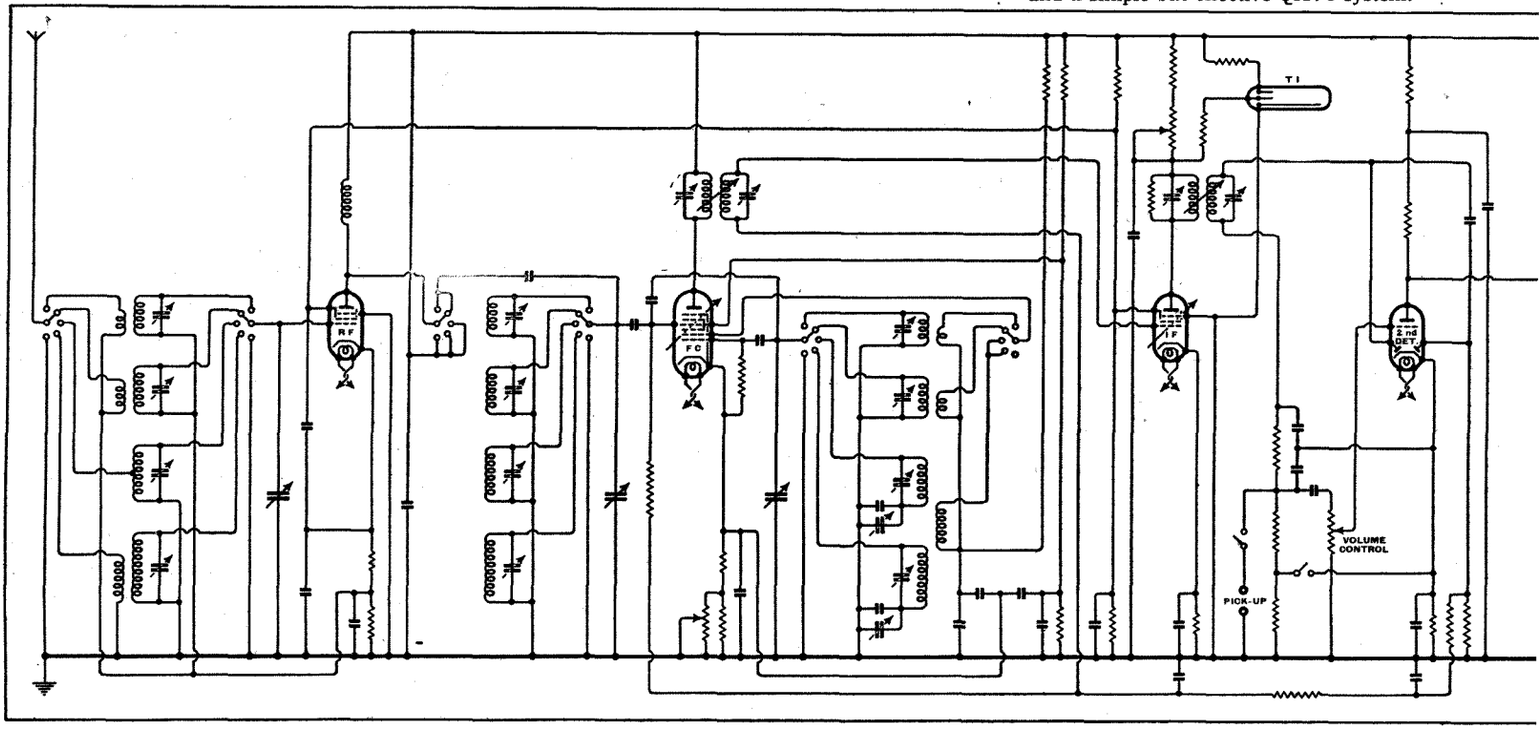
IT is a characteristic of Pye productions that they invariably give the impression of being well engineered. Not only are the mechanical details of the chassis a source of satisfaction to anyone with an eye for craftsmanship, but the electrical design generally reveals one or more points of originality suggesting a receiver which has been evolved for a specific purpose rather than one which is a mere adaptation of some currently popular circuit.

Thus we find in the T10 that an RF amplifier is introduced for the two short-wave ranges only, and is cut out of circuit on the normal broadcast wave ranges where sufficient range is already provided by the remaining stages of the circuit. Most designers leave the RF stage in operation on all wavebands in order to take advantage of the extra selectivity provided by the tuned intervalve coupling. This advantage is not foregone in the Pye receiver, as the two groups of coils preceding the frequency-changer valve each include four tuned circuits. On the medium- and long-wave ranges, however, the circuits are coupled to form a bandpass filter without intermediate amplification.

The RF amplifier valve is of the variable-mu type but is not controlled from the AVC line. On the medium- and long-wave ranges it is suppressed by applying negative bias and by connecting a by-pass condenser between anode and earth.

The frequency-changer valve is of the octode type and is included in a balanced circuit designed to maintain good conversion efficiency without pulling on the shortest wave ranges. This valve and the IF amplifier which follows it are both controlled from the AVC line, and in the case of the frequency-changer there is an additional control of sensitivity consisting of a variable resistance in the cathode return lead. This control is operated by a separate knob on the front of the cabinet and with it is associated a switch controlling the bias circuits of the second-detector stage by means of which the inter-station noise suppression control

The provision of RF amplification on the two short-wave bands only is a logical if unconventional feature of the circuit, which also includes variable selectivity and a simple but effective QAVC system.



may be put out of action. Quiet tuning between stations is effected by biasing the signal diode rectifier, and the sensitivity control in the frequency-changer stage determines the level above which the signal strength of a station is able to open up the rectifier circuit.

The IF amplifier operates at 465 kc/s, and both the input and output transformers associated with it are of the type in which the coupling is varied mechanically. The neon-type tuning indicator is also operated from this stage, control being effected through the volt drop in the anode-decoupling resistance.

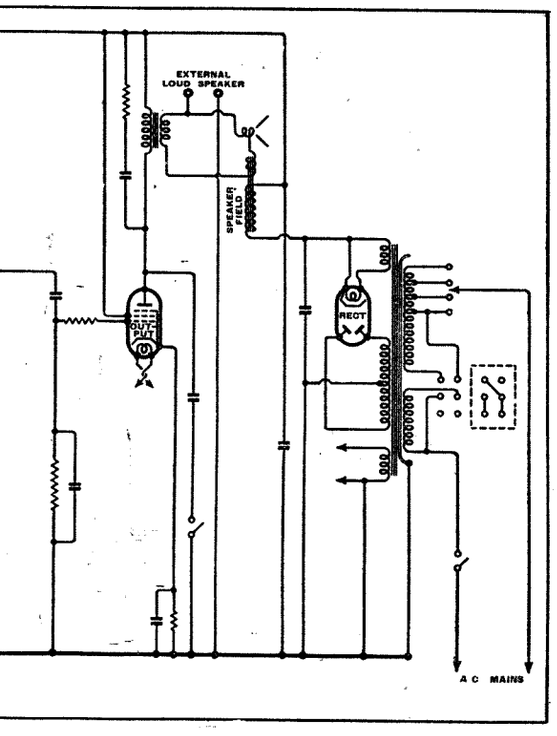
A separate diode is used for the supply of AVC bias, and the triode amplifying portion of the second detector stage is resistance coupled to a pentode output valve capable of delivering 2.5 watts at 7 per cent. distortion to the 9-inch moving-coil loud speaker. The tone-correcting resistance and capacity across the primary of the output transformer have fixed values designed to suit the characteristics of the loud speaker employed.

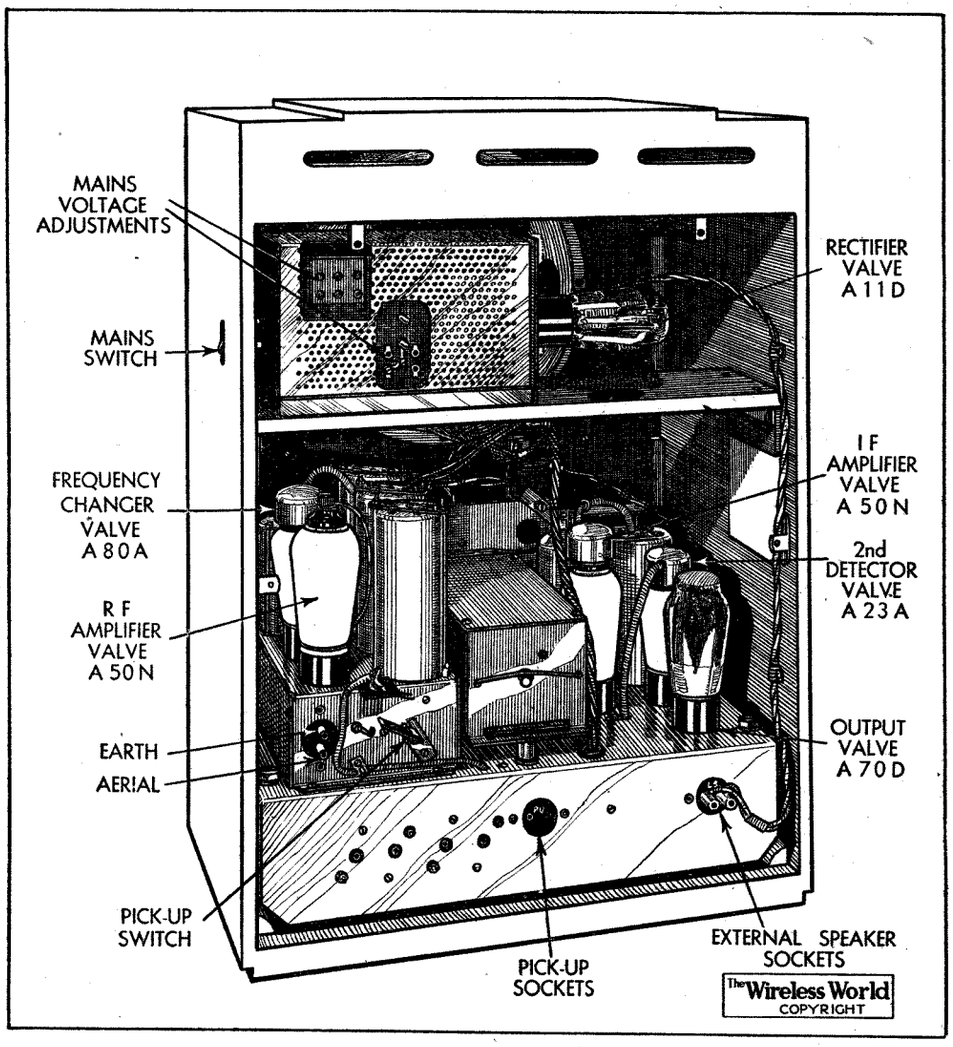
Tone Control by Selectivity

Tone control is, therefore, virtually carried out in the IF stage, and, with the variable selectivity control in the mid-position or a little below, very good quality is obtained with ample bass response, due to the effective baffle area of the large cabinet. There is no noticeable harmonic distortion at normal levels, with consequent clarity in orchestral items and other concerted music. Decreasing selectivity calls up a vigorous upper middle register response before the really high frequencies are reached, with the result that full-width audio-frequency reproduction is best appreciated at a somewhat lower volume level.

The variable selecticity alone does not provide quite sufficient top cut for the interference which town-dwellers may experience on the short-wave ranges. Accordingly the makers have arranged a switch contact at the maximum selectivity (low tone position) which connects an additional fixed condenser across the anode circuit of the pentode output valve. There was a good deal of local interference while the set was undergoing test, and the background noise on the short-wave range bands were entirely free from second-channel whistles.

It was on these bands that the action of the simple but effective inter-station noise suppression circuit was best appreciated. The cut-off on each side of a station has the precision of a mechanical relay, and while the quality and volume of the station, when properly tuned, in no way differ from the conditions when the QAVC is out of action, the silence between stations is complete without even a trace of mains hum.





The chassis is rubber mounted and the power pack forms a separate unit and is mounted on a shelf above the main chassis.

forced us to keep the selectivity control in this position except for a few powerful Continental transmissions.

Of the efficiency of this set on the short waves there can be no doubt. On any afternoon after 3 p.m. (G.M.T.) Pittsburgh, Schenectady and Bound Brook were all strong enough to force themselves on the attention of the listener without effort on his part while traversing the "ultra-short" waveband. Any fluctuations of signal strength came easily within the scope of the AVC system, the excursions of which could be verified by slightly mis-tuning a station and listening to the rise and fall of the side-band hiss. The selectivity provided by the two tuned circuits preceding the frequency-changer ensured that short-wave stations were received at only one point on the dial, and for the same reason the normal broadcast

The range of the set on the medium- and long-wave broadcast ranges is more than adequate, and the omission of the RF stage is quite justified. With the QAVC circuit in action no fewer than eleven foreign stations, in addition to the various Regional B.B.C. programmes, were of sufficient strength in daylight to overcome the QAVC bias, and many more stations were available, though, of course, with more background noise with the QAVC switched out of circuit. Adjacent station selectivity was possible in all cases with the exception of the locals, where, in the case of the Brookmans Park transmitters, one channel was lost on either side of the National and 1½ channels on either side of the Regional when using the set in Central London. The high sensitivity is main-

Pye All-Wave Receiver—

tained on the long-wave range, and the Deutschlandsender was clearly received between Droitwich and Radio-Paris with but slight side-band splash from the former station. It is, perhaps, here that one feels most the need for a tone-control independent of the variable-selectivity control.

The circular tuning scale is of ingenious design with four quadrants, one for each waveband. There are four pointers attached to a central boss, and as the scales are of necessity somewhat cramped the pointers are of the knife-edge variety so that relatively the same accuracy of reading is provided as with a larger scale and the thick pointers generally provided. In addition, there is an independent pointer which makes one complete revolution over a 360 deg. scale, and from it readings may be taken for future reference of the settings of stations not marked on the dial. The pointers are driven by a two-speed knob with a ratio of 200:1 for fine tuning, the slow-motion knob being fitted with a finger-tip control for ease of manipulation.

At the back of the set sockets are provided for the addition of a gramophone pick-up, and an interesting type of low-capacity switch has been added as an extension to the wave range switch spindle in order that the pick-up leads may not affect the radio performance. An external loud speaker of the low-impedance type may be added, and the Pye system of plugs and sockets enables any combination of internal and external loud speaker to be made. By the simple process of reversing a connector plate the set can be instantly converted for 100-150 or 200-250-volt mains.

In conclusion, we would congratulate the makers on the production of a very comprehensive instruction manual including much useful information on short-wave reception.

Letters to the Editor

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

Television Costs

READING your leader in the issue of October 2nd, the paragraph, "It cannot be expected that members of the public in large numbers will put down nearly a hundred pounds for a television receiver until . . .," made me ponder.

If—and your estimates are fairly accurate—the cost of a receiver is to be one hundred pounds, where do you consider the public in large numbers are coming from?

I should say, at a rough guess, that 80 per cent. of the listening public to-day could not afford twenty pounds, yet 100 per cent. of licence holders are, through part of their annual 10s. fee, financing television experiments for the benefit of 20 per cent. of their better-off brethren.

I consider it is a scandal that the B.B.C. should be saddled with the responsibility of finding the cash for television, to the detriment of the ordinary broadcast programmes, and thereby to the majority of their regular listeners.

Pick up "The Radio Times"; you will find that week after week the book is, with monotonous regularity, the same programme, same artists, the same orchestras, at the same time, same day. This savours of contracts to obtain minimum rates, and by tying the B.B.C. to television we are not helping them to avoid it.

This brings us to your second paragraph, programme value.

Are the licence holders to be expected to pay a heavier licence to allow the B.B.C. to compete with other interests? It is rather looking ahead, but I do think the point will arise, and it is better to face it now.

At present "television" is, so to speak, a rich man's plaything. The average man, apart from appreciating the wonders of it, is not actually looking forward to it. And why?

He has learnt from bitter experience, with his four- or five-valve set, how costly replacements are. What is he going to do if he had a television receiver with about twenty valves and a cathode-ray tube to replace at times?

How is it certain firms can advertise skeleton sets containing six B.V.A. multiple valves at a price of £7? Valves could be sold to the public at half their present prices with a handsome profit. This problem has got to be tackled before the average man thinks of increasing his liabilities with a television set.

With all the best respects to the *Wireless World*, and, let me add, which I purchase each week, not as a technical man, but because of the interesting matter which it contains in its pages.

E. W. A. MACKENZIE.

Tottenham, N.17.

"Optical Problems in Television"

I WAS very interested in the article under the above title by Mr. Percy W. Harris. He raises a point which is often overlooked, that the phenomenon of persistence of vision and the problem of flicker in television reception is not so easily solved as in cinematography.

It has long been realised that flicker is a function of brightness; but we were led to believe that flicker would disappear at a picture frequency round about 40.

Unfortunately, this is not the case with television. In fact, with the present-day high-definition television, in spite of a high picture frequency, flicker is still apparent, which, of course, is accentuated by the improved illumination of present-day cathode-

SUMMARY OF SETS TESTED AND REVIEWED BY *THE WIRELESS WORLD*

For the convenience of potential purchasers of manufacturers' receivers, the following list has been compiled of sets reviewed in the pages of *The Wireless World* from July 3rd to October 9th. This list will be supplemented from time to time with the details of the latest reviews. Earlier lists of reviews published since October 4th, 1935, were printed in the issues of March 27th and July 3rd, 1936.
It is possible to give only a brief summary here, and readers are referred to issues, dates of which are given in the last column, for the full reviews.

Maker.	Set.	Type.	Circuit, Valves excluding rectifiers.	Wave Ranges.	Price.	Reviewed.
					£ s. d.	1936.
A.C. Cossor, Ltd.	378	Table	Straight 3 (A)	M, L	8 8 0	July 3rd
Philips Lamps, Ltd.	246B	Car Radio	Superhet 6 (*)	M, L	17 17 0	,, 10th
Murphy Radio, Ltd.	B23	Table	Straight 3 (B)	M, L	6 7 6	,, 24th
Degalliers, Ltd.	Challenger 524	Chassis	Superhet 21 (A)	8–16, 16–57.5, 57–187, 187–555, 850–2,050 m.	40 0 0	Aug. 7th
McMichael Radio, Ltd.	365	RG	Superhet 4 (A)	M, L	29 8 0	,, 21st
The Gramophone Co., Ltd.	H.M.V. 485A	RG	Superhet 5 (A)	7–16, 16.7–51, 46–140, 185–560, 750–2,200 m.	37 16 0	Sept. 11th
Marconi's Wireless Telegraph Co., Ltd.	RG34A	Table	Superhet 9 (B)	14–200 m. (5 bands)	—	,, 25th
Philips Lamps, Ltd.	795A	Table	Superhet 4 (A)	16.7–51, 200–585, 725–2,000 m.	18 18 0	Oct. 2nd
Pilot Radio, Ltd.	U650	Table	Superhet 5 (A)	16–52, 48–150, 175–550, 750–2,100 m.	16 16 0	,, 9th

Abbreviations: RG = Radio-gramophone; A = AC; B = Battery; M = Medium; L = Long. * 12 volts.

ray tubes. We are still looking for larger images and still more illumination, and so under existing conditions flicker is likely to remain.

I am at present interested in a scheme where frequency economy is essential, but with a new method of synthesis it is anticipated that flicker will be overcome even when a comparatively low picture frequency is used.

In conclusion, I do not consider that it will be essential to have an image made up of so great a number of lines as 500, as suggested by Mr. Harris, when we have learnt the right way to analyse our image.

London, S.E.9. R. W. CORKLING.

Single-Span Receiver for Short Waves

I SHOULD be pleased to hear from any of your readers regarding the means they used in adapting their Single-Span receiver to include the short-wave range.

I had looked forward to an article in *The Wireless World* on this conversion, particularly after the reference to the subject in the "Hints and Tips" column of May 11th, 1934, and I regret this has not been done.

Regarding the Single-Span receiver itself, when linked to the "W.W." P-P quality amplifier and a good loud speaker, I have nothing but praise. It is all that a good set should be, and I feel that it is worthy of having its field of usefulness extended by the addition of a short-wave range. Will one of your more experienced readers, who has made this alteration, help in this matter?

Appreciating your very able efforts to keep us well abreast of modern radio developments. H. J. G.

Edinburgh.

[The Single-Span principle is not directly adaptable to SW reception, since on these wavelengths an aerial filter would not be very effective in reducing second-channel interference. There is no reason why such a set should not be successful on SW, however, if a tuned aerial circuit is substituted for the filter.—ED.]

Receiver Specifications

I HAVE just read again the correspondence columns in your issue of September 11th, and I see that Mr. Haywood, of Coventry, is making a claim to "stage" rating for B.T.H. I should like to point out to Mr. Haywood that the Ediswan (?) "two-stage" set was a three-stage receiver, as it contained a detector with two stages of A.F., the valves for these latter being contained in one envelope, and called by the makers TS2.

This, however, is by way of introduction. I should like, if I may, to criticise some of the specifications put out by manufacturers nowadays when describing their receivers.

It is easy to get hold of makers' catalogues at any radio shop, and I would suggest that anyone interested should get a supply and read them in a perfectly unbiased attempt to get any information about the goods "described."

For myself, I can claim twelve years' service experience, and quite average common sense, but I must admit that in some cases it takes me half an hour's study to discover whether a set is for AC or universal supply, and that in a number of cases this is finally solved by the acquaintance I have with the manufacturers' "type letters."

If proof of this is required, I would point out that all the catalogues in the shop where I work have been gone over and marked "AC," "U" or "B" to indicate the power supply.

Again, it is very kind of manufacturers to give one a coloured plate of the receiver, but it is awkward when asked "How many valves?" to have to admit ignorance, because the manufacturer will not supply the information. It is also bad that a superheterodyne can only be distinguished from TRF because somewhere in the text one sees mention of a heptode.

Further information that should be supplied is the power consumption. Of course, one can always measure this, but the manufacturer surely *knows* how much his products take from the power supply!

And finally, some statement of absolute sensitivity and top cut-off would be very welcome. I observe one manufacturer this year is putting out a dial showing the IF band width. Most users will not know what the figures mean, but this is a step in the right direction.

Do the manufacturers want to sell sets, or pigs in pokes? H. MOORBY.

Inverness, N.B.

Home Recording

I HAVE read with interest the article on home recording by Mr. Robert W. Bradford, in the September 25th issue, and I would like to endorse his praise of the V.G. recorder and records, they are excellent. When replaying there is no need for any scratch filter whatsoever, and the full frequency response of a high fidelity radiogram can be used without a trace of needle scratch. Also the quality of the recorded item, whether it be music or speech, is like the original—whether it be radio or microphone.

I notice that Mr. Bradford is using an expensive "Level Indicator," perhaps the cheap method I use may be of use to experimenters in this field. If the cutting head is wound to 15 ohms (V.G. supplied me with one at no extra cost), then a 6-volt. 0.04 amp. lamp will give a very clear indication of volume level, being just alight for normal volume recording. At present I am using a circuit I have devised for preventing the amplifier giving more than a predetermined output, however loud the input. I have made many records with the circuit in use, and have not had a trace of distortion anywhere. The persons singing or playing can do just as they please, and recording is merely putting the cutting head to the blank disc, and stopping the motor at the end. G. P. DENNY.

Worthing.

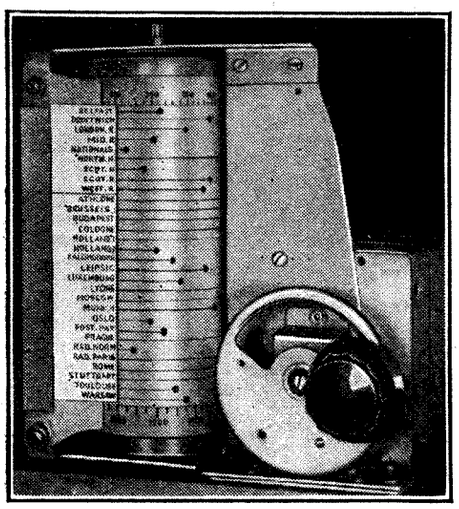
Modern Radio Communication, Volume I, 6th edition, by J. H. Reyner, B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E., M.Inst.R.E. Pp. 330 + xiii and 157 illustrations. Sir Isaac Pitman and Sons, Ltd., Parker Street, Kingsway, London, W.C.2. Price 5s.

THAT this volume should run to its sixth edition is sufficient evidence of its merits. It takes its place among the more important of elementary textbooks for serious students of radio communication, especially prospective candidates for preliminary and intermediate examinations.

Although the size of the volume has not been changed, several improvements and some slight corrections have been made. Only fundamental principles are treated, and the use of mathematics has been avoided as far as possible. For the proofs of certain statements and formulæ, too advanced for an elementary textbook, the reader is referred to Volume II. Most chapters conclude with one or more examples for the student to work, and numerical answers are given at the end of the book. Specimen examination papers are also given. O. P.

Alphabetical Tuning Scale

MUCH ingenuity has been devoted to the devising of tuning scales, but so many designs that provoke our admiration at a first introduction fail to stand the crucial test of practical use. So far as those showing station names are concerned, a common shortcoming is that the names are grouped on the dial in a sequence corresponding to their position in the radio spectrum, and, unless the user can memorise the approximate position of a desired station, its location may take some time.



The Burns tuning dial, allowing station names to be grouped alphabetically or in any other order desired.

Alphabetical or geographical grouping is an obvious remedy for this, but it is one that tends to complicate the design of the tuning system.

A dial that seems to offer a highly practical solution to the problem has been designed by Mr. W. A. Burns; its operation is almost self-evident from the accompanying illustration. A rotating drum, suitably linked to the condenser spindle, is marked with dots which correspond to the various stations when registering with the edge of the station-name scale. Circumferential lines drawn on the surface of the drum in the manner shown give clear indication as to whether right- or left-handed rotation of the knob is required for tuning-in the desired station.

It is understood that the system of construction, which is clearly susceptible to modification to suit special requirements, is the subject of a patent application.

CURRENT TOPICS

News of the Week in Brief Review

Cheaper Radio Telegrams

A NEW night wireless telegraphic service has been introduced for the convenience of passengers on transatlantic liners who desire to communicate cheaply with the U.S.A. Telegrams handed in before midnight will be delivered on the following morning, the charge being a flat rate of 19 cents per word to any part of the United States. The ordinary rate varies from 21 to 29 cents according to the distance of the destination from the coast station. This service will be available on ships of all nationalities.

Fiji Islands Calling

SINCE the installation of the new transmitter at the Suva short-wave station, a very considerable increase in range has taken place. Amalgamated Wireless (Australasia), which operates the station, is particularly anxious to receive reports from this country, and would gratefully acknowledge any which are sent either to Suva or to the head office at Sydney, N.S.W. The station works on 9,540 kc/s (31.45 metres), and may be heard from 10.30 a.m. to midday (G.M.T.) daily except Sunday.

In Old Baghdad

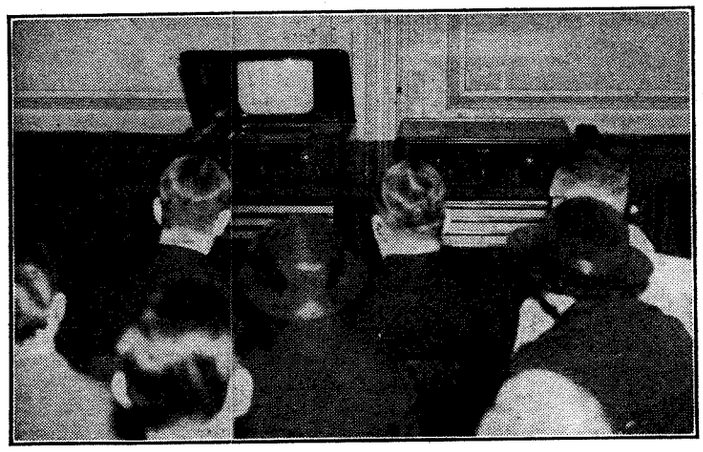
IRAK is apparently determined to make herself as well known to the nations of the world as she was in the days of the great Caliph, as it has been decided to erect a high-powered station about 12 miles from Baghdad. The station will be designed and built on the most modern lines, and the preparation of plans has been put into the hands of Mr. Barlow, the British radio engineer recently engaged by the Irak Government to advise them on wireless matters.

New Use for Ultra-shorts

THE application of ultra-short waves have been many and varied, the latest idea in the U.S.A. being to use them in order to enable the driver and guard of a railway train to keep in telephonic communication with each other. It might be thought that an ordinary line telephone would serve the purpose equally well and be far less expensive. Apparently, however, American trains are greatly addicted to the habit of breaking a coupling, and it is just at such a period that a vital need is felt for communication between the two severed portions of the train.

Bombay Police Wireless

THE use of wireless by the various police forces of the world is gradually spreading, the latest addition to the ranks of users being the Bombay police. At first two cars only are being equipped with apparatus, these carrying out experimental work in conjunction with the installation at police headquarters. After the expiry of a year the position will be reviewed, and, if favourable results have been obtained, the use of wireless will be greatly extended.



TELEVISION FOR ALL. Co-operation between the Southern Railway Co. and Baird Television, Ltd., has enabled a further series of free demonstrations of television to take place daily at Waterloo Station during the normal periods of transmission from Alexandra Palace. The present times are 11 a.m.–noon and 3–4 p.m. daily.

America and Sponsored Programmes

THERE are signs that many American listeners are getting a little tired of the advertisements accompanying the sponsored programmes of their broadcasting stations, and are showing a willingness to make a contribution towards the cost of programmes without advertising. They are not likely to get these programmes by wireless, however, since there would be no guarantee that pirate listeners would not derive enjoyment from the programmes without contributing towards their cost. The idea is to provide programmes to subscribers *via* landline after the manner of the relay exchanges over here. Already the sponsors of the scheme are making preliminary enquiries in several U.S. cities. They would not relay radio programmes as is done over here, but would send out their own, it being proposed to provide three programme channels to give, respectively, light music, classical music and talks.

Wireless Theory at Fault?

IT has long been one of the axioms of radio that the speed of wireless waves is similar to that of light waves, namely, about about 300,000,000 metres per second. According to reports received from France, however, experts are now throwing considerable doubt upon this figure, it being alleged that the speed of wireless waves is much slower, the actual figure given being 250,000,000 metres per second. This astonishing upsetting of pre-conceived ideas is said to be due to extensive measurements in connection with longitude determination in which all the large observatories of the world co-operated in 1933. These figures have not yet been confirmed, however, and, as the report somewhat naïvely adds, it would be very unsafe to draw any final conclusions at present.

Test Match Commentaries

DURING the present tour of the M.C.C. Team in Australia a special broadcast of one hour's duration will be made each day, commencing at 1.45 p.m. (G.M.T.) from Melbourne, VK3LR, on 31.34 metres, use being made of a horizontal rhombic aerial directed on London. The programme, in addition to cricket news and commentaries, will contain talks of general interest, sandwiched between light musical items. An epitome of the week's Australian news in English, French and German will be featured on Sundays, Wednesdays and Fridays respectively. The transmissions will be preceded by the call of the Australian lyre bird, and, to assist identification still further, the midnight chimes of the Melbourne Central Post Office clock will be heard a quarter of an hour after the commencement of the programme. This transmission will be known as Programme D.

Programme A, which is transmitted daily from 8.30 a.m. to 10 a.m. (G.M.T.), consists of talks, market reports, weather and news, and is intended primarily for listeners in the State of Victoria. Programme B consists of a relay of the National programme of the local medium-wave station, 3LO, and is transmitted from 10 a.m. to 12.30 p.m., and from 12.50 p.m. to 1.30 p.m. (G.M.T.). Programme C is similar in nature to programme A, but is intended for the benefit of Australian listeners generally rather than only for those in Victoria. It is transmitted from 12.30 p.m. to 12.50 p.m. (G.M.T.) daily.

A Fatal Experiment

TWO medical students at Ghent in Belgium have been badly injured in an explosion which took place during a wireless experiment which they were carrying out. They were endeavouring to discover if an explosive mixture could be ignited by ultra-short-wave emanations. It is not clear, however, whether the explosion was due to the wireless waves or arose through some other cause. One of the students has since died.

Turkish Developments

BROADCASTING is said to be growing steadily in popularity throughout the Ottoman Republic, it being reported that the total number of receiving sets in the country now exceeds 6,000. There are at present only two transmitters, these being at Ankara and Istanbul, but the erection of two new stations is contemplated in the near future.

U.S. Listeners

ACCORDING to a report issued by the American Commission on radio reception, the State of New York has by far the largest number of radio-equipped homes, the figure being just under three million. Next comes Pennsylvania with two million. Illinois, California and Ohio have approximately 1½ million each, while all the other States have less than one million, the lowest being Nevada with 22,000. The total number of radio-equipped homes in America is 23 million.

New Apparatus Reviewed

Recent Products of the Manufacturers

G. I. MICROPHONE

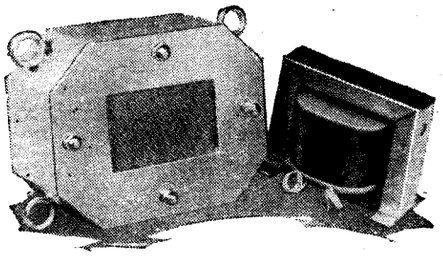
THIS microphone is a transverse-current type based on the design of *The Wireless World* model described last year. It is understood that several modifications have been effected in the internal construction, though the dimensions and shape remain the same.

These modifications have increased its resistance slightly, but as this is accompanied by a very low noise level and quite high sensitivity the changes are all to the good.

The microphone gives a satisfactory response throughout the whole of the audible range, and there are no resonances of any real consequence anywhere between 50 and 8,000 c/s. There is a slight falling off in the output above about 7,000 c/s, but even so the level up to 10,000 c/s is quite adequate for all normal requirements of public address, amateur experiments and home recording. The bass output is also sufficiently well maintained to ensure a good balance.

The reproduction of speech is exceptionally good and there is no trace of harshness, which is one of the failings of some carbon microphones.

Sibilants are inclined to be a little overstressed if the speaker is too close to the microphone and talks loudly, but this effect entirely disappears by speaking quietly or moving about four feet away. A variable control of polarising voltage might serve the same purpose. Best results were obtained by facing the microphone and not speaking across its face.



G. I. transverse-current microphone and transformer.

Our tests were made with polarising voltages of four, six and eight, and six appears to be the most suitable for general purposes. The current passed is then between 7 and 8 mA.

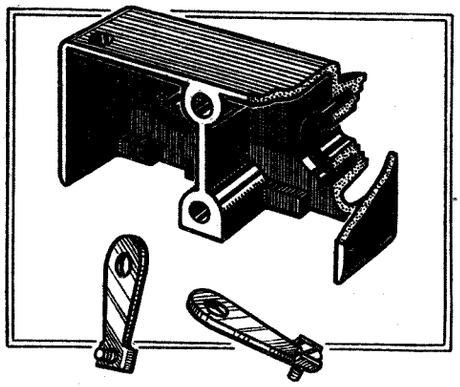
Though the sensitivity is high, the output is hardly sufficient to enable the microphone to be operated satisfactorily from an ordinary broadcast set without the addition of a small pre-amplifier.

The workmanship and finish are outstandingly good. Cream and chromium is the scheme adopted.

It is made by Gilbert Industries, Ltd., 518, London Road, Westcliff-on-Sea, Essex, and the price is 25s. A special transformer for it costs 8s. 6d.

FOR LOUD SPEAKER OVERHAULS

MESSRS. HOLIDAY & HEMMERDINGER, Holmer Works, Dolefield, Bridge Street, Manchester, 3, have introduced a set of feeler gauges for use in re-centring moving-coil loud speakers. The material used is non-metallic and there are four sets, each of four gauges, contained in a neat leather case. The four thicknesses are 0.015, 0.010, 0.0075 and 0.0005 inch and the price of the complete outfit is 2s. 6d.



Belling-Lee high-voltage terminal mount.

BELLING-LEE TERMINAL MOUNT

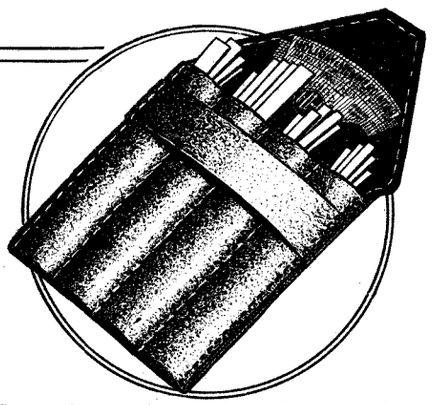
BELLING AND LEE, LTD., Cambridge Arterial Road, Enfield, Middlesex, have introduced a new terminal mount that has been designed especially for use in high-voltage circuits. It is intended for incorporation in apparatus associated with television where DC voltages of 6,000 or more are employed.

A special feature of the device is that the position of the terminals is arranged to give a long surface path between them so that leakage is reduced to a minimum for a mount of this size.

It is moulded from high-grade bakelite and can be mounted in an upright or in a horizontal position. With each mount is supplied two metal-tag terminals, their purpose being to enable it to be secured in place with the terminals upright, yet providing accessible contact points for the wiring. When mounted on its side these tags need not be used. The mount supports two terminals and the holes are approximately $\frac{3}{16}$in. in diameter, so it will accommodate terminals with shanks up to 2BA in size. It measures 2in. long, 1in. wide, and is a shade under $\frac{7}{8}$in. high; the price is 6d. complete.

PYE "MATCH-ALL" EXTENSION LINK

THE majority of modern receivers provide a connecting point for an extension loud speaker, and it is customary to specify an impedance figure for any extra unit that may be used. It is essential that this advice be observed, for if the extra loud speaker has an unsuitable impedance it will adversely affect the reproduction of both internal and external loud speakers.



Gauges for centring moving-coil loud speakers.

Though many listeners may have spare loud speakers available, there is thus a natural reluctance to make use of them if their impedances are of the wrong values. It will, therefore, be of interest to know that Pye Radio, Ltd., Radio Works, Cambridge, have evolved a unit designed especially to enable any loud speaker to be matched to, and used as an extension unit with, any wireless receiver.

Described as the "Match-All" Extension Speaker Link, it consists of a transformer provided with tappings on both primary and secondary windings.

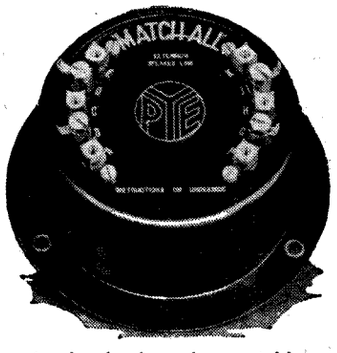
As in some cases the unit may be used as an auto-transformer, it is very wisely stated in the instructional leaflet that the unit be isolated from the DC circuits.

Where matching is effected to the low-impedance winding on the receiver's output transformer this condition is complied with automatically, but in cases where the "Match-All" unit is connected to the primary side, or to a choke-filter circuit of an early type receiver, a condenser of from one to four mfds. must be joined in each lead between the unit and the set.

A table is provided giving the correct connections for matching loud speakers of from one to 6,000 ohms or more to either high- or low-impedance output points on a receiver.

When the extension speaker is located a considerable distance from the set, say 30 feet or more, it is recommended that two matching units be employed, one close to the receiver and the other at the distant point.

The connections recommended in such cases provide for a satisfactory matching to



Pye extension loud speaker matching unit.

a long extension line without an appreciable loss in volume or any impairment of the reproduction. Ordinary twisted flex or bell wire can then be used for the line.

The unit is assembled in a metal container measuring $4\frac{1}{4}$in. overall diameter and 2in. high, and the price is 10s. 6d.

Listeners' Guide for

Outstanding E

THE RACE-COURSE SCENE from the original production of "The Arcadians" in 1909. Leonard Henry and Horace Kenney again take part in the broadcast version, which will be revived in the Regional programme at 8.15 on Wednesday and again Nationally on Friday, October 23rd.

THE long-awaited inaugural broadcast of the new concert-cum-cinema organ in the St. George's Hall takes place this week. It is announced that in the three-quarters of an hour programme on Thursday at 8 four well-known broadcasting organists—Harold Ramsay, Quentin MacLean, Reginald Foort, and Reginald Porter-Brown—supported by Henry Hall and the B.B.C. Dance Orchestra, and Mark Lubbock with the Theatre Orchestra, will demonstrate its possibilities. It will be interesting to hear an organ of this type combining with an orchestra and a dance band in "straight" and rhythm music.

NEGROID

TWICE during this week negro songs come into the programmes. On Sunday, by courtesy of the Columbia Broadcasting System, a programme of negro spirituals will be relayed Nationally from America at 9.5. It will consist of part of a religious service from the Negro Church, Washington, D.C., conducted by Elder Lightfoot Solomon Michaux.

The second occasion will be on Tuesday at 8.45 (Regional), when the first of three programmes on negro songs headed "From Jungle to Jazz" will be broadcast. The idea underlying this cavalcade of negro songs is to show the development from melody and rhythm of the Zulus to songs and rhythm of to-day. In this first broadcast Africa will be the theme.

The programme has been devised by Jules Bledsoe, who will also be singing, supported by the Variety Orchestra.

RUNNING COMMENTARIES

ON Saturday afternoon two sports commentaries will be given in the National programme. The first is at 2.5, when Colonel R. H. Brand will describe the progress of the play in the National Covered Court Tennis Championships of Great Britain from the Queen's Club, West Kensington. Immediately following this, at 3.30, listeners will be switched over to the Brooklands Motor Course, where they will hear F. J. Findon on the Brooklands Mountain Championship.

"STAR-GAZING"

WHILST having nothing to do with astronomical observations, it is an apt title for a programme which picks out the stars of the theatre world. In the series of programmes "Star-Gazing" by the collaborators of "Scrapbook" fame, Leslie Baily and Charles Brewer, theatrical celebrities will tell how incidents in their lives have brought them before the public. Could a better choice than Robert Hale be made for the first broadcast on Thursday at 7.30 (Nat.), and again on Saturday, October 24th? He will bring with him his children, Binnie and Sonnie, who he discouraged, without success, from following in father's footsteps.

MUSIC OF THE WEEK

THE seventh season of the Sunday Orchestral Studio Concerts begin this week in the Regional programme at 9.5, with Section B of the B.B.C. Orchestra and Alexander Kipnis (bass).

For the music series this week has been chosen works for string quartets and is headed "The String Quartet Before Haydn." The recitalists will be the Stratton String Quartet and the Roth String Quartet. The first concert is on Sunday at 6.15, when the works of Northern German composers will be given. On Monday at 6.40 (Nat.), Tuesday at 7 (Nat.) and Thursday at 7.30 (Reg.) works of Italian, Austrian and South German composers will be dealt with respectively.

A distinguished visitor, José Iturbi, will be heard playing the solo pianoforte work in Mozart's pianoforte Concerto in D minor during the Symphony Concert to be broadcast from the Queen's Hall at 8.15 and 9.25 on Wednesday. Not only is he a first-class pianist, but he is also a conductor of exceptional attainments. He is to conduct at the Sunday Orchestral Studio Concert on October 25th. The Symphony Concert on Wednesday opens with the B.B.C. Choral Society singing Gerrard Williams' arrangement of "God Save the King." Dr. Adrian Boult will be conducting the B.B.C. Symphony Orchestra, and Noël Eadie and William Parsons will be heard in Vaughan Williams' "A Sea Symphony."

"GHOSTS OF LONDON"

IN this series of programmes of musical memories devised by Wilfrid Rooke Ley, listeners will be given pictures of happenings in the lives of famous musicians when resident in or visiting England. The first of the series will be given Nationally at 9.30 on Sunday.

A CENTURY OF OPERETTA

ANOTHER distinguished visitor comes into this week's programmes with the broadcast "One Hundred Years of Operetta," when Victor Reinshagen conducts the Theatre Orchestra. Webster Booth will be the soloist. Apart from the fact that the orchestra will be under the baton of such an outstanding theatre musician, this programme should be very

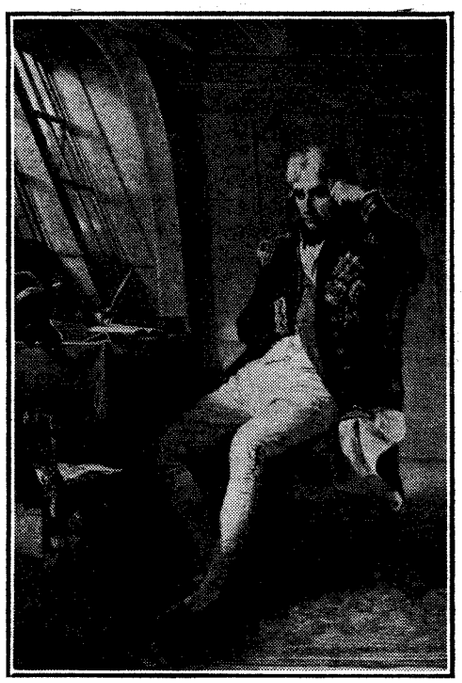
interesting and tuneful. Victor Reinshagen, who is a Russian by birth and Swiss by nationality, is, at the age of twenty-eight, conductor at the State Theatre, Zurich.

the Week—

Broadcasts at Home and Abroad

TRAFALGAR DAY

THE right atmosphere will undoubtedly be introduced into the broadcasting play "Nelson's Last Journey," for the author is Thomas Woodrooffe, the commentator, who was a lieutenant-commander in the Royal Navy. This play will be given on Trafalgar Day (Wednesday) at 7.30 (Nat.), and will deal with the time from Nelson's last night ashore at the inn at Burford Bridge until the great victory and tragic death.



"THE EVE OF TRAFALGAR." Nelson in his cabin in the "Victory" on the eve of the great battle: from the painting by Lucy.

FLORENCE NIGHTINGALE

A RADIO adaptation of Reginald Berkeley's play "The Lady with a Lamp" is to be given on Monday and Tuesday at 9.35 (Nat.) and 7.30 (Reg.) respectively. Val Gielgud has been able to secure Diana Wynyard for the part of Florence Nightingale. This will be her second broadcast; the first was in "A Winter's Tale" in January last year.

LADY ELEANOR SMITH talking to Gipsy Petulengro at the "In Town To-night" dinner last year. Petulengro will be heard during the betrothal ceremony broadcast from a gipsy encampment in Hertfordshire to-night (Friday) at 8.40 (Reg.), when Thomas Woodrooffe will be the official commentator.

GUITAR RECITAL

SPANISH music will be given its true interpretation when Segovia gives a guitar recital on Monday at 8.30 (Nat.). He is a great exponent of this expressive Spanish instrument, and this recital should be listened to by all who attempt to play the guitar, which is the most fashionable instrument in modern dance bands.

SCANDINAVIAN

THE first of a series of inter-Scandinavian concerts will be given to-night at 7.15 from Helsinfors and will be relayed by all Finnish, Norwegian, Swedish and Danish stations. The Helsinfors Municipal Orchestra will play a selection of famous Finnish music, the outstanding item being "Tulen sunty" (The Birth of Fire) by Jean Sibelius. This work is written for baritone solo, male choir and full orchestra, and is seldom heard outside Finland. The choir will be the Finnish Students' Choir (Ylippilaskunnan Laulajat).

DANISH OPERA

A SHORT programme which should be well worth tuning in comes from Copenhagen on Tuesday at 8.20, lasting only half an hour. The Danish wireless orchestra will give a representative selection of Danish operatic works by Bechgaard, Borresen and Carl Nielsen.

HIGHLIGHTS OF THE WEEK

FRIDAY, OCTOBER 16th.

Nat., 8, Lauri Wylie's "Wireless Puppets." 9.40, Chamber Music: Vivien Lambelet, Isidore Phillips and the International String Quartet.
Reg., 7.30, Hawaiian Rhapsody, a radio musical play. 8, B.B.C. Military Band and Arthur Fear. 8.40, "O Romani Rommerin."
Abroad.
Brussels I, 8, "Tales of Hoffmann."

SATURDAY, OCTOBER 17th.

Nat., 7.30, "In Town To-night." 8.15, B.B.C. Orchestra (C), and Garda Hall. 9.20, Music Hall.
Reg., 4.15, Lauri Wylie's "Wireless Puppets." 7.30, The Alfredo Campoli Trio. 8.30, Discussion: "Conflict or Conciliation in the Coal Field?" 10.25, Ambrose and his Orchestra.
Abroad.
Radio-Paris, 9, Choral and Band Concert from the Salle des Etats de Bourgoyne, Dijon.

SUNDAY, OCTOBER 18th.

Nat., 5.35, "Hippolytus." 7.5, Recital: Joan Coxon and Paul Makanovitzky (violin). 9.5, Negro Spirituals from America. 9.30, "Ghosts of London."
Reg., 5.45, Concert by the Orchestre Radio from Brussels. ¶Operatic Programme: Munn and Felton's Band. 9.5, Sunday Orchestral Concert.
Abroad.
Berlin, 7, "Rigoletto."

MONDAY, OCTOBER 19th.

Nat., 7.20, "Entertainment World." 8.30, Guitar Recital: Segovia. 9.35, "The Lady with a Lamp."

Monday, October 19th, continued.

Reg., 8.30, "I was There"—Klondyke—T. E. Hockley. 9.30, Concert Marches: B.B.C. Military Band.
Abroad.
Berlin, 7.10, "Raise the Curtain": Excerpts from current Berlin Theatre Programmes.

TUESDAY, OCTOBER 20th.

Nat., 6.25, The Bernard Crook Quintet. 8, St. George's Hall Organ.
Reg., 7.30, "The Lady with a Lamp." ¶Van Phillips and his Two Orchestras. 11.40 Pianoforte Recital: William Busch.
Abroad.
Konigsberg, 7.10, Orchestral Concert.

WEDNESDAY, OCTOBER 21st.

Nat., 7, Carroll Gibbons and the Savoy Hotel Orpheans. 7.30, "Nelson's Last Journey." 8.15 and 9.25, Symphony Concert from the Queen's Hall. ¶Dorothy Hogben's Singers and Players—Music of the Hunt.
Reg., 6, B.B.C. Military Band. 8.15, "The Arcadians." 9.30, The World Goes by.
Abroad.
Brussels 1, 8, European Concerts: "Francesca da Rimini."

THURSDAY, OCTOBER 22nd.

Nat., 6.40, One Hundred Years of Operetta. 7.30, "Star-Gazing."
Reg., 6, B.B.C. Dance Orchestra. 8.45, "North of the River": London Entertainments to be found north of the Thames.
Abroad.
Copenhagen, 7.10, Liszt Concert.

LISZT PROGRAMME

THIS week's Thursday concert from Copenhagen is devoted to the works of Liszt, who was born on October 22nd, 1811. The augmented wireless orchestra will be playing under the direction of Nicolai Malko. The concert begins at 7.10.

OPERA

THE outstanding opera performances of this week come from the theatres and opera houses. From the Théâtre Royal de la Monnaie comes Offenbach's "Tales of Hoffmann," relayed by Brussels No. 1 at 8 to-night. If only for the haunting barcarolle this relay is certain to have many listeners. Earlier in the evening, at 6.30, Budapest No. 1 relays "A Winter's Tale" from the Royal Hungarian Opera. English listeners are invariably interested in the music of any composer who uses the plays of our own immortal Shakespeare.

On Saturday Monte Ceneri relays Mascagni's "Cavalleria Rusticana" at 8 from the Teatro Sociale, Bellinzona.

Sunday brings a studio performance of Verdi's "Rigoletto" from Berlin (Funkstunde) at 7. From Königsberg comes another studio performance at 7, namely, "Das Dorf ohne Glocke" (Künneke).

THE AUDITOR.

PAUL GILSON, the great Belgian composer, whose dramatic oratorio, "Francesca da Rimini," will be given in French for the Belgian European Concert to be broadcast from Brussels No. 1 at 8 on Wednesday.

Inherent Receiver Noise

II.—SOME FURTHER ASPECTS

By A. L. M. SOWERBY, M.Sc.

Part I appeared in our issue of October 9th.

IN the first instalment the author explained the nature of the two kinds of noise that impose a limitation on the usable sensitivity of a receiver. He now goes on to discuss other problems of noise, of particular interest being those relating to the superheterodyne receiver.

THERE remains to see how far the amount of noise produced by thermal agitation and by the amplifying valves themselves is capable of reduction, and how far it depends on the type of set used and the wavelength being received.

Both thermal and shot noise depend on the width of the frequency-band passed by the set. In a non-distorting amplifier no harmonics of any frequency initially present can arise during amplification; noise-frequencies present at the anode or grid of the first valve are therefore harmless provided they are filtered out before they can reach the detector. In a straight set F must therefore be taken to stand for the overall resonance curve of the receiver.

It need hardly be emphasised that the band of frequencies passed cannot be too far reduced without losing the outer sidebands that carry the higher notes of music. A certain small amount of noise can be excluded, at least theoretically, by making sure that the band of frequencies presented to the detector for rectification is no wider than that which we require eventually at the loud speaker, instead of relying solely on the audio-frequency side of the set to keep the band-width down. On the other hand, it can be shown that one component of the noise produced at the detector can be reduced by making sure that the AF amplifier passes a band of frequencies no wider than that of the tuned circuits. For minimum noise, therefore, the tuned circuits and the AF amplifier should cut off at the same upper frequency.

These precautions, however, only touch quite small components of the total noise; so far as the main bulk of it is concerned either the tuned circuits of the AF amplifier may be used to control the total range of frequencies. It has already been mentioned that the modulation-depth caused by music drops towards the higher audible frequencies, while noise-voltage remains high; this accounts for the high-pitched hissing character of the noise and indicates that a limitation of high notes by a falling characteristic will have more apparent effect on the noise than on the music. The musically abominable knob labelled "Tone Control" can therefore often be made use of when receiving a distant station; music remains more or less intelligible even though noise is quite drastically cut.

Thermal noise is controlled, also, by the value of the resistance between grid and cathode of the first valve. If, as is usual, this position is filled by a tuned circuit, it can be shown that for a constant injected voltage the noise/signal ratio is reduced by decreasing the radio-frequency resistance of the circuit. For a constant signal input, halving the RF resistance quadruples the signal power at the loud speaker, but only doubles the noise power. Bringing the signal output back to its original level by reducing the gain of the set to half its original value leaves us with the noise power halved as the sole final result of the series of adjustments.

In finding this relationship it was assumed that the tuned circuits subsequent to the first, or, alternatively, the AF amplifier, were controlling the range of frequencies finally reaching the loud speaker, and that the reduction of RF resistance did not narrow the frequency-band at all. If such a change is to be admitted, reduction of RF resistance would naturally have even more effect, and it can be shown that in the very unlikely event of the first circuit controlling the frequency-range halving its RF resistance would divide the noise output by four for an unchanged signal-output. In this case variation of inductance also has its effect, but this is not normally within our control, since the value has to be such as to tune over the wave-range required. Where the first tuned circuit across which the thermal noise is being developed is followed by further identical tuned circuits in cascade (as in a multi-stage amplifier) the effect of these in reducing the frequency-band is given as a curve in Fig. 4.

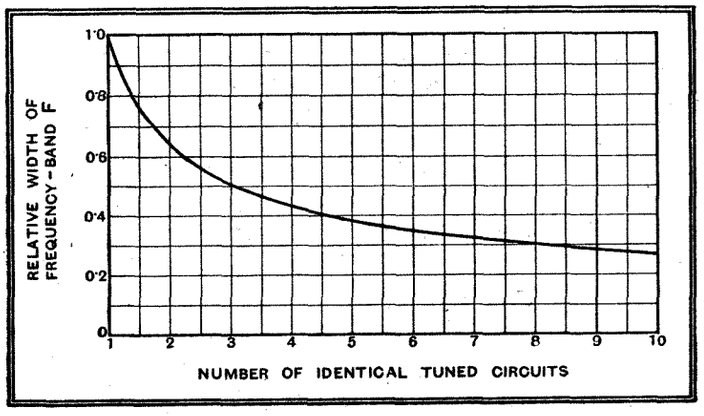


Fig. 4.—In cases where the tuned circuits control the band of frequencies passed, this curve gives relationship between F and the number of circuits used.

Lines of Attack

The practical range over which we can control thermal noise is, unfortunately, very limited; reduction of frequency range at the cost of quality of reproduction, and decrease of the resistance of the first tuned circuit in which it arises are the only lines of attack. Since tuned circuits are already fairly "good" in most cases, and the frequency-band of the average set wants widening rather than restricting, not much can be done.

There is always the possibility of immersing the first circuit in liquid air (−190° C.), which would reduce the output of noise to little more than one-third of its normal value, while by using liquid helium (−267.9° C.) it could be reduced to less than one-fiftieth. But this, while perfectly possible as an experiment in a laboratory, is hardly practicable for everyday reception!

On the broadcast band, as we have seen, shot noise is normally much less intrusive than thermal noise. This does not remain true for short-wave reception, so that it is worth while to glance at the possibility of reducing shot noise by careful design of the set. The shot *current* is determined solely by the anode current of the first valve; it is an elementary precau-

Inherent Receiver Noise—

tion to keep this low. In this connection the effects of secondary emission should not be overlooked; if there is secondary emission from the anode the steady current will be correspondingly reduced, but the shot noise will be increased since we now have to take into account the irregularity of electron-departure as well as of electron-arrival. Even though the steady values of the opposing currents have to be subtracted, the irregularities will add.

The shot-voltage applied to the grid of the second valve in the set is the product of the shot-current and the impedance (tuned circuit, etc.) through which it flows. Since the signal voltage is built up in exactly the same way, by the passage of the signal currents through this same impedance, changes in the anode circuit will affect both signal and noise in practically the same way. Changes in the tuned circuit, therefore, will not seriously alter the signal/noise ratio—except, of course, through altering the frequency band passed, but this has already been discussed.

The main point to notice here is that the gain of the first stage should be made as high as possible, so that by the time the signal reaches the first anode, where the shot noise will be added to it, it should be as large as possible. This means that the first valve should be one that gives a $0.53 \times 1/10^{-6}$ and a magnification m of 50.5. If we assume that the tuned circuit in the grid of the valve has the same characteristics as these we have just found for the anode circuit, the noise values work out thus:

Thermal Noise.

$$Vt = \frac{1.25 \times 10^{-10}}{\sqrt{10^4 \times 3 \times 10^3}} (F = \pm 5 \text{ kc/s}) = 0.69$$

microvolts.

With a gain of 6 times, this becomes 4.14 μV at the grid of the second valve.

Shot Noise.

$$Vs = is \times R = 5.64 \times \frac{10^{-10} \times 3 \times 10^3}{\sqrt{10^4 \times 3 \times 10^{-3}}} = 9.3$$

microvolts.

This time the shot noise is more than double the thermal noise, and both, it will be noticed, are far lower in value than we found on the broadcast band. In view of the fact that the grid circuit, even though of dynamic resistance only 3,000 ohms, has the very respectable magnification of 50, a good step-up from the aerial may be expected, and it should be possible to obtain reasonably noise-free signals on 20 metres with an input to the aerial of well under a microvolt.

The fact that the frequency band covered by the tuned circuits is very much wider than is the case on medium waves is not of very much importance, for the AF amplifier will cut off most of the extra range before the loud speaker is reached. But it is true that secondary effects at the detector will introduce some small additional amount of noise that could have been avoided if it had been possible to restrict the band of frequencies reaching it more nearly to that actually required for final reproduction.

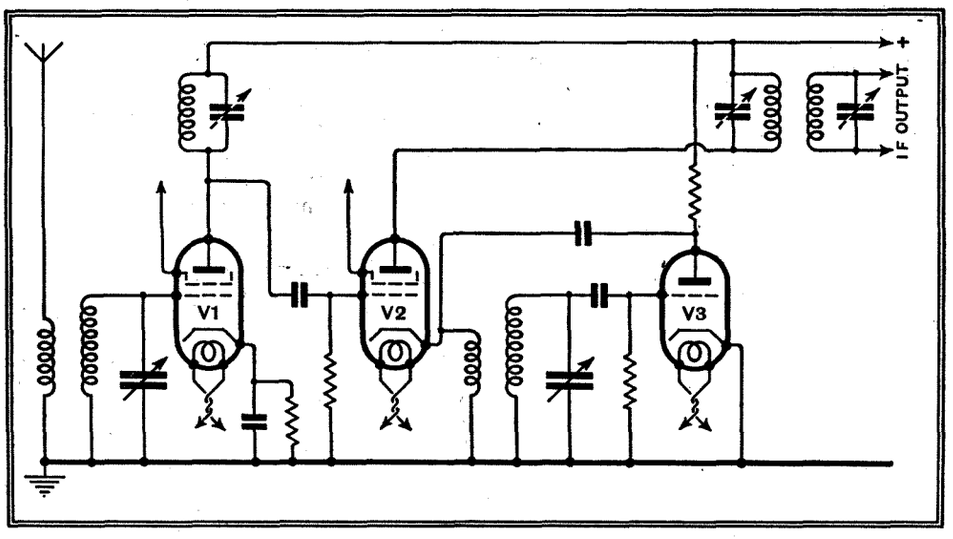


Fig. 5.—Skeleton diagram of first two stages (RF and frequency-changing) of superheterodyne discussed in text. V1 = RF amplifier, V2 = first detector, V3 = oscillator. Note that oscillator noise is injected at a point where *amplified* thermal noise and shot noise already exist.

very high stage gain while consuming the minimum of anode current.

On short waves the values of shot and thermal noise come out rather differently. Data for tuned circuits is not so readily available at these wavelengths, but if we assume that a radio-frequency stage gain of 6 times is obtained at 20 metres with a valve of slope 2 mA/V, and that the tuning range of the anode circuit is from 12 to 30 metres (all reasonably practical figures), we find that the tuned circuit has an effective dynamic resistance of 3,000 ohms, uses an inductance of 0.63 microhenrys, and has an RF resistance of 1.19 ohms, which give an L/r ratio of

So far we have restricted our discussion to the sources of noise in a "straight" set, consisting of ordinary high-frequency stages followed by a detector. The introduction of the superheterodyne principle

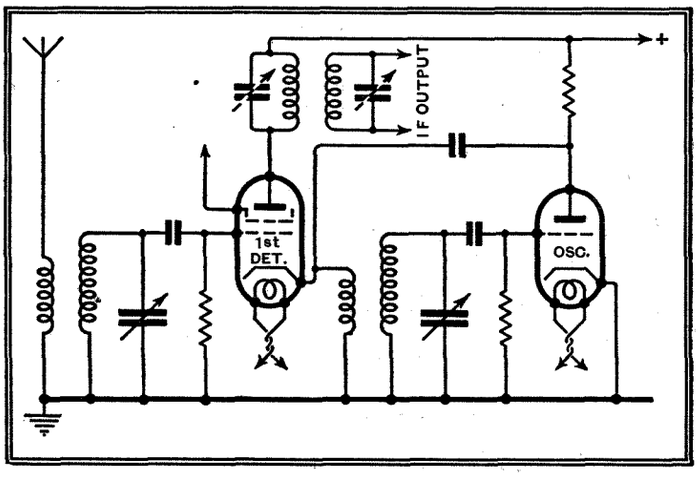


Fig. 6.—Skeleton circuit of superheterodyne in which no RF stage precedes the frequency-changer. Note that oscillator noise now has to be compared only with *un-amplified* thermal voltage in first circuit.

makes some slight difference to the noise level even on the broadcast band, while on short waves it can introduce a considerable amount of extra noise if care is not taken with the design.

Taking the broadcast band first, it is at least perfectly evident that in the oscillator valve we have a further source of short noise. Restricting ourselves for the present to the type of superheterodyne in which a radio-frequency stage precedes the frequency-changer (Fig. 5), we see that there is already shot noise in the signal reaching the frequency-changer; the contribution from the oscillator is at least not likely to exceed the noise already present. And this, as we have seen, is in turn swamped by the thermal noise in the first tuned circuit. We therefore conclude that on the broadcast band a superheterodyne should not be appreciably noisier than a straight set, provided that both begin with a stage of ordinary high-frequency amplification, and provided, also, that the process of frequency changing is not such as to bring noise from additional sources.

This last point evidently requires investigation, which can only be undertaken mathematically. If one works out the various combinations that arise when four voltages of different frequency (oscillation, carrier, one sideband, and noise) are simultaneously impressed on a first detector having a grid-volts/anode-current curve expressible by an equation of the fourth power, one reaches the rather frightening conclusion that the output at the anode contains currents of 160 different frequencies. Most of these fortunately turn out to be harmless, either on the grounds that they cannot pass the IF amplifier, that they will be turned out by the preselector, or, more usually, because their magnitude is trifling.

Suppose we are receiving a signal at 1,000 kc/s with a superheterodyne of which the intermediate frequency is 100

Inherent Receiver Noise—

kc/s. The oscillator will be set at 1,100 kc/s. Any noise voltages round about 1,000 kc/s will be converted, along with the signal-sidebands, into current round the intermediate frequency. Noise accompanying the original carrier is thus passed through to the detector exactly as in a straight set. If there is present at the grid of the frequency-changer any noise voltage round about 1,200 kc/s (the second-channel interference point), this, also, will be converted to IF, and will go through the set along with the signal. In the absence of selective tuning to eliminate this voltage before the frequency-changer is reached, the noise voltage in a superheterodyne would be 40 per cent. greater, and the power output of noise double that of a straight set of equal sensitivity.

Second-channel Noise

Still keeping to the case where a stage of radio-frequency amplification precedes the frequency-changer, we can make a rough estimate of this second-channel noise. The thermal noise in the grid circuit of the first valve will be comparatively small, because at the second-channel frequency the tuned circuit will have an impedance of roughly one-twentieth of that which it has at the frequency to which it is tuned. The anode circuit also being off tune, this reduced voltage will undergo but small amplification, so that in the end it will be only about one-thirtieth of that associated with the carrier. The shot noise is less reduced, for it is subject to the preselection of the second tuned circuit only; across this the shot current at the second-channel frequency will develop perhaps one-tenth of that at signal frequency. The shot noise will thus contribute more than the thermal noise at the second-channel frequency, but the sum total of the extra noise will still be quite small.

Additional minor sources of noise are also possible; for example, noise voltages at 100 kc/s on either side of the second and third harmonics of the oscillator can give rise, after frequency changing, to noise at intermediate frequency. But even one tuned circuit at 1,000 kc/s can be relied upon to reduce the noise voltages at 2,100, 2,300, 3,200, and 3,400 kc/s to insignificant proportions.

In a superheterodyne in which the frequency-changer is the first valve the position is rather different, and much more difficult to define exactly. The comparatively simple frequency-changing circuit of Fig. 6 shows that since the oscillation is injected in the grid-cathode circuit, any noise accompanying it has to be compared with the unamplified thermal noise present in the first tuned circuit. First, there is the thermal noise in the oscillator grid circuit; the anode current corresponding to this will develop some not inconsiderable voltage across the rather indefinite impedance of the reaction coil. The shot current of the valve will also produce a noise voltage across the same coil, and the two together are injected into the grid circuit of the first detector in series with the unamplified signal. However vague we may be as to the exact magnitude of the oscillator noise we can at least be certain that it is likely to exceed very considerably the thermal noise of 3 to 4 microvolts, which is the sum total of the "natural" noise accompanying the signal. In addition, there is little to prevent at least a certain amount of oscillator noise at the second-channel frequency from reaching the first detector; this will contribute a little extra to the total noise.

In agreement with these conclusions, it is generally recognised, as an empirical fact, that a sensitive superheterodyne built to the circuit "frequency-changer, two IF stages, detector" is impossibly noisy, while a set of equal sensitivity built to the circuit "AF stage, frequency-changer, one IF stage, detector" offends enormously less on this account, and behaves, from the noise point of view, more or less indistinguishably from an equivalent straight set.

We have already seen that noise on the short waves differs from that on the broadcast band in two respects: first, it is much less, and, second, shot noise, instead of thermal noise, predominates.

The selectivity of a short-wave tuned circuit, expressed as discrimination against signals removed from resonance by a fixed number of kilocycles, is much lower than that of one intended for the broadcast-band. Even at the higher intermediate frequencies (about 450 kc/s) habitually chosen for short-wave sets, a very considerable portion of noise at the second-channel frequency consequently reaches the grid of the frequency-changer, so making a superheterodyne nearly twice as noisy as a straight set. The only means that suggests itself of reducing this extra noise is to use as many tuned circuits as convenience permits between the AF valve and the frequency-changer. Extra tuned circuits preceding the first valve may reduce noise picked up by the aerial, but will have no effect whatever on either thermal or shot noise.

APPENDIX.

Some Noise Formulæ.

Thermal Noise.

$V_t = 1.25 \times 10^{-10}\sqrt{FR}$ at 290 degrees absolute. (17° C., 63° F.)

If r = equiv. series resistance of tuned circuit

V_0 = signal reaching first grid,

then, on the assumption of constant injected signal voltage into the circuit,

V_t/V_0 is proportional to $\sqrt{r}$ for constant bandwidth, F.

V_t/V_0 is proportional to r where first tuned circuit controls F.

In this latter case, if we take F as being the range over which the response of the tuned circuit exceeds $1/\sqrt{2}$ of that at resonance,

$F = r/L$

and $V_t = 2.5\pi \times 10^{-10} f\sqrt{L}$ volts

or, if C is the tuning capacity,

$$V_t = \frac{2.5\pi \times 10^{-10}}{\sqrt{C}}$$

For p tuned circuits, all alike, F as defined above is

$\left(\sqrt{2^{1/p}-1}\right)\frac{r}{L}$ Fig. 4 gives values of $\left(\sqrt{2^{1/p}-1}\right)$

Shot Noise.

$i_s = 5.64 \times 10\sqrt{FI}$ amps.

$V_s = i_s \times R = 5.64 \times 10^{-10} R\sqrt{FI}$

where R is dynamic resistance of tuned circuit.

$$V_s/V_t = \frac{i_s(R + R_0)}{\mu V_g}$$

This is *independent of* R if R is negligible compared with R_0 (screened valve); *small* if μ/R_0 is large enough.

RANDOM RADIATIONS

By "DIALLIST"

Fine Short-wave Reception

THE other night, when B.B.C. stations were relaying from the U.S.A. the results of the final of the Women's Golf Championship, I flicked over the switch of the "all-wave" set to see what direct reception was like. Running over the 19-metre band I found the transmission coming from Radio City, New York, in the most amazing way. The strength was such that full loud speaker volume was obtained with the control turned well down. There was no fading, quick or otherwise, no atmospherics, no distortion. It was, without exception, the best reception of short-wave signals that I have ever had from the other side of the Atlantic.

That was between 22.30 and 22.50 G.M.T., when it would be daylight in New York. It was interesting to notice how the signal began to deteriorate as darkness drew on at the transmitting end. There was noticeable decline in the strength, and slow fading became apparent. The B.B.C. engineers can't have had much trouble with their relaying that night, for at the time when they were working with New York, signals were at the very top of their form.

It Doesn't Always Happen

Transatlantic and other distant relays are not always so straightforward as that, though. I was talking the other day to one of the B.B.C. engineers, and asked him to add to my knowledge of the receiving outfit at Tatsfield. Tatsfield, as you probably know, is a double-purpose receiving station. One of its duties is to keep a watch on frequencies of long-wave and medium-wave stations on behalf of the I.B.U.; the other is to receive such short-wave transmissions as the B.B.C. wants for its relays. When these come from across the Atlantic three fairly widely separated channels are generally used simultaneously. The receiver is built on the grand scale, with three separate signal frequency and intermediate frequency departments, one for each transmission. By an ingenious arrangement any signal which falls below a certain level is instantly cut out. As fading doesn't occur simultaneously on different wavelengths, only the signal that is best and strongest at any moment is accepted and passed on to the audio-frequency circuits. Thus, in the

course of a single relay there may be dozens of changes from station to station and back again and, unless very rapid fading is present the output from the receiving set can be kept pretty constant.

An Operator's Problem

A SHIP'S wireless officer sends me a problem which I pass on to readers in the hope that they may be able to offer a solution. "I wonder," he writes, "if anybody can tell me why it is that very long waves are usually better received in daylight than after dark. I am thinking particularly of GBR, which works on 18,750 metres. Coming from Jamaica this trip I could read GBR easily in the daytime, but at night I couldn't hear him at all. When the distance from the station is less than 1,500 miles the signal is readable at night, though it is surprisingly weak considering that GBR has 350 kilowatts in the aerial." He goes on to tell me that Droitwich is quite well received on the ship's smoking-room wireless set up to 2,500 miles, beyond which atmospherics get the upper hand.

Very long wavelengths, such as that used by GBR, are rather outside the scope of most amateur experimenters nowadays, though years ago I remember winding a set of coils for the special purpose of receiving St. Assise, the big French commercial station, which was then working on something like 22,000 metres. It is rather interesting to note that with these very long waves we are getting well into the audio frequencies. 18,750 metres, for instance, corresponds to 16,000 cycles.

This Advertising Business

THE British authorities seem to have had a certain amount of success in their endeavours to induce the French Government to put the brake on English advertising programmes from stations in France. The French Government has announced that it will in future tax the gross receipts from advertising to 48 per cent., which is a fairly high figure. Some of the lay papers loudly foretell that now that France has taken action the Duchy of Luxembourg may follow suit. I don't think it will myself, and there is absolutely no means of compelling it to take any action at all. The only thing that will stop the pouring of radio advertising into this country from abroad is the discovery that it doesn't pay the advertiser. It will probably go on paying him so long as large numbers of our own people tune in foreign stations because they can't get what they want at home. The logical solution is for the B.B.C.'s programme people to see that listeners do get on one set of the home wavelengths the light and bright fare for which they yearn.

"Language Lessons"

I AM glad to see that the whole question of political and propaganda broadcasting is to be considered in the hope of arriving at a satisfactory working arrangement between European nations. On the long and medium waves there are two loopholes which may present difficulties. The offending country may plead (*a*) that its propaganda items are intended only for home consumption and that it is not to blame if foreigners using sensitive sets pick them up; or (*b*) that violent triades in foreign tongues are not propaganda at all, but just language lessons. These pleas, though, will not wash on the short waves, of which the outstanding quality is the ranges that they achieve, and it is on the short waves that the bulk of propaganda is done. Ask anyone who is stationed in the East about it and he will tell you that half a dozen countries are making regular broadcasts of a political nature from high-powered short-wave stations, not only in English but in many "native" tongues as well. Language lessons, of course!

Television Bad Luck

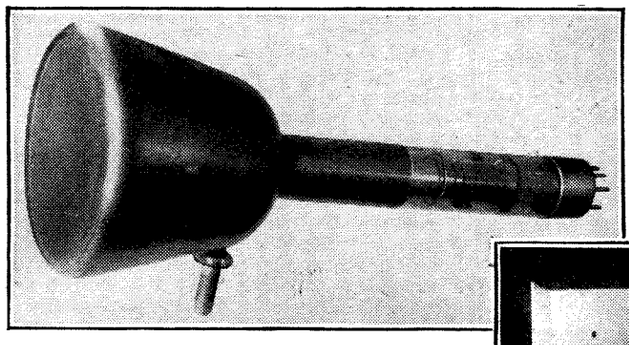
THE B.B.C.'s television staff has had pretty bad luck in the way of illness. Mr. Gerald Cock, the head of the department, is laid up in bed as I write, and wasn't there to keep an eye on the first test transmissions. Then one of the announcer hostesses went down with appendicitis not long before the Radio Exhibition, and there have been other minor casualties as well. Mr. Cock trusts to be fit and well again before the regular service starts on November 2nd, and I am sure that we hope that both he and all the members of the Alexandra Palace staff will be in the best of form for the opening day.

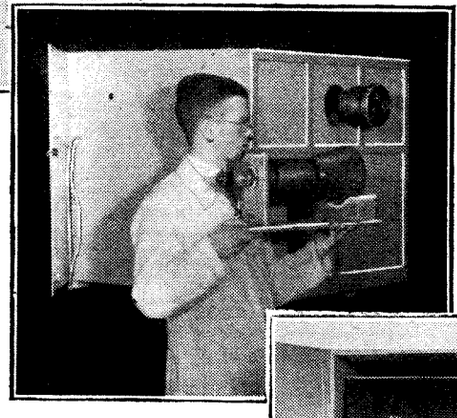
A recent portrait of Mr. Gerald Cock, Television Director of the B.B.C.

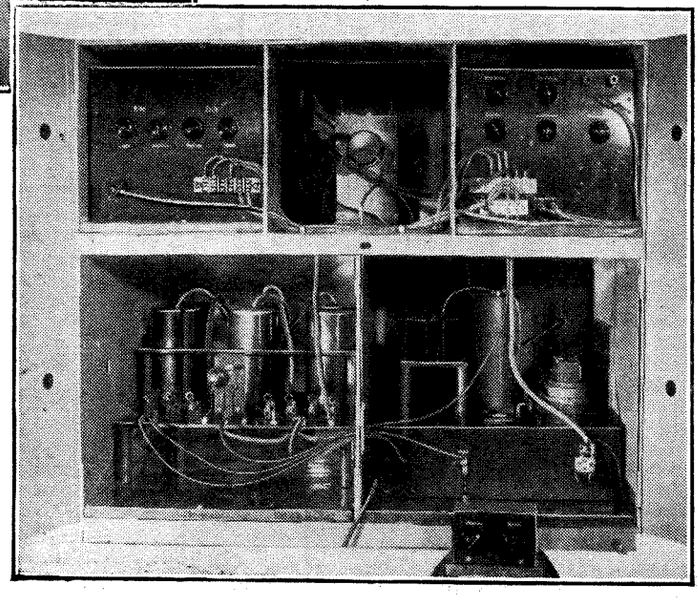
Many Thanks

A KIND reader, to whom my best thanks, sent me a whole bundle of radio magazines from Egypt, Australia and New Zealand. Very interesting reading they make, and they open one's eyes quite a bit to broadcasting conditions in other countries. Australia and New Zealand both have excellent broadcasting services, and in both countries there is an army of keen experimenters and long-distance men. It's good to see that home construction still flourishes at the other side of the world; articles on building sets—even crystal sets—appear regularly, and advertisement pages show that there is a considerable market for components. It is, though, rather sad to find so few British goods or receiving sets announced or referred to in these journals. Australia is building up a wireless industry of her own, it is true; but there should still be room for the British set if only more of our manufacturers would turn out suitable apparatus.

MAGNIFYING THE TELEVISION IMAGE







The upper illustration shows the new Telefunken cathode-ray tube used in the projection of pictures. It has a flat end and gives a picture 5 cm by 6 cm in size, which is projected on to a screen by an optical system, part of which can be seen in the centre photograph. The enlarged picture obtained on the screen is 100 cm. by 120 cm. The lower illustration shows the interior of the receiver used with this system.

Recent Inventions

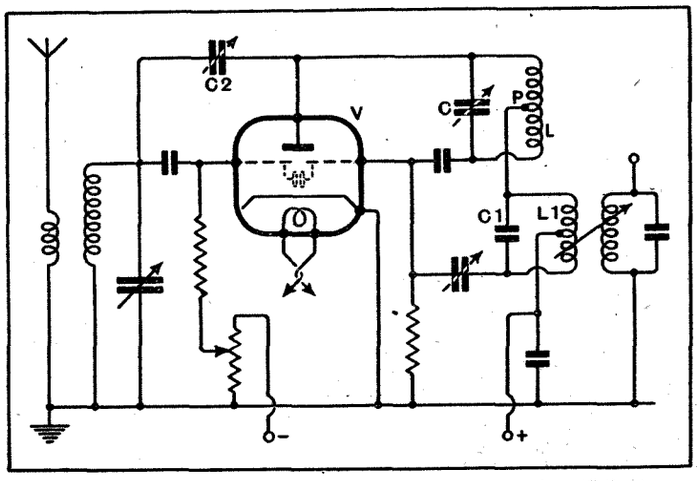
Brief descriptions of the more interesting radio devices and improvements issued as patents will be included in this section.

SUPERHET CIRCUITS

TO increase selectivity, as well as overall amplification, one of the intermediate-frequency circuits is back-coupled to an extent which would normally produce undesirable self-oscillation, which is, however, prevented because the local-oscillator valve is already oscillating at a much higher frequency.

As shown, the combined detector and oscillator valve V is of the double-grid type, and generates local oscillations in the circuit L, V1 through the medium of an electromagnet M, which moves the coils L, L1 towards or away from each other. The magnet, in turn, is controlled by the anode current of an auxiliary amplifier V2, the grid of which is biased by the load resistances R, R1 of two diodes.

The two input circuits A, A1 of the latter are coupled to the IF coils L, L1, the circuit A being tuned 9 kc/s below and the circuit A1 9 kc/s above the intermediate frequency. The presence of a strong interfering station will



Superheterodyne frequency changer for which is claimed high efficiency.

C. The resulting intermediate frequency appears in the circuit L1, C1, which is back-coupled across the grid and plate of the valve by a connection to the mid-point P of the coil L. The back-coupling compensates for the heavy damping of the IF frequency which normally occurs owing to the large amplitudes present in the mixing tube, and in this way enhances the selectivity of the set. The local oscillations are prevented by a balancing condenser, C2, from getting back into the aerial and so being radiated.

Radio Akt. D. S. Loewe. Convention date (Germany) December 13th, 1933. No. 450247.

o o o o

AUTOMATIC SELECTIVITY

THE width of side-band accepted by the tuned HF circuits of a broadcast receiver is automatically regulated in accordance with the degree of interference present in the particular part of the wave-band to which the set is tuned. In most selectivity-control circuits, the effective width of the band "accepted" by the set depends only upon the intensity of the programme then being received. By contrast, in the present arrangement, the controlling factor is the strength of any interfering signals that may be present.

The required effect is secured by altering the closeness of the coupling between the two IF valves V, now cause the "balance" of the load resistances R, R1 to be upset, and will so apply a negative grid-bias to the amplifier V2. This, in turn, energises the magnet M to swing the coils L, L1 apart, and so "narrows" the width of the accepted side-band.

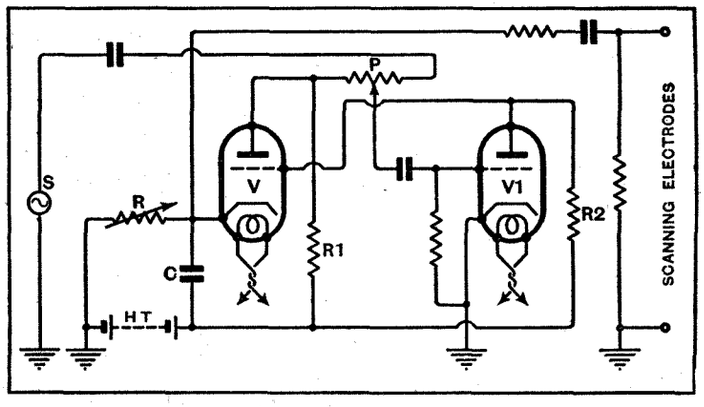
N. V. Philips Gloeilampenfabrieken. Convention date (Germany) April 13th, 1935. No. 450081.

TIME-BASES FOR TELEVISION

"SAW-TOOTHED" oscillations for scanning purposes are produced by charging-up the condenser C from a source HT through a variable resistance R. The condenser is shunted by a combination of two valves V, V1. At a critical anode voltage, the valve V discharges, and in doing so produces a voltage across R1 which throws the grid of the valve V1 negative, and so cuts down its anode current. This, in turn, produces a voltage drop across the resistance R2 which throws the grid of the valve V more positive, and by making it more conductive, accelerates the process of discharge. At the end of the discharge period the reverse action takes place, the voltage across the resistance R2 now swinging the grid of the valve V more negative, and increasing its internal resistance so that the condenser is again effectively insulated. The net effect is to "snap" the discharge valve V into and out of operation.

Synchronising-impulses are applied from a source S through a tapped potentiometer P, which regulates the amplitude of the synchronising-voltage to the amplitude of the feed-back voltage, thus ensuring a smooth and continuously adjustable control.

Hazeltine Corporation (assignees of H. M. Lewis). Convention date (U.S.A.) February 9th, 1935. No. 449743.

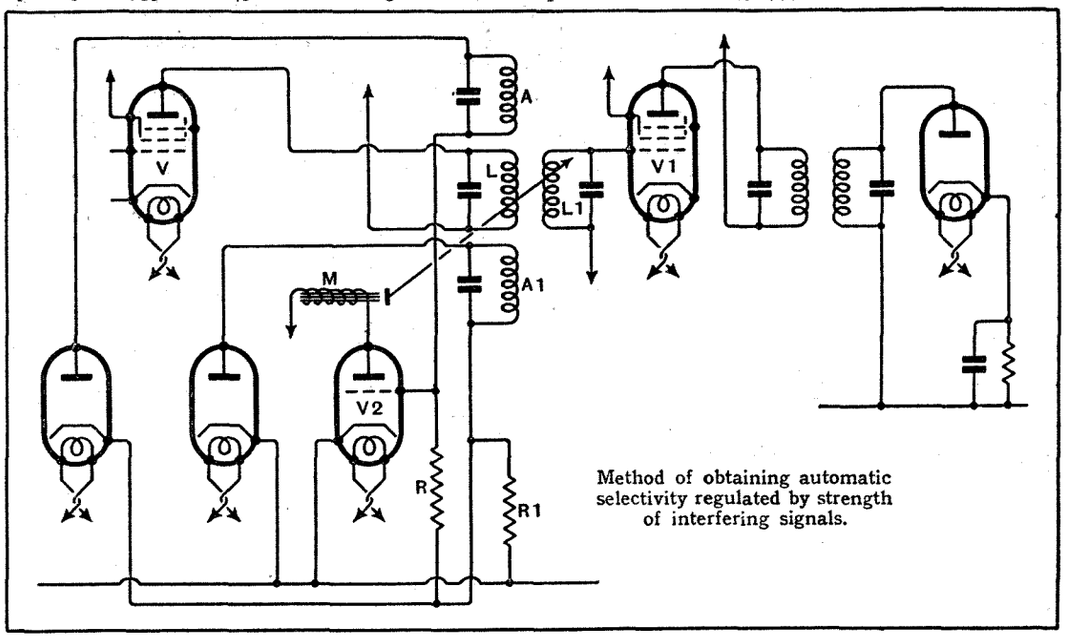


Time-base circuit for use in television apparatus.

FREQUENCY MODULATION

CERTAIN advantages are claimed for the transmission of wireless signals, either for sound or television, by a process of frequency modulation as distinct from the more usual method of amplitude modulation. In order to effect frequency-modulation, the original signals are applied to deflect the stream of electrons passing through a cathode-ray tube. As it impacts against the fluorescent screen of the tube, the stream produces radiations which are passed through a screen of varying transparency. They then fall on to a photo-electric cell, the output from which is amplified and fed to the transmitter. The transparent screen is so graduated that the light passing through produces a current of sinusoidal form in the photo-electric cell.

H. A. Richardson. Application date November 30th, 1934. No. 450444.



Method of obtaining automatic selectivity regulated by strength of interfering signals.

The Wireless World

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EDITORIAL COMMENT

Political Propaganda

Foreign Language Broadcasts

THE Report of the Ullswater Committee on Broadcasting which was published early in the year included a recommendation in connection with the Empire broadcasting service, which reads as follows:—

> "In the interest of British prestige and influence in world affairs, we think that the appropriate use of languages other than English should be encouraged."

At the time that Report appeared we commented on this recommendation and emphasised our anxiety if such a proposal should be hastily acted upon, particularly having in mind the fact that this country had been active in endeavouring to get international agreement to suppress the broadcasting of propaganda addressed by one country to another. But conditions are changing and it may be necessary to look at this matter again in the light of altered circumstances.

It is true that this country has been active in endeavouring to obtain agreement to suppress broadcast propaganda, but so also this country has for years set an example in the cause of disarmament. Recently, however, because other nations have failed to contribute to this cause, we have been forced to take steps to strengthen our defences and increase our armaments.

If there is no prospect of agreement to discontinue propaganda broadcasts, is not this a parallel with the failure of disarmament, and ought not this country to consider whether broadcasts should be regarded as part of our national defence scheme?

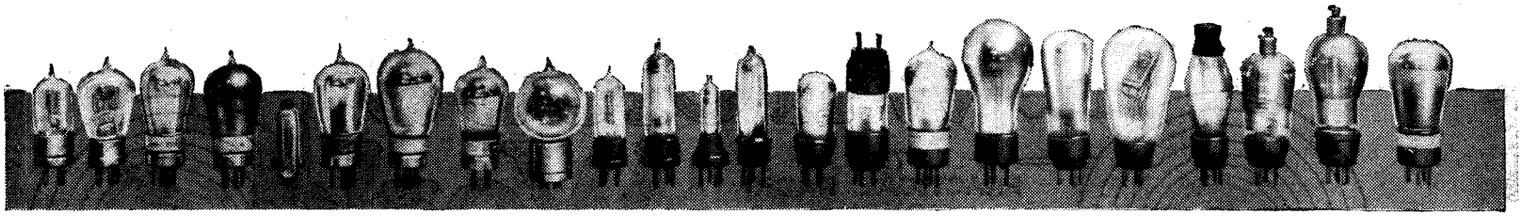
If there is any feeling of anxiety lest the broadcasting of propaganda to other nationals would be regarded as an aggressive action, the alternative might very well be considered of arranging that those stations which are putting out propaganda not in the interests of this country should be systematically jammed in the territory of the Empire on the offending wavelengths during their transmissions. This action could only be regarded as defensive and would surely be legitimate in the peculiar circumstances.

It is difficult to see how we can go on indefinitely allowing free action against our interests by foreign broadcasting stations without taking any counteracting steps.

Neither a proposal to broadcast propaganda to offset the effect of unfriendly foreign efforts, nor a policy of jamming these offensive broadcasts, are matters which it would be right or fair to ask the B.B.C. to decide upon, and indeed it may be questioned whether, in order not to disturb B.B.C. impartiality, it would not be proper for such efforts to be conducted by stations unconnected with the B.B.C. organisation. But these are matters on which we would not ourselves put forward recommendations, being fully conscious of the limitations imposed by incomplete knowledge of the situation as a whole.

A Contrast

We cannot omit to express regret that it should be found necessary to consider such suggestions as we have put forward tentatively above, in view of the potentialities of broadcasting, if only it were used instead as a means of bringing the nations together. An example which other nations might do well to follow is being set by the Scandinavian countries in a programme arranged for October 27th, when speeches will be broadcast successively by three kings and a president, to encourage a still closer friendship between the peoples of Denmark, Sweden, Norway and Finland.



The Development

From "R" Valve to Triode-Hexode

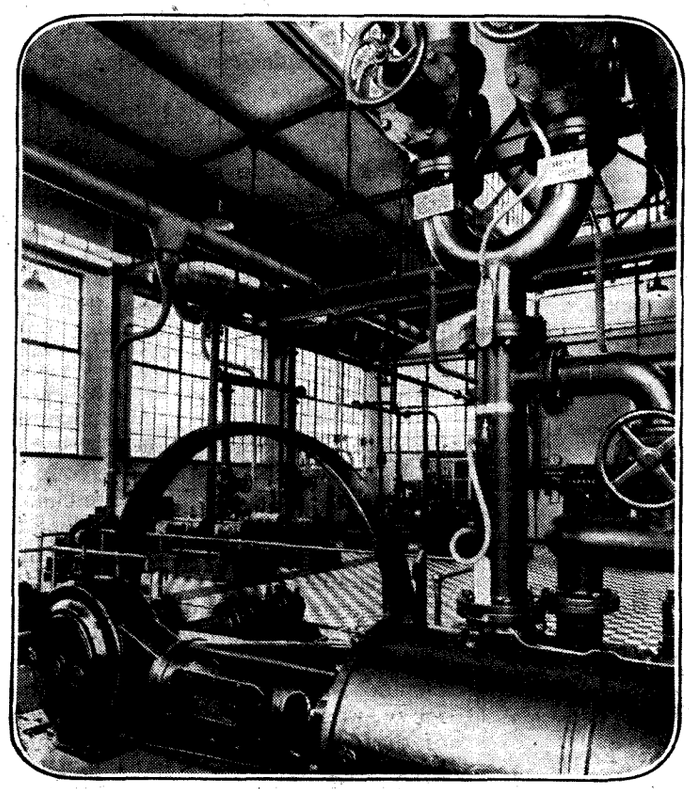
WHEN modern radio valves are compared with those used in the early days of broadcasting, either on the basis of their quantitative or their technical efficiency, the enormous progress which has been achieved in fourteen years is at once apparent. It is, of course, a commonplace to those who have been associated with the industry since its foundation, but there are very large numbers of listeners whose experience dates from quite recent days, and so it is well, from time to time, to trace back the landmarks on the road of progress in order to appreciate what has been done.

Progress has been made along three principal lines—sometimes in one direction, sometimes in others, and occasionally in all directions simultaneously. These three directions are in respect of (a) cathode efficiency and performance; (b) characteristics; and (c) consistency of performance. Each will be dealt with in turn.

With the exception of valves having an appreciable gas content, which had a limited vogue as sensitive detectors, the only valves available to the pioneer listener were the "hard" or highly evacuated triodes with tungsten filaments which were commonly known as the "R" type. Judged by present-day standards, the emissivity of these filaments was extremely low—of the order of 200-300 mA. per sq. cm. of cathode surface when operated at bright heat corresponding to a temperature of about 2,500 deg. K., and their efficiency was equally poor, being from 3 to 4 mA. per watt of filament consumption only. A low-tension consumption of some 3 watts was therefore needed for each valve, to supply which large and expensive 4-volt accumulators were necessary, and the cost of recharging was a serious item. Moreover, the filaments themselves were subject to some disadvantages, namely, erratic life, distortion due to the high operating temperature, and so forth, and the high cost, originally 35s. each, was a considerable obstacle to the rapid development of the industry.

Exhausting by "Getter"

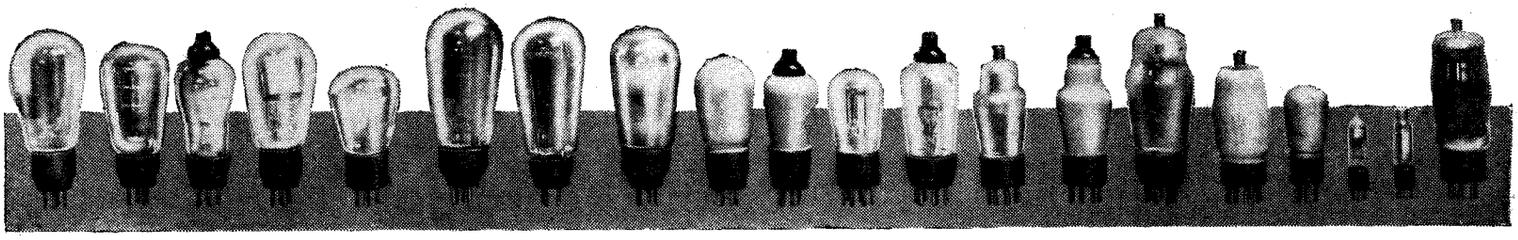
In an attempt to improve filament life and filament efficiency, tungsten wires containing a proportion of thorium oxide were tried, such wires having already been adopted for electric lamps. Considerable success attended the experiment, and the emission of the new filaments was also found to be greater initially, although it rapidly fell off after a short period of service. The historic researches of Langmuir and others indicated that the rapid deterioration of the emissive properties was mainly due to the presence of residual gases in the bulb, a problem which was solved by improvements in methods of exhausting, culminating in the eddy-current method of heating the electrodes and of vaporising the magnesium "Getter."



A view of a corner of the Mullard valve works.

The emissivity of the thoriated tungsten filament was some 700 mA. per sq. cm., an advance of from 100 to 250 per cent., and the efficiency as much as 33 mA. per watt, so that considerable economies in low-tension consumption resulted, and receivers could be operated with comparatively small and inexpensive accumulators. Although the filament temperature was reduced to between 1,800 and 1,900 deg. K., they still had the disadvantages of the bright filament from the point of view of mechanical strength, especially as the lower wattage consumptions necessitated the use of small-diameter wires.

The next step in cathode efficiency was the result of experiments primarily directed toward improving characteristics and reliability, to be dealt with later, but in achieving these objects a much-improved filament was also evolved. Previously, various workers, notably Wehnelt, had noted the high emissivity of the so-called alkaline earth metals which include barium and strontium, and valves having platinum or other filaments coated with these oxides had been used by Round and others. Attempts were made to revive this type of filament in improved form, but manufacturing difficulties, and the high cost of platinum, allied with its poor strength, presented formidable obstacles for a long time. Ultimately the vapour process of producing oxide-coated filaments swept most of these difficulties away. In this process an oxidised metal filament—usually tungsten—is, after partial evacuation, exposed to barium vapour, resulting in the formation of barium oxide on the surface of the cathode. The vapour may be derived directly from the metal or by the reduction of an unstable barium compound such as barium azide *by heating in vacuo*. Fila-



of the Radio Valve

By T. E. GOLDUP, A.M.I.E.E.
Head of Technical Service Dept., Mullard Wireless Service Company, Ltd.

VALVE development has made such great strides that it is only the old-timer who appreciates the vast difference between present types and the old "R" valves, which were probably the only specimens generally available when broadcasting began some fifteen years ago. In this article the history of the valve is traced through these years.

ments of this type operate at still lower temperatures, about 1,000 deg. K., have a very satisfactory emissivity of the order of 500-600 mA. per sq. cm., and are three times as efficient as thoriated filaments, the figure being 100 mA. per watt.

Indirectly Heated Valves

More recently a return has been made in some types of valves to the pasted filament. The emissivity of pasted filaments is substantially the same as for those made by the vapour process, and the efficiency of the pasted nickel type is from 20 to 25 per cent. higher. The working temperature is about 850 deg. K.

The revival of the Wehnelt cathode had another important result, namely, the development of the indirectly heated cathode for mains-operated valves. The types hitherto described employ filamentary cathodes, that is, the heated filament serves also as the valve cathode, and a potential gradient equal to the voltage of the low-tension battery exists along it. For use on AC low-tension supplies, an equipotential cathode was, however, essential except, perhaps, in the output stage, as otherwise the AC variations in the cathode potential modulated the anode current at supply frequency and resulted in intolerable hum.

The indirectly heated cathode consists, in essence, of a metallic tube, usually of nickel, with an oxide coating on its outside surface and an independent heating element inserted in the tube, adequate insulation between the heater and the cathode tube being provided by a hollow refractory cylinder interposed between the cathode and heater. Originally developed for AC mains operation only, when the heaters were connected in parallel on a 4-volt low-tension supply, little difficulty was experienced in providing adequate electrical insulation between heater and cathode. The need for similar valves for use in DC mains receivers, and later for the so-called "universal," i.e., AC/DC sets, in which it is necessary to operate the heaters in series on the mains voltage and thus permit considerable potential differences between heater and cathode in certain stages of the receiver, presented more formidable problems in the matter of insulation. Early solutions involved the use of insulators which materially increased the time taken by the cathode to attain emitting temperature, and recent developments have centred around reduction of heating time. Quick-heating cathodes are now fitted to AC mains valves, but valves in the universal range still take considerably longer to reach working temperature.

Valve-testing in the Mullard works.

Valve Characteristics

Side by side with the evolution of the modern high-efficiency cathode the electrical characteristics of radio valves underwent steady improvement. It must be remembered that the only valve generally available for broadcast reception when the service was inaugurated was the hand-made "general purpose" triode which had to serve as high-frequency amplifier, as detector, as low-frequency amplifier, and, usually, as output valve also. Its characteristics were poor, a mutual conductance of considerably less than unity being the normal value. An impedance of the order of 30,000 ohms struck a not particularly happy medium for the many purposes for which the valve was employed, but it must be added that in those early days the connection between valve characteristics and circuit efficiency was not fully recognised. As knowledge grew, triodes of differing impedances were developed and labelled "high frequency" and "low frequency" types, and later special detectors and output valves having characteristics more particularly suited to the various functions appeared in makers' lists. The pioneer work in this direction paved the way for the highly efficient triode output valves employed to-day for powerful domestic sets, public address equipment, and simi-

The Development of the Radio Valve—

lar apparatus. But a still more important problem which had to be solved at that period was the provision of better valves for use as radio frequency amplifiers.

The comparatively high capacitances existing between the electrodes of the early triodes permitted serious feed-back of signal energy from the anode to the grid circuit, and resulted in instability which rendered efficient high-frequency amplification impossible. The device of neutralising this feed-back by an equal but opposite feed-back which could be adjusted by a variable balancing condenser resulted in some improvement in this direction, but was not completely effective over the whole tuning range of the receiver, and also added to the complexity of operation.

In 1927, however, the screened tetrode, popularly know as the "screened grid" valve, was developed, and swept away the need of the neutralising circuit. In this valve a second grid, interposed between the control grid and anode, formed a fairly satisfactory electrostatic screen between the anode and grid circuits. Inter-electrode capacity was substantially reduced, and consistent and reasonably efficient high-frequency amplification was possible, the stage gain being greatly increased by the possibility of using coils of higher efficiency without risk of instability.

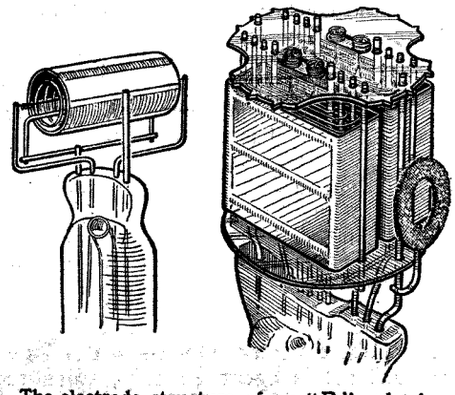
The Pentode

Meanwhile, the use of higher efficiency cathodes, improved constructions and more accurate manufacturing methods, had permitted increases in the mutual conductances of valve types, usual values for general purpose triodes at this period being of the order of 2.0 to 3.0 mA/V. With the introduction of screened tetrodes, therefore, the valve situation was reasonably satisfactory with the exception of valves for the output stage, where the comparatively low sensitivity of the triode necessitated the use of multi-stage low-frequency amplifiers in sets of even moderate power.

The high gain obtained with the screened tetrode could not be utilised in valves suitable for operating as power output valves because, in order to obtain the necessary large cutput, the anode voltage swings would be so great that over a portion of each cycle the anode would be at a potential less than that of the screen, resulting in secondary emission from the anode and consequent unstable circuit conditions. But the solution was eventually found in the introduction of a third grid, the "suppressor" grid between the screen and anode, connected back to the cathode, thus preventing the collection of secondary electrons by the screen or "auxiliary grid" as it was then termed. The pentode valve thus came into being, and, due to its high sensitivity, effected a considerable reduction in the amount of low-frequency voltage amplification required, in many cases permitting a pentode to be driven directly from the detector stage.

The next important development in time sequence was the application of the pentode principle to high-frequency amplifiers so that, by avoiding the negative resistance effect the new valves, known as screened pentodes, gave stable operation over a wider range of anode voltage swing and required less critical adjustment of operating conditions. Full advantage could now be taken of tuned circuits of the highest efficiency, and stage gains of a much higher order were attainable.

Prior to the introduction of the screened pentode screened-grid valves with modified control grids came into use. These so-called variable-mu valves were used with the already known variable grid bias method of adjusting the sensitivity of the receiver, either manually or automatically, to control the volume, and, in the case of the automatic volume control circuit, a substantially uniform volume level was maintained irrespective of carrier strength within certain limits. Automatic volume control also compensated, to a large degree, for the effects of certain forms of fading. The variable-mu type of grid was applied also to the screened pentode, and later to various forms of frequency changer.



The electrode structure of an "R" valve is shown on the left, and of a modern multi-electrode type on the right.

The necessity, under conditions of increasing ether congestion, of improving the selectivity of household receivers, brought about a revival of interest in the superheterodyne type of receiver about five years ago. It had previously fallen out of favour on account of its tendency to re-radiate and difficulties in obtaining simple and efficient control of the circuit using existing valves and components. Now, however, improved components and the wider choice of valve types made possible more satisfactory designs, the best, at the time, being the use of a screened-grid or screened pentode valve either as mixer valve in conjunction with a separate heterodyne oscillator, or as a complete frequency changer, the injection of the heterodyne frequency being effected in the cathode circuit. But the efficiency of this type of frequency-changing device was low, and it was again left to the valve designer to solve the problem. The solution was the development of a new range of multi-electrode valves, each of which comprised a triode section for use as heterodyne oscillator and a "mixer" section of either screened tetrode or screened pentode characteristics, the two systems being arranged concentrically around a common cathode. The advantage of this arrangement is that the coupling between the oscillator and mixing systems is electronic; that is to say, the electron stream from the cathode is first modulated at heterodyne frequency and then remodulated at signal frequency, the intermediate or "beat" frequency being produced in the electron stream through the mixer section.

Modern Frequency Changers

The arrangement of the various electrodes in the octode is such that the cathode is surrounded by the oscillator grid and anode. Outside these electrodes come a screen-grid, the control grid, another screen-grid, a suppressor grid, and finally the anode. Only a portion of the total electron stream is collected by the oscillator anode; the remainder, under the influence of the high potential screen, forming a "virtual cathode" from which electrons are drawn by the mixer system.

Advantages of these frequency changers include negligible re-radiation, high efficiency as indicated by the value of the conversion conductance, and the ability to operate at low anode current values with corresponding reduction of valve noise level. The variable-mu characteristics of these valves permits AVC to be applied to the frequency changer as well as to the radio frequency and intermediate frequency stages, thus increasing the effectiveness of the control.

At the same time, some circuit designers remained faithful to frequency changers of the type requiring circuit coupling between the oscillator and mixer sections, and more recently the growing desire to produce receivers for operation on short and ultra-short wavelengths has led to renewed interest in this type of valve, since valves of the electron-coupled type show a tendency to frequency drift at high and ultra-high frequencies, mainly due to space-charge effects which cannot satisfactorily be overcome by neutralising. Combined frequency changers comprising triode-oscillator and pentode-mixer in a common envelope, and requiring circuit coupling, had been available as an alternative to the electron-coupled frequency changers of the heptode and octode types, but a more recent valve is the triode-hexode, comprising a triode-oscillator and hexode-mixer located on a common cathode, the heterodyne frequency being applied to the mixer system in this case after the electron stream in the hexode has been modulated at signal frequency. The characteristics of these valves are such that frequency drift is reduced to a very low value.

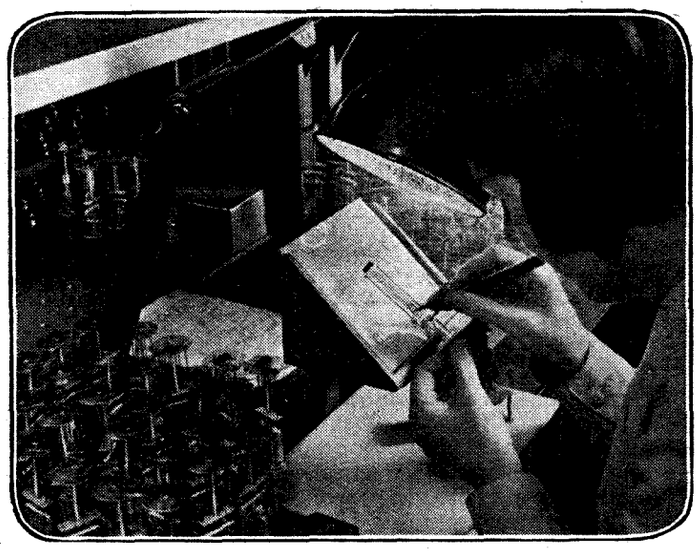
The general adoption of AVC and the growing desire for a higher standard of reproduction, together with the large gains obtainable in the pre-detector stages of modern sets, has, during the past two years, led to the general adoption of the diode as a detector, usually associated with a second diode in the same envelope

The Development of the Radio Valve—

for use as a rectifier for the AVC system. Previously, amplifying detectors of the triode or tetrode, or even screened pentode, types had been employed, but the necessity for amplification in this stage had disappeared, particularly since the use of reaction as a sensitivity and selectivity control was no longer essential. At first it was found desirable to employ a stage of audio-frequency voltage amplification between the diode detector and the output stages, and this was sometimes achieved by employing a multi-function valve comprising two diodes and a triode in one envelope, and other combinations of diodes and amplifying systems also had a short vogue. High sensitivity output pentodes were then developed, which made it possible to drive the output stage direct from the diode detector, and the multi-purpose valve is now declining in popularity, although it survives in places as a combined duo-diode and high sensitivity output pentode.

Reliability

If there is one point more than another upon which valve manufacturers can justly congratulate themselves, it is that the enormous improvements in cathode efficiency and in operating characteristics already noted have not been achieved at any sacrifice of reliability. In fact, although the chemical reactions in cathode production are of the utmost delicacy and the constructions employed for the more elaborate types of valves are of high complexity, the consistency of performance shown by modern valves is far greater than that of any previous types.



An operator examining the grid of a valve; one of the many routine checks on accuracy of construction.

It is true, that, from time to time during the development of new types, difficulties have arisen, but they have been speedily overcome; and at the same time other problems, in connection with the consistent performance of valves under changing conditions of reception, have been completely solved. One such series of difficulties has been the matter of secondary emission. An apt parallel may be drawn between the emission of electrons from the heated cathode and the vaporisation of a liquid such as water. There are, in both cases, forces to be overcome before, in the one instance, the water molecules will leave the bulk of the liquid and enter the super-posed atmosphere as vapour or, in the other instance, electrons will leave the surface of the cathode. Again, the disposal of the water vapour under constant conditions of heating depends upon external forces, and in the same way the voltages applied to the various electrodes of a valve determine the number of electrons which they will collect and the momentum with which those electrons will strike the surface of the collecting electrodes. Swiftly moving electrons will eject a certain number of secondary electrons, which give the effect of what may be termed a "reverse conductance" in the valve. In valves having pentode characteristics, the deleterious effects of secondary emission are avoided, so far as emission from the anode is concerned, by the suppressor grid, but with valves of high efficiency there may be a tendency to secondary emission from other electrodes. In eliminating this tendency many points have had to be taken into consideration, including materials used, form and construction, methods of manufacture, working conditions both electrical and thermal, and heat dissipation.

In order to trace how increased reliability and consistency of performance has been achieved it is necessary first to consider once again the valves available at the commencement of broadcasting. Valves of the "R" type were almost entirely hand made, and slight, or even considerable differences in dimensions and electrode spacing were unavoidable, resulting in corresponding variations in characteristics as between valve and valve of the same type. The gradual introduction, to an ever-increasing extent, of jigs and accurately adjusted automatic machinery, and extending knowledge and better control of the physical and chemical processes involved has in a large degree been responsible for improved uniformity of characteristics and performance.

Then improved processes themselves have contributed to this same end. For example, the modern pasted filament, by avoiding the deposition of excess barium on the bulb, has decreased unwanted capacity effects and, in the case of output valves, assisted in heat dissipation.

New cathodes and improved methods of manufacture permitted closer electrode spacing, with corresponding increases in mutual conductance. But the introduction of powerful moving-coil speakers, often mounted in close proximity to highly sensitive valves, provided conditions of mechanical vibration under which even small movements of the electrodes produce rhythmic variations of characteristics resulting in over-amplification of certain audio frequencies, a cumulative process which produced the noise known as microphony. More rigid constructions for the electrode systems were devised to solve the problem. Electrodes were made of stiffer section, and firmly anchored together mechanically, efforts in this direction culminating in the modern construction embodying "steady" mica discs which, butting firmly against the inner flange of the domed bulb, lock the whole electrode structure securely and prevent even infinitesimal inter-electrode movement.

Above all, there has been the constant trend towards greater and greater accuracy in manufacture and assembly. Valve components, sub-assemblies and assemblies, manufactured to the closest limits and designed with a view to increased electrical insulation and minimum capacity, accurate control of each and every manufacturing process and, finally, the most rigid final testing, have combined to render the modern radio valve an instrument of precision, and to ensure a standard of reliability and consistent characteristics of the very highest order.

The Radio Industry

A LEAFLET from Marconi's Wireless Telegraph Co. describes an improved direction finder, Type DFg.10, which allows a Marconi-Adcock aerial system to be installed at a position remote from the receiver, or, alternatively, permits the operation of two receivers simultaneously at the centre of a common aerial system. These methods have obvious advantages for airport working.

The Autumn Edition of the International Radio Amateur Call Book has now appeared; it costs 6s., post free anywhere, from F. L. Postlethwaite, 41, Kinfauns Road, Ilford, Essex.

The American "limber" screwdriver recently illustrated is produced by the Commonwealth Products Company, 401, Broadway, New York City.

A New Book

PROCEEDINGS of the International Telephone Consultative Committee (plenary meeting in Budapest); English edition. An important publication for telephone engineers, and of interest to radio engineers in so far as it deals exhaustively with the co-ordination of radio-telephonic and wire systems. The formulation of international standards for line characteristics and their measurement also have an important influence on the technical arrangements for international exchanges of programmes by wire. Pp. 660, with many illustrations and diagrams. The International Standard Electric Corporation, Connaught House, 63, Aldwych, London, W.C.2, 25s. net.

Grid Loss at Ultra-High

WHY VALVES FAIL TO AMPLIFY EFFECTIVELY BELOW SEVEN METRES

THIS article explains the more obscure causes of difficulties encountered in receiving ultra-short wavelengths, and shows why valves of the "acorn" type become increasingly desirable as frequency rises.

IT is well known to ultra-short-wave experimenters that as the wavelength is reduced far into the single-figure region it becomes almost impossible to obtain any effective amplification by straightforward methods. It is also quite difficult to persuade even an oscillator to function, as designers of ultra-short-wave superheterodyne receivers know to their cost.

Some, at least, of the reasons for this condition of affairs are familiar. For example, there is great difficulty in preventing serious back-coupling through even the best screened valve. Then dielectric losses increase as the frequency increases, or wavelength diminishes. At the lower radio frequencies there is no narrow limit to the tuning capacity that may be used, and it is possible to add a considerable amount to the circuit in such a form as to ensure reasonably small losses. The odd stray capacities, over which one has less control, and which generally are rather "impure," are thereby made to comprise only a small proportion of the total capacity, and their ability to introduce losses is therefore restricted. At the very high frequencies, however, the total capacity is necessarily so small that the greater part is likely to consist of these relatively inefficient "strays."

Another consideration is that, owing to the limited amount of inductance that can be employed in a tuned circuit, the ratio of inductance to capacity (L/C) is low, and as r, the radio-frequency resistance, cannot be made very small, it follows that L/rC cannot be made large. This quantity is well known as the "dynamic resistance," and is relied upon for building up a large amplified voltage. When multiplied by the mutual conductance g of a high-resistance valve, in the anode circuit of which the dynamic resistance R is connected, the stage gain is approximately gR. For example, 100,000 ohms is quite an easily attainable R at ordinary broadcast or intermediate frequencies, and with the moderate g of 1 milliamp per volt, or 0.001 amp per volt, the stage gain is 0.001 × 100,000, or 100. But if R, together with any parallel paths formed by valves, etc., cannot be made to exceed 1,000 ohms it is obvious that it is impossible to obtain any amplification at all with this particular valve.

The drop from 100,000 to 1,000, which is by no means fanciful, seems to require a good deal of explanation, and the combined effect of the conditions just described fails to account for more than a part of it. The most important factor of all is a rather more obscure one, and the remainder of this article is devoted to it.

One reason why the valve is of such immense value at frequencies lower than those now being discussed is that it acts practically instantaneously. Even although a signal applied to the grid may alternate several million times per second, the anode current responds with no perceptible lag. Suppose, for the sake of argument, that it does lag by one-hundredth

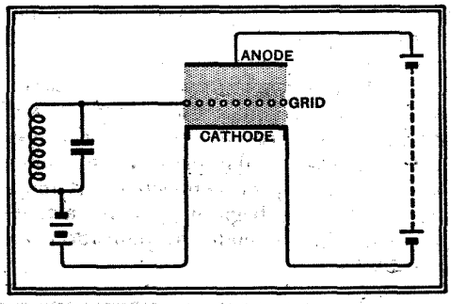


Fig. 1.—Diagram of a triode valve with a uniform distribution of electrons in the space between cathode and anode. When the equilibrium is upset by a very rapid change in grid voltage, not only is the total number of electrons changed but, owing to the time required for them to traverse the space, uniformity is momentarily disturbed.

of an alternation at a frequency of one megacycle per second (300 metres). It is clear that the electrons must cross the space inside the valve at a very hot pace indeed to do the journey in 0.00000001 of a second! And that is quite a poor performance for a valve. Actually, one is accustomed to considerably smarter work. But even this standard of agility fails to keep perfect step with ultra-high-frequency oscillations. In ordinary receiving valves some lag is noticeable above about 15 megacycles per second.

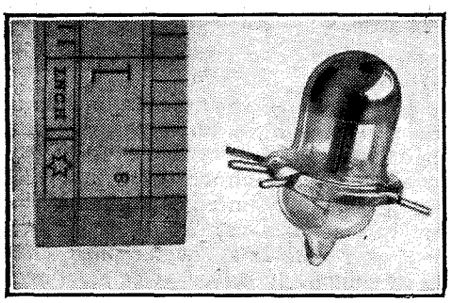
In what manner is it noticeable? If it were merely a matter of the amplified signal occurring a few thousand-millionths of a second later than the original, it would be of some slight theoretical interest. But although it may not be obvious at first glance it actually has a very serious practical influence.

To understand why this is so it is necessary to consider closely what takes place during a single oscillation of a signal in a valve. Fig. 1 shows diagrammatically a simple triode valve. The grid is supplied with a negative bias greater than the peak voltage of the signal, with the object of preventing grid current at any moment during the cycle of oscillation. It is not so negative as to cut off all current to the anode, and this current is indicated by a uniform cloud of dots representing electrons moving from cathode to anode.

Grid Currents

Now, it is well known that when electrons actually land on the grid in greater numbers than those leaving it, this surplus finding its way back to the cathode through the external circuit is what we call a grid current. But it is perhaps not so well known that, owing to the repulsion of electrical particles of like sign, such a current is set up when the number of electrons *approaching* the grid exceeds those receding from it, or vice versa.

When a valve is working under the conditions described, with adequate bias, there is, of course, no grid current due to electrons being attracted on to the grid. And at ordinary frequencies the rate at which the grid changes the flow of electrons from cathode to anode is so slow compared with the rate at which the electrons perform this journey that they are never taken by surprise, as it were, so as to lead to a non-uniform distribution in the cathode-anode space.

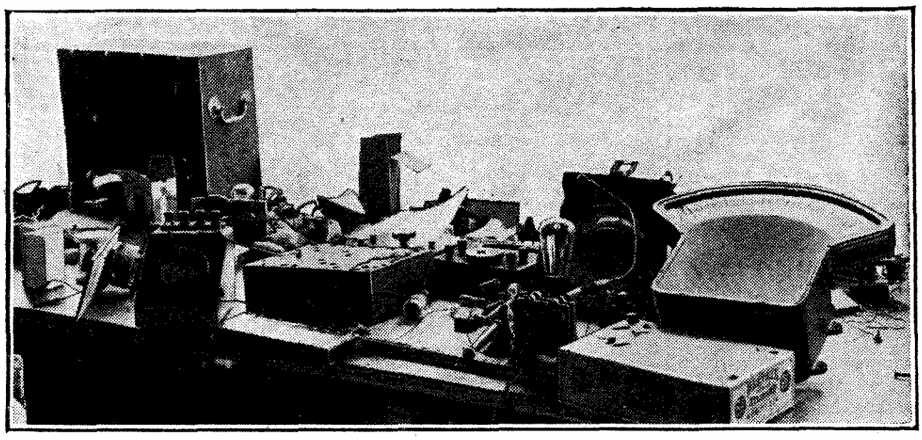


An "acorn" valve; specially designed for ultra-high-frequency work.

But when the frequency is very high, this state of affairs does not hold good. To take an extreme example, suppose that the grid potential, which has been such as to permit a steady current to flow across

Frequencies

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



General view of apparatus used for the measurement of grid loss. From right to left are: large-scale voltmeter for oscillator bias ; milliammeter for oscillator anode current ; oscillator valve ; test circuit ; milliammeter for test valve anode current ; test valve battery ; battery voltmeter ; absorption wavemeter.

to the anode, is suddenly made so much negative as to cut off all current. A billionth of a second later there are no new electrons coming from the cathode, because the large negative voltage of the grid exerts an overwhelmingly restraining influence. But the space in the valve still contains large quantities of electrons that were on their way to the anode, but have not yet had time to get there. Those on the anode side of the grid are still moving anodewards under the attracting influence of the positive voltage there, and are given, as it were, an additional kick in the pants by the sudden disagreeable negative grid voltage. Those on the cathode side of the grid take this same blow in the face, and are driven back on their tracks towards the cathode. In either case electrons are receding from the grid, and none are approaching, so a current flows into the grid by way of the external circuit. The direction of this current is the same as that which the large negative bias would produce if a conducting path were provided between grid and cathode, although no such conductor in the ordinary sense actually exists.

That this is so is evident by reviewing the situation a millionth of a second later. By this time all electrons have been driven from the inter-electrode space; none are moving either towards or away from the grid, and consequently no grid current of any sort is passing. The current that did flow could last only for the minute space of time during which electrons had been surprised into disorderly and irregular ranks.

The process is reversed when a less negative (i.e., relatively positive) potential is suddenly applied to the grid, so that again the current is in the direction that it would take if a conducting path existed.

If, instead of these isolated instantaneous changes of grid potential, there is substituted an ultra-high-frequency signal, we now have a *continuous* very rapid change of potential, and the cathode-grid path must be imagined to be there all the time. In practice the resistance of such a path may be quite low—only a few thousands of ohms—so that it constitutes intolerably heavy damping on any tuned circuit that may be connected. It may, as hinted at the beginning of this article, be so low as to render amplification impossible.

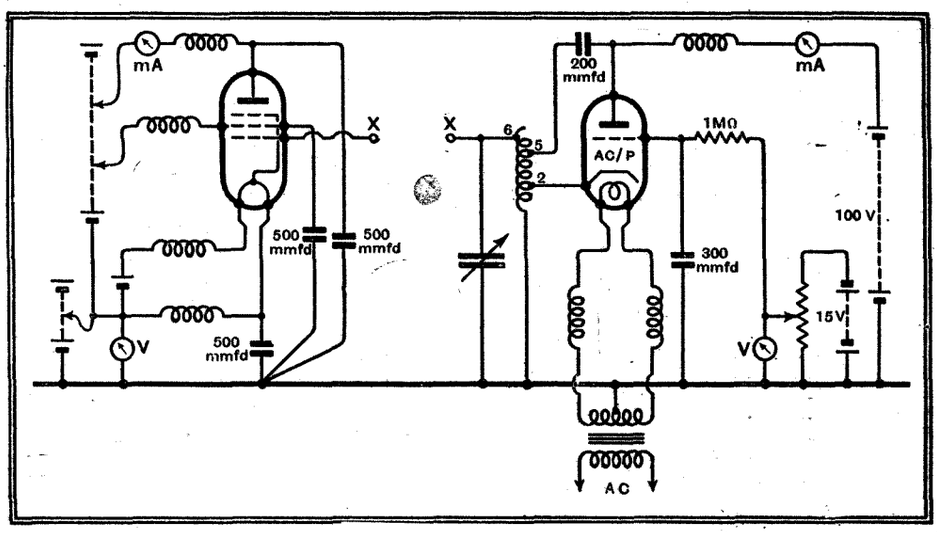


Fig. 2.—Circuit employed for measuring the grid input resistance of valves at ultra-high frequencies. The left-hand portion represents a valve under test, and the points XX are then made to coincide.

It is therefore important to know what things control the amount of such damping. The subject is very fully dealt with, in theory and practice, by W. R. Ferris in a paper in the "Proceedings of the Institute of Radio Engineers" for January, 1936. Some of the controlling factors will be clear from the foregoing account of the phenomenon. The length of the *transit time* of the electrons is one of them. The transit time, and consequently the grid loss, can be reduced by increasing the anode voltage, so as to accelerate the electrons more rapidly, and by reducing the distance between the electrodes.

These methods are limited by manufacturing difficulties, or by the point at which the gap is broken down by the anode voltage, whichever comes sooner. They have the incidental advantage of increasing the mutual conductance of the valve, and so assisting amplification; but unfortunately this gain is offset by the fact that the *mutual conductance* happens to be another of the factors controlling grid loss. It is quite easy to see that if the mutual conductance of the valve is large, so that a great body of electrons are controlled by a given change in grid voltage, the undesirable grid current is also relatively large, and the equivalent resistance of the valve input is low. Without further information regarding any particular case it is impossible to say whether the net result of enhanced mutual conductance is going to be good or bad.

Losses Increase with Frequency

Still more obvious is the effect of *frequency*. The higher the frequency the greater the loss; and the paper by Ferris shows that this factor shares with the transit time the distinction of increasing the loss in proportion to its square. Hence the rapidly increasing difficulty in getting valves to work when the frequency is pushed up into the multi-megacycles.

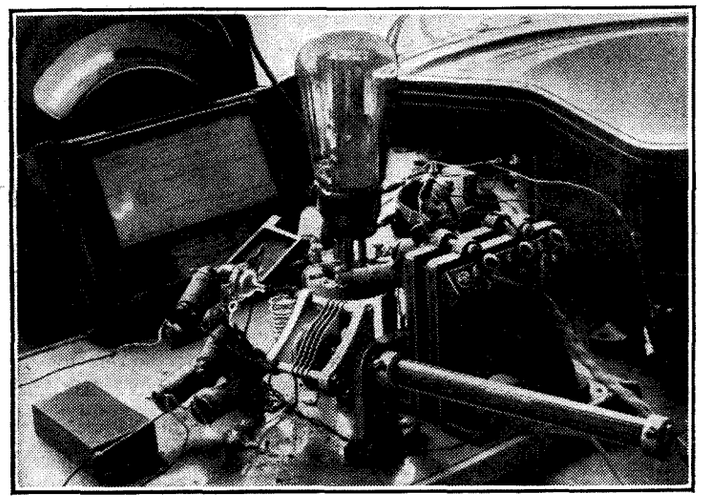
In addition to these three easily definable factors, the loss is affected to some extent by the dimensions of the valve in ways that cannot be stated in simple form. It is therefore interesting to examine some results of measurements made on typical valves under normal conditions of operation.

Grid Loss at Ultra-High Frequencies—

The method of measurement at such high frequencies demands careful consideration, when actual circuit quantities differ very widely from those optimistically marked on the diagram. It is a sound principle to make measurements under conditions that resemble as closely as possible those of actual operation. Although one may not then succeed in isolating with theoretical correctness the quantity in question, any divergences therefrom are those that apply in practice.

One method is described in Ferris's paper. The present writer has devised an alternative scheme, illustrated in Fig. 2. The right-hand portion represents an oscillating valve with a fixed anode voltage and variable bias. The exact grid voltage at which oscillation can start is measured on a voltmeter with a very extensive scale, and to allow of a wide range of variation a low-impedance type of valve was chosen. It stands in an elevated low-loss holder, and much care was exercised in the placing of the components to reduce connections to a minimum. All tests were made at a frequency of 54 Mc/s, and as at such frequencies an earth connection of the ordinary type is useless, an artificial earth was made by laying out the circuit above a large copper sheet. Chokes carrying heater or filament currents are, of course, of appropriately low resistance. The coil consists of seven turns of No. 16 tinned copper wire ½in. diameter. As it stands, oscillation starts when the bias is reduced to 11.9 volts. By connecting various small non-inductive resistors across the oscillatory circuit from the point X to "earth," other corresponding starting biases are noted, and a curve drawn connecting resistance with grid voltage. By noting the starting bias when an unknown resistance is connected, and referring to the curve, the high-frequency value of the resistance can be determined.

The weak point of this scheme is that one assumes the resistors to maintain their DC values of resistance at such a high frequency. It is known that they do not, and, in evidence of this, resistors of different construction yielded slightly conflicting results. However, the results with the resistors giving the *least* damping effect were accepted as being the most reliable—this agreed with consideration of the resistors themselves—and in any case the probable error is serious only at the high values, which are not of greatest interest for this purpose.



Close-up of test circuit. Immedately behind the tuning condenser in the foreground is the oscillator coil, with the oscillator valve to the right and an "acorn" valve under test to the left. Note the collection of HF chokes for isolating the test valve from the batteries.

The starting point is detected by a sudden change of anode current, which may be large or small, or a rise or fall. Very smooth control of bias is therefore desirable.

The Testing Circuit

A typical arrangement of a valve under test is shown to the left of Fig. 2. The separation between XX is merely for the sake of clearness, as in actual fact it is reduced to an absolute minimum by joining the valve grid pin direct to the variable condenser. No valve holder is used, the connections being made with short wires; and the by-pass condensers lead direct to a single spot close to the earth end of the tuning condenser. The grid-to-earth path of the valve occupies much the same physical position as did the trial resistors.

For each valve selected for the test the damping is measured first with the valve connected, but cold; secondly with the cathode heated and grid bias applied (to prevent ordinary grid current), but no HT; and thirdly under various full working conditions. The first two results, marked (i) and (ii) in the accompanying table, are generally not greatly different, and they serve to distinguish the sort of loss being studied from those due to other causes. For the reason already mentioned, the figures given in columns (i) and (ii) are of questionable accuracy.

But in each case when *anode* current is allowed to flow to a normal extent the *grid* resistance drops to a very low figure. Owing to the method of test, this drop is due solely to the electron lag, and the serious nature of it is thus made apparent. In all these tests the valve is operated with no anode load, as otherwise the effect being studied would be mixed with the "Miller effect"; and, moreover, the adjustment of anode tuning would be extremely critical.

Although triodes are not generally useful as amplifiers at even low radio frequencies, they are used as oscillators; and the figures given show why oscillation becomes increasingly less free as the frequency is raised. It must be remembered that a resistance of 5,000 ohms at the frequency of test becomes only 1,250 ohms at 108 Mc/s (just below 3 metres), so that whatever efforts may be made to reduce losses elsewhere are of negligible avail. Another bad effect of the electron lag is that the reaction, on which the maintenance of oscillation depends, comes in the wrong phase to be useful.

The Hivac "X" valves are "midgets," with exceptionally low inter-electrode capacities. This is helpful in reducing the initial loss and in enabling a higher value of inductance to be used, but it does not appear that they confer a very substantial benefit in the shape of reduced lag loss, in relation to mutual conductance. The slightly increased inductance is incidentally helpful in this respect, however, as the grid loss may be reduced by tapping down on the coil.

HF INPUT RESISTANCE OF VARIOUS TYPES OF VALVE

Valve	High-frequency input resistance: ohms. (i)	(ii)	(iii)	Conditions for (iii). Anode Volts.	Grid Volts.	Anode Milli-amps.	Screen Volts.
Triodes.							
Mullard 354V ...	50,000	32,000	5,000	280	− 7½	1.8	—
Mazda AC/HL ...	32,000	20,000	6,500	260	− 7½	4.0	—
Hivac XD	28,000	35,000	7,600	100	− 1½	0.6	—
Hivac XD	28,000	35,000	15,000	100	− 3	0.1	—
Hivac XP	35,000	50,000	9,700	100	− 7½	3.4	—
Hivac P215	33,000	35,000	9,000	100	− 6	3.7	—
Mullard "Acorn" ...	Over 250,000	200,000(?)	55,000	100	− 3	1.7	—
Osram "Acorn" HA1	Over 250,000	150,000(?)	50,000	100	− 3	4.0	—
Tetrode.							
Hivac XSG	50,000	50,000	15,000	120	− 1½	0.5	60
Hivac XSG	50,000	50,000	25,000	120	− 3	0.2	60
Pentodes.							
Mazda AC/VP1 ...	25,000	20,000	4,000	180	− 3	6.0	180
Mazda AC/VP1 ...	25,000	20,000	18,000	180	−10½	1.0	180
RCA "Acorn" 954 ...	Over 250,000	Over 250,000	45,000	250	− 1½	2.9	110
Triode-hexode.							
Osram X41	28,000	32,000	4,000	250	− 3	2.2	80
Osram X41	28,000	32,000	20,000	250	−10½	0.3	80

Grid Loss at Ultra-High Frequencies—

The second line relating to the "XD" valve shows how, when the mutual conductance of the valve is lowered, the grid conductance falls too (resistance rises). The XP valve, although of better mutual conductance, inflicts less loss than the XD. The P215 is a full-size valve of comparable characteristics.

The "acorn" valves are specially designed, by providing very small electrode clearances, to minimise input loss. The success of this construction is strikingly demonstrated by the figures, although the actual values should not be given too much credence as, for reasons explained, they are only very approximate above 25,000 ohms. But it can at least be said that the input resistance of an "acorn" under working conditions is higher than that of many valves when "dead"!

Valves of this type are the only ones capable of direct amplification down to 1 metre and even lower. The mutual conductances are quite high, too, and compare favourably with those of valves of conventional design.

The figures for the AC/VP1 and X41, typical variable-mu pentode and frequency changer respectively, show how heavily the input circuit is damped under the conditions when greatest amplification and selectivity are desired—when signal strength is below the AVC bias starting level.

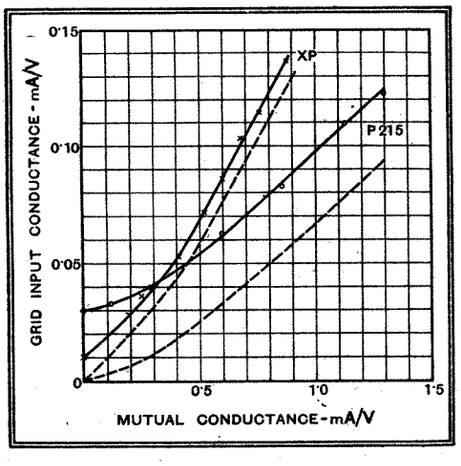


Fig. 3.—Curves showing how the grid input conductance of valves increases almost in proportion to the mutual conductance, but may differ considerably in valves of similar characteristics. The full-line curves show the total conductance, and the dotted curves that due to electron lag only.

The desirability of connecting the valve across only a part of the tuned circuit is plain. And again the overwhelming advantage of the "acorn" type of construction stands out.

The effect of altering the grid bias, and hence the mutual conductance, is illustrated for several of the types of valves selected. This relationship has been examined in greater detail for a pair of valves having fairly similar characteristics but different construction—the XP and P215. Fig. 3 shows curves connecting grid loss with mutual conductance. To make the relationship clearer, the loss also has been expressed as a conductance—the reciprocal of the grid input resistance. For one thing, the electron lag effect can be separated from the other valve losses with the greatest of ease by simply subtracting the conductance under the condition of zero anode current; i.e., by dropping the curves bodily until they pass through the origin.

It is now possible to see that the miniature valve is not necessarily advantageous for ultra-high-frequency work, and may actually cause more than double the electron-lag loss for a given mutual conductance. These curves also support the theory that for a given valve the grid input conductance is proportional to the mutual conductance—at any rate above the bottom bend of the valves' characteristic curves.

Diode valves have not yet been mentioned; for ordinary receiver purposes the electron lag is not very important, but for valve voltmeter purposes it certainly is. For a very full investigation of this, refer to E. C. S. Megaw's article in "The Wireless Engineer," February, March and April, 1936. It is sufficient to point out that the *triode* valve voltmeter is not to be recommended at ultra-high frequencies, because of its low input resistance.

DISTANT RECEPTION NOTES

THERE has been no official announcement that I have seen about the new Rome transmitter's being in action. I think though that it must be already testing at times with at any rate a good deal of its power, for on some evenings Rome on 420.8 metres is a terrific signal. The new plant is rated at 120 kilowatts.

Rome No. 2, also rated at 120 kilowatts, should be at work this winter. Where it is going to find a channel goodness knows. By the Lucerne Plan a Rome No. 2 of 1 kilowatt shares the 238.5 metre wavelength with San Sebastian and Riga. A station known as Rome No. 3 is now working on 238.5 metres with 1 kilowatt. The new station cannot possibly use an international common wave, where the maximum power allowed is modest. In fact a station rated at 120 kilowatts *must* under the plan work on a wavelength above 271.7 metres and on an individual channel—unless it is synchronised with a station in its own country.

Brussels No. 1 and No. 2 should open their new 100 kilowatt plants before long. This should mean admirable reception here, for the present 15 kilowatt stations are pretty well heard, though not quite so well as they were some time ago, further instances of that curious "fatigue" which seems to affect not a few stations when they have been in use for some time.

Political troubles in France have probably delayed the construction of the Radio National station which is due shortly to replace Radio-Paris as the French long-wave broadcasting station. Situated in the middle of the country, and rated at 200 kilowatts, it should provide a far better national service than an 80-kilowatt station near Paris.

Radio-Paris has had a long and distinguished career. Old hands will remember its early days as Radiola with a 7 kilowatt plant, whose aerial used to be a landmark if you travelled to Paris *via* Dieppe. From 7 kilowatts it rose to 15; from 15 to 75, and from 75 to 80. It has always been a most reliable station.

Prague No. 2 on 249.2 metres has not been working for some little time. Presumably the station has been wholly or partially dismantled to make way for the new 60 kilowatt equipment that will replace it in the course of the next few months. The 60 kilowatt transmitter, when it is ready, may not be too easy to receive, for its immediate neighbours are Frankfort (and its five other German partners) on one side and the 60 kilowatt Lille P.T.T. on the other. Some pretty accurate wavelength-keeping will be needed between 245 and 259.1 metres with Radio Marconi, Lille, Prague, Frankfort, Nice, Copenhagen, Monte Ceneri and Kosice (soon also to rise to the dignity of 60 kilowatts) all in a row!

Indications at present point to an excellent autumn and winter for European reception. The number of stations well received after dark is greater now than it has ever been at this time of year. About America I don't feel so sanguine. Sunspots being what they are, atmospherics may be troublesome when we try to span very long distances on the medium waves.

D.-EXER.

CLUB NEWS

The Wirral Amateur Transmitting and Short-wave Club

An interesting talk on transmitter design was given by Mr. J. Davies (G20A) at the recent monthly meeting held at the King's Square Café, Birkenhead. The next meeting will be held on October 28th at 7.30 p.m. The address of the Hon. Secretary is "Caldy," Irby Road, Heswall, Cheshire.

The Kentish Town and District Radio Society

An excellent field day was recently held in the vicinity of Hadley Highstone in conjunction with members of the Radio Society of Great Britain.

A 56 Mc/s transmitter, consisting of a push-pull oscillator with 8 watts input, was employed in conjunction with a half-wave vertical

The 56 Mc/s. transmitter at the Kentish Town field day.

aerial, 30ft. high, the feeders being 29ft. 6in. in length. The receivers employed were of the super-regenerative type, and good contacts were maintained throughout the day. The society holds weekly meetings, full information concerning which may be obtained from the Hon. Secretary at 27, Herbert Street, London, N.W.5.

UNBIASED

By FREE GRID

Repellent wooden structures.

The B.B.C. Mangles History

EMPIRES may rise and fall and kingdoms wax and wane, but the B.B.C. goes on for ever, or at least its history-mangling department does. I have been compelled on a previous occasion to complain of the B.B.C. programme department's lamentable lack of accuracy when attempting to introduce historical facts into their programmes, but I do think that their effort in the recent broadcast of "Cavalcade" surpassed anything that they have previously attempted.

It is no use their trying to palm the blame off on to the author as they have done on previous occasions. If the author really did make the error—which I very much doubt—then it was the B.B.C.'s duty to draw his attention to the fact in their usual polite and charming manner. If they deny their liability to perform this duty, then they are setting up a very dangerous precedent as it would be possible for anybody giving a talk to introduce all sorts of wild inaccuracies for political propaganda and other base purposes, and to claim immunity from interference on the grounds that what is good for the goose is good for the gander.

I suppose that the great majority of you must have noticed the particular inaccuracy which I have in mind at the moment. The principal characters in the play were all gathered together on what the announcer told us was the night of December 31st, 1899, to welcome in *the year* 1900 *and the beginning of the twentieth century*. In case there are any of my readers who have themselves fallen into this hoary old trap of thinking that January 1st, 1900, instead of January 1st, 1901, saw the beginning of the new century, they may take comfort from the fact that they are in excellent company since I well remember at that time quite a heated controversy raging in the correspondence columns of some of our leading newspapers, several eminent men of the period showing a truly appalling ignorance of the elementary rules of arithmetic.

Lack of historical accuracy.

If there is any one of you who still cannot see the point I would ask you to imagine that when *The Wireless World* first saw the light of day at the beginning of April, 1911, you had determined to join the large band of "readers from the first number," and had forwarded a sum to cover a hundred years' subscription to this journal. Would you not be indignant if you received a notice in April, 2010 instead of in April, 2011 to tell you that your subscription had expired? To make matters still simpler, supposing that *The Wireless World* had started at the beginning of the Christian era and that on January 1st, in the year A.D. 1, you had forwarded a subscription covering nineteen hundred years. Would you have been satisfied to have been told on January 1st, 1900 that your nineteen hundred years of subscription had expired? Obviously not, and equally obviously the twentieth century cannot commence until the nineteenth one has expired.

The Bigger the Better?

IT is astonishing how the old superstition persists that first-class musical quality cannot possibly be obtained from a receiver of reasonable dimensions and cost. I am moved to make this remark as a result of a recent visit I paid to the house of a friend to see and hear the new quality set on which he has just paid his first instalment.

Hardened as I am to sets of all sorts and sizes, I must confess that I was staggered at the gargantuan monstrosity which confronted me when I put in an appearance at his riverside residence. The thing was so huge and unwieldy that it might almost be said that he has a set with sleeping quarters attached rather than a house containing a receiving set. This state of affairs is partly accounted for by the fact that he lives, or, rather, exists, in one of the repellent wooden structures known as bungalows which mar the sylvan beauty of the upper reaches of Old Father Thames. These wretched hovels, owing to the restricted space inside them, would, I admit, make even a midget set seem unduly large and unwieldy, but, even allowing for this, the set was outsize.

The quality was, however, undoubtedly good, and I grudgingly admitted as much to him, but nevertheless pointed out in no uncertain terms that equally good results could be obtained with a set of much less unwieldy dimensions. My friend, however, gave a strongly worded and pigheaded denial and nothing I could say would shift him from his silly opinion. His attitude reminded me very much of a certain class of old-fashioned amateur photographer which refuses to acknowledge the virtues of the modern miniature camera, but still dwells in the photographic fog of mid-Victorian days when even a half-plate camera was considered as rather beneath contempt owing to its compactness and lightness.

I think that to a large extent the dreadful noises churned out by certain of the foreign midgets which are available is responsible for this state of affairs and I should not like you to think that I hold any brief for them. Nor am I trying to argue that these outsizes in sets do not give first-class quality. My point is that it is possible to make them much smaller without the slightest sacrifice in reproductive fidelity and *very* much smaller without a serious loss of this desirable attribute. In other words, there is no virtue in size *per se*.

At the same time, I would not like you to think that I, of all people, am on the side of the wretched super-compact type of set which seems to be gaining a certain amount of favour in some quarters. Rabbit-hutchy as many of the dwellings are which certain unscrupulous local councils pass as fit for human habitation nowadays, there is still room in even the worst of them for a normal-sized wireless set.

It is not as though super-compactness brought with it any material advantage to outweigh all its manifest disadvantages. Apart from the travesty of music which some of the modern super-compact sets produce, if a faulty component develops it is well-nigh ungetatable without the aid of a tin-opener; in fact, I would rather have the Brobdingnagian type of set for it does at least do its stuff and is easy to repair.

Television in America

THE PHILCO AND FARNSWORTH SYSTEMS DESCRIBED

By Our New York Correspondent

AS yet there is no television service in America, but there are various experimental transmissions. In this article our New York Correspondent describes the Philco and Farnsworth systems and comments on the television position.

DURING the last eight years, Philco has progressed from the 60-line scanning disc invented by Nipkow, to the 345-line electronic system of 1936. All of this work has continued with little or no publicity until August of this year, when the 345-line system was demonstrated to the Press *via* 7 miles of 51 Mc/s radio. This demonstration was of great interest to all—the definition, steadiness, and freedom from flicker; the size of the image, which was nearly twice that of their rivals; the 7in. by 8in. mirror in the cabinet top; number of controls also had been greatly reduced; and, of greatest interest to the writer, the pictures were of a clean black and white, which was certainly possessed of far greater entertainment value than the greens and blues of the other television pioneers.

In addition to the development of circuits Philco pioneered in research on larger and brighter cathode-ray tubes giving black and white images; more sensitive camera tubes with better detail, and also cathode-ray projection tubes to provide larger pictures. The latter have not made their public bow as yet, but will no doubt play a part in the future development of the art. Much time was spent in the minimisation of distortion in all parts of the system.

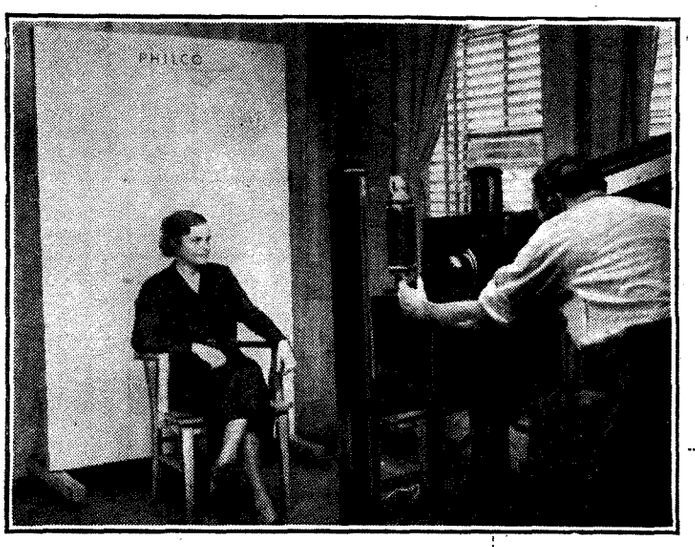
Philco also found it necessary to develop new and unique methods of modulating their 1.5 kW ultra-high-frequency transmitter, where the sidebands cover a territory of approximately 5 Mc/s, as compared with the 20 kc/s sidebands of sound transmission.

Field tests were begun in December of 1935, and regular nightly broadcasts on 51 Mc/s (sound on 54.25 Mc/s) commenced on June 18th, 1936.

The electrical specification for the Philco system is as follows:—

Channel width	6 Mc/s.
Spacing between television and sound carriers	3.25 Mc/s approx.
Polarity	Negative.
Number of lines ..	345 interlaced (to be 445 in near future).
Number of pictures per second	60
Aspect ratio	4 : 3
Percentage of television signal devoted to synchronising	20 per cent.
Synchronising signal ..	Narrow vertical.
Carrier frequency of picture transmitter ..	51 Mc/s.
Carrier freq. sound trans.	54.25 Mc/s.

These specifications agree with the standards recommended by the Radio Manufacturers' Association at a recent hearing before the Federal Communications Commission, with the exception of the number of lines, which will be changed as soon as possible to the new standard of 445.



At work in the Philco Studio. The camera and operator are seen in the foreground.

When using motion-picture film, a special projector is employed which moves the film at the standard rate of 24 frames per second, so that the sound will be satisfactory, while 30 frames per second are transmitted to secure 60 interlaced pictures per second. Although this may seem unbelievable the writer can vouch for its very satisfactory operation—both regarding the sound and picture.

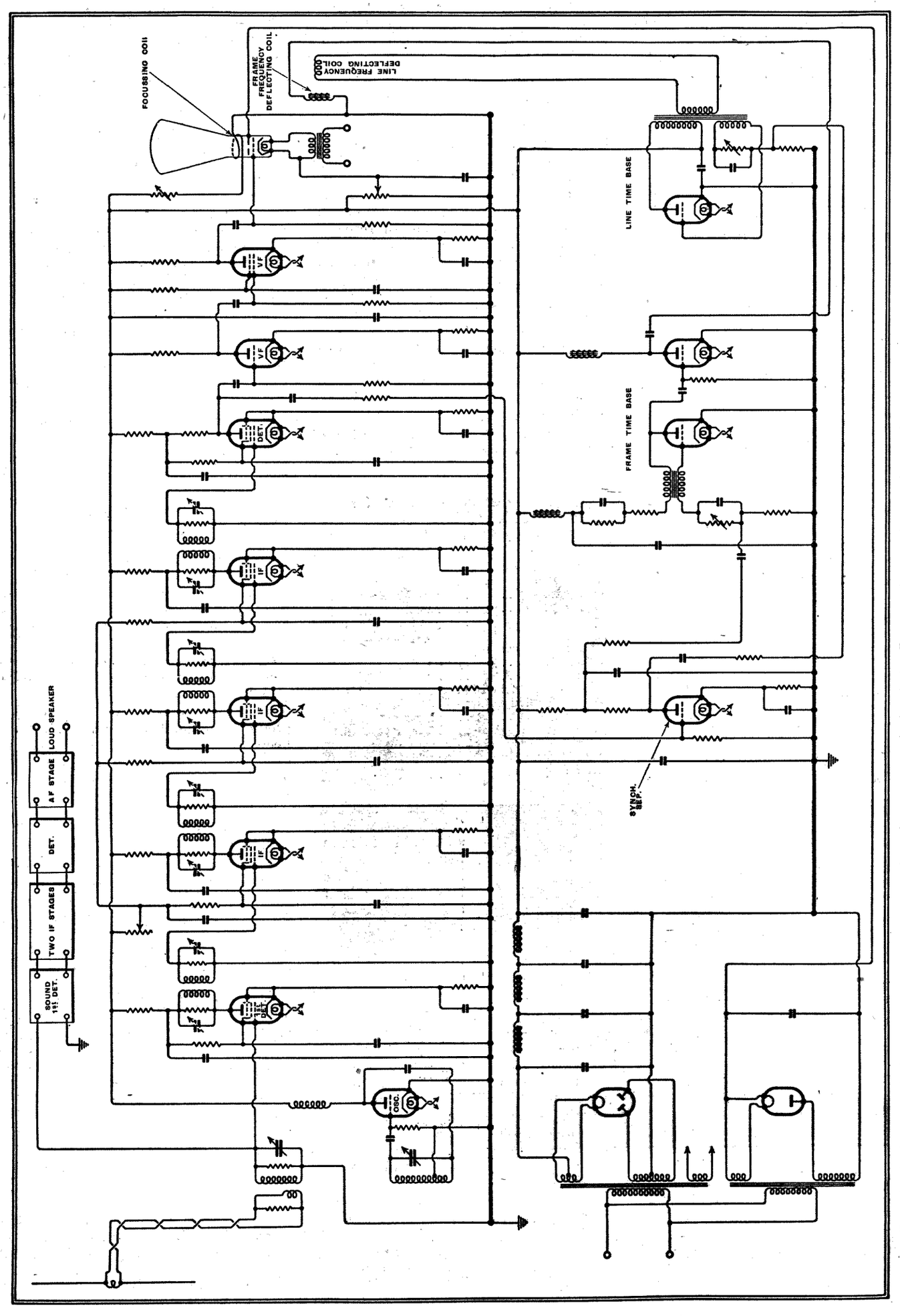
An untouched reproduction from a picture received at a distance of seven miles from the transmitter by the Philco system.

Thirty-six valves are employed, including those used in the various power supplies, which is not too bad, when it is realised that at least two American broadcast receivers of sound alone employ a greater number than this. Also, the two receivers are separately tuned between 42 and 86 Mc/s for the sake of flexibility, although it is quite simple to combine these controls.

During the Press demonstration staged by Philco the guests were assembled at the home of Mr. Grimditch, Chief Engineer of Philco, while the various televised subjects appeared in the television studio in Philco's main plant, seven miles away.

Two girls employed by Philco were televised, while the guests voted for the most pleasing personality. A sort of long range popularity or beauty contest.

Next, Boake Carter, Philco's very popular daily news commentator (broadcast), conducted an interview with one of the Philadelphia newspapermen present at the demonstration. This demonstrated conclusively the entertainment value of television, as Carter's rapidly changing facial expressions added greatly to the enjoyment of his speech—holding the interest of all.



The circuit diagram of the vision receiver, power supply units, and time-basis of the Farnsworth television receiver. Acorn valves are used for all stages up to the first vision-frequency amplifier.

Television in America—

To conclude the demonstration, sections of several sports motion-pictures, some made under poor light conditions (such as an undersea diving picture) were televised and the detail was sufficient to permit of their enjoyment. A boxing bout was also staged, and the whole ring could be seen quite clearly, and the action followed.

THE FARNSWORTH EQUIPMENT

Farnsworth was the first to back the cathode-ray or electronic television system in America. In the past year or two, quite a bit of information on his filamentless tubes or multipactors has been released, but little information on his television system. Recently, however, Farnsworth Television, Inc., released photographs and circuit diagrams of their latest television receiver, although development work is still progressing at a furious rate.

The sound and vision channels are conventional in the main, although the employment of 11.25 Mc/s for the sound IF and 13.25 Mc/s for the picture require the use of the 954 or "acorn" pentode as IF amplifiers. These valves are also used as first and second detectors in both channels, the 955 acorn triode being used as common oscillator and as first vision frequency amplifier in the vision channel. One of the most interesting features of their high frequency design is the use of *one* oscillator to supply the two intermediate frequency amplifiers.

The Smoothing Equipment

The use of a three-section filter denotes that a high degree of smoothing is necessary for the vision circuit HT supply. This type of filter should attenuate frequencies of 120 cycles and above by at least 70 db, which is much more smoothing than normally employed in sound reception.

To the writer a disappointing feature of the design is the use of an anode-bend detector followed by a single pentode output amplifier in the sound channel. It would seem that more attention might be paid to high fidelity sound reproduction.

Also of interest is Farnsworth's use of a 9in. reproducing CR tube operating in a horizontal position with no shadow box. This practice would seem to point to the viewing of images in darkness. This tube was named by its inventor the "Oscillight."

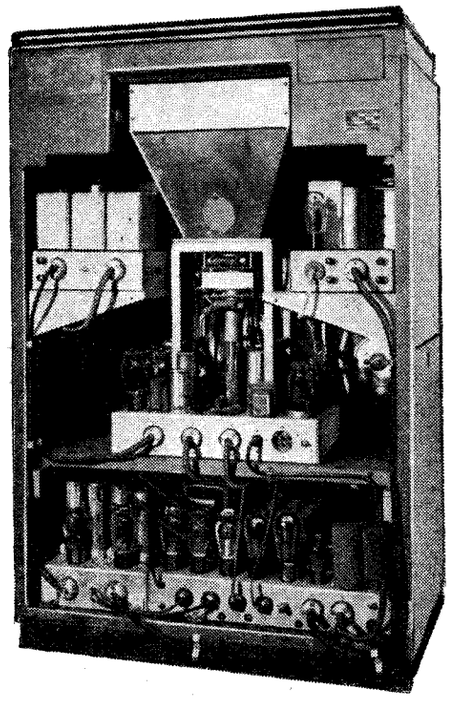
Philo T. Farnsworth recently applied to the F.C.C. for permission to construct a 1 kW experimental television transmitter near Philadelphia. He stated that $800,000 had been spent in 8 years in the development of an all-electronic system of television transmission and reception.

To support his application for the transmitter permit a demonstration was staged, and there were several who thought that the clearness and detail of his outside scenes were superior to those of any of his contemporaries in this country. The steadiness and lack of flicker were also reported to be ahead of Farnsworth's competitors.

COMMENTS ON TELEVISION IN GENERAL

RCA recently staged a very successful demonstration of its system, field tests on which have been carried out for several months, for its licencees. At this time technical information on its receivers, development and testing were handed out for use in the development of receivers by these licencees.

To the writer it would seem that the success of television must depend on the use of frequency modulation, with its great reduction in the effect of both man-made and natural static. Anyone having experience in the elimination of noise from broadcast reception will realise the difficulties besetting the practical application of television, where the effect of interference is many times more annoying. Also, the use of ultra-high frequencies makes certain forms of interference, such as the ignition interference caused by automobiles, very annoying. The use of DC in most of our largest cities, where television must gain its foothold, increases greatly the difficulty of noise suppression or elimination. While legislation or city ordinances may eventually muzzle all of the innumerable sources of interference, it can *never* control the thunder gods, and it will take years to accomplish the former.



Rear view of an experimental model of the Philco television receiver.

In America the obstacles facing television are largely economic—the technical problems having been largely solved. Television service could be initiated in several of our larger cities within a few months.

The public insists on television pictures of sufficient size to be viewed by several members of the family, and with a brilliance which will permit of a first-class home-movie image in spite of normal light within the room, as some member of the family group will want to read or sew while others are viewing the televisor. Expense and bulk will continue to limit the market for the television receiver for some time. The fact that one cannot watch the television screen while doing anything else (except knitting, crocheting or tatting, perhaps) means that the housewife will get but little use from it during the day, and that the tired business man may not care much about concentrating already strained eyes on a small screen for any length of time. This distinction from sound broadcasting, which does not demand the same concentration, would also seem to slow down the sales possibilities of the new instrument of entertainment.

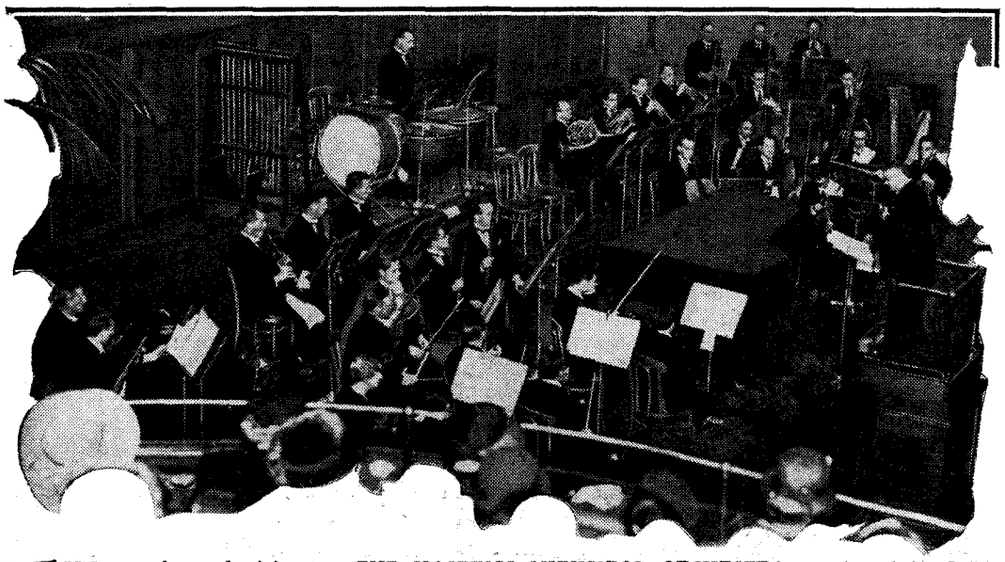
The Programme Question

Further complication results from the fact that little material suitable for sound broadcasts would be improved by being made visible, and that the cost of programmes especially designed for television would be so great—taking into consideration costumes, scenery, elimination of scripts with consequent increase in rehearsal time—that it is difficult to visualise the pocket from which this limitless supply of cash will issue. It would be another matter if it were possible to start off with sponsored programmes, but that does not seem feasible when the number of lookers-in will be few and far between. Motion-picture films might be used, but the cost of producing a number of films sufficient to keep America amused would seem prodigious. In the United States there would seem to be little chance of Government subsidy, which makes the horizon still darker. However, a way will be found, no doubt.

One last pessimism of the writer is to the effect that distortion of any sort—lack of detail, flicker or drift, spots caused by interference, or streaks resulting from power supply ripple will not only be displeasing to the looker, but will cause acute distress if watched for any length of time. The eye is already being subjected to constantly increasing use and abuse; a constantly growing need for medical advice or help in the form of spectacles is the result of our high-pressure era with its artificial light. This last warning would indicate that a nearly perfect image will be required before the average eye can tolerate the added burden. Such difficulties have never beset audible broadcasting.

The cost and technical complexity of any nation-wide method for the distribution of programmes would seem to indicate that for some time the only method which could be used would be the motion-picture film. This would not be too cheap if it is recalled that it would be used only once or twice, and that a large number of prints would be necessary.

Listeners' Guide for the



THE HASTINGS MUNICIPAL ORCHESTRA, conducted by Julius Harrison, will be heard from the Regional transmitter on Sunday at 9.5 with Isobel Baillie as soloist.

THE regular television transmissions from the Alexandra Palace will be ushered in on Monday, November 2nd. At present few are fortunate enough to possess television receivers and millions are outside the station's service area, but all will be interested in the following.

As a prelude, an insight into this twentieth century wonder will be given to listeners on Thursday at 9.20 (Nat.), and again Regionally at 3.35 on Saturday, October 31st, when a special programme will be broadcast. It aims at presenting the history of television from the days of Edison's early experiments to the erection of the first B.B.C. transmitter at the Alexandra Palace. A sound picture of the work during the experimental transmissions from the Palace will also be given. This programme should be well worth hearing.

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AN HISTORICAL PLAY

NORMAN EDWARDS' radio play, "The Queen of Baltimore," which was to have been broadcast last January but was postponed owing to the death of King George, will be given on Sunday at 9.5 (Nat.). It deals in an hour or so with the life story of Betsey Patterson, of Baltimore, who married Jerome Bonaparte, Napoleon's young brother. The author will act as narrator, and among a large and strong cast will be Carol Goodner, Philip Wade, Mary O'Farrell, Ivor Barnard.

MUSIC NOTES

A VERY useful pamphlet on the principal musical events to be broadcast during the autumn season has been issued by the B.B.C. and is obtainable free on application to the B.B.C. Publishing Department, 35, High Street, Marylebone. In the introduction Dr. Adrian Boult writes: "It is hoped that music lovers of every category will find that they have been well provided for by the B.B.C. in the coming season." From a cursory glance at the lists of broadcasts this hope seems to be sure of fulfilment. The pamphlet is to be commended to all who *plan* their listening time.

During the present week the special recital series will be entitled "The Composer-Virtuoso," in which classical pianoforte recitals will be played by Frank Mannheimer, Frank Merrick and Iso Elinson. The first recital will be on Sunday at 6 (Reg.), introducing Chopin, when the original grand piano played by Chopin at his first recital in London in 1848 will be used. The succeeding recitals will be of sonatas by Hummel on Monday at 7.30 (Reg.), Brahms on Tuesday at 7.5 (Nat.), Mozart on Wednesday at 10.20 (Nat.), and Beethoven on Friday, October 30th.

Orchestral Concerts

The second of the Sunday Studio Orchestral Concerts will be given Regionally at 6.30. José Iturbi, who was solo pianist at the Symphony Concert last Wednesday, will conduct Section B of the B.B.C. Orchestra, which comprises seventy-nine players.

The London Philharmonic Orchestra, conducted by Sir Hamilton Harty, will be heard from the Queen's Hall during the Royal Philharmonic Society's concert on Thursday at 8.15 and 9.45 (Reg.). The idea of giving an introductory talk is being continued, and this will precede the broadcast—at 8.

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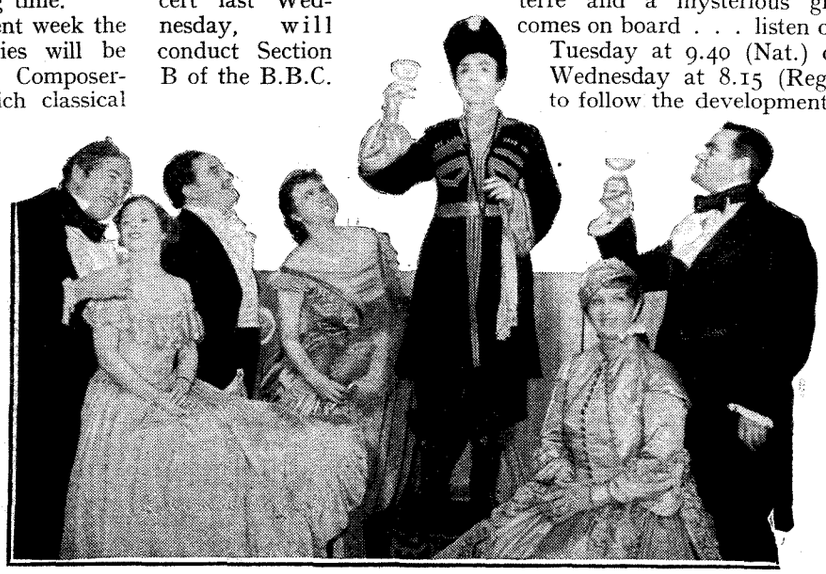
UP ALOFT

FROM the top of one of the masts of the National transmitter at Droitwich Kenneth Adams will give his impressions of dawn breaking over the countryside around. During his ascent in the lift to the top of the 700 ft. mast he will also describe his feelings as the earth recedes from him. The commentary was recorded yesterday morning, and will be broadcast to National listeners to-night (Friday) at 8.45.

◈ ◈ ◈

A GHOST STORY

INSTEAD of the usual haunted house the scene chosen for the play "Off Finisterre" is a liner homeward bound from India with a passenger list of apparently ordinary people. The author is Horton Giddy, whose first radio play was "In the Shadow." I understand that the atmosphere on board will be so realistic that one will imagine that one is "looking in." A fog envelops the liner as she approaches Cape Finisterre and a mysterious girl comes on board . . . listen on Tuesday at 9.40 (Nat.) or Wednesday at 8.15 (Reg.) to follow the developments.



"DIE FLEDERMAUS." A scene from the second act of Johann Strauss's opera, which will be relayed Nationally from Sadler's Wells on Wednesday at 9.20. On the right is Tudor Davies, who fills the role of Eisenstein. Winifred Kennard takes the part of Rosalinde, and Janet Hamilton-Smith that of Adele.

Week

Outstanding Broadcasts at Home and Abroad

FROM LAUSANNE

A RECITAL of folk songs of French- and Italian-speaking Switzerland will be relayed from Lausanne on Sunday at 6.30 (Nat.). The "Chanson Romande" chorus of Radio Lausanne will be conducted by Hans Haug, who is on the staff of Radio Lausanne, and has made a special study of French-Swiss folk songs, and has brought to light many long forgotten gems.

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"STRANGE TO RELATE"

UNDER the above heading a programme in which music, history and personalities combined to tell their own anecdotes was broadcast with great success last April. It attracted the attention of Robert Ripley in America, whose "Believe It or Not" series of cartoons, books and films will be known to many listeners, and he offered Charles Brewer and Leslie Baily the use of his library of curious coincidences. Three more of these "Strange to Relate" programmes are to be given, the first on Monday at 8.30 (Nat.) and others in November and December, in which will be included some of Ripley's curiosities as well as material collected by the above collaborators. Listeners who have had strange and unbelievable experiences may have the opportunity of "telling the world" if they will write to Charles Brewer at B.H.

SPAIN IN HAPPIER DAYS

AN Andalusian story of one hundred years ago has been adapted into an amusing play for radio by Phillip Leaver, which will be broadcast on Thursday at 7.15 (Nat.), and again Regionally the following evening. The story, entitled "The Three-cornered Hat," deals with passionate happenings in the South, and tells the story of Carlos, the miller, and his wife, Frasquita, with whom his Honour Don Eugenio de Zuniga y Ponce de Leon, the Governor of the Province, falls in love. The miller's retaliation forms the main action, and the amusing situations should make good radio entertainment. A strong cast includes Jan van der Gucht, Tessa Deane, Marie Burke and Bobbie Comber.

◈ ◈ ◈

OPERA

FROM Sadler's Wells the second act of "Die Fledermaus," the scene of which is set in the ballroom at Prince Orlofsky's, will be relayed Nationally on Wednesday at 9.20. This opera will also be heard from Paris P.T.T. on Sunday at 8.30.

From the Continent Friday's only opera broadcast is Donizetti's "The Daughter of the Regiment," from Frankfurt at 7.10. On Saturday, Puccini's seventh opera, "The Girl of the Golden West," is being given from Milan at 7.45. Another old favourite, Verdi's "La Traviata," is being given by Leipzig on Sunday at 6. One advantage of listening-in to this opera is that the frail consumptive "Lady of the Camelias" is unseen, and the rôle can therefore be filled by a more robust prima donna. The work of a comparatively little known contemporary composer, Rischka, will be given from Breslau at 7 on Sunday. It is entitled "Gevatter Tod."

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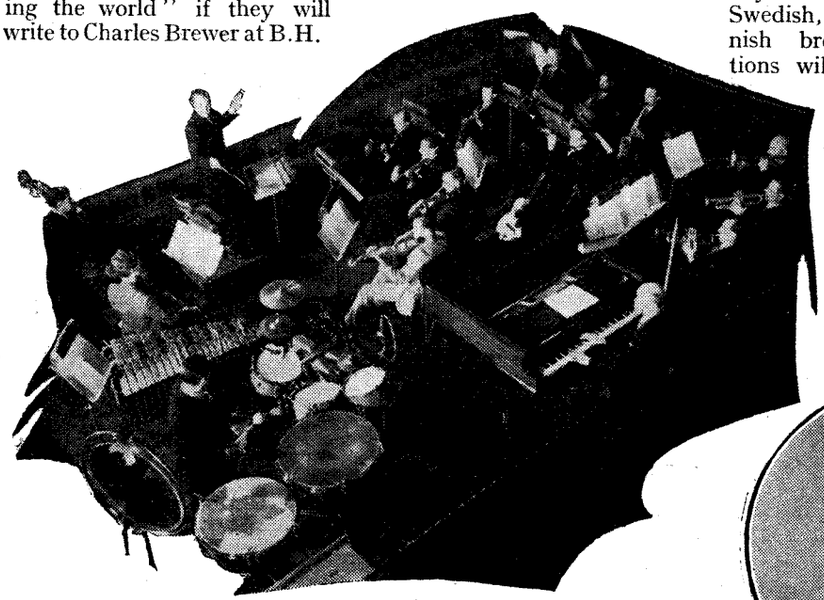
THREE KINGS BROADCAST

A UNIQUE inter-Scandinavian broadcast takes place on Tuesday when all the Danish, Swedish, Norwegian and Finnish broadcasting organisations will unite in the programmes "Day of the North," when throughout the day each country will in turn supply programmes which will be relayed over the whole network in Scandinavia.

The day starts with a relay of Divine Service from the ancient cathedral of Trondheim followed by chimes from the oldest churches of the four countries. The crowning event of the day is at 6.30, when Their Majesties King Gustaf of Sweden, King Christian of Denmark, King Haakon of Norway, and His Excellency President Svinhaufvud of Finland each broadcast a short speech. It is understood that many foreign broadcasting organisations have applied for the right to relay the royal speeches, and it is, therefore, likely that these addresses will be radiated in many other countries. THE AUDITOR.



LEADERS ALL. The B.B.C. Variety Orchestra is unique in that all its members except three have been leaders of famous orchestras. In a special forty-minute programme, "Intermission," on Tuesday at 6.25 (Nat.), the first of a series, members of the orchestra will display their talents as soloists and as a combination. The orchestra is here seen conducted by Kneale Kelley, whose place has now been taken by Charles Shadwell (below).

HIGHLIGHTS OF THE WEEK

FRIDAY, OCTOBER 23rd.

Nat., 6.25, Donald Thorne at the B.B.C. Theatre Organ. ¶"The Arcadians." 8.45, Visit to Masthead at Droitwich.
Reg., 8, Harold Darke—Concert Hall Organ Recital. 9, B.B.C. Dance Orchestra.
Abroad.
Brussels No. II, 8.30, Eugène Ysaye Commemoration Concert.

SATURDAY, OCTOBER 24th.

Nat., 7.30, "In Town To-night." 9.20, Music Hall, including Sid Dooley and George Robey. 10.20 B.B.C. Theatre Orchestra and Garda Hall.
Reg., 3, Saturday Contrasts. 4.15, "Star-Gazing"—Robert Hale. 9.20, A. E. Housman programme. 10.25, Henry Hall's Hour.
Abroad.
Milan, 7.45, "The Girl of the Golden West" (Puccini).

SUNDAY, OCTOBER 25th.

Nat., 4, Music of Eric Coates—B.B.C. Orchestra (C) conducted by the composer. 6.30, Relay from Lausanne. ¶Commodore Grand Orchestra. 7.55, Service from Norwich Cathedral. 9.5, "The Queen of Baltimore."
Reg., 6.30, Sunday Orchestral Concert. 9.5, The Hastings Municipal Orchestra.
Abroad.
Paris PTT, 8.30, "Die Fledermaus."

MONDAY, OCTOBER 26th.

Nat., 7.20, "The Music Shop"—No. 2. 8.30, "Strange to Relate."
Reg., "The Rocky Mountaineers." ¶B.B.C. Military Band.
Abroad.
Luxembourg, 8.5, Viennese Music.

TUESDAY, OCTOBER 27th.

Nat., 6.25, "Intermission"—B.B.C. Variety Orchestra. 8, B.B.C. Orchestra (B) playing Bruckner's Sixth Symphony. 9.40, "Off Finisterre."
Reg., 6.40, "From the London Theatre." 8, Café Colette Orchestra. 9, Violoncello recital—Suggia. ¶G. T. Pattman at the B.B.C. Theatre Organ.
Abroad.
Strasbourg, 8.30, First Subscription Concert of the Strasbourg Municipal Orchestra.

WEDNESDAY, OCTOBER 28th.

Nat., 7.15, Stanelli's Eleventh Bachelor Party. 9.20, Act II of "Die Fledermaus."
Reg., 6, Old-time songs—The B.B.C. Military Band, Phyllis Scott and John Rorke. ¶"Jungle to Jazz"—2. 8.15, "Off Finisterre."
Abroad.
Toulouse, 8.10, Concert Version of Massenet's "Werther."

THURSDAY, OCTOBER 29th.

Nat. 7.15, "The Three-cornered Hat." 9.20, Television Feature
Reg., 7.30, B.B.C. Singers. 8.15 and 9.45, Royal Philharmonic Society's Concert.
Abroad.
Radio-Paris, 8.45, The National Orchestra.

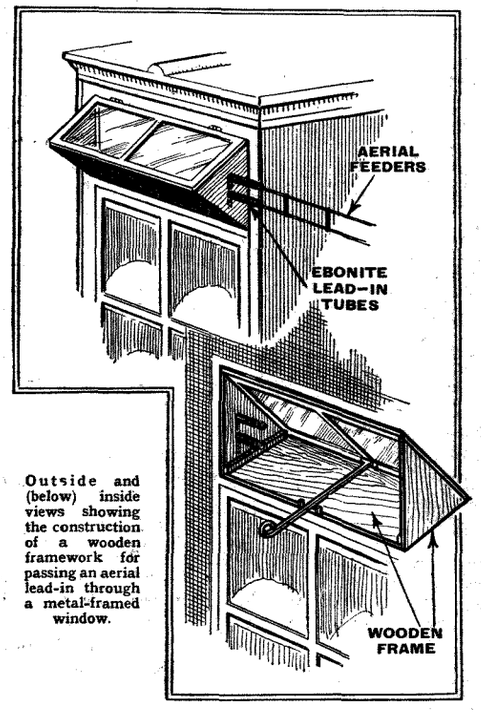
HINTS and TIPS

Practical Aids to Better Reception

EXPERIMENTERS are often confronted by sundry problems which though connected with radio-electrical matters necessitate the exercise of a little mechanical ingenuity for their solution.

Such a case arose recently when it was required to fit a pair of lead-in tubes for the feeders from a voltage-fed Hertz short-wave aerial, the said feeders being of the tuned variety and consequently at high RF potential.

Short-Wave Aerial Lead-in



Outside and (below) inside views showing the construction of a wooden framework for passing an aerial lead-in through a metal-framed window.

The only possible place of entry into the "den" was *via* the window or window frame and this happened to be of the steel frame type. Like most experimenters' equipment it might become a permanent fixture or be only a temporary affair, and so it was not thought justifiable either to drill the metal window surround, or to remove a pane of glass and drill it for the two tubes.

A solution was eventually found by making up a wooden framework and fitting it in the window opening, it being so arranged that the window, which was hinged at the top, could still be opened a reasonable distance yet closed down on to the new fitting when necessary. The lead-in tubes were then fitted in one side as shown in the illustration.

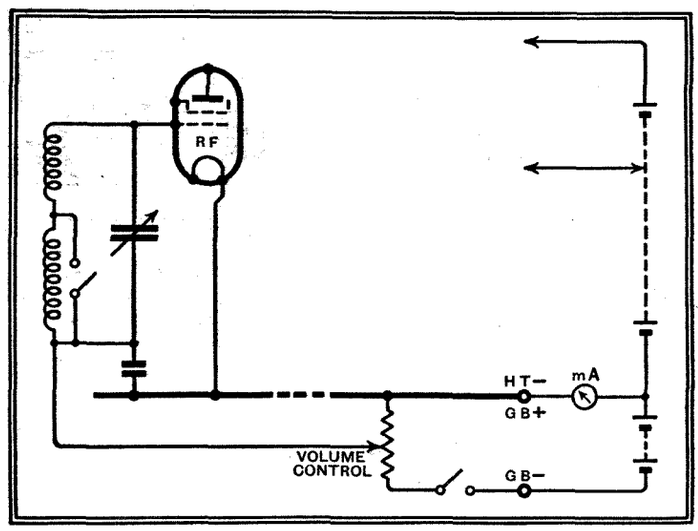
Ply-wood about $\frac{1}{4}$-inch thick can be used and the fitting may be secured by bending up $\frac{1}{2}$-inch wide strips of thin brass to fit over the edges of the window surround and screwing them to the wooden structure. The outside of the building may be painted to match the exterior decoration so as not to be unsightly when viewed from the outside.

THE method of measuring the total HT consumption of a battery set by inserting a milliammeter between the HT- wander plug and the – socket on the battery may give rise to misleading readings if the battery feeding the set is of the combined HT and GB type incorporating a common HT– GB+ tapping. In the majority of "straight" receivers fed by a battery of this description the grid bias section supplies current to a potentiometer.

Misleading Current Readings

In some designs this potentiometer has a value of 1,000 ohms only, so that the current taken (supposing a 9-volt grid potential is applied across it) is 9 milliamps. Now a current of this order may quite well exceed the standing HT current of a modern receiver. The result is that a milliammeter connected in series with the common HT – GB+ lead may either read an absurdly low current, no current at all, or actually a negative current! A little thought will show the reason for this effect to be due to the fact that the HT and GB currents flow in opposite directions from a common tapping.

Various methods can be adopted to ascertain the total HT consumption in these circumstances. A glance at the circuit diagram will show whether the negative GB plug connected to the potentiometer can or cannot be removed with impunity. Generally this tapping supplies only the variable-mu valve, or valves, through the potentiometer and so the effect of removing it is equivalent to tuning the pre-detector volume control on full and eliminating the current taken by the potentiometer, thus permitting a true reading of the total HT milliamps at maximum volume to be obtained. If this tapping supplies grid bias to any other valves, the best way to measure the total HT drain is to add up the currents drawn by each positive lead or, while leaving the meter in the negative lead, temporarily to connect a suitable external grid bias battery, not forgetting to join the – of this added grid battery to the HT– GB+ socket of the combined HT and GB battery.



A case where readings of anode current cannot be taken in the usual manner.

A SOURCE of voltage loss in AC mains sets which is more than likely to be overlooked is an open circuit in the reservoir condenser associated with the rectifying valve. Electrolytic condensers are often used in this position, and it is an unfortunate fact that with some of the earlier specimens the dielectric is inclined to deteriorate with age until the resulting capacity is too low to have any appreciable effect.

Lost HT Voltage

It might be thought that a disconnection in this condenser would betray itself by an increase in hum, but the smoothing is usually sufficient to render a slight increase in ripple unnoticeable. More important is the fact that there will be no reservoir for the initial unsmoothed pulses from the rectifier, and as the HT output is to a great extent proportional to the size of this condenser, the result is a serious voltage drop, which may amount to as much as 80 volts. In practice the rectifier itself is very liable to be suspected for this deficiency, especially when a new valve is found to confer a certain improvement, whereas actually the improvement may be merely due to the better regulation of the new valve.

A simple way of making sure that this condenser is still intact is to break one of its connections with the set "on" and a voltmeter connected across the smoothed HT output. There should be a definite drop of at least 20 volts, the actual figure depending on the AC input voltage and the regulation of the rectifier and transformer. If there is no noticeable change, then it is fairly safe to assume that the condenser is faulty.

BROADCAST BREVITIES

NEWS FROM PORTLAND PLACE

Take Your Choice

ALREADY the television programmes are being framed in such a way that televiewers may know what type of entertainment to expect on different days of the week.

Cecil Madden, who is acting as co-ordinating producer, is reserving Mondays for "Picture Page," the magazine type of programme which made an instantaneous hit when presented in the Marconi-E.M.I. experimental transmission on October 7th.

To Suit All Tastes

Tuesdays will feature the "Starlight" series of programmes, in which stars of the screen and stage will appear, usually in acts specially devised for television. Novelties and surprises may be expected on Wednesdays, ballet on Thursdays, and "From the London Theatre" on Fridays.

Saturdays will be ear-marked for variety and vaudeville, which will always contain material of special interest to children.

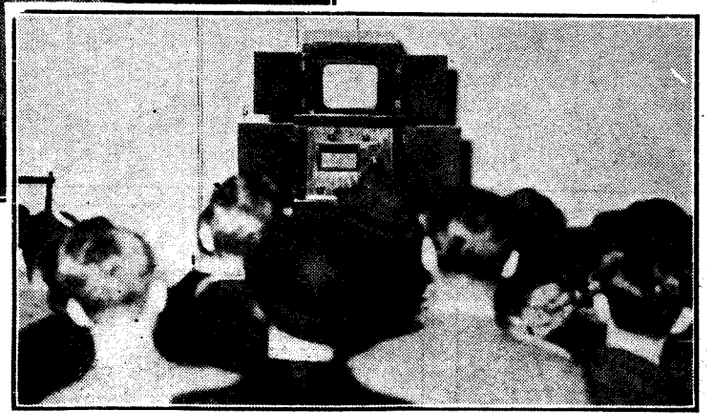
B.B.C. as Fairy Godmother

THE B.B.C. is continuing in the role of fairy godmother to Indian broadcasting by giving a six-months' course of training in the technique of modern broadcasting to two engineers of All-India Radio. And there is nothing to pay.

Broadcasting from the Cenotaph

A ROOM in Richmond Terrace, overlooking Whitehall, will be used by a B.B.C. commentator during the broadcasting of the Service of Remembrance from the Cenotaph on Armistice Day. As usual, the music by the massed bands of the Brigade of Guards will be picked up by a microphone connected to a sunken "point" in the roadway and thence to the "O.B." van in Palace Yard.

It is not generally realised, perhaps, that the strokes of Big Ben preceding the Two Minutes' Silence are heard *via* this microphone, and not *via* the permanent microphone in the Clock Tower. The effect is much more impressive.



PUBLIC INTEREST IN TELEVISION. These pictures, taken by a "W.W." staff photographer last week, show the interest taken in the demonstrations of television now being given daily at the Science Museum, South Kensington.

A Land-line Comparison

IN celebrating the tenth anniversary of its formation in November, 1926, the National Broadcasting Company of America reviews the extent of its "coverage" at the present time—two-thirds of the United States—and reveals that this tremendous area of approximately 2,000,000 square miles is served by 21,630 miles of land-line for S.B.s, i.e., about one mile of land-line per ninety square miles.

A comparison with B.B.C. lines is interesting. Approximately 1,100 miles of Post Office lines are rented by the B.B.C., this figure not allowing for duplication, triplication and even quadruplication of circuits between the various centres. The area of Great Britain and Northern Ireland is approximately 96,000 square miles, so that the S.B. network in this country provides about one mile of land-line per 87 square miles.

The similarity of the American and British ratios is remarkable.

Lord Mayor's Show By Television?

TO televise the Lord Mayor's Show may seem an impossibility, except to those people (and there are many) who think that technical obstacles were made only to be overcome. And actually the optimists may be right, even in these pioneer days of 1936, for plans are afoot to put at least a portion of the Show on the television screens on November 10th.

If all goes well, part of the procession will be transported to Alexandra Palace to parade before the Emitron cameras in the studio.

Prime Minister to Broadcast

ONE of the most important public utterances of the year—the Prime Minister's speech at the Lord Mayor's Banquet—will be heard by National listeners on November 9th. Although the occasion is a festive one, the speech of the evening is invariably devoted to a weighty consideration of foreign affairs, and Mr. Baldwin is not likely to make an exception to this well-established precedent.

The speech will doubtless be tuned in by many listeners on the Continent.

Football Recording for New Radio Play

THE mobile recording unit contributes some interesting discs to "Kick Off," a football play with music which is figuring in the Regional transmissions on November 4th. The play concerns the activities of the "Midchester Rovers Football Club" and, unlike most productions of its type, will include genuine sound records of cheering crowds, high kicks, and the partisan groans. The records were actually made on the ground of the West Bromwich Albion Football Club.

Conspicuous by Absence

Amid a large cast of players and camp followers in this high-spirited play (the authors are C. H. Averill and Alan Fitton) there is an incomprehensible omission, viz., the referee. But perhaps football referees are considered to be as hackneyed as mothers-in-law.

Fun in Inverness

BURGHEAD is already changing the face of existence in many a Highland glen. Quite a number of canny Scots in Inverness and beyond provided themselves with radio sets in good time to hear the opening ceremony on Monday of last week, and radio dealers on both sides of the Caledonian Canal report good business.

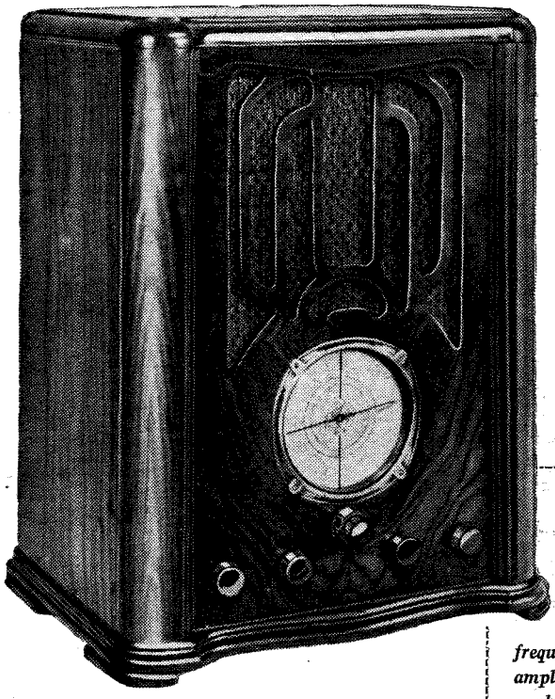
Why Burghead Broke Down

It was a pity that the North Scottish transmitter broke down for forty minutes within a day of the start, but such mishaps can be endured manfully by a population which has eked out an existence for fourteen years without a B.B.C. service of any kind.

The breakdown, by the way, was one of those trivial but maddening affairs that make engineers the cautious race they are. It was caused by two faulty grid condensers in the C unit.

Warning

THE standing joke at Alexandra Palace is a notice which smites the visitor when he arrives, panting and perspiring, at the top of the tower after climbing fifteen flights of stairs. (There is no lift.) It warns him that unauthorised persons must not climb the mast.



Ferguson

MODEL 378 UNIVERSAL

Efficient Short-wave Reception Down to 13 Metres

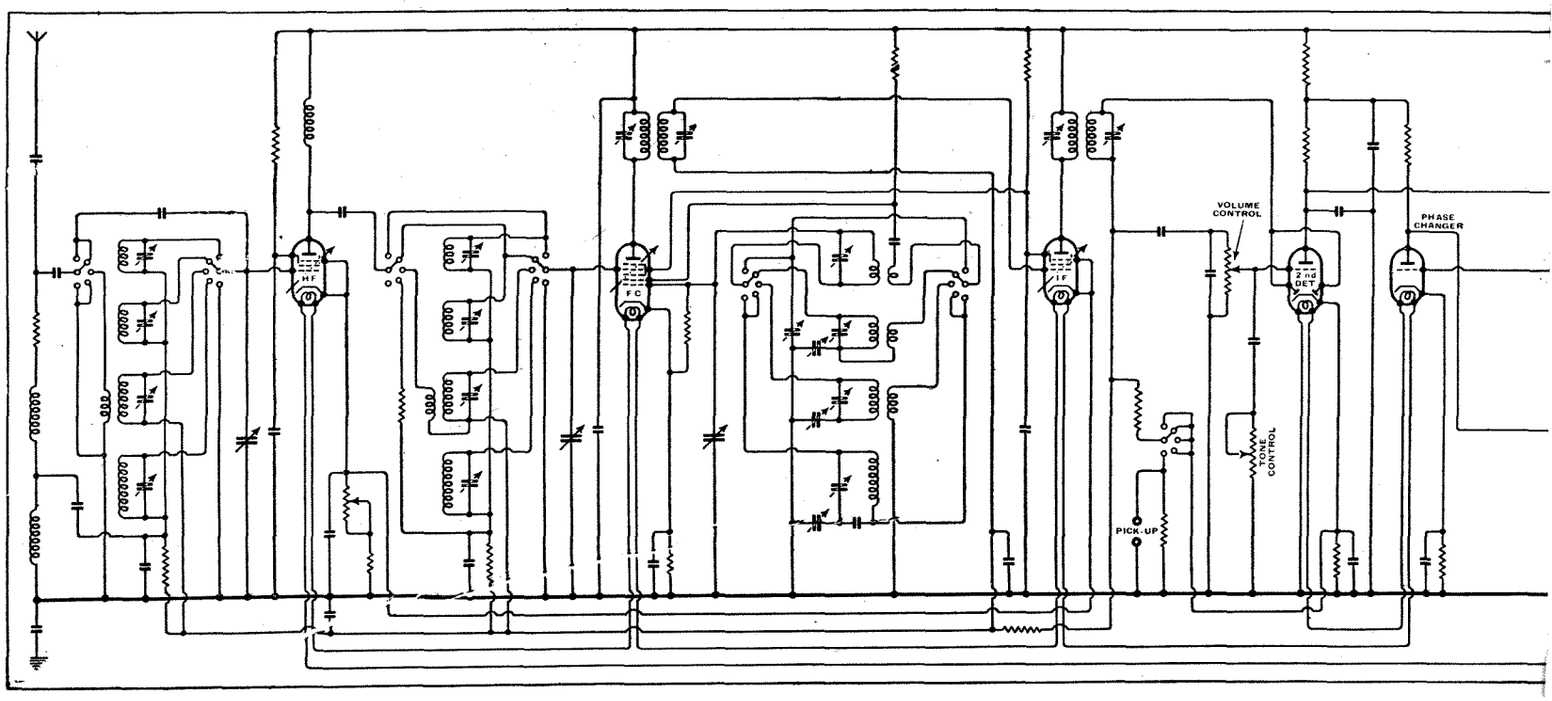
FEATURES.—***Type.***—*Table model all-wave receiver for AC or DC mains.* ***Wave Ranges.***—*(1) 12½-30 metres. (2) 28-62 metres. (3) 200-550 metres. (4) 1,000 to 2,000 metres.* ***Circuit.***—*Var.-mu pentode RF amplifier—heptode frequency-changer — var.-mu pentode IF amplifier—double-diode-triode second detector —phase reversal valve — push-pull pentode output valves. Two half-wave rectifiers in parallel. Two barretter voltage regulators.* ***Controls.***—*(1) Tuning (two-speed). (2) Volume. (3) Sensitivity. (4) Wave-range switch. (5) Tone and mains on-off switch.* ***Price.***—*16½ guineas.* ***Makers.***—*Ferguson Radio Corporation Ltd., Power Road North, Chiswick, London, W.4*

BOTH in chassis layout and cabinet design this receiver is typical of American practice in all-wave superheterodyne construction. The valves used are of American manufacture, but the set itself is made and tested in this country. Two models are available —one for AC mains only and the other for either AC or DC supplies. The circuits employed are essentially the same, but the volume output of the universal set is necessarily lower than that of the AC receiver. As the final stage consists of two pentodes in push-pull the output of both sets is unusually generous, that of the AC receiver being rated at 8 watts undistorted and that of the AC/DC set at 5 watts. The latter figure is in excess of that given by the majority of AC sets with single output valves, and it was thought that the opportunity should not be missed of testing the short-wave performance of a set fitted with universal valves, more especially as the Model 378 is designed to go down to 12½ metres.

The wavelength coverage of the set is divided into four bands and the RF amplifier, a variable-mu pentode, is in operation on all four wavebands. The amplification of the RF stage can be controlled separately by a sensitivity control consisting of a variable resistance in the cathode return circuit. The aerial coupling is interesting for the fact that no fewer than three different methods have been employed to maintain a consistent performance as the wave range is varied. Thus on the two short-wave ranges the coupling is through a small capacity to the high potential end of the coils, on the medium-wave broadcast band the coupling is magnetic and on the long-wave band bottom-end capacity coupling is employed. The aerial circuit itself is also arranged to resonate over certain sections of the range covered in order to level out the sensitivity of the receiver.

The coupling between the RF stage and the frequency-changer is of the tuned-grid type, and the method of feeding the various circuits follows closely the arrangement adopted in the aerial circuit. The connections of the heptode frequency-changer are interesting for the fact that the ultra-short-wave coil in the oscillator section is permanently in series with the other circuits. By this means not only is a switch contact eliminated,

The circuit is notable for the generous specification of the output stage, which incorporates resistance-coupled pentodes in push-pull, and for the care which has been taken to obtain a constant filament temperature and well-smoothed HT supply.



but the leads in the case of the lowest wave range can be considerably shortened.

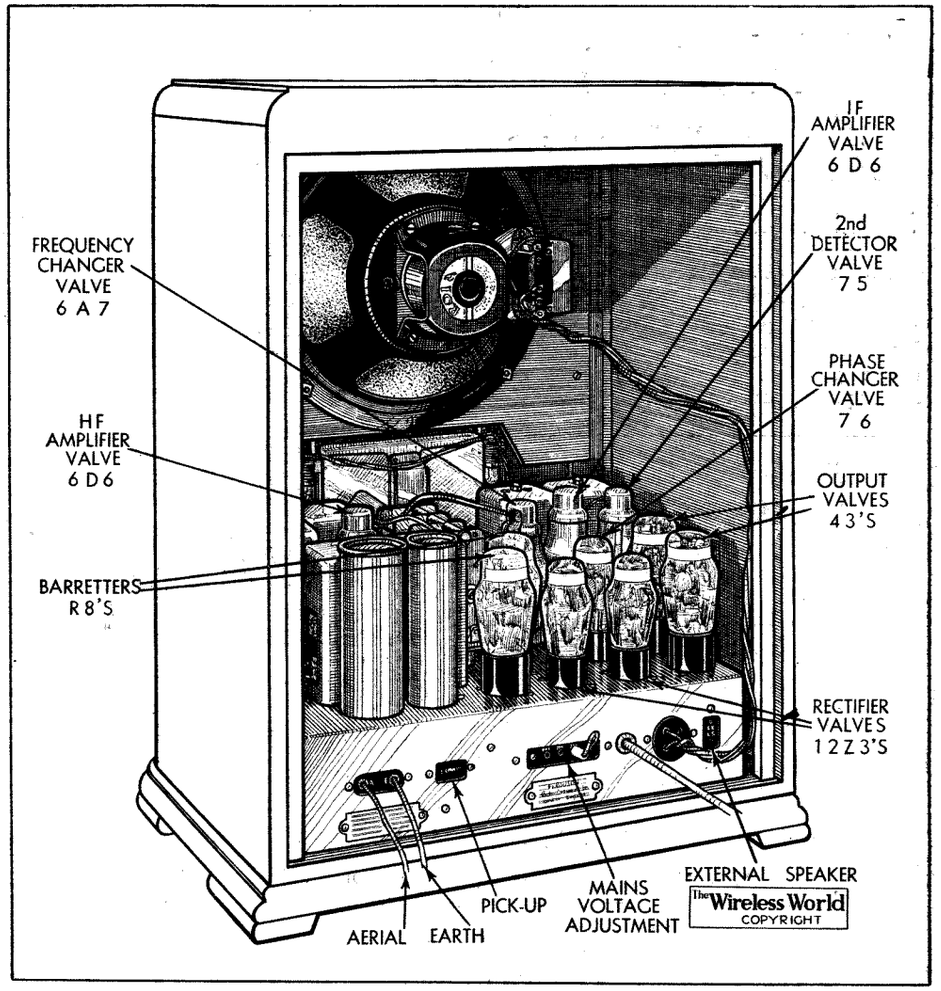
A single IF stage is interposed between the frequency-changer and the double-diode-triode second detector. The diodes in the latter stage are connected in parallel and both AVC and the AF output to the amplifying portion of the valve are taken from the load resistance. All three valves preceding the second detector stage are controlled from the AVC line.

The tone control in this receiver is effected at an unusual point, namely, between the grid of the amplifying portion of the second detector and earth. The coupling to the push-pull pentode output valves avoids the use of an iron-cored transformer by employing resistance-capacity coupling in conjunction with a separate phase-reversal valve. Rectification in the case of AC supplies is effected by two half-wave rectifier valves connected in parallel, and the usual smoothing circuit incorporating the field of the loud speaker is in this case supplemented by a separate choke.

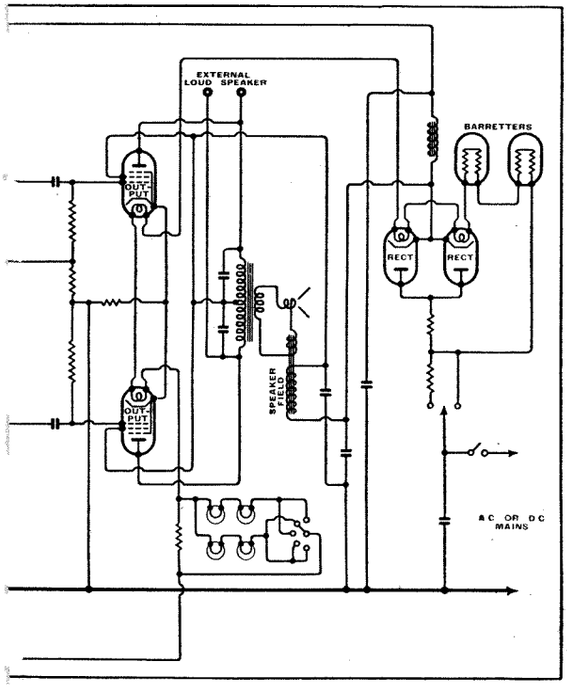
The Controls

The valve heaters are connected in series and are supplied with current through two barretter tubes. Following the usual American practice the mains on-off switch is incorporated with the tone control.

The set takes a little longer to warm up than the average AC receiver, but stable operating conditions are reached as soon as any sound is obtainable from the loud speaker. The ratios of the two-speed tuning dial are admirably suited to both short-wave and normal broadcast requirements. The dial itself is large and easily read and is not unnecessarily overladen with stations calibrations. The particular receiver tested developed a silent spot at a point near the top of the range of the volume control, but fortunately more than adequate volume was obtainable from the loud speaker before this point was reached. The 10-inch Rola loud speaker gave an excellent bass response which was quite free from any objectionable resonances. Even at volume levels the performance of this receiver at the lower end of the ultra-short-wave range, which goes down below the limit most makers set for themselves. The American stations on the 19- and 16-metre bands were up to the standard of performance which one expects of a first-rate all-wave receiver of modern design, but the 13·93-



All valves dealing with RF currents are completely enclosed in detachable metal shields and those associated with AF and power supply circuits are grouped in a readily accessible position at the back of the chassis.



far in excess of those which would normally be required in the average living room the response had the characteristic clarity which is a sign of low harmonic content, and from this point of view alone there is no doubt that the push-pull output stage is well worth while.

The tone control has a wide range and is most useful, for the degree of high-note response required varies considerably between different wave ranges. The long-wave range will stand the full amount of top and then gives just the right balance. On the medium-wave band, on the other hand, some reduction is necessary even when listening to the local station, and on the short-wave ranges, of course, the tone control can be turned down with advantage in reducing the amount of background noise. Noise between stations on the normal broadcast bands is also effectively kept within limits by the sensitivity control.

We were particularly impressed with metre transmitter of W8XK, Pittsburgh, came through at a volume level which we have seldom before enjoyed on a commercial broadcast set. The good reception round-the-world echo effect which is often tally, enabled us to observe the curious round-the-world echo effect which is often noticeable on the Daventry Empire stations. The superposition of the direct and reflected rays caused the speech and music to sound as though it were emanating from a long corridor.

The performance on the medium-wave band is notable for the efficiency of the reception towards the top end, and the number of interesting transmissions available in daylight from, say, 450 to 550 metres appeared to be much above the average. The selectivity on this range enables the London Regional transmitter to be approached within two channels on either side of its normal setting when using the set in Central London. The selectivity is also sufficient to give ade-

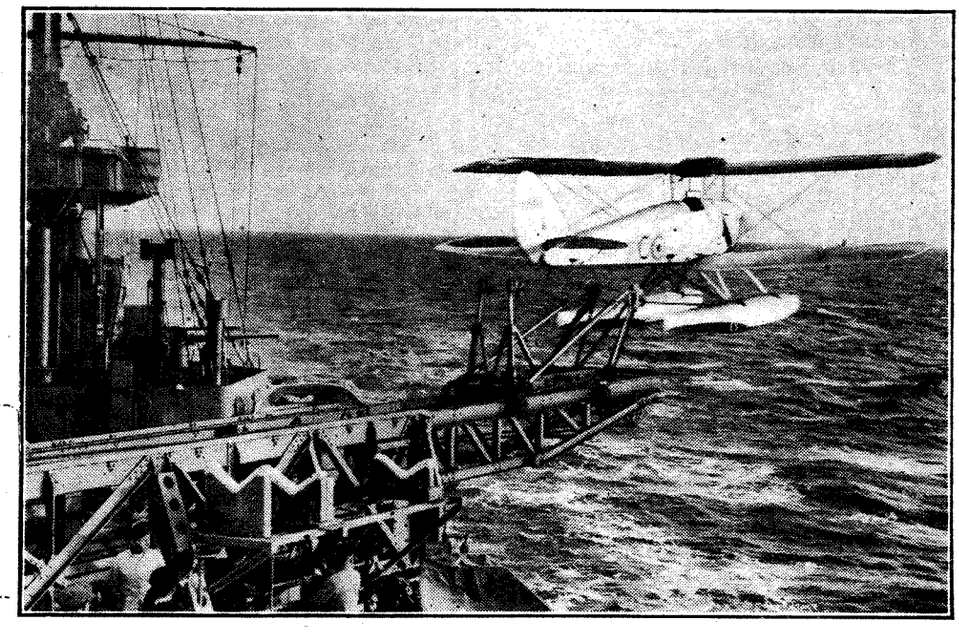
Ferguson—

quate separation between London National and Fécamp. On long waves, on the other hand, the Deutschlandsender is easily receivable clear of Droitwich and Radio-Paris and the long-wave performance taken as a whole is in every way comparable as regards range and sensitivity with the lower wave ranges, a state of affairs which is not always a feature of receivers of American design.

In conclusion we would compliment the makers on the efficiency of the mains smoothing equipment. It was impossible to detect either from the presence of hum or any change in the character of the background noise whether the set was connected to an AC or a DC supply. The barretter tubes performed their function well for reasonable fluctuations of the mains voltage, an important point in short-wave reception where the oscillator frequency is generally sensitive to changes of cathode temperature.

NOTES AND NEWS

Recent Events Briefly Reviewed



WIRELESS AT THE HELM. The empty pilot's cockpit bears silent witness to the fact that the "Queen Bee" aeroplane, here shown in process of being launched from H.M.S. *Neptune* is controlled by wireless. After a three-hour flight, the aircraft landed safely on a rather choppy sea.

Use of Police Wireless Spreading

CEYLON is the latest country to consider the adoption of police wireless. Several new motor-patrol cars have recently been added to the equipment of the police department. At present no wireless set is fitted to these patrol cars, but it is likely that this deficiency will be remedied in the near future.

Public Television Demonstrations

YET another opportunity has been provided for members of the public in the London area to witness the B.B.C.'s television transmissions, as a receiver has been set up in the wireless department of Pratts, of 210-224, Streatham High Road, where the programmes may be viewed during normal transmitting hours, which are, at present, from 11 a.m. to midday and 3 p.m. to 4 p.m. daily. Possibly, before very long, other large departmental stores will provide similar facilities. Among other places where television is "on view" are the S. Kensington Science Museum and one of the waiting rooms at Waterloo Station.

Swedish Short-wave Station

SWEDEN has at last decided to make an official entry into the realm of short-wave broadcasting, and it is hoped to erect a transmitter in the vicinity of Motala. Hitherto the role of national short-wave broadcaster has been undertaken by an amateur, Dr. Siljeholm, who has been working on the 40-metre band.

Wireless Progress in Finland

THE tenth anniversary of the opening of the Finnish broadcasting service is now being celebrated in the Land of a Thousand Lakes. In this connection it is interesting to recall that it is only thirteen years ago since a well-known Helsinki bank applied for Government permission to instal a wireless set for the purpose of receiving foreign stock-exchange quotations. The Department of Communications took nearly a year to deliberate upon this weighty matter and eventually decided to refuse permission.

Jugoslavian Exhibition

LARGE crowds were attracted to the recently held wireless exhibition in Belgrade. Sets exhibited came from a large number of countries, including Germany, Austria, Great Britain, Holland, Belgium, and the U.S.A. It is stated that a marked decline occurred in the sale of American receivers, owing to the fact that the Jugoslavian Government now insists on a reciprocal trading agreement, the U.S.A. being compelled to open her markets to Jugoslavian goods in exchange for the same facilities being granted to her exporters. A British autogram exhibited by the G.E.C. is said to have been the star exhibit of the Show and attracted much attention.

Another "World's Smallest Set"

IT appears that the days of the stunt "smallest set in the world" are not entirely over, as an American five-valve set, which has made its appearance, is contained in a cabinet which is less than four inches long, other dimensions being in proportion. A Paris journal, in commenting on this, draws attention to a receiver produced by a French engineer which is entirely contained in the barrel of a fountain pen. It need scarcely be added that this was a crystal set.

Eiffel Tower to be Rejuvenated

THE world's most famous wireless mast, namely, the Eiffel Tower, which some time ago was stated to have been condemned to demolition, has been saved, according to reports received from Paris. The area which it covers is included in the grounds set aside for the 1937 Paris Exhibition, and it is to be completely rejuvenated for the occasion at a cost of 3½ million francs. Two completely up-to-date restaurants are to replace the present structures on the first platform, and new elevators are to be installed which will apparently do away with the necessity of changing lifts in mid-air as is the case at present when going to the summit. It is believed that the real reason why the Tower has been saved is that it forms the highest possible support in Paris for an ultra-short-wave television aerial.

Balkan Activity

A CONSIDERABLE speeding up is said to be taking place in the building of the new Bulgarian high-powered transmitter. This station is to have a power of 100 kW., and the transmitter buildings are now rapidly taking shape at Vakarel, some twenty miles outside Sofia, on the main road to Istanbul. It is hoped that the buildings will be opened in December and that the station will be put into service next May. The aerial is to be some 600ft. high, and the transmitter is being built on a hill about 450ft. above the town, which is itself between two and three thousand feet above sea level.

Wireless Licence Figures

THERE was a net increase of over 45,000 in the number of wireless licences in existence at the end of September, this bringing the total to 7,789,767. There has been an increase of over half-a-million during the past twelve months, and it is thought that, with the extra number expected to be taken out during the Coronation period, the licence figures will have passed the eight-million mark and have made substantial progress towards nine millions by this time next year

Notes on the ALL-WAVE SUPER SEVEN

By W. T. COCKING

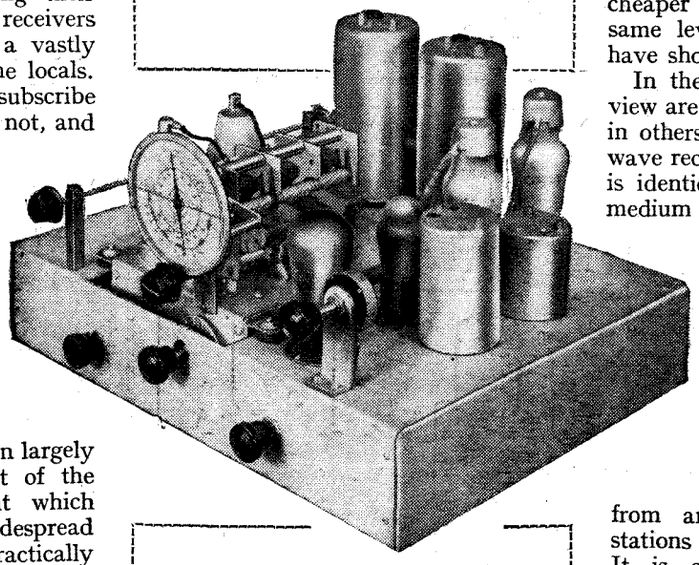
IT has been stated, probably with a good measure of truth, that the majority of listeners keep their sets tuned to the local station and rarely listen to foreign transmissions. If this be the fact, it would seem that the majority of listeners are wasting their money by buying or building receivers which are certainly capable of a vastly wider range of reception than the locals. There are some, it is true, who subscribe to this belief, but the majority do not, and whatever their reason may be they want a receiver with as wide a range as possible.

They may or may not spend 90 per cent. of their time listening to the local station, but they most certainly desire to be able to listen to foreign transmissions. Nor will any foreign station satisfy them: they must be able to make their choice.

It is this attitude which has been largely responsible for the development of the superheterodyne—a development which has been so thorough and so widespread that this type of receiver has practically ousted the straight set. Sensitive and selective superheterodynes are now made with as few as three valves and as many as twenty-four or even more.

A well-designed superheterodyne of moderate size, say five to nine valves, will enable good reception to be obtained on practically every medium and long wave channel, even when only a moderately good aerial can be erected. Some receivers are naturally better than others, but the differences are nowadays more in the quality of reproduction, the signal-to-noise ratio, and in the liability or otherwise to special forms of interference than in sensitivity or selectivity. Most sets will produce loud signals from the majority of European stations which are working on clear channels, but not all will give as good quality of reception as others.

THE CHARACTERISTICS OF THE RECEIVER



THE design of a modern receiver depends upon the performance which it is required to give and in this article the characteristics of the All-wave Super Seven are discussed. The use of this receiver with the Push-Pull Quality Amplifier is also treated.

The All-wave Receiver

This being so, it might be thought that listeners would rest content with the station-getting properties of present receivers and would demand a higher standard of performance in other respects so that better reception would be obtained. This is not the case, however. Instead, they ask for a greater choice of stations. They are no longer content with European reception, they demand world-wide reception. The tuning range of receivers is consequently being extended to cover the short wavelengths as well as the medium and long, and the all-wave receiver has made its appearance.

To the scientific mind this may seem somewhat illogical. Such a mind argues on these lines: "We have got to the point where almost any modern set will bring in all but the weakest signals. Sensitivity and selectivity in most sets are adequate, but many are lacking in quality of reproduction. The next step is thus to concentrate on quality and the attainment of a high signal-to-noise ratio. When we have got all sets as good in these respects as they now are in other matters, it will be time enough to consider short waves."

This is a reasonable attitude to take up and, in fact, the only sound one if one is aiming at perfection and considering receivers as a whole. The listener's point of view is different, however, for he knows quite well that, although some receivers are deficient in many respects, it is quite possible for him to obtain a receiver which is as nearly perfect in all its aspects as it is possible to make it. It may be expensive, but it is there if he can afford it. Why, then, should he wait until the cheaper receivers are brought up to the same level of perfection before he can have short-wave reception?

In the writer's opinion both points of view are right in some respects and wrong in others. There is no doubt that an all-wave receiver costs more than a set which is identical save that it covers only the medium and long wavebands. For a given performance the listener must pay in cash for the ability to receive short waves. In the case of the cheaper receivers this extra money would be better spent in improving the performance on the broadcast bands; the majority of listeners would obtain more pleasure for their money from an improved performance than from an increase in the number of stations which it is possible to receive. It is another matter with more expensive receivers, however, for here a high standard of performance on the broadcast bands can be provided and any improvement might cost much more than the addition of short-wave ranges. Then the listener may get more pleasure from the extra tuning range and its inclusion is entirely justifiable.

These views of the writer's are embodied in the All-Wave Super Seven.[1] In common with most "all-wave" sets, its title is one of courtesy, for its tuning range does not cover all wavelengths used in wireless communication, but only the more important part of the short wavelengths in addition to the medium and long wavebands. The receiver is primarily a highly sensitive and selective broadcast set giving a very high standard of performance on the medium and long wavebands.

Receiver Characteristics

The inclusion of variable selectivity enables the optimum balance between the conflicting requirements of selectivity and quality to be secured in all circumstances. Particular attention has been paid in design to the attainment of good characteristics in this portion of the apparatus and a novel circuit has been adopted.

[1] *The Wireless World*, August 7th and 14th, 1935.

All-wave Super Seven—

The automatic volume control system, moreover, has been specially chosen so that distortion is not introduced and the refinement of a "Local-Distance" switch has been included. This refinement is one which is not always necessary, but which may on occasion be important. Every AVC system has its overload point, that is, there is always a certain maximum signal strength which can be dealt with faithfully; any signal stronger than this is distorted. It is in local reception that such overloading is most likely to occur, and it is in such reception that the avoidance of distortion is most important. The use of a "Local-Distance" switch in effect extends the range of the AVC system and enables the strongest signals to be reproduced without distortion. Whether or not it is necessary in any individual case naturally depends upon how far one is from the local station and upon the efficiency of one's aerial.

In order to secure the maximum signal-to-noise ratio an RF stage is included and there are two signal-frequency tuned circuits, so that in view of the intermediate frequency of 456 kc/s second channel interference is effectively excluded. The frequency-changer is of modern type employing electron coupling, and is followed by two IF stages which feed a diode detector and AVC valve. This is resistance-coupled to an AF stage employing a triode. Apart from the output stage and mains equipment, the receiver thus employs six valves.

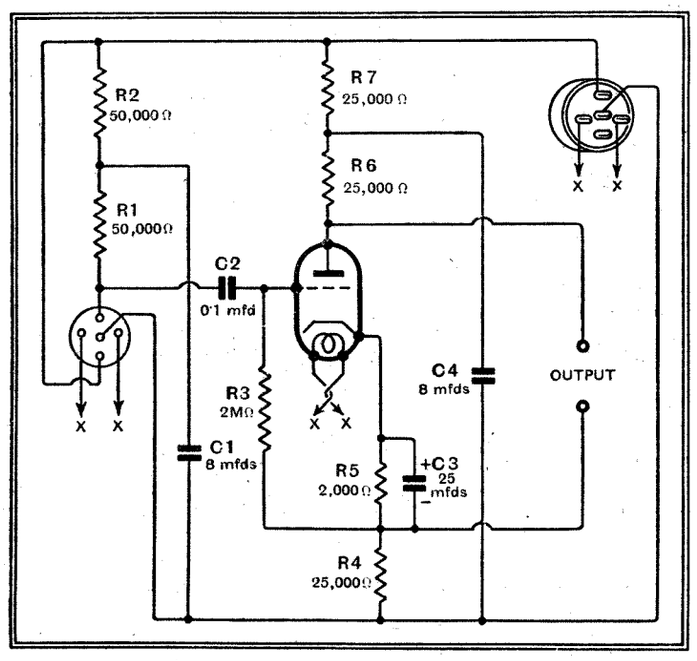


Fig. 1.—Circuit for a coupling unit to link the All-wave Super Seven with the Push-Pull Quality Amplifier.

Considering the performance on the medium and long wavebands, it would be difficult to obtain any worth-while improvement for ordinary purposes. The sensitivity is adequate for all but the most exceptional requirements. At low selectivity the distortion introduced is so small that it may be said to be negligible, and at maximum the selectivity is high enough to permit most stations to be received without interference. Higher selectivity would occasionally be of some advantage, it is true, but its attainment would involve a disproportionate increase in cost, for it would entail the addition of three more tuned circuits, another valve with its associated by-pass and decoupling components, and much more thorough screening.

From the theoretical point of view AVC could be improved, but only by the inclusion of another valve. As it is, AVC performs its main function of smoothing out fading admirably, and it is only in its inability to keep a local station down to the same level as a distant transmission that it can be said to fail. Most important of all, it does not introduce distortion as so many systems do.

It is thus clear that, although in some respects improvement in the medium and long wave performance is *possible*, it would very appreciably increase the cost of the equipment and the benefit would only occasionally be apparent. Rather than attempt it, therefore, it was felt that it would be more beneficial to include a short-wave tuning range. Here, again, cost is an important factor, and each additional range adds to it, since more coils and trimmers have to be provided as well as a larger chassis to contain them.

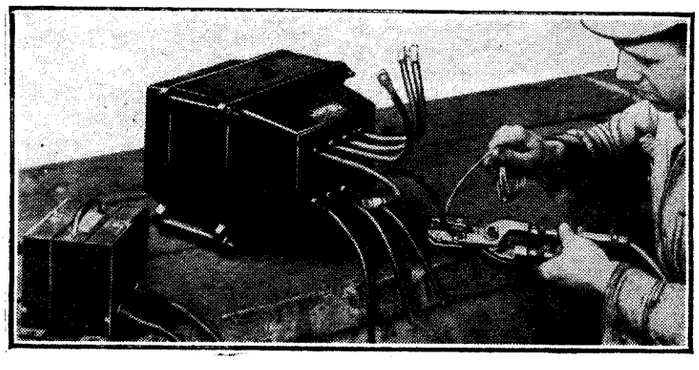
On balance it was felt that a single short-wave band would meet most requirements, since the majority of the world's short-wave broadcasting stations could be included within it. The range obtained is actually some 16-50 metres. Below 16 metres, the only stations of importance are some of the Empire transmissions and W8XK on 13 metres. The former are of no importance in this country, since they can rarely be well received on account of the skip-distance and the directional aerials which are used. Above 50 metres, there is also very little to be received in most cases.

All the most interesting stations fall within the tuning range and at suitable times the American W3XAL, W2XAD, W2XE, and W8XK, the French Radio-Coloniale, the German Zeesen, and the Italian Rome and Vatican City transmissions can be very well received among others. In addition the 20- and 40-metre amateur bands are included, and on the former it is common to hear American amateurs working on telephony. There is thus plenty to interest one on this band.

Turning now to the output stage, this is built with the mains equipment as a separate unit in order that alternative apparatus may readily be employed. The power unit designed for the receiver includes a single PX4 valve fed through a high-quality transformer, and giving an output of some 2.5 watts. This is adequate for many requirements and enables very good quality to be secured when large volume is not needed.

For the highest standard of reproduction and where large volume is needed the Push-Pull Quality Amplifier,[2] the PA Amplifier,[3] or the amplifier of the Pre-tuned Quality Receiver[4] can be used. A feeder-unit is needed for the connection between the receiver and amplifier and the unit described in *The Wireless World* for August 16th, 1935, is suitable. It is, of course, necessary to provide a resistance-capacity coupling between the last valve of the receiver and the feeder unit and to provide decoupling for this last valve. Alternatively, a unit can be built to the circuit of Fig. 1, and this method has the advantage that no balancing adjustment is necessary. The resistance R1 provides the coupling from the last valve of the receiver and R2 and C1 decouple the anode circuit of this valve. The split output necessary for push-pull is obtained across the equal resistances R4 and R6, and decoupling is provided by R7 and C4. The valve can be of almost any type without appreciably affecting the performance; the MH4 or MHL4 or their equivalents in other makes are entirely suitable.

[2] *The Wireless World*, May 11th and May 18th, 1934.
[3] *The Wireless World*, April 3rd and April 10th, 1936.
[4] *The Wireless World*, September 25th and October 2nd, 1936.



NEW-STYLE SOLDERING IRON. These American "Hot-Jaw Pliers" as they are called, combine the functions of a soldering iron and a pair of pliers. They are heated from the mains through a step-down transformer.

RANDOM RADIATIONS

By "DIALLIST"

High Fidelity

LIKE myself, you've probably heard one or more of this season's high-fidelity sets. If so, you were no doubt impressed particularly by the way in which they handle the upper audio frequencies, which make speech clear and help to give brilliance to music. At the same time, it may have occurred to you that the upper-register performance of these sets takes us not only forward, but also *back* to the quite early days of wireless. The old horn loud speaker brought out the upper audio frequencies amazingly well. If you don't believe me, and have one tucked away in junk cupboard or lumber room, pull it out and link it *via* a suitable transformer to the "extension" terminals of your set. Unless the latter has a sharpish cut-off at 4,500 cycles or a little more, you may be surprised by the performance of the old loud speaker. It has no bass, of course; but its treble may be a bit of a revelation after some moving-coil loud speakers.

Why We Lost the Treble

It's rather interesting to trace the way in which we lost for a time the brilliant treble that years ago was such a marked feature of radio reproduction. The first big step towards real quality was the introduction of the Western Electric "Kone" loud speaker. This was a balanced-armature instrument with a markedly good bass response; it did not, however, deal too well with the high notes. I remember that I used to run mine in double harness with an ancient Amplion fitted with a largish exponential horn.

The craze for bass became so great that the treble was largely neglected in reproduction. Then, as Prague Plan followed Geneva Plan and Lucerne Plan Geneva, the need for selectivity increased until it became customary to make sets with a cut-off at about 4,500 cycles. We lost sight very largely of the treble, and it is only now that it is returning in commercial receivers with the high-fidelity set. Except for the "locals," there are comparatively few transmissions on which you can give high fidelity its head—unless you don't mind high-pitched heterodyne whistles. Still, it's well worth while, for it does make you realise how very good the B.B.C. transmissions are.

Felt Wants

LATELY I've been noting down some of the things which seem to me to be badly needed in receiving sets. Most of them are only quite small and inexpensive fittings, but their presence or absence makes a deal of difference. First of all, a dial-light switch for battery sets. You need the dial to be illuminated only when you're tuning-in a station or searching round. As the greater part of everyone's listening is to the local stations, there is little point in wasting LT current—and using up the filament life of the lamp—by keeping it alight when you're nowhere near the set. An arrangement has been devised whereby the dial light is turned on by pressing the tuning knob inwards against a spring; directly the pressure is released it is switched off automatically. Then there's a real demand for another switch to cut out the internal loud speaker at will, leaving the one connected to the extension terminals still at work. Both kinds of switches are found in a few sets, but not in enough.

And Some More

And there are some other things that would be popular, in case designers care to make a note of them. In some battery sets you can't install or replace the HTB without removing half a dozen screws to get the back off. If a back to the cabinet is necessary, why not fix it with clips? In both mains and battery sets the little panels containing the aerial and earth sockets and those for pick-up and extension loud speaker are sometimes rather inaccessible and the sockets may be so close together that the insertion of the plugs is a fiddling business. Instruction books should be accurate; I've come across one or two lately whose text doesn't agree with the illustrations and others which give minute directions for connecting leads that don't exist! Bigger tuning knobs, particularly in "all-wave" sets, and larger and more openly marked dials would be welcome. The McMichael people put down the success of their new radiogram largely to its big, easy-to-read dial. Lastly, the positions of wave-change switches should always be clearly indicated; it's rather annoying to have to strike matches or use a flashlamp to discover what the short-wave or the gramophone position is!

Those Place Names

THE more I listen to the news bulletins the more annoyed do I become with the B.B.C. habit of trying to pronounce foreign place names as they are pronounced in their own countries. News from Spain, for instance, sometimes becomes almost incomprehensible on this account. What is the gain to anyone when Gijon is pronounced Hee-hone, or Majorca My-yorka?

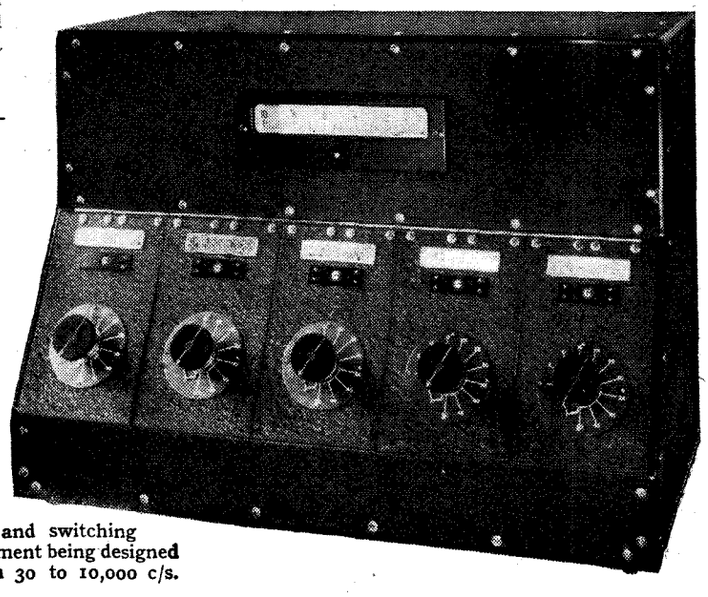
It isn't as if the B.B.C. accent was always correct. I'm told by Spanish experts that announcers make some pretty fair bloomers in their mouthing of the place names of Spain. Wouldn't it spare announcers a lot of awkward moments and be much to the advantage of listeners if this kind of thing were dropped and foreign names were pronounced as you and I pronounce them while talking to one another? We'd feel like kicking the fellow who described a visit to Vallyatholeeth or asked for Barthelona nuts!

The Luck of the Toss

WHOEVER does the tossing for the Baird people is a good deal luckier than some of our county cricket captains! Three times now Bairds and E.M.I. have spun a coin (a real golden sovereign, so I'm told) for the honour of having first innings, and each time the Baird representative has won. For the Radio Exhibition demonstrations, for the October test transmissions, and for the regular programme service to begin on November 2nd it was the same story. "Heads" (or maybe "Tails"), cried the Baird man, and heads (or maybe tails) it was. By the law of averages the E.M.I. caller should soon start having a run of successes—except that there now seems to be nothing left to toss for.

Better and Better

Meanwhile the television test transmissions continue to reach higher and higher levels. One of the best things yet done was the televising of Henry Hall's dance band, which came through to perfection, showing the characteristic attitudes and mannerisms of the performers to the life. Other big successes were the meeting of the Model Aeroplane Club in the grounds of the Alexandra Palace and a non-stop variety programme. I've asked a good many people who have seen the results of both systems which they thought the better. It's early days yet to say definitely, for neither team has yet got properly into its stride, and both may have cards up their sleeves. The general opinion is that, so far, the Baird system gives the clearer results on "close up" of individuals and on talking films, but that the E.M.I. emitron camera is superior to the delayed-film process for big scenes in the studio and for outdoor work.



BRITISH RADIO APPARATUS FOR ABROAD.

A five-channel microphone control panel recently made by Trix Electrical for the Lithuanian Government Broadcasting authorities. The contract included the supply of a companion amplifier rack with main and auxiliary amplifiers, rectifier units and switching panels, the whole equipment being designed for level response from 30 to 10,000 c/s.

Recent Inventions

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

ALL-WAVE AERIALS

A COMPACT form of aerial, capable of receiving signals ranging from the ultra-short to long, consists of three parallel wires of different length, spaced apart on common supports. The longest wire, for instance, is anchored to a bracket attached to the chimney stack, and passes through two other brackets on its way down to the set. A second bracket is fixed half-way down the roof, and also serves as the terminal fixing for a second aerial. The third bracket is fixed near the end of the roof and serves as a guide for the first two aerials and also as a terminal fixing for the third and shortest aerial. One or all of the aerials may be provided with capacity "loading" at the insulated end.

K. T. Hardman. Application date August 23rd, 1935. No. 450714.

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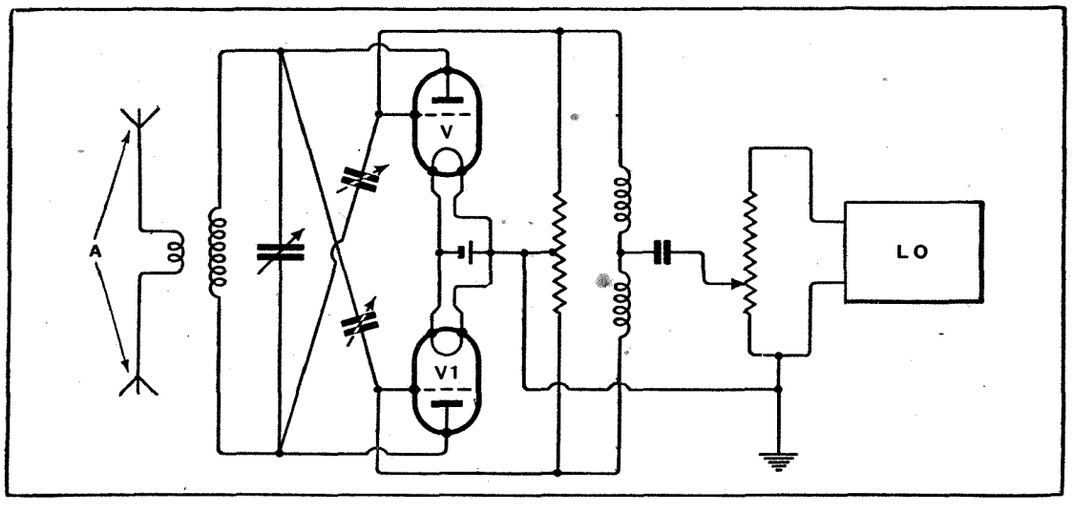
SUPER-REGENERATIVE RECEIVERS

THE super-regenerative type of circuit is particularly suitable for handling ultra-short waves, though it is often difficult to prevent the "quenching" oscillations from affecting the quality of the received signals. This is due to the fact that both the quenching frequency and the AF signals share the same path, and that the "tone" or frequency characteristic of the latter is impaired in the process of separation.

The inventor has discovered that when a signal is received, the quenching oscillations are modulated by it and develop corresponding side-bands. He accordingly amplifies the local frequency and derives the required signals from it by demodulation.

As shown in the figure, the local, or quenching frequency, is supplied from a valve V1 to the anode circuit of the back-coupled input valve V. The grid of the latter is coupled to the next amplifier V2 through a circuit L, C tuned to the quenching frequency, which is accordingly passed on for subsequent amplification and detection.

L. H. Paddle. Application date January 5th, 1935. No. 450150.



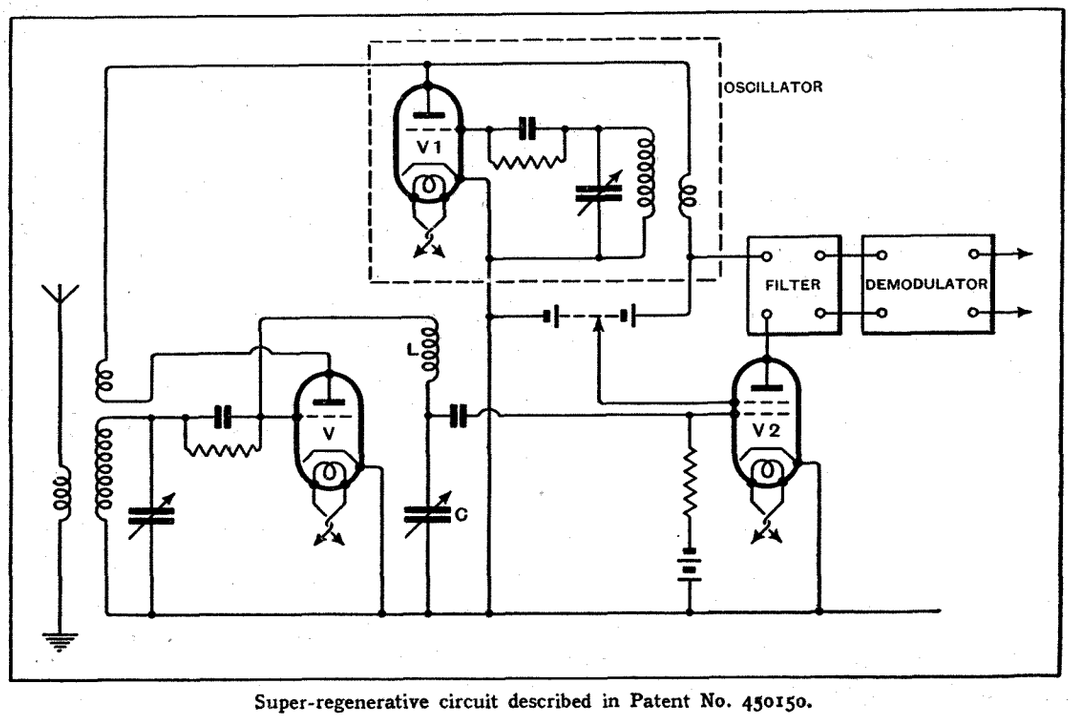
Automatic repeating circuit for ultra-short-wave signals.

SHORT-WAVE SIGNALLING

ULTRA-SHORT-WAVE signals are automatically relayed from point to point by means of a chain of unmanned relay stations whereby the effective range of operation is extended far beyond the so-called "optical" distance. It is, however, necessary to prevent "singing" at the relay by the reaction between the incoming (weak) signals and the outgoing (amplified) signals. According to the invention this is accomplished by using a receiving circuit of the super-regenerative type, which amplifies the incoming waves, but is periodically checked or "quenched" before the valves become overloaded.

As shown in the figure, weak incoming signals are received on a dipole aerial A which is coupled both to the anodes and grids of a pair of push-pull valves V, V1. The signals reappear, greatly amplified, in the anode circuit, and are fed back to the aerial A for retransmission. Meanwhile the amplifiers V, V1, are checked from self-oscillation by the quenching-frequency supplied from a local oscillator LO.

Standard Telephones and Cables, Ltd. (assignees of A. B. Crawford). Convention date (U.S.A.) May 24th, 1935. No. 450810.



Super-regenerative circuit described in Patent No. 450150.

DIRECTIONAL AERIALS

THE Adcock type of aerial is insensitive to ether waves which are polarized horizontally. For this reason it is free from the so-called "night-effect" which is produced by the reflection of waves from the Heaviside Layer, and which makes it difficult to take accurate bearings at night-time on an ordinary frame aerial.

According to the invention the usual inductive coupling between the horizontal transmission lines used for feeding the signal pick-up from an Adcock aerial to the common receiver or indicator is replaced by a potentiometer coupling. The feed lines are connected to the potentiometer by brushes, which are rotated to the position in which minimum signal strength indicates the bearings of the distant transmitter.

Standard Telephones and Cables, Ltd. (assignees of Le Materiel Téléphonique). Convention date (France) November 20th, 1934. No. 451019.

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TELEVISION IN COLOUR

THE object is scanned by a helix mirror supplied with different coloured lights, say, red, green, and blue, and the reflected light falls on three photo-electric cells through similarly coloured filters. The resulting signal currents are fed to the receiver over separate channels. Delay networks introduce the phase difference required to compensate for the different spacing of the light sources.

H. E. Ives (assignor to Bell Telephone Laboratories Inc.). Nos. 2037166 *and* 2037167.

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CONTENTS

EDITORIAL COMMENT

Short Waves

Popularity a Gradual Process

INTEREST in the short-wave bands is not really a new activity because, although this season a very large proportion of the broadcast receivers have been fitted with tuning ranges covering the more interesting short-wave broadcasting bands, the short-waves have for years been the happy hunting ground of the amateur. Amateurs, especially those who have learned to read morse, have had a wealth of interest available to them on the short waves, and those few who have been licensed to use short-wave transmitting sets have been even more fortunate.

The purpose of this present Short-Wave Issue of *The Wireless World* is to encourage readers, and especially those who hitherto have not interested themselves in short waves, to become more familiar with these bands and feel at home when operating a short-wave set.

Leading the Public

We have heard it said that the public, although they are buying broadcast receivers fitted with short-wave bands for the sake of novelty, are not, as yet, getting much advantage from the possibilities of short-wave reception. It is here, we feel, that readers of *The Wireless World* can assist by helping their less-technical friends to make the most of the opportunities which short-wave receivers provide. The layman, familiar with reception on the normal broadcast bands, is often at a loss when tuning on the short waves, and is probably rather at sea as to where to search for the most promising results.

Although the short-wave bands which have been added to the normal broadcast receivers provide an excellent introduction for the public to short-wave reception, the possibilities of distant short-wave reception ought not to be finally judged on this standard because in many cases the addition of a short-wave band has been made to a standard receiver with little or no extra cost to the purchaser and so can hardly be regarded as the last word in efficiency on these waves. As interest increases we may expect improvements in design to be made gradually.

Television Aerials

Demand That Should Be Met

AMONG the suggestions advanced recently regarding an aerial for the reception of television signals is one that consists of a vertical portion half-a-wavelength long and terminating in a matching section to which is joined a 70-ohm concentric transmission line. One advantage claimed for this scheme is that the low-impedance line, being a co-axial cable with a metal outer conductor, is quite easy to install, for it can be clamped to the wall, taken through rooms, or even buried underground. Since the outer conductor is earthed it possesses the advantages of an anti-interference system.

Cables of this kind have been available in the U.S.A. for some time past, yet no attempt has been made, so far as we are aware, to introduce them here. It must be admitted that there was little demand for them before the advent of television, but the time would now appear to be opportune to give serious consideration to the merits of the system, and if there is sufficient justification for it then manufacturers should take the necessary steps to produce the required equipment with the least possible delay.

Which are the Short Waves?

URGENT NEED FOR RATIONAL CLASSIFICATION OF WAVELENGTHS

By F. L. DEVEREUX, B.Sc.

A GOOD deal of confusion has arisen in the application of the terms "short" and "ultra-short" to the lower wave-ranges in "all-wave" broadcast receivers. The article discusses alternative approaches to the problem of wavelength classification and suggests a possible solution.

MANY people who, after many years of listening, pride themselves on knowing their way about the medium- and long-wave ranges feel entirely at sea when introduced to an "all-wave" set for the first time. Even those who have had experience of one of the simpler sets of this type with a single short-wave band must be somewhat shaken when they see sets advertised with an additional "ultra-short" band which are yet incapable of receiving even the sound accompaniment to the television programmes. Beyond the short waves, indeed! At 7 metres we are barely on the fringe.

To gain the right perspective let us compare the average layman's mental picture of the distribution of wavelengths with the spectrum drawn up on a scientific basis. Fig. 1 (*a*) may be taken as a fair average of most people's idea of the distribution of wavelengths in the region of the ether spectrum devoted to broadcasting. Below the television transmissions on the left of the spectrum and above the long-wave broadcast band on the right may be imagined extensive regions as yet undeveloped as far as broadcasting is concerned.

Now, to be of any value, a spectrum intended to indicate the space available for broadcasting stations should be plotted on a linear frequency scale if it is to show which are the "built-up areas" and which the open spaces awaiting development. The reason for this is that the channels required by broadcasting stations are of approximately equal width when the side-band frequencies are taken into account. A wider channel is required for the transmission of vision than for high-quality sound, but the necessity for a frequency scale applies in both cases.

The spectrum in Fig. 1 (*b*) covers all the wavelengths which it has so far been

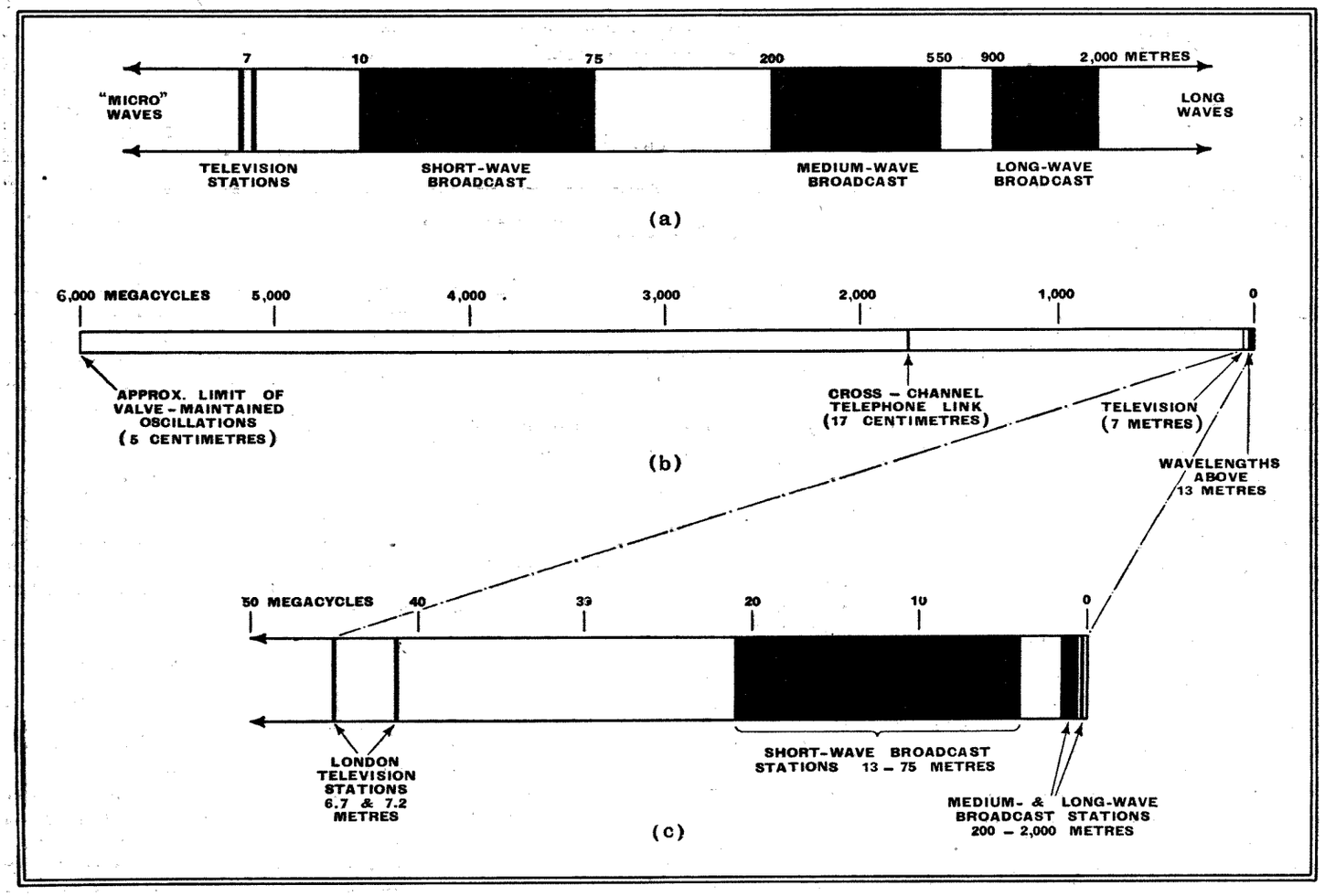


Fig. 1.—The average listener's conception of the relative width and spacing of wavebands used in broadcasting (a) compared with the spectrum plotted on a frequency basis, (b) and (c). The middle scale (b) gives a true picture of the space available for development on "ultra-short" wavelengths.

Which are the Short Waves?—

found possible to sustain as continuous oscillations by means of valves. All the wavelengths used in broadcasting, including the "shorts" and so-called "ultra-shorts," are so crowded together near the long-wave (low-frequency) end of the scale that it is necessary to enlarge them as indicated by the dotted lines to the size of Fig. 1 (*c*) in order that a closer analysis may be made. It will be seen that our mental picture of the distribution is but a distorted image of the true state of affairs. As for the application of the term "ultra-short" to wave ranges terminating at 13 metres, this will probably sound as quaint in a few years' time as does this extract from an article on the construction of a short-wave receiver which appeared in an issue of this journal in 1920: "There are a number of wireless men who possess first-class receiving sets which give excellent results on wavelengths of from 1,000 metres, but when an attempt is made to go lower than this great difficulty is experienced . . ."

If more than one short-wave band is provided, it is surely better to number them and to adopt the convention that No. 1 SW band is the first to be encountered on descending from the medium waverange, No. 2 SW the next lower in wavelength, and so on.

Receiver Technique

But this is by the way. Our problem at the moment is to find some general classification of wavelengths which is readily applicable to present needs, but which will not be rendered obsolete by possible future developments. Any nomenclature will "date" which is based solely on current practice, and it is for this reason that one promising method of subdivision is open to objection. We refer to the more or less well-defined points at which changes in receiver technique become necessary as the wavelength is reduced.

Nowadays, normal broadcast receiver practice, as exemplified in sets designed for the medium- and long-wave broadcast bands only, is easily extended without modification down to 50 metres. Between 50 and 15 metres, however, severe crowding of stations is apparent when using the standard 0.0005 mfd. type of tuning condenser, and the designer is faced with the alternative of using a smaller capacity or of providing a slow-motion drive with a high reduction ratio. The set also becomes susceptible to microphonic noises arising both in the valve and in the vanes of the tuning condenser, and it becomes necessary to mount the chassis on rubber supports.

Below 15 metres a modified form of broadcast receiver construction is still permissible, but close attention must be given to stray capacities and the achievement of low contact resistance in the waverange switches. Down to about 5 metres direct RF amplification is still possible, but becomes increasingly difficult. The region below 5 metres, which is as yet undeveloped from the broadcasting point of view, calls for a complete change in receiver technique, and skeleton construction with inductances mounted directly on valveholders, etc., becomes a necessity. Valves of normal design are also difficult to work, and push-pull circuits, or, alternatively, special miniature valves, must be adopted. In the case of transmitting valves where, on account of the high power to be dissipated the dimensions cannot be kept sufficiently small, magnetron and electron oscillator circuits are usually adopted. Since new valves are always making their appearance, however, it is possible that any classification on this basis may be upset before very long.

A more permanent source of classification is to be found in the properties of the waves themselves. The propagation of wireless waves over the surface of the earth is effected in two ways, namely, by the ground wave and by the sky wave which is reflected from the Kennelly-Heaviside layer or ionosphere. Above 1,000 metres the ground ray predominates and signals are disseminated with little attenuation other than that consequent on the natural spreading out of the wave with distance. Below 1,000 metres the effect of the ground ray diminishes and reflection from the ionosphere results in fading effects and marked differences between the day and night ranges of a station. Below 200 metres the reflected ray begins to play a predominant part. Its importance is established beyond question when the 100-metre mark is reached, and below 100 metres the skip distance effect comes into play.

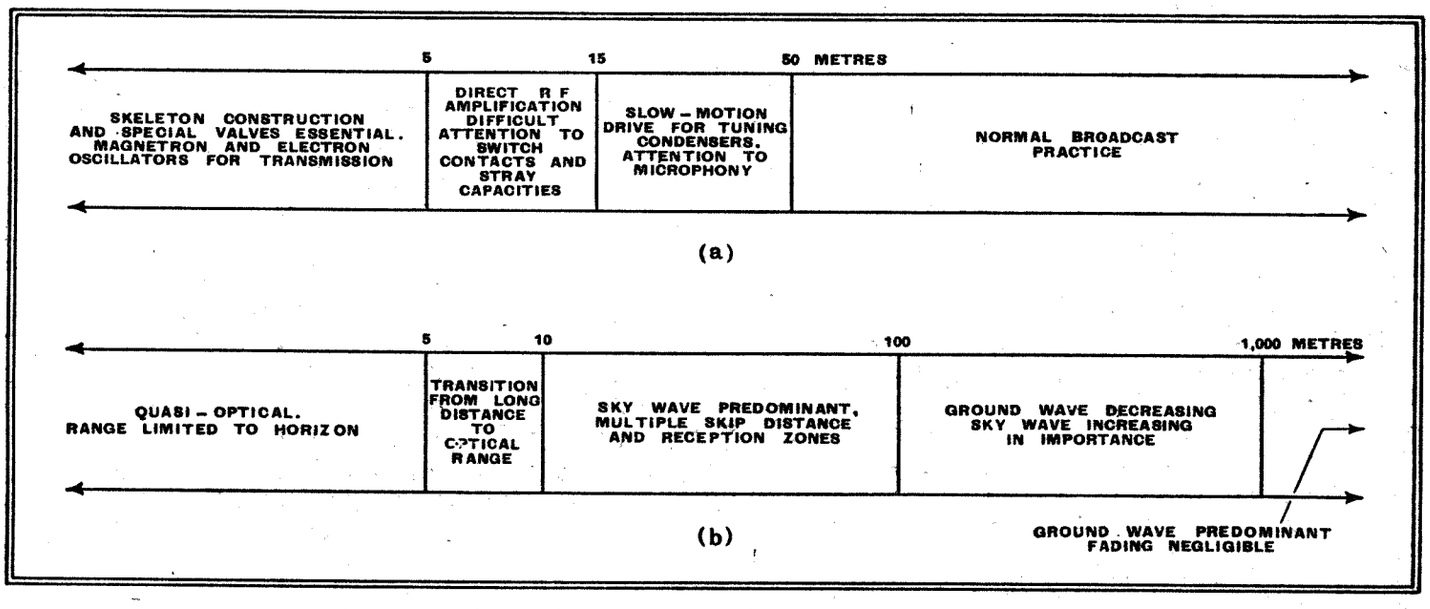


Fig. 2.—Possible methods of wavelength classification (a) according to circuit technique and (b) on the basis of propagation characteristics. A logarithmic scale has been adopted for convenience in lettering.

The band from 100 down to 10 metres is a very useful one for long-distance communication, as by selecting a suitable wavelength it is possible to arrange for a high degree of signal strength at some given far-distant point at all times of the day and night and at different seasons of the year. The multiple reflections between the ionosphere and the ground account for the excellent reception of far-distant short-wave broadcasting stations, and most long-distance communication services will be found in this region.

"Optical" Wavelengths

The point at which reflection from the ionosphere ceases and the transmission acquires "optical" properties is at the moment difficult to define, but it lies somewhere between 5 and 10 metres, probably about 8 metres. Below 5 metres, in the absence of a ground wave and a reflected sky wave, the range is limited to the horizon visible from the transmitting aerial.

The difficulty with the foregoing

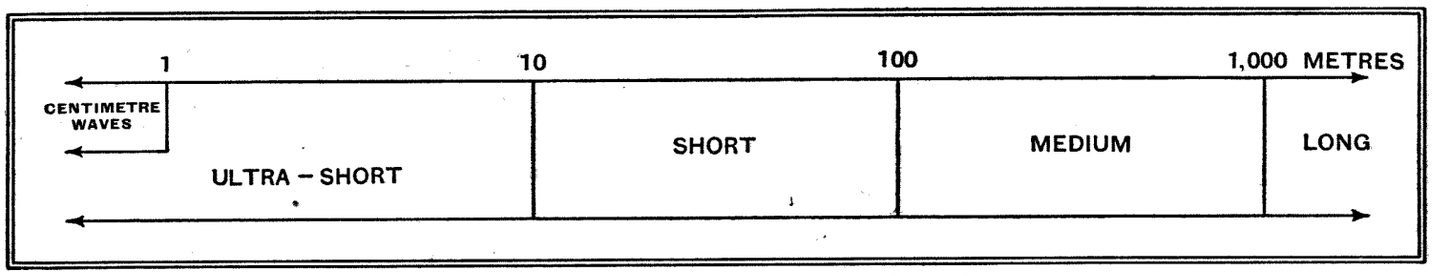


Fig. 3.—Suggested final classification with boundaries at 10, 100 and 1,000 metres. "Centimetre" waves are included in the wider category of "ultra-short" waves.

method of classifying wavelengths is the absence of hard lines of demarcation between the different modes of propagation. Strictly speaking, classification on a decimal or metric basis is the only one which gives sub-divisions which are not of an arbitrary character. On this basis wavelengths above 1,000 metres might be described as kilometre waves, those from 100 to 1,000 metres hectametre waves, 10 to 100 metres decametre waves, 1 to 10 metres metre waves, 0.1 to 1 metre decimetre waves, and 0.01 (1 cm.) to 0.1 metre as centimetre waves. This is rather an academic classification, but any attempt at simplification, say, by restricting the sub-divisions to centimetre, metre, and kilometre waves would give bands which are too wide to be of any value.

A Satisfactory Compromise

It would seem, therefore, that the best solution is one of compromise in which all the foregoing methods of approach have contributed their share. There is general agreement that the essential characteristics of long waves are well established at and above 1,000 metres, while those of short waves begin to assert themselves at and below 100 metres. That being the case, it is logical to classify the intervening wavelengths between 100 and 1,000 metres as medium waves, and to avoid confusion the 200 and 550 band might be termed the medium *broadcast* range. It may be thought that a medium waveband from 100 to 1,000 metres is rather too broad, but it would be a pity to introduce further sub-divisions in this category if at some not-far-distant time the centre of interest in broadcasting should shift to a lower waveband where more room is available for high-quality broadcasting.

There is likely to be less controversy about the next proposed sub-division, namely, that from 100 down to 10 metres. Here is a region in which the properties of the waves themselves and the methods applied to their reception are both well defined. Clearly, these are the short waves.

Below 10 metres the mode of propagation and the methods of reception and transmission undergo a fundamental change, and we see no reason why the term "ultra-short"—already well established—should not continue to be used, provided that it applies to *all* wavelengths below 10 metres. For convenience, wavelengths below 1 metre might be termed "centimetre" waves, but this should be clearly understood to be a local sub-division within the wider category of the ultra-short waves.

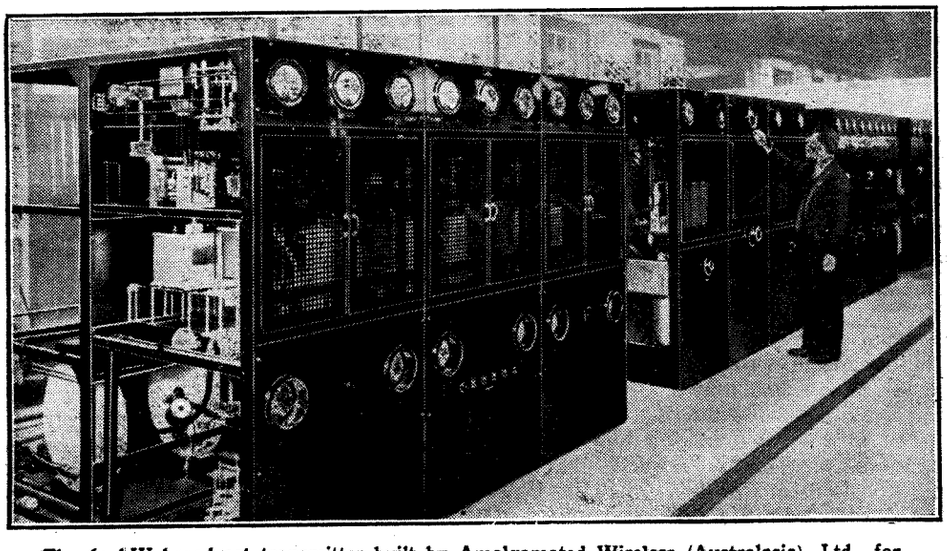
The suggested final classification is epitomised in Fig. 3, and, if generally adopted, should go far to clear up the present confusion of thought and expression when dealing with wavelengths below the familiar medium and long broadcast bands.

Giant Broadcaster for New Zealand

AMALGAMATED Wireless (Australasia), Ltd., has just completed what will be the largest broadcasting station of its nature in the Southern Hemisphere. The transmitter is to be erected at Wellington in a geographical position which should enable it to serve a large area of each of the two islands of which the Dominion is composed. The apparatus was supplied to the order of the New Zealand National Broadcasting Service.

The photograph shows the transmitter temporarily assembled to undergo testing trials before being shipped to New Zealand. This is the fifth broadcast transmitter constructed and installed by A.W.A. for the New Zealand National Service in the past three years.

The importance of this new station may be judged when it is revealed that its power exceeds the combined power used by all the broadcasting stations in the capital cities of the neighbouring Commonwealth of Australia; these stations, of course, serve a much larger population.



The 60 kW broadcast transmitter built by Amalgamated Wireless (Australasia), Ltd., for erection at Wellington on behalf of the New Zealand National Broadcasting Service.

A Guide to Amateur Radio. Fourth edition. Published by the Incorporated Society of Great Britain, 53, Victoria Street, London, S.W.1. Price 6d.

FOR many years now the expression "Radio Amateur" has been a synonym for any keen experimenter interested in the short waves solely as a pastime. It is therefore most appropriate that the history of the amateur movement should be dealt with in the first chapter of the latest edition of a Guide to Amateur Radio, now in its fourth year of publication.

That interest in amateur experiments is not only well sustained but actually attracting more enthusiasts is perhaps well exemplified by the fact that the present issue of the Guide contains over 120 pages, as compared with the 48-page publication of 1933.

Though it is intended mainly for the beginner, the experienced amateur will find much to interest him, since the various sections are contributed by amateurs who have made a special study of the subjects of which they write. It is very well illustrated, both in the matter of circuits and of actual apparatus, and the subjects cover every aspect of amateur radio.

Some very useful information is given in Chapter 13 on "How to Become a Radio Amateur," assuming that the beginner has hopes of one day obtaining the necessary permission to operate a transmitting station. The advice given is very sound.

It is a handbook that will be of great assistance to all those interested in the amateur movement. H. B. D.

Short Waves and the Constructor

PRACTICAL HINTS AND TIPS

By W. T. COCKING

ALTHOUGH the circuit diagram of a short-wave receiver may differ little from that of a broadcast set, an examination of the complete apparatus may reveal surprising variations. Much heavier conductors are often used and much smaller values of decoupling and by-pass capacity, while every endeavour is made to keep leads as short as possible.

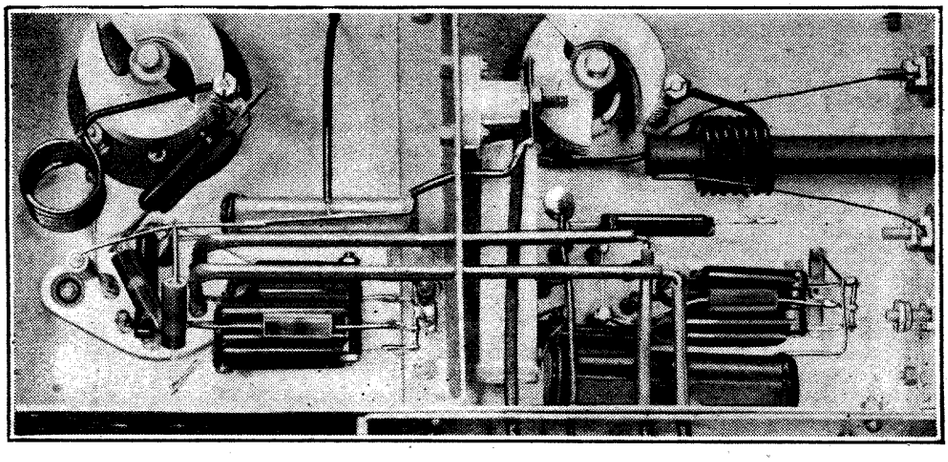
Difficulties in short-wave receiver design are all brought about by the high frequencies involved and they are more readily appreciated if we think in frequency rather than the more familiar wavelength. The medium-wave broadcast band of 200-500 metres corresponds to a frequency range of 1.5 — 0.55 Mc/s, but in the short wavelengths of 10—50 metres the corresponding frequencies are as high as 30 — 6 Mc/s.

Now the reactance of an inductance is proportional to frequency and the reactance of a capacity is inversely proportional to frequency, so that it is clear that at 30 Mc/s a stray capacity coupling will have a reactance only one-twentieth of that at 1.5 Mc/s, while a common inductance coupling will have a reactance twenty times as great. It can easily be seen that if we have a layout of components which is just satisfactory from the point of view of unwanted coupling at 200 metres (1.5 Mc/s) it will not be so at 10 metres (30 Mc/s); to obtain the same freedom from interaction the couplings must be reduced to one-twentieth of the value.

Now every piece of wire has inductance, capacity and resistance. In the case of connections, the inductance and resistance are usually negligible at broadcast frequencies and we are consequently accustomed to think only of the capacity of the leads to other objects. At high frequencies, however, not only is this same capacity much more important, but the inductance may become appreciable. At low frequencies, foot-long leads to a by-pass condenser are unimportant, nor are they important on the broadcast band save in so far as they may couple with other circuits. At high frequencies, however, their inductance may be high enough for the reactance to be greater than that of the condenser, so that in effect the condenser is not connected.

Condensers themselves possess inductance, however, and this was widely recognised some years ago when it was discovered that a 1 mfd. paper condenser ceased to act as a condenser at wavelengths below about 1,000 metres! This led to the production of the so-called non-inductive condenser. Actually, such a condenser still has inductance but considerably less than that of older types; the resonance frequency of a 1 mfd. type is usually about 1 M/c and it is a satisfactory by-pass over the broadcast bands.

Nowadays smaller capacities are used and these naturally have a lower inductance also and are consequently effective at much higher frequencies. Even mica-type condensers have some inductance, however, and as a result it is necessary to use small capacities at high frequencies. The purpose of a decoupling or by-pass condenser is to offer as low an impedance as possible at the working frequency. If it were not for the inductance, the impedance would always fall with an increase in the capacity. There is inductance, however, and in consequence the minimum impedance is secured not with the largest capacity but with that value of capacity which resonates with the inductance at the working frequency. Every condenser should thus be thought of as a series resonant circuit.



An underview of an experimental ultra-short-wave receiver. The oscillator components are in the left-hand compartment and the grid circuit of the RF valve in the right.

Mechanical Details

On ultra-short wavelengths (below 10 metres) a mica-dielectric condenser of about 0.0005-0.001 mfd. offers the minimum impedance, and for general short-wave working mica-type condensers of some 0.01 mfd. offer the best compromise for a wide waveband. In an all-wave set, it is sometimes necessary to use two condensers in parallel. A 0.01 mfd. mica condenser for the short wavelengths in parallel with a 0.1 mfd. paper condenser for the broadcast bands is sometimes used. Care is needed in the choice of capacities in relation to the wavelengths, however, for it is possible for parallel resonance to occur at some frequency when there are two condensers in parallel and at that frequency the impedance will be abnormally high.

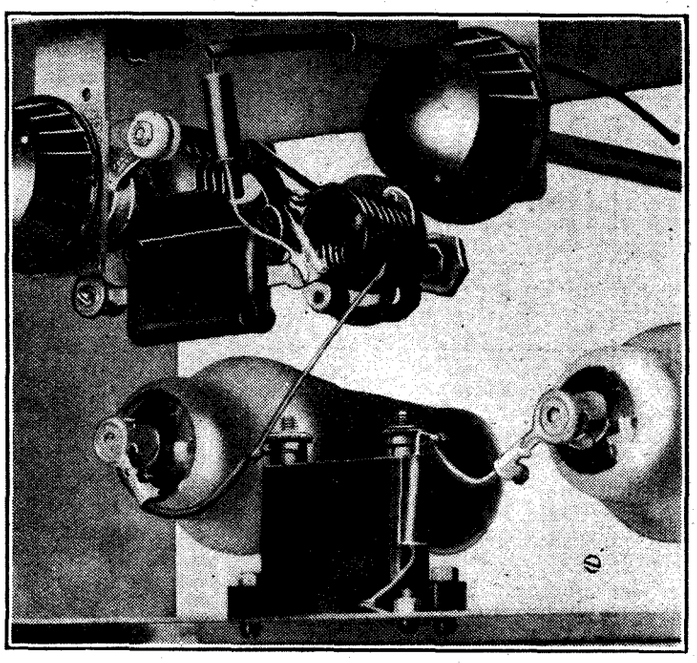
When it is remembered that a mica-type condenser may have enough inductance to resonate with its capacity within the working range of the set, it is easy to understand the vital importance of short leads. If they are to be effective, condensers must be connected right on the job, and experience has shown that a very simple and effective construction which gives the minimum possible length of lead is that shown in one of the accompanying illustrations.

This form of construction is best adapted to 7-pin valveholders of the chassis mounting type. In the case of a triode-hexode, the screen by-pass condenser is slipped between the cathode and screen-grid pins on the one hand and the anode and oscillator-grid pins on the other, and its tags soldered directly to the screen and cathode pins. A bunch of three condensers then has the three tags at one end soldered together and to the chassis and the three tags at the other end are soldered directly to the cathode and each

Short Waves and the Constructor—

of the heater pins. Heater by-pass condensers are usually necessary because the heater wiring is generally of high enough impedance at radio frequencies to cause trouble; an alternative path is desirable.

In addition to points such as these, the general layout is of great importance. It is of little use striving after short leads if this means that the components are brought so close together that large couplings exist between them; better long leads than this. By careful design, however, it is possible to combine the two to a very large degree. In general, the best results are secured when the layout follows the circuit diagram as far as possible. Not only is such an arrangement often electrically the best, but it is usually also the easiest mechanically and gives a maximum of accessibility to the parts. Its disadvantage is that it sometimes leads to rather a large receiver, since there is a good deal of waste space.



An upper view of the equipment showing the intervalve coupling mounted close to the top caps of the valves.

It is not always necessary to follow this practice throughout a receiver, but only in important stages, such as the RF and FC stages of a superheterodyne.

One method which has been found very satisfactory in experimental apparatus is to mount the valves horizontally and to divide the metal chassis into three compartments. The RF pentode has a top anode connection whereas the triode-hexode has a top grid, so that the layout falls very conveniently with the valve-holders at opposite ends of the chassis. We thus start off in one compartment with the tuned input circuit to the grid of the RF valve and all the decoupling necessary to this stage. The middle compartment contains the intervalve coupling, and the third the oscillator circuits and frequency-changer decoupling. With the exception of the return leads from the intervalve coupling, all leads are less than about two inches long and many are much shorter. The return leads from the intervalve coupling are necessarily fairly long for they must return to the valve cathodes. They can obviously be shortened with any layout only by using shorter valves.

The anode-lead of the frequency-changer is led out through the side of the chassis to an IF transformer mounted alongside. This is an important point, for it has been found that in certain cases the inductance of a long anode-lead can cause a frequency-changer to generate parasitic oscillations.

An alternative arrangement is the one adopted in the apparatus illustrated. The valves are mounted vertically and side by side, the RF valve grid circuit and the oscillator components being grouped around the valveholders. The intervalve coupling is fitted at a higher level so that it directly joins the anode and grid of the two valves.

When switching must be introduced in order to permit a number of wavebands being covered, it is usually impossible to secure such short leads and the difficulties of design are greatly accentuated. Fortunately, the designer is afforded some relief in that longer leads become progressively less important as the wavelength increases. If he can succeed in keeping them very short on the shortest waveband, the other bands can more or less look after themselves.

Nevertheless, switching always introduces some losses and a single-band receiver is much nicer both theoretically and practically. Unfortunately, few will tolerate it.

A New Text Book

Principles of Radio Engineering. By R. S. Glasgow, M.S. 520 pages + xii, 344 illustrations. Published by McGraw-Hill Publishing Co., Ltd., Aldwych House, London, W.C.2. Price 24s.

AS the technique of wireless advances it becomes increasingly important that the student should have a sound knowledge of the conditions which govern the operation of various circuits. The basic principles, of course, do not change with time, but the increased complication of modern circuits entails a more thorough understanding of them, and in particular of their application in solving practical problems. The author has been wise, therefore, in devoting the major portion of the book to an analysis of the more commonly used circuit arrangements.

He opens by a preliminary chapter in which the fundamentals of wireless theory are briefly but competently discussed. The standard of the book is such that most of the material in this section should be at least fairly familiar to the reader, but its inclusion will serve well to refresh his memory of fundamental facts. The theory of resonant circuits is discussed in the second chapter, and this is followed by one dealing with the properties of coils and condensers. Coupled circuits and transformers are also treated, and a chapter is devoted to valve theory.

The chapter on audio-frequency amplification contains no fewer than eighty pages, and the treatment is particularly good. The different methods of intervalve coupling are explained and analysed, as also are the operating conditions of output valves. The discussion here is not confined to single triodes, but push-pull operation receives the attention which it deserves. Graphical methods of distortion calculation are given, and both Class B and Class AB methods of operating push-pull output stages are treated, in addition to Class A. Pentodes are, of course, included, and the up-to-date outlook will be realised when it is said that even negative feed-back amplifiers receive a mention.

The input impedance of a triode is treated in a somewhat unusual manner, for it is expressed as the combination of a series resistance and reactance for an anode circuit load impedance also expressed as the combination of a series reactance and resistance. It is, of course, usual to express the impedances as the parallel combination of resistances and reactances, for this convention leads to somewhat simpler equations.

RF Technique

By comparison with the space devoted to amplifiers for audio-frequencies those operating at radio-frequencies are rather briefly treated; oscillators and power RF amplifiers are well dealt with, however, while both modulation and detection are adequately discussed. The concluding chapters on receiving systems, aerials and wave propagation are necessarily rather more general, but the matter contained in them forms a good grounding for those whose particular interest in these more specialised subjects leads them to seek more detailed information elsewhere.

The book is unusually free from errors, but a mis-statement regarding the decibel occurs on page 171. The decibel is actually a method of expressing a power ratio, and the number of decibels is ten times the logarithm of the ratio of the powers. This is correctly stated by the author's equation (25), but he goes on to say in equation (26) that the decibel is also twenty times the ratio of two voltages, and omits to state that this is true only when both voltages are developed across the same value of resistance. The error is of importance because he recommends the use of the decibel to express the gain of an amplifier. A figure for gain expressed in this way, however, is meaningless unless the value, or at least the ratio, of the input and output impedances is also stated.

The book is well printed and bound, and can be confidently recommended to all desiring a text book covering in a thorough manner the more important aspects of wireless theory. The treatment is to a considerable degree mathematical, but not unduly so.

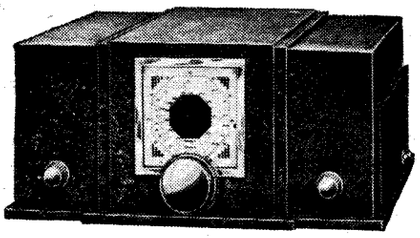
W. T. C.

Specialised Receivers

NON-STANDARD SETS FOR THE SHORT WAVEBANDS

OUT-OF-THE-WAY requirements, particularly on the shorter wavelengths, are now well catered for by various makers of special-purpose receivers. Among those described in this section are to be found "overseas" sets, covering two or more short wavebands in addition to the medium broadcast band; these sets have also a certain appeal to home listeners who take short-wave reception seriously. There are also more specialised sets, including many which cover only the short and/or ultra-short bands; most of these differ from standard broadcast receivers in that they are generally used with an external loud speaker and sometimes with an external power supply unit.

EDDYSTONE.—Although it is designed primarily for overseas requirements and is built to withstand tropical conditions, the Eddystone All-World 8 is by no means without interest to the short-wave enthusiast at home. A superheterodyne circuit with a total of eight valves is employed; the set is for battery operation, and wave changing is effected by interchanging inductance units



Eddystone "All-World 8" receiver.

which normally cover from roughly 13-34, 27-69 and 240-573 metres, although additional units are available for other short wavebands as well as for long broadcasting waves from 800-2,000 metres.

A separate loud speaker is employed, and the set, without accessories but with valves and the three inductance units mentioned above, costs £27 10s.

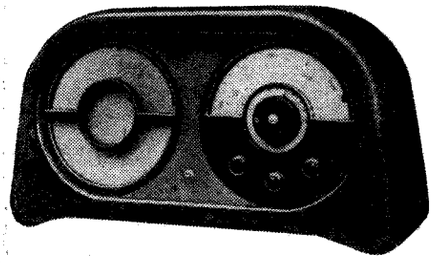
The "Homelander" is a rather less ambitious receiver with a TRF circuit covering waves from 13-85 and 250-550 metres in two steps. It embodies a built-in speaker and is battery operated; the price is £12 10s.

The Eddystone All-World 4 is mounted in a die-cast aluminium alloy cabinet and is exceptionally flexible in the matter of wave range, as interchangeable coils are used. The coils normally supplied cover from 13.6-95 and 250-500 metres, but other windings for short, intermediate and long bands are available. This is also a battery set.

Several short-wave sets, transmitters, converters, etc., for the home constructor are described in the Eddystone Short Wave Manual.

* * *

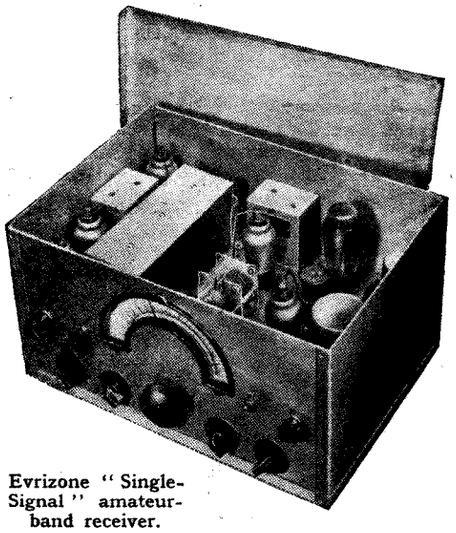
EKCO.—The Ekco SW86 superheterodyne is an AC receiver manufactured for export only, tropical proofed components being used throughout in its construction. Wave coverage is 13.3-28, 27-60, and 200-560 metres. A pentode first detector and separate triode oscillator are preceded by a signal-frequency stage, and the output valve is a pentode. The bakelite cabinet in which this receiver is housed has been found particularly suitable for overseas conditions.



Ekco superheterodyne for short and medium wavelengths.

* * *

EVRIZONE.—The Evrizone "Single-Signal" superheterodyne is a specialised set designed for the amateur bands—10, 20, 30, 40, 80 and 160 metres. It is available either for AC, DC or universal mains supply, and the extreme selectivity which is required for



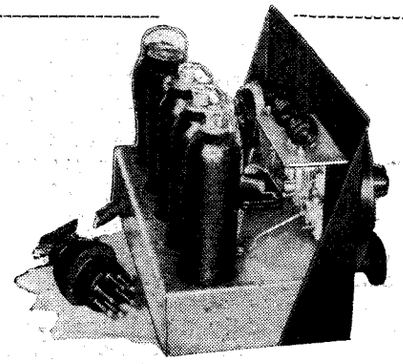
Evrizone "Single-Signal" amateur-band receiver.

amateur working under certain conditions is obtained partly by the use of reaction, which takes place both in the tuned RF stage and in the IF amplifier. Band selection is carried out by interchanging triple-coil units, and the form of tuning adopted—ganged, but with external trimmers—is extremely practical for a receiver of this kind. The AC or DC model costs £20, an extra charge of £2 being made for the AC/DC version. A special tropical model costs 50s. extra. Prices do not include power supply or AF amplifier, but suitable units can be supplied.

* * *

EPOCH.—One of the very few commercial receivers designed exclusively for working on the ultra-short waves is the Epoch superheterodyne, made by the Radio Development Co. By using appropriate coils wave ranges between 1.5 and 10 metres may be received.

The circuit arrangement includes an RF pentode as frequency changer and two variable-mu RF pentodes with resistance coupling as IF amplifiers; the second detector feeds into an output pentode. All-metal valves are used throughout.

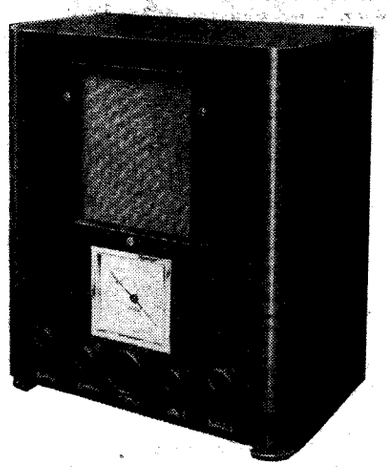


Epoch ultra-short-wave superheterodyne.

The receiver unit, which is exceptionally compact, does not include power equipment, but a companion unit is available for supplying anode and heater current.

* * *

G.E.C.—Except for the fact that it has a special tuning dial, the G.E.C. model BC3782 is externally a conventional superheterodyne. However, it covers three short wavebands (16-36, 36-98, 80-220 metres) in addition to the medium broadcast band. It is an AC model giving the exceptionally large output of 6 watts from push-pull valves; there are six other valves in all. Variable selectivity is included.



G.E.C. four-band "overseas" model with 6-W output.

The receiver complete costs 25 gns. and is also available in radio-gramophone form at 44 gns.

* * *

GRAHAM-FARISH.—The "Quest Short Wave Two" is a battery set, supplied in the form of a kit of parts, which covers wavebands of 12-25 and 21-50 metres by means of plug-in coils; an extra coil for the 38-102 metre band is available.

The detector is a special short-wave screened-grid valve with a ceramic base and a top grid cap; an interesting feature is the

Specialised Receivers—

application of reaction to the screening grid. This valve is coupled by the auto-transformer to an output pentode. The kit of parts, complete with valves, costs £3 10s. 6d.

A somewhat similar receiver for which a kit is produced at the price of £4 10s. is the "Discovery" model, with a circuit essentially similar to that of the two-valve set, but with the addition of an RF stage. Wave changing is effected by a switch, but coils for the 38-102 metre band can be plugged in.

* * *

HAYNES RADIO.—Model DS superheterodyne for AC mains is essentially a short-wave set, no medium or long wavebands being covered, and this fact is taken advantage of in the design of the IF amplifier. Wavelengths from 5.5 to 60 metres are dealt with in five steps, and the circuit comprises an X41 frequency-changer with ganged input and oscillator circuits, followed by a two-stage IF amplifier which includes a total of six tuned circuits. The output valve is a pentode rated at 2½ watts.

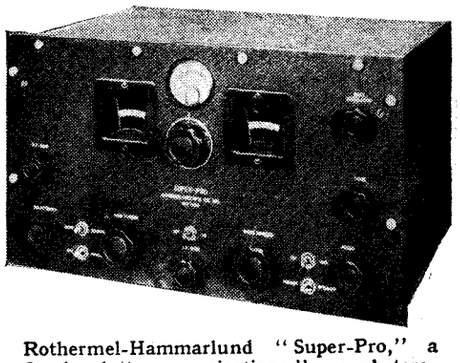
Unlike many of the other Haynes productions, this receiver is built as a single unit complete with mains equipment, and is available if required with suitable modifications to accommodate American valves. The complete unit costs £18 10s.

* * *

LISSEN.—A detector-2AF circuit is used in the Lissen Band-Spread Short Wave Three set which is supplied as a kit of parts for the home constructor. The set is for battery operation, and, as its title implies, parallel tuning condensers are used in order to minimise the difficulties usually encountered in short-wave tuning. Wavelengths between 13 and 55 metres are covered in two steps, and a switch change-over is provided. The complete kit of parts costs £3 9s. 6d.

* * *

ROTHERMEL - HAMMARLUND. — In the Rothermel-Hammarlund "Super Pro" receiver the technique followed is rather that of Service or "communications" apparatus than that of broadcasting or amateur sets. A wave-range coverage of from 15 to 555 metres is given in five steps without gaps. The circuit is an exceptionally ambitious one, including 2 RF and 3 IF amplifying stages, a separate oscillator and beat oscillator (the latter for CW reception), and a separate AVC valve and bias rectifier.



Rothermel-Hammarlund "Super-Pro," a five-band "communications" superheterodyne.

The receiver is essentially one for the wireless user who takes the subject seriously, as there are no fewer than fourteen controls; these give extreme flexibility, but for ordinary requirements the set is quite simple to operate as tuning is fully ganged.

AC power supply equipment is built into a separate unit, and the set complete except for loud speaker costs 85 gns.

* * *

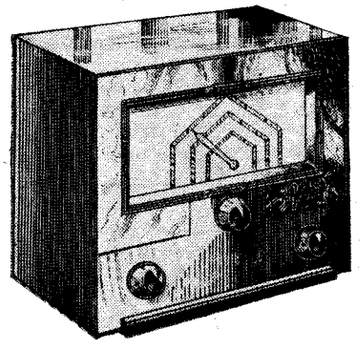
UNIRAD.—In addition to the medium broadcast band, the Unirad AC superheterodyne, Model SM5/M7, covers three short wavebands—12.5-28, 27-81 and 80-230 metres. A triode-hexode frequency-changer is preceded by an RF stage, and there is an intermediate AF amplifier which, incidentally, is controlled for AVC as well as the other valves already mentioned.

All coils for the short wavelengths are wound "on air" with copper tube, while other windings are specially impregnated and stoved to withstand exacting climatic conditions. The receiver costs £29.

Converters and Adaptors

Short-wave Reception with Normal Sets

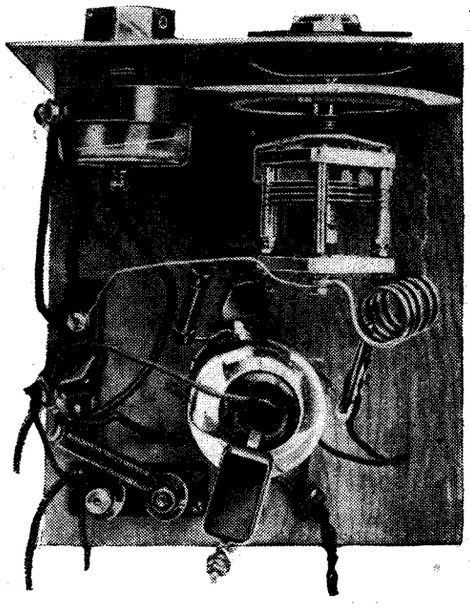
AERIALITE.—Two Aerialite short-wave converters are produced for working in conjunction with either mains- or battery-operated sets. Model No. 1 is a single-valve auto-



Aerialite No. 2 Converter.

dyne oscillator covering a single short-wave band from 16-52 metres.

Model No. 2 is similar, but covers 13.5-65 metres in two steps with switch change-over; there is also a third position on the



Bennett Television Co.'s "Guinea Kit" assembled.

switch, which automatically makes the appropriate changes in connections between the receiver and unit in order that the wiring need not be disturbed. These converters cost £2 7s. 6d. and £3 3s. respectively.

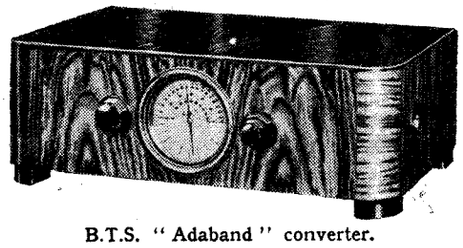
* * *

B.T.C.—There are three B.T.C. kits (price 21s.) for home constructors, including converter-adaptors for AC mains and battery sets and an electron-coupled converter for ultra-short wavebands; the latter covers the 5-10-metre band and so includes the television frequencies. The converter-adaptor kits can be used as single-valve receivers.

There is also a B.T.C. converter-adaptor supplied ready wired in a metal cabinet at 30s. (for either battery or mains receivers).

* * *

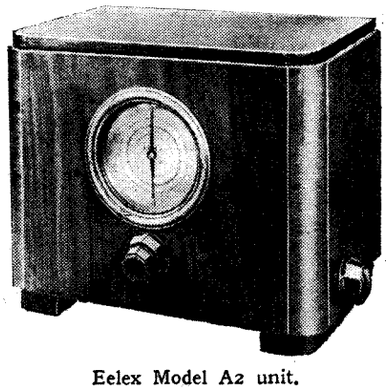
B.T.S.—Both battery and AC/DC versions of the B.T.S. Adaband short-wave converter are produced. The mains model embodies its own rectifying equipment, and a heptode frequency-changer is employed. Appropriate circuit alterations are carried out by a change-over switch, no coil changing being necessary. The mains and battery models cost, respectively, £6 12s. 6d. and 5 gns., while there is a somewhat simpler converter at the price of £2 12s. 6d.



B.T.S. "Adaband" converter.

EELEX.—Two screened grid valves, one working as a detector-amplifier and the other as a separate oscillator, are employed in the Eelex M2 converter for AC mains; the unit includes its own power supply gear, and operation is simplified by the provision of constant reaction. Two wavebands (15-30 and 28-55 metres) are covered by reversing the coil in its base. This model costs £8 15s.

Model A2 converter covers wavelengths between 14 and 55 metres in two steps, and all wiring changes are effected by a switch. This model and its AC/DC counterpart, Model U2, are suitable for AC or universal receivers; both cost £4 14s. 6d. A third converter, Model B4, which employs a triode oscillator, is suitable for either battery or AC sets and costs 39s. 6d.



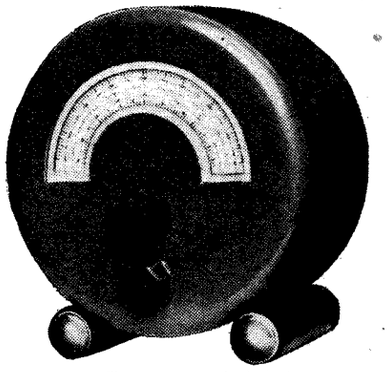
Eelex Model A2 unit.

Converters and Adaptors—

EVRIZONE.—Evrizone single-valve and two-valve converters are each made for AC or battery supplies. All models cover wavelengths between 14 and 162 metres in four steps with switch change-over; the single-valve converters are intended for super-heterodynes, while the two-valve models, which include an IF stage, are for straight receivers. Prices are respectively £5 and £7 10s.

* * *

FARREX.—Circular all-metal containers are used to house the Farrex converters, which are available in several styles. Model F1 embodies a universal mains power pack, and so can be used with any AC, AC/DC, or DC mains receiver; the wavelength covered is from 12 to 100 metres, with switch



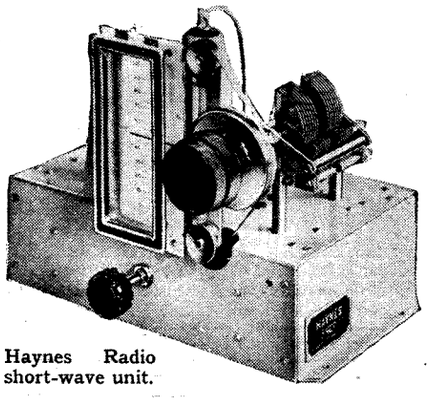
Farrex converter.

change-over. This unit costs 79s. 6d., while Model BF2, for battery receivers, is essentially similar, but without the power pack.

Model AF3 is designed to draw its power supply from an AC receiver and is fitted with suitable adaptors; it costs 59s. 6d.

* * *

HAYNES RADIO.—A wave-range of from 5.5 to 60 metres is covered in five steps by the Haynes short-wave converter, which is primarily designed to operate with the two-HF tuner produced by this firm. The unit draws its power supply from the receiver and requires 4 volts 1 amp. and 220 volts HT. A triode-hexode valve is employed as a frequency-changer. The unit costs £5 15s. 6d. with valve.



Haynes Radio short-wave unit.

OSTAR-GANZ.—A heptode frequency-changing valve of the indirectly heated high-voltage type is employed in the Ostar-Ganz short-wave converter supplied in the form of a kit of parts at the price of £4 10s. by Eugen Forbat. The instrument employs plug-in coils, and covers wavelengths between 15 and 90 metres in three steps. The unit is, of course, for universal mains operation and includes its own rectifying valve.

PETO SCOTT.—An AC/DC power unit is included in the Peto Scott converter, which may accordingly be used in conjunction with any mains set, irrespective of the form of supply. A heptode frequency-changer is employed; waverange changing is by a switch, and the band covered is from 13 to 74 metres. A switch change-over from broadcast to short waves is also provided. The complete instrument costs £4 17s. 6d.

* * *

R.I.—Models of the Antinodal short-wave converter are available both for mains- and battery-driven receivers. A switch change-over is provided between the 12-35 and 30-90 metre bands which the instrument covers. The price of the AC or DC converter is £6 5s., while the battery model costs £4 15s.

* * * *

REGENTONE.—Television waveranges are within the scope of the Regentone short-wave converter, which has a coverage of from 6½-80 metres in two steps with switch change-over; the switch is also arranged to make the appropriate alterations in the aerial circuit for either normal broadcast or short-wave reception. A triode-hexode valve is employed as a frequency-changer. This converter is completely self-contained with its own power equipment; in the AC form it costs £4 19s. 6d., and for AC/DC £5 5s.

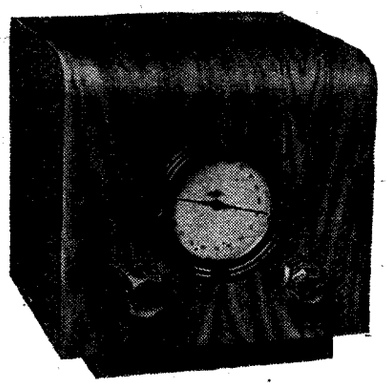
* * *

SCIENTIFIC SUPPLY STORES.—The "Scientific" converter-adaptor can be used either as a short-wave tuner or as a super-heterodyne converter; it covers a wave-range of from 14 to 66 metres and costs 39s. 6d. complete. A kit of parts is available for the home constructor at 28s.

This firm also supplies kits of parts for converters, etc., described in this journal.

* * *

UNIRAD.—A somewhat unusual refinement in the form of a signal-frequency HF



Peto Scott "Short-wave Pre-selector."

stage is to be found in the Unirad short-wave converter, which, for AC supplies, costs £8 and includes rectifying equipment. The frequency-changer is a pentode.

The waverange coverage is 13-55 metres, and the unit works in conjunction with a broadcast set tuned to 500 metres.

* * *

UNIT RADIO.—In the Model 523 converter, which embodies a combined change-over and waverange switch, special precautions are taken to overcome the difficulty sometimes brought about by the looseness of coupling between the aerial and grid circuits of the normal broadcast receiver. This model is for either AC or battery receivers, and costs 50s. Model 506 covers a more extended range (5-100 metres) and is a completely self-contained unit available for battery receivers at £3 2s. 6d., or for mains supply at £3 15s.

* * *

VIDOR.—This converter is battery operated and has a waverange of from 13.5 to 51 metres. The price is £2 7s. 6d.

B.B.C. EMPIRE TRANSMISSIONS

The following are the official call signs, times, wavelengths and aerial directions of the various transmitters at the Daventry Empire Station. Great care should be taken, however, to listen in to the announcements from the station as these particulars are always liable to be changed at short notice.

Transmission No.	Call Sign.	Frequency Mc/s.	Optimum Direction.	Times (G.M.T.).
1	GSO	15.18	West	17.15–21.00
	GSB	9.51	East and West	8th Nov.–27th Feb. (1937) 08.00–10.00
2	GSH	21.47	North and South; East and West	11.00–13.45
	GSF	15.14	East...	
3	GSH	21.47	North and South; East and West	14.00–17.00
	GSF	15.14	East...	
	GSB	9.51	East and West	
4	GSI	15.26	North and South	17.15–21.00
	GSD	11.75	North and South	17.15–21.00
	GSB	9.51	North-West and South-East ...	17.15–21.00
	GSF	15.14	West	21.05–22.45
	GSD	11.75	East and West	21.05–22.45
	GSB	9.51	North and South	21.05–22.45
5	GSP	15.31	East and West	23.00–01.00
	GSD	11.75	North-West and South-East ...	
	GSC	9.58	East and West	
6	GSD	11.75	North-West and South-East ...	02.00–04.00
	GSC	9.58	North-West and South-East ...	

The remaining six transmitters, not included in the above schedule, have the following frequencies (given in Mc/s.): GSA, 6.05; GSE, 11.86; GSG, 17.79; GSJ, 21.53; GSL, 6.11; GSN, 11.82.

GUIDE TO ALL-WAVE RECEIVERS

SALIENT FEATURES OF THE MULTI-BAND SETS

ALTHOUGH there never has been—and possibly never will be—a true all-wave set, the current expression is nevertheless a convenient one to describe a receiver covering medium and long broadcasting waves, plus one or more short wavebands. Most of the receivers enumerated in this classified list are primarily broadcast sets, but a few tend towards specialisation in the short-wave region. In many cases the chassis described are available in radio-gramophone or console form.

Make.	Model.	Type.	Supply.	Short Waveband(s) (Metres).	Other Wavebands (Metres).	Price.	Remarks.
AERODYNE ..	49	TRF	Battery	18–50	200–550; 800–2,000	7 gns.	Batteries extra.
	51	TRF	Battery	16.5–50	200–550; 800–2,000	8 gns.	„ „
	52	TRF	AC	16.5–50	200–550; 800–2,000	9 gns.	——
	55	TRF	AC/DC	16.5–50	200–550; 800–2,000	9½ gns.	——
	54	Superhet	AC	16.5–50	200–550; 800–2,000	13 gns.	——
ALBA	870AC ..	Superhet	AC	17–50	200–550; 760–2,000	11 gns.	Iron-cored coils.
	870U	Superhet	AC/DC	17–50	200–550; 700–2,000	12 gns.	„ „
	850AC ..	Superhet	AC	19–50	200–550; 900–2,000	14 gns.	„ „ Two IF stages.
ANSON	Commander ..	Superhet	AC	8–16; 16–57.5; 57–187	187–555; 850–2,050	185 gns.	24-valve radiogram, with fully automatic record changer; bifurcated AF amplification.
ARMSTRONG ..	8-Valve ..	Superhet	AC	13.5–35; 34–85	200–550; 800–2,000	£9 17 6	Chassis and valves only; phase-reversed push-pull.
	Colonial 8-valve	Superhet	AC	12.5–40; 40–100	200–550; 800–2,000	11 gns.	Chassis and valves only; RF stage; 6-W. push-pull output.
BRITISH BELMONT	825	Superhet	AC/DC	16–50	190–560; 930–2,100	£10 17 6	——
	746	Superhet	AC	15–55	195–590; 800–2,100	12½ gns.	——
	845	Superhet	AC/DC	15–55	195–590; 800–2,100	13 gns.	——
	856	Superhet	AC	15–55	195–590; 800–2,100	17 gns.	Pentode output, 5 W.
BRUNSWICK ..	BTA/1 ..	Superhet	AC	16–49	175–550; 1,000–2,000	16½ gns.	Nine tuned circuits.
	BGA/1	Superhet	AC	16–49	175–550; 1,000–2,000	32 gns.	Radiogram; 8 valves, 9 tuned circuits.
BURGOYNE ..	AWS	Superhet	AC	19–55	200–570; 800–2,000	14 gns.	" Mirraflex " large-scale dial.
	AWT	TRF	AC	19–51	200–570; 800–2,000	9½ gns.	Also available in AC/DC form.
	AWP	TRF	Battery	19–52	200–550; 1,000–2,000	8 gns.	Suitcase portable; SW reception with short external aerial.
BURNDEPT ..	251	TRF	Battery	13.5–48.5; 48–145	200–580; 900–2,000	£7 19 6	Price includes batteries.
	252	TRF	AC/DC	13.5–48.5; 48–145	200–550; 900–2,000	9 gns.	——
BUSH	SSW33 ..	Superhet	AC	17–53	198–550; 850–2,000	11½ gns.	——
	SSW37 ..	Superhet	AC	17–53; 75–200	198–550; 850–2,000	15 gns.	Optional plate aerial; triode output.
C.A.C.	Austin Empire	Superhet	AC	9.4–29; 21–75	200–550; 800–2,000	16 gns.	Litz coils; 3-circuit IF input transformer.
CARLISLE	47	Superhet	AC	17–50	200–560; 800–2,000	11 gns.	Iron-cored coils.
CLIMAX	DX5	Superhet	AC	12–30; 25–80	200–550; 800–2,000	14 gns.	Wavelength and frequency calibration.
COSSOR	3733	*	Battery	17.25–72.5	200–500; 826–2,000	£7 15 0	Without batteries.
	3783	*	AC	17.25–72.5	200–500; 826–2,000	£9 15 0	——
	3774	Superhet	Battery	16–40; 38–100	195–550; 1,000–2,000	13 gns.	Without batteries; Class " B " output.
	3764	Superhet	AC	13–40; 38–100	195–550; 1,000–2,000	15 gns.	——
	* Special circuit: superhet on short waves; TRF on medium and long.						
DECCA	520	Superhet	AC	16–49	200–550; 1,000–2,000	12½ gns.	" Uni-selector " control system.
DEGALLIER ..	600	Superhet	AC	15–52	190–550; 900–2,000	£8 0 0	6 valves.
	700	Superhet	AC	15–52	190–550; 900–2,000	11 gns.	8 valves.
	800	Superhet	AC	11–39; 39–64	190–550; 900–2,000	13 gns.	Also as console and R-G.
	900	Superhet	AC/DC	11–39; 39–108	190–550; 900–2,050	£16 0 0	12 valves.
	524	Superhet	AC	8–39; 39–108	190–550; 900–2,000	£40 0 0	Twin speakers; 24 valves.
DYNATRON ..	V84	—	AC	11–28; 27–55	200–550; 800–2,000	26 gns.	(All models.) Superhet on SW bands; TRF
	V93	—	AC	11–28; 27–55	200–550; 800–2,000	36 gns.	on other bands. Signal frequency SW stage;
	E167	—	AC	11–28; 27–55	200–550; 800–2,000	120 gns.	triode output, 3.5 or 7 W.
EKCO	AW87	Superhet	AC	19–50	200–590; 800–1,950	12 gns.	Export Model.
EVER READY ..	5001	Superhet	AC	13–33; 30–80	198–556; 900–2,000	18 gns.	——
	5013	TRF	AC/DC	18.5–54	202–560; 900–2,000	9½ gns.	——
	5015	TRF	Battery	18.2–54	202–560; 900–2,000	8½ gns.	Pentode output. Price includes batteries.
EVRIZONE ..	BD710	Superhet	Battery	13.5–30; 25–50; 45–90; 85–162	200–550; 800–2,000	£20 0 0	Pentode push-pull output; batteries included.
	UP69	Superhet	AC/DC	17–53	200–550; 800–2,000	13 gns.	Pentode output 3.1 W.
	AD68	Superhet	AC	14–30; 25–50; 45–90; 85–162	200–550; 800–2,000	£16 0 0	„ „ 3.5 W.
	AD78	Superhet	AC	14–30; 25–50; 45–90; 85–162	200–550; 800–2,000	£20 0 0	Pentode push-pull output, 7 W.
	AD59	Superhet	AC	17–53	200–550; 800–2,000	14½ gns.	Pentode output, 3.5 W.
	AP69	Superhet	AC	17–53	200–550; 800–2,000	18½ gns.	Pentode push-pull output, 7 W.

Make.	Model.	Type.	Supply.	Short Waveband(s) (Metres).	Other Wavebands (Metres).	Price.	Remarks.
FERGUSON ..	378	Superhet	AC	13–30 ; 30–60	200–550 ; 1,000–2,000	16½ gns.	Push-pull pentode output, 8 W.
	378	Superhet	AC/DC	13–30 ; 30–60	200–550 ; 1,000–2,000	16½ gns.	„ „ „ 5 W.
	366	Superhet	AC/DC	16–50	200–550	10 gns.	——
	365	Superhet	AC	13–30 ; 30–60	200–550 ; 1,000–2,000	22 gns.	Radio-gramophone.
FERRANTI ..	Arcadia ..	Superhet	AC	19–51	200–550 ; 900–2,000	15 gns.	8 stages. Magnascopic dial ; triode output ; var. selectivity.
	Magna ..	Superhet	AC	19–51	200–550 ; 900–2,000	12½ gns.	7 stages ; pentode output.
	Magna ..	Superhet	AC/DC	19–51	200–550 ; 900–2,000	13½ gns.	„ „ „
	Nova	Superhet	AC	19–51	200–550 ; 900–2,000	12 gns.	„ „ „
	Nova	Superhet	AC/DC	19–51	200–550 ; 900–2,000	13 gns.	„ „ „
	Nova	Superhet	Battery	19–51	200–550 ; 900–2,000	11½ gns.	——
	Parva	TRF	AC	19–51	200–550 ; 900–2,000	9 gns.	——
	Parva	TRF	AC/DC	19–51	200–550 ; 900–2,000	9½ gns.	——
FOURWAVE .. (Rogers-Majestic)	11-6	Superhet	AC	16.4–53	176–540 ; 750–2,000	18½ gns.	——
	11-8	Superhet	AC	16.4–53	176–540 ; 750–2,000	40 gns.	Triode push-pull output, 10 W. Console model.
	11-9	Superhet	AC	16.4–53	176–540 ; 750–2,000	65 gns.	Triode push-pull output, 15 W. Radiogram.
	11-11	Superhet	AC	16.4–53	176–540 ; 750–2,000	70 gns.	„ „ „ Console.
G.E.C.	BC3745 ..	Superhet	AC/DC	15.8–50	200–550 ; 900–2,200	12½ gns.	——
	BC3750 ..	Superhet	AC	15.8–50	200–550 ; 900–2,200	15½ gns.	Var. selectivity.
	BC3780/1 ..	Superhet	AC	16–36 ; 36–98	200–550 ; 1,000–2,000	25 gns.	Push-pull pentode output, 6 W. ; var. selectivity ; tropical finish.
H.M.V. .. .. (The Gramophone Co.)	800	Superhet	AC	13–25 ; 24–46 ; 45–80	200–550 ; 1,000–2,000	110 gns.	High-fidelity radiogram, 15 valves ; PP output, 10 W. ; var. selectivity ; 2 speakers.
	801	Superhet	AC	7–16 ; 16.7–53 ; 46–140	185–560 ; 750–2,200	80 gns.	High-fidelity auto-radiogram ; PP output, 10 W. ; 3 speakers ; 2 tone controls.
	581	Superhet	AC	7–16 ; 16.7–53 ; 46–140	185–560 ; 750–2,200	48 gns.	Bureau auto-radiogram ; pentode output, 3 W. ; also as normal radiogram and table model.
	480	Superhet	AC	16.7–53 ; 46–140	185–560 ; 750–2,200	17½ gns.	Vernier scale ; 2 tone controls.
	482	Superhet	AC	16.5–51.5	200–580 ; 725–2,000	16 gns.	Vernier scale ; " fluid light " indicator.
	491	Superhet	AC	16.5–52	195–575 ; 725–2,000	13½ gns.	5 valves.
	486	Superhet	AC/DC	16–50	200–580 ; 750–2,000	13½ gns.	4 valves.
	149	TRF	Battery	18–50	195–560 ; 785–2,000	9½ gns.	Pentode output. Price includes batteries.
HALCYON	Royal County ..	Superhet	AC/DC	16.5–51	190–560 ; 850–2,000	12 gns.	——
	Briton ..	Superhet	AC/DC	16.5–51	190–560 ; 850–2,000	10 gns.	——
	SW Battery 3 ..	TRF	Battery	19–45	200–550 ; 900–1,950	7 gns.	Pentode output ; batteries extra.
HAYNES RADIO ..	RX	Superhet-TRF combined	AC	5.5–8.3 ; 9.8–16.5 ; 15–25 ; 22–40	200–550 ; 1,000–2,000	£35 7 6	Push-pull triode output, 6 W. ; other outputs available.
HIGGS	AW57R ..	Superhet	AC	13–27 ; 25–75 ; 75–150	196–550 ; 1,000–2,000	12 gns.	5 wavebands.
	AW57R ..	Superhet	AC/DC	13–27 ; 25–75 ; 75–150	196–550 ; 1,000–2,000	12 gns.	„
	AW77B ..	Superhet	AC/DC	16.8–52 ; 45–130	196–550 ; 900–2,000	16 gns.	RF stage operative on all bands.
INVICTA	CW3B ..	TRF	Battery	17–51	200–550 ; 900–2,000	£7 9 6	Batteries extra.
	CW3BAC ..	TRF	AC	17–51	200–550 ; 900–2,000	9 gns.	——
	FS36	TRF	Battery	90–220	220–570 ; 900–2,000	£7 19 6	For fishing vessels or yachts.
	AW57	Superhet	AC	13–27 ; 27–75 ; 75–200	200–550 ; 800–2,000	14 gns.	5-band model, also as radiogram.
KOLSTER-BRANDES	KB515 ..	TRF	AC	19–50	200–550 ; 900–2,000	9½ gns.	——
	KB525 ..	TRF	AC/DC	19–50	200–550 ; 900–2,000	9½ gns.	——
	KB535 ..	TRF	Battery	19–50	200–550 ; 900–2,000	8½ gns.	Price includes batteries.
	KB560 ..	Superhet	AC	19–52	200–570 ; 850–1,950	16 gns.	——
LINGUAPHONE ..	All World Recordiogram	Superhet	AC	12.5–40 ; 40–100	200–550 ; 800–2,000	50 gns.	Recording radiogram, complete with microphone, etc. 3-band model at 30 gns.
LISSEN	8114	Superhet	AC	13–33 ; 30–80	198–560 ; 877–2,000	17 gns.	6 valves ; seven tuned circuits.
	8216	TRF	AC	18.5–52	202–560 ; 900–2,000	9 gns.	——
	8133	TRF	AC/DC	18.5–52	202–560 ; 900–2,000	9 gns.	——
	8165	TRF	Battery	18.5–52	202–560 ; 900–2,000	8 gns.	Price includes batteries.
McCARTHY ..	BS5AW ..	Superhet	Battery	16.5–50	200–550 ; 800–2,000	£6 0 0	Chassis and valves only ; pentode output.
	S6AW	Superhet	AC	16.5–50	200–550 ; 800–2,000	£7 0 0	Chassis and valves only ; pentode output ; AC/DC model also available.
	RF6AW ..	Superhet	AC	16.5–50	200–550 ; 800–2,000	£8 10 0	Chassis and valves only ; pentode output ; RF stage.
	PP8AW ..	Superhet	AC	11.5–36 ; 26–80	200–550 ; 800–2,000	£12 0 0	Chassis and valves only ; triode PP output.
McMICHAEL ..	362	Superhet	AC	18.6–51	200–550 ; 900–2,000	15½ gns.	RF stage ; band-spread tuning.
MAGNUM	AW3	TRF	Battery	17.5–52	210–550 ; 800–2,000	8 gns.	——
MARCONIPHONE ..	346	Superhet	AC	7–16 ; 16.7–53 ; 46–141	185–560 ; 750–2,250	18½ gns.	5-band table model, also available as automatic or non-automatic radiogram.
	345	Superhet	AC	16.7–53 ; 46–141	185–560 ; 750–2,250	17½ gns.	4-band table model.
	534	Superhet	AC	16.5–52	200–580 ; 725–2,000	16 gns.	3-band table model.
	382	Superhet	AC/DC	16–50	198–580 ; 750–2,000	13½ gns.	Universal 3-band table model.
	556	Superhet	AC	16.5–52	200–580 ; 725–2,000	13½ gns.	——
	375	TRF	Battery	18–50	195–560 ; 725–2,000	9½ gns.	——
MIDWEST	VT18	Superhet	AC	4.5–10 ; 10–25 ; 25–75 ; 75–200	200–550 ; 850–2,400	£37 10 0	Chassis, speaker and valves ; 18-valve model.
	RP16	Superhet	AC	9–25 ; 25–75 ; 75–200	200–550 ; 850–2,400	£35 10 0	Chassis, speaker and valves ; 16-valve model.
	MT14	Superhet	AC	9–25 ; 25–75 ; 75–200	200–550 ; 850–2,400	£31 10 0	Chassis, speaker and valves ; 14-valve model.
	VT11	Superhet	AC	9–25 ; 25–75 ; 75–200	200–550 ; 850–2,400	£26 5 0	Chassis, speaker and valves ; 11-valve model.

Make.	Model.	Type.	Supply.	Short Waveband(s) (Metres).	Other Wavebands (Metres).	Price.	Remarks.
MILNES	Diamond	Superhet	Battery	15–38.5 ; 37–90	200–550 ; 800–2,000	16 gns.	RF stage operative on all bands ; pentode output.
	Pearl	Superhet	AC	15–38.5 ; 37–90	200–550 ; 800–2,000	17 gns.	" " " " "
MULLARD	MAS3	Superhet	AC	16.7–51	200–585 ; 725–2,000	11½ gns.	Pentode output, 3½ W.
	MUS3	Superhet	AC/DC	16.7–51	200–585 ; 725–2,000	12½ gns.	" "
	MAS4	Superhet	AC	16.7–51	200–585 ; 725–2,000	14 gns.	" "
	MUS4	Superhet	AC/DC	16.7–51	200–585 ; 725–2,000	15 gns.	" "
	MAS5	Superhet	AC	16.7–51	200–585 ; 725–2,000	17 gns.	" "
	MUS5	Superhet	AC/DC	16.7–51	200–585 ; 725–2,000	18 gns.	" "
	MBS4	Superhet	Battery	16.7–51	200–585 ; 725–2,000	14 gns.	QPP output. Price includes batteries.
NOVO	FC96	Superhet	AC	14.5–30 ; 29–58	200–550 ; 800–2,000	13½ gns.	9 stages ; 6 valves.
	FC95	Superhet	AC	14.5–30 ; 29–58	200–550 ; 800–2,000	12½ gns.	9 stages ; 5 valves.
	FC34	TRF	AC	16–30 ; 29–51	200–550 ; 800–2,000	9½ gns.	——
	FC33	TRF	Battery	16–30 ; 29–51	200–550 ; 800–2,000	8½ gns.	——
PETO SCOTT	7004	TRF	AC	18–52	200–550 ; 900–2,100	9 gns.	——
	7032	TRF	Battery	14–31 ; 28–62	200–550 ; 900–2,100	£7 15 0	Price includes batteries.
PHILCO	471	Superhet	AC	16.6–52	198–566 ; 937.5–2,000	10 gns.	3 W. output.
	582	Superhet	AC	16.7–52.1	175–566 ; 940–2,000	14 gns.	6 tuned stages ; 5 W. output.
	290	Superhet	AC/DC	16.7–52.6	199–565 ; 859–2,000	17 gns.	——
	99	Superhet	AC	16.6–50	176.5–545 ; 857–2,000	22 gns.	Push-pull pentode output, 7 W.
	295	Superhet	Battery	16.7–54	200–555 ; 857–2,000	15 gns.	Batteries extra.
PHILIPS	745A	Superhet	AC	16.9–51	200–585 ; 725–2,000	12 gns.	Adaptovisor dial.
	745U	Superhet	AC/DC	16.9–51	200–585 ; 725–2,000	13 gns.	As 745A, but with DC/AC converter.
	714B	Superhet	Battery	16.9–51	200–585 ; 725–2,000	14 gns.	QPP output, 5 valves ; price includes batteries.
	797A	Superhet	AC	16.9–51	200–585 ; 725–2,000	14½ gns.	Var. selectivity ; Adaptovisor dial.
	797U	Superhet	AC/DC	16.9–51	200–585 ; 725–2,000	15½ gns.	As 797A, but with DC/AC converter.
	795A	Superhet	AC	16.9–51	200–585 ; 725–2,000	18 gns.	Mono-knob control ; var. selectivity.
	795U	Superhet	AC/DC	16.9–51	200–585 ; 725–2,000	19 gns.	As 795A, but with DC/AC converter.
PILOT	U650	Superhet	AC	16–52 ; 48–150	175–550 ; 750–2,100	16 gns.	RF stage operative on all bands.
	U225	Superhet	AC/DC	16–52	181–555 ; 731–2,140	14 gns.	" " " "
	U335	Superhet	AC	16–53	180–540 ; 800–2,000	12 gns.	——
PORTADYNE	A53	Superhet	AC	16–50	200–560 ; 800–2,000	12 gns.	——
	A64	Superhet	AC	16–50 ; 50–150	200–560 ; 800–2,000	14 gns.	RF stage operative on all bands.
PRISM	PR47	Superhet	AC	13–35 ; 30–75	200–550 ; 1,000–2,000	57 gns.	Automatic radiogram ; triode PP output, 8 W.
PYE	Empire	Superhet	AC	13–33 ; 30–82	198–560 ; 900–2,000	33 gns.	10-valve Console model ; RF stage on short waves.
	T10	Superhet	AC	13–33 ; 30–82	198–560 ; 900–2,000	18 gns.	6 valves ; RF stage.
	T10A	Superhet	AC	13–33 ; 30–85	200–550 ; 900–2,000	16 gns.	5 valves.
R.A.P.	Transatlantic	Superhet	AC or AC/DC	19–52	200–550 ; 800–2,000	12 gns.	——
	Regent	Superhet	AC or AC/DC	16–51 ; 44.5–150	200–550 ; 750–2,000	17 gns.	RF stage operative on all bands.
REGENTONE	AW3	TRF	AC	17.5–50	200–550 ; 900–2,000	9 gns.	AC/DC model, 9½ gns.
	AWS	Superhet	AC	17.5–50	200–550 ; 900–2,000	12½ gns.	AC/DC model, 13 gns.
R.G.D.	625	Superhet	AC	16.5–51 ; 50–140	200–540 ; 800–2,000	25 gns.	RF stage all bands ; triode output, 3 W.
	630	Superhet	AC	16.5–51 ; 50–140	200–540 ; 800–2,000	30 gns.	" " " "
	645	Superhet	AC	16.5–51 ; 50–140	200–540 ; 800–2,000	45 gns.	" " " "
	660	Superhet	AC	16.5–51 ; 50–140	200–540 ; 800–2,000	60 gns.	RF stage all bands ; triode output, 3½ W.
	880	Superhet	AC	16.5–51 ; 50–140	200–540 ; 800–2,000	80 gns.	RF stage all bands ; triode output, 6 W. ; resistance-coupled push-pull.
	1220	Superhet	AC	16.5–51 ; 50–140	200–540 ; 800–2,000	120 gns.	RF stage all bands ; triode output, 12 W. ; resistance-coupled push-pull.
SCOTT (Keates & Co., Agents)	Scott All-Wave	Superhet	AC	13–30 ; 28–65	199–555 ; 800–2,000 (optional) ; 72–180 (optional)	£165 0 0	High-fidelity model ; 27 valves ; output, 35 W.
	Scott Quaranta	Superhet	AC	13–30 ; 28–65	" " "	£950 0 0	40-valve model.
SUNBEAM	Table	Superhet	AC	17–50	200–550 ; 800–2,000	12 gns.	6 valves ; RF stage.
	Table	Superhet	AC/DC	17–50	200–550 ; 800–2,000	12½ gns.	" "
TRUPHONIC	NAW5	Superhet	AC	16–49	200–550 ; 900–2,000	11 gns.	Also available for AC/DC ; same price.
ULTRA	47	Superhet	AC	13.5–30	200–550 ; 900–2,000	17 gns.	——
	48	Superhet	AC	16.8–50	200–550 ; 900–2,000	13 gns.	——
UNIRAD	AW5/M7	Superhet	AC	12.5–28 ; 27–81	230–550 ; 950–1,925	£29 0 0	3 RF circuits.
	AW5/B7	Superhet	Battery	12.5–28 ; 27–81	230–550 ; 950–1,925	£29 0 0	QPP output, 1¾ W. ; batteries included.
UNIVERSAL HIGH VOLTAGE	AW Super 4	Superhet	AC/DC	16–54	200–550 ; 850–2,000	15 gns.	Table model ; chassis, radiogram, etc., also available (all models).
	AW Super 5	Superhet	AC/DC	16–54	200–550 ; 850–2,000	17 gns.	——
	*AW Super 6	Superhet	AC/DC	16–54	200–550 ; 850–2,000	19 gns.	——
	AW Super 7	Superhet	AC/DC	13.3–27 ; 26.5–54	200–550 ; 800–1,950	24½ gns.	PP output, 5–6 W.
	AW Super 8	Superhet	AC/DC	13–33 ; 28–73	200–560 ; 800–2,200	29½ gns.	" "
	AW Super 9	Superhet	AC/DC	13–33 ; 28–73	200–560 ; 800–2,200	33 gns.	" "
	AW Super 10	Superhet	AC/DC	13–33 ; 28–73	200–560 ; 800–2,200	35 gns.	" "
	* A combined AC/DC and battery model of this set is available at 25 gns.						
VIDOR	253	TRF	Battery	13.5–48.5 ; 48–145	200–550 ; 900–2,000	£7 19 6	Price includes batteries.
	254	TRF	AC/DC	13.5–48.5 ; 48–145	200–550 ; 900–2,000	9 gns.	——

Circuits for Short-wave Converters

By H. B. DENT

SOME PRACTICAL METHODS DESCRIBED

QUITE a satisfactory method of receiving the short waves if one only possesses an ordinary broadcast set is by the addition of a converter. Such a unit is actually nothing more than a short-wave frequency-changer, though sometimes it does also include its own HT and LT supply circuit, and for preference should embody also a tuned RF stage. With this addition, however, it begins to lose the simplicity that is usually stated to be one of the main features of a short-wave converter.

In its simplest form it could be arranged as shown in Fig. 1, which represents a battery-operated unit employing a heptode-type frequency-changer. There is only one circuit to adjust, and this is the oscillator, the aerial being aperiodic.

The selectivity of such a unit is very poor indeed; nevertheless, it is quite capable of receiving most of the stronger short-wave stations. Second-channel interference will at times be very troublesome, and one other defect possessed by this simple version is that stations are often received on harmonics of the oscillator.

A signal on 20 metres, for example, if at all strong, will also be heard when the converter is tuned to 40 metres, and possibly to 60 metres as well, which makes identification of stations a difficult matter and often leads to some confusion.

One way of avoiding ambiguity is to tune the aerial, the circuit for a converter of this type being shown in Fig. 2. This is a mains-operated unit and is shown as a two-range converter which could be made to cover 14 to 30 and 26 to 55 metres or so with self-contained coils and waveband switching.

Condensers C1 and C9, which are the aerial and oscillator tuning condensers respectively, could be each of 0.00015 mfd. and ganged for convenience of operation. The oscillator tracking condensers C13 and C14 can be fixed capacities with tolerances not greater than ±5 per cent.

Grid, or reaction, windings are a matter for experiment, but they must be wound over the earth ends of the coils L6 and L8, and about a third or a half of the number of turns used for the tuned coils in each case will probably be found satisfactory. It may be necessary to include a small amount of resistance, R4, 10-50 ohms or so, in series with the grid condenser C10, to prevent oscillator squegger at low-capacity settings of the condenser C9.

A triode-hexode valve, such as the X41, for example, requires about 12 volts peak RF for best operation.

Measurement of this is made by inserting a 0-1 milliammeter in the earth end of the grid leak R2 at the point marked X and adjusting the reaction windings and series resistance to give a reading of about 0.2 mA over the whole tuning range.

Though the familiar reaction-coil-type oscillators can be made to function satisfactorily on the short waves, the stray capacity across the circuit is inclined to be rather high, and it is often very difficult to tune down below about 15 metres with this arrangement. One of the most

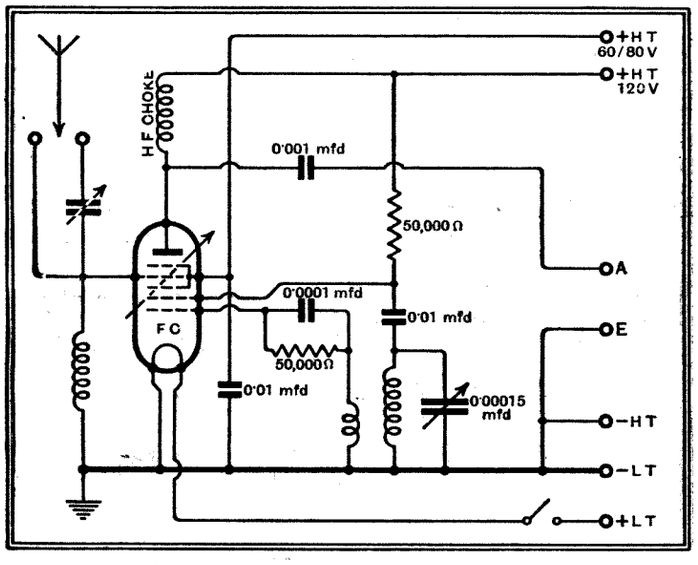


Fig. 1.—Simple short-wave converter using a heptode valve and plug-in coils.

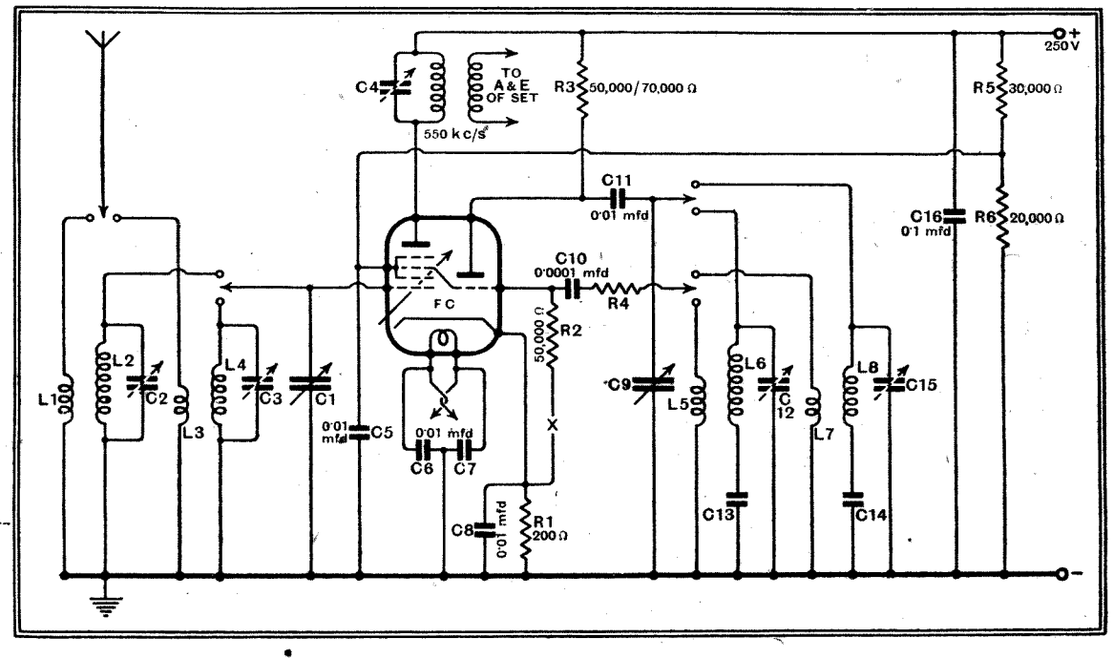


Fig. 2.—Mains-operated converter having a tuned input circuit, waveband switching and single control.

Circuits for Short-wave Converters—

satisfactory oscillators for use on the short waves is the Colpitts, its only drawback being that it demands a split-stator condenser.

A converter circuit embodying an oscillator of this style is shown in Fig. 3, where C9 is the split-stator oscillator condenser. This circuit has quite low stray capacities and is ideal for short and ultra-short-wave apparatus. The coil assembly is also simplified and, as will be seen from the circuit, only one coil, and without tappings, suffices for each waveband in the oscillator section.

Separate Oscillator Control

The only difficulty is in obtaining a suitable condenser for C9, as this must have the same law as C1 if the two are ganged, and each section should be twice the capacity.

Since the stray capacities across the oscillator circuit in the Colpitts arrangement are very low, it should be possible to gang C1 and C9 (Fig. 3), even though the latter be only half the capacity of the former, by suitably proportioning the inductances.

Owing to the difficulties this is almost certain to lead to in practice, it is, perhaps, advisable to dispense with the *apparent* advantages of single control and tune C1 and C9 independently. This plan has much in its favour; the tedious business of tracking is avoided, and no pad-

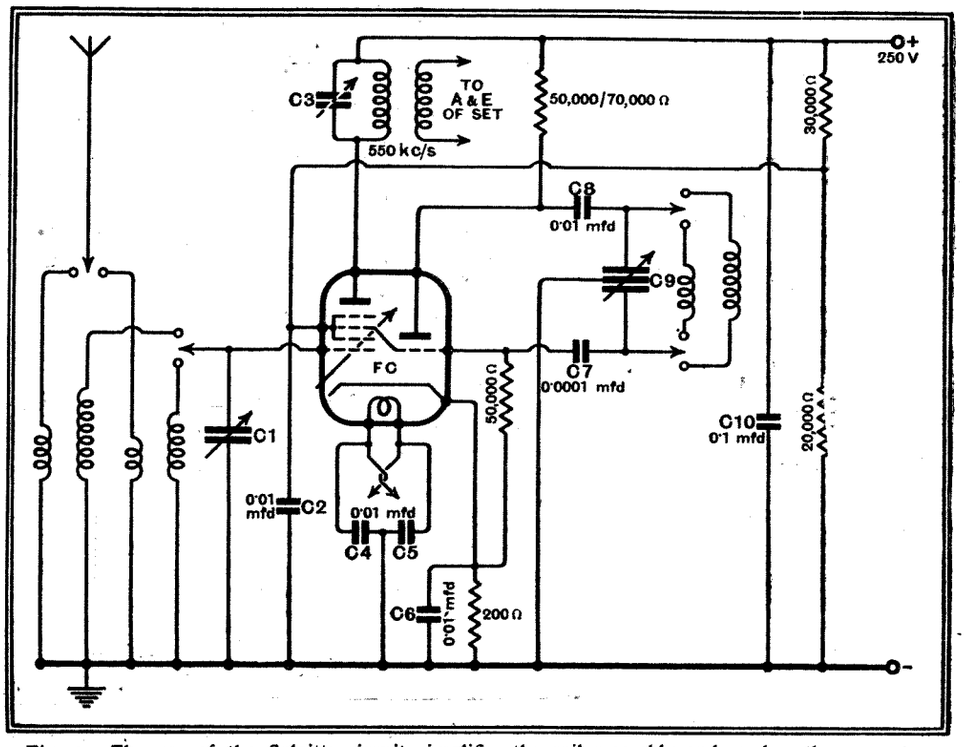


Fig. 3.—The use of the Colpitts circuit simplifies the coil assembly and renders the converter suitable for use on the ultra-short waves. Separate controls should be used for C1 and C9.

channel interference is inevitable with these arrangements, even though an intermediate frequency of about 550 kc/s is used. It is not practicable to employ a higher intermediate than this if a superheterodyne broadcast set is used, as beats

on the short waves, an RF stage before the frequency-changer is well-nigh indispensable. To be of any real value, this stage must be tuned, as an aperiodic RF amplifier would hardly justify its inclusion. The additional tuned circuit thus

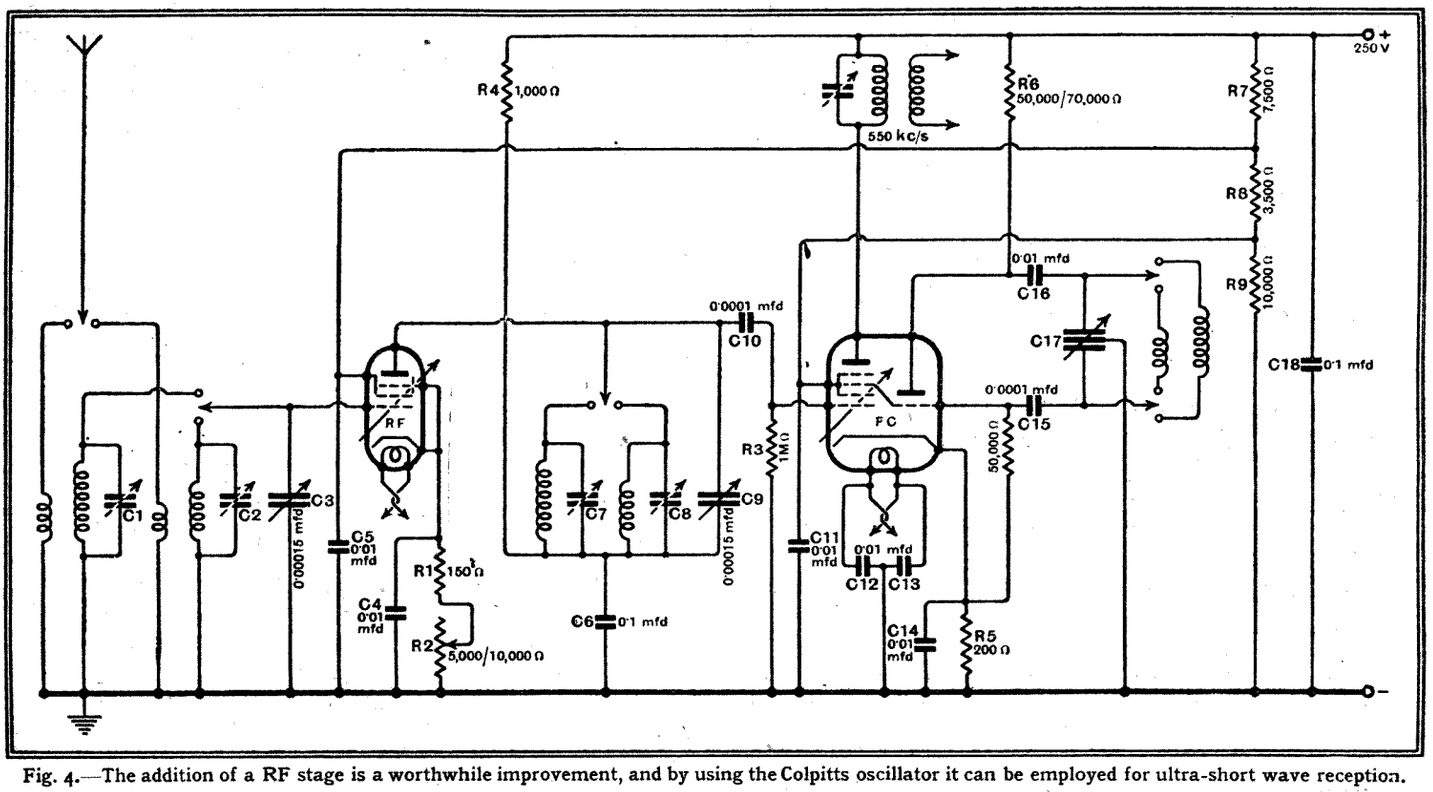


Fig. 4.—The addition of a RF stage is a worthwhile improvement, and by using the Colpitts oscillator it can be employed for ultra-short wave reception.

ding condensers, either parallel or series, are necessary.

The circuits discussed so far have been single-valve frequency-changers only, and the best of them providing only one tuned circuit at signal frequency. Some second-

between the harmonics of the set's oscillator and the fundamental, and also the harmonics, of the short-wave oscillator become very troublesome. With a straight set this effect does not, of course, appear.

In order to obtain really good results

available not only eliminates practically all second-channel interference, but it also gives a much better signal-to-noise ratio.

The complete circuit for a converter embodying this feature is shown in Fig. 4. Here again a Colpitts oscillator is em-

Circuits for Short-wave Converters—

ployed. The aerial and RF circuits can be ganged, but the oscillator should be a separate control.

Though this may seem a retrograde step, it is strongly advised, since the process of accurately tracking all the circuits is by no means an easy matter unless the constructor has access to a signal generator.

Even with a more orthodox style of oscillator, the ganging and tracking of the circuits, on, say, three wavebands, is not a matter to be undertaken lightly, and unless it is very accurately carried out the advantages of the RF stage are lost.

The aerial and RF stages do not present much difficulty, so that these can well be ganged. The only real disadvantage of the separator oscillator control is that every signal can be tuned in at two places on its condenser. It is of little consequence, however, as the two signal circuits, which are operated by a single control, can be calibrated, the oscillator then being adjusted to the beat which gives the best signal.

A separate volume control for the RF stage is useful, as it avoids overloading the frequency-changer on strong signals. Such a control is included in the circuit of Fig. 4 in the form of a variable cathode bias resistance of about 10,000 ohms.

In order to avoid confusion, the circuits in which waveband switching is included are shown with two ranges only, but, of course, three or four can be embodied. One advantage of the Colpitts oscillator is that it functions quite well on the ultra-short waves, so that one range might be devoted to this region and arranged to take in the sound channel of the Alexandra Palace television transmitters, as well as the 10-metre amateur band, which is becoming quite a fruitful source of telephony signals at week-ends.

Though not shown in the circuits, all idle coils should be short-circuited, and as there are some good waveband switches now available that embody contacts for this purpose, it does not unduly complicate the wiring.

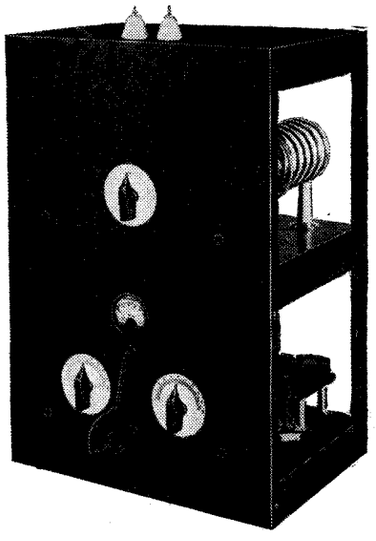
Ordinary standard short-wave condensers can be used as split-stator condensers for a Colpitts oscillator. A two-gang model with the coil connections taken to the two sets of fixed vanes and with the rotor spindle "earthed" complies with the circuit requirements. Of course, the oscillator coils will have to be of larger inductance than the signal circuit ones, but this is a matter that can quite easily be solved by trial and error methods.

Transmitting Equipment

Complete Sets and Kits

MOST amateur experimenters like to design and build their own transmitting apparatus, and wherever such a course is possible it is unquestionably a sound policy since much can be learnt by planning and making equipment of this nature.

Often, however, many obstacles have to be surmounted before any really satisfactory results are achieved. As in every other branch of science, experience is a valuable asset, so that some amateurs prefer to forgo the spade work and either purchase their equipment in more or less complete form or obtain designs and kits of parts from specialist firms.



Eddystone Four-Band crystal-controlled transmitter for CW and telephony working on the 14, 7, 3.5 and 1.7 Mc/s bands.

Whichever course is favoured, no difficulty will be experienced since there are several firms that make a speciality of this service.

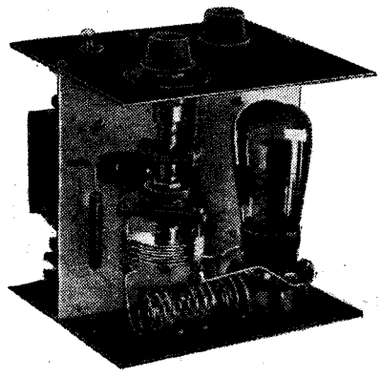
Stratton and Co., Eddystone Works, Bromsgrove Street, Birmingham, not only provide designs for CW and telephony transmitters for use on the amateur frequencies, but are in a position also to supply complete transmitting sets.

Their Four-Band transmitter is a crystal-controlled set constructed in the approved rack form giving easy access to all parts and allows for quick changeover from CW to telephony. It can be operated on the 14, 7, 3.5 and 1.7 Mc/s bands.

The circuit employed comprises a crystal-controlled oscillator, frequency doubler and an RF pentode power amplifier. A speech amplifier for a carbon microphone and AC power pack are included. Full constructional details are available, and the parts for the transmitter section cost £16. Speech amplifier and power unit are extra.

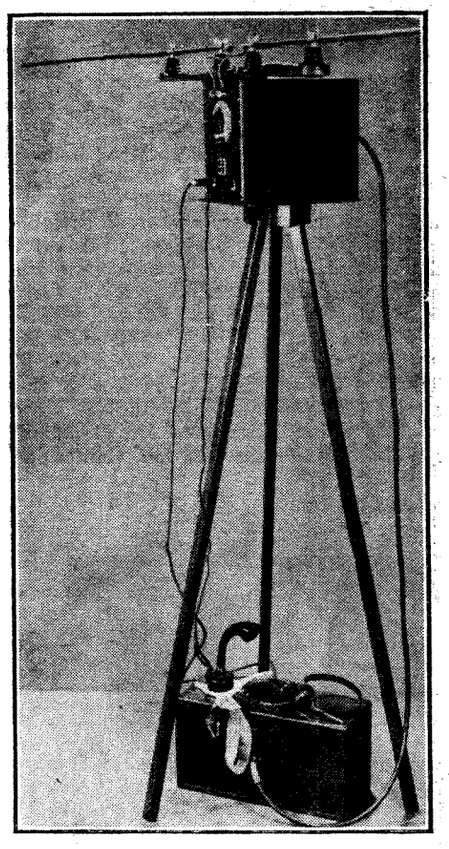
Designs are available also of sets for use on the ultra-short waves. There is a combined transmitter and receiver for the five-meter band, also a compact two-valve transreceiver.

Ultra-short wave radio telephones are a speciality of Transreceivers, Ltd., 444, Ewell Road, Surbiton, Surrey, which firm has been devoting considerable time to the development of small portable apparatus, mainly for commercial, the Services and overseas use.



Five-metre transreceiver made by Eddystone.

The model 101 is a battery-operated two-valve set, both valves being always in use, the "send-receive" switch making the necessary changes to the circuit. For reception the RF oscillator is employed as a self-quenched super regenerative detector, and the other valve, which is a pentode, as an AF amplifier. For transmission the quench is removed and the pentode becomes a modulating stage.



Ultra-short wave portable radio telephone made by Transreceivers, Ltd.

In addition to portable sets, Transreceivers, Ltd., also make mains-operated models for use at fixed sites as well as duplex working sets.

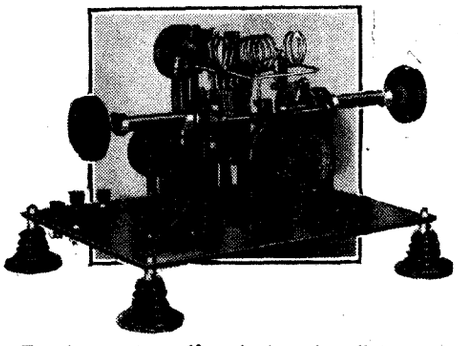
The Radio Development Co., Aldwych House, Aldwych, London, W.C.2, have for some time been interested in the design and production of ultra-short wave equipment, sets for 5 and 1½ metres being now available. Their 5-metre transmitter is rated at 10 watts output and can be operated either

Transmitting Equipment—

from AC or from batteries by fitting the appropriate style of valve. It makes use of an American-type 53 double-triode arranged as a self-excited push-pull oscillator. It does not include modulating equipment, but advice regarding this is available to all who may require it.

Their small transreceiver embodies three Hivac Midget valves, namely two triodes and one pentode. All three are used in a super regenerative circuit for reception, but for transmission one triode and the pentode only are employed; the former as the RF oscillator and the latter as modulator.

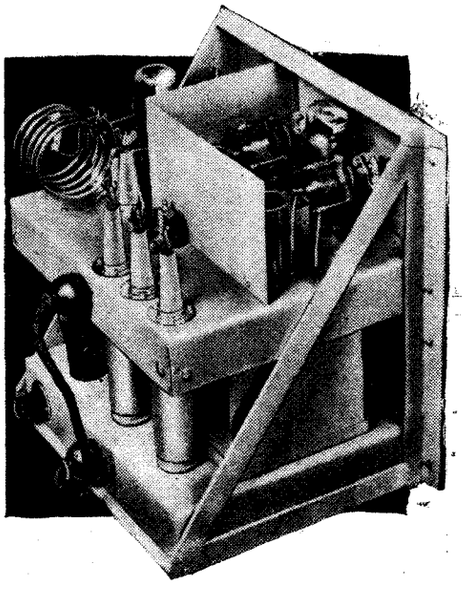
The 1½-metre set is for AC operation and consists of two separate units. One is an RF oscillator having two AC2/Pen/DD valves operated in push-pull as a self-excited oscillator and with resonant-grid lines of ½-inch copper tube for frequency stabilisation. The other unit contains power supply equipment and modulation amplifier.



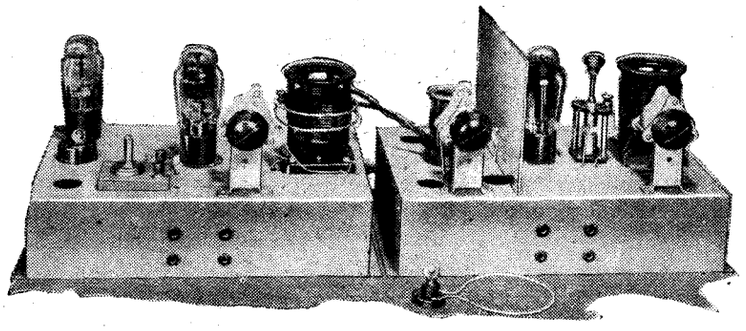
Epoch 5-metre self-excited push-pull transmitter, rated at 10 watts.

A five-metre battery-operated portable transreceiver which is a compact two-valve radio telephone is also obtainable from the Scientific Supply Stores (Wireless), Ltd., 126, Newington Causeway, London, S.E.1. It is supplied in kit form and costs £2 18s. 6d. without valves or batteries.

The design and construction of CW and telephony transmitters for the amateur wavebands are specialities of Harmony House Sound and Service, 116, Cambridge Road, Churchtown, Southport. The various units are assembled on separate chassis arranged for mounting in a rack-type frame. Meters are included where essential and provision is made for inserting measuring instruments in the circuits not so equipped by fitting jack sockets.



Rack-type assembly giving access to all units as adopted by Harmony House Sound and Service for their transmitting apparatus.



Oscillator and RF amplifier units for the 14 and 7 Mc/s bands are obtainable in kit form from Eugen J. Forbat.

Units that will form the nucleus of a transmitting set for either the 7 or 14 Mc/s band are obtainable in kit form from Eugen J. Forbat, 28-29, Southampton Street, Strand, London, W.C.2.

One is a crystal-controlled pentode oscillator in which is included the power supply unit for it and for the companion RF power amplifier. This second unit can be employed for the purpose just stated, if operation takes place at the crystal frequency, or by changing the two coils, as a frequency doubler.

Ostar-Ganz Universal valves are fitted so that the apparatus can be used on either AC or DC supplies. The oscillator and power supply unit costs £8 8s. and the amplifier unit £4 4s. The complete kit comprising both parts is available for £10 10s.

Modulation amplifiers with single or push-pull output stages for use with the transmitter kit can be supplied if required.

Advice regarding the design and layout of transmitters for amateur use can be obtained from the Raymart Manufacturing Co., 44, Holloway Head, Birmingham. Some of the parts that this firm supply for the purpose are included in another section in this issue.

Another firm that offers advice regarding the construction of transmitters is Lissen, Ltd., 113-117, Charing Cross Rd., London, W.C.2.

Though not marketing complete sets, theoretical circuits and practical plans embodying the short-wave components made by them are available.

Television "Spectacles"

COUNTERPART TO THE HEADPHONE SET

ONE has come to regard a television receiver as a bulky piece of apparatus which, should it ever form part of the domestic furniture, will have to be installed in such a position that the screen can be viewed as conveniently as possible by the whole family circle. In the days of mechanical scanning this notion was perfectly true, and even with the more modern cathode-ray technique the tendency is all towards the use of large tubes designed to give as big a picture as possible. All of which seems to put any idea of a portable receiver completely out of court.

Of course, there are some people who still regret the advent of the loud speaker in broadcasting, and yearn for the comparative peace and portability of the old-fashioned headphones. But it is rather interesting to note that something on parallel lines has been proposed in a recent patent (No. 451980) for television.

Magnifying Eyepiece

The inventors point out that cathode-ray tubes can, after all, be made small, and that one with a screen, say, two inches square, could be conveniently held, when suitably mounted, either in the hand, or even fitted on the head like a pair of spectacles. The eyepiece would include a magnifying lens so as to offset the reduction in the initial size of the picture.

The receiver proper, including the time-base circuits, will, of course, be of normal size and will "stay put" wherever convenient, the signal and synchronising voltages being fed from it to the portable "eyepiece" through light flexible leads. To make everything complete, a pair of headphones can be added to receive the accompanying sound.

If ever stereoscopic television should arrive, the single eyepiece might be replaced by a pair of binoculars, which, by feeding a a slightly different picture to each eye, will produce the desired effect of depth.

[A similar scheme was recently suggested in our Correspondence columns.—ED.]

THE RADIO INDUSTRY

A SUCCESSFUL demonstration of the Pye television receiver was recently given at John Barnes' Stores, Finchley Road, London, N.W.

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Owing to unforeseen increases in the cost of raw materials and labour it has been found necessary to increase by 10 per cent. the prices of certain converters and generators produced by the Electro Dynamic Construction Co.

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A new AC/DC superhet (Model 369) is announced by McMichael. A constant-gain aerial-coupling system is one of the technical features of the set, which costs 12½ guineas.

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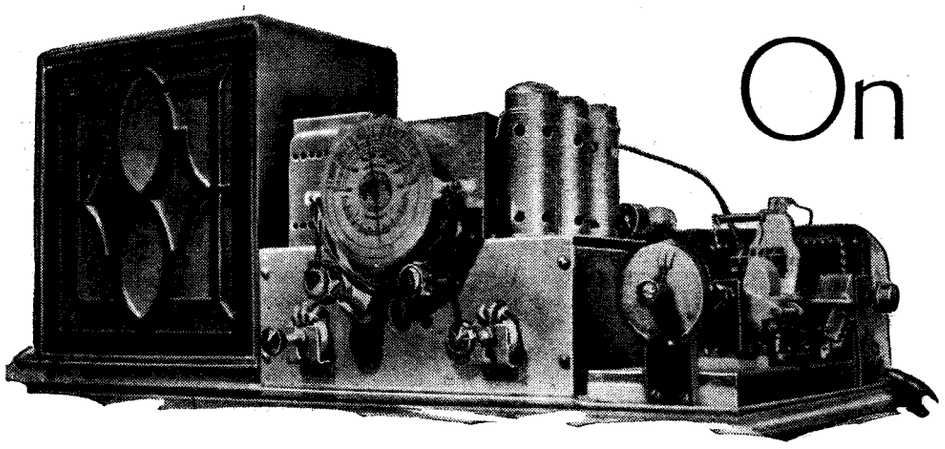
Ferranti announces the introduction of kits of replacement components comprising useful selections of resistances, condensers, volume controls, etc., for the use of service engineers. Various "manufacturers' type" components, as used in Ferranti sets, are to be available separately for the same purpose.



On the Short Waves

NOTES FROM A LISTENER'S LOG

THE race for a place in the sun on the short waves goes on, and the pace gets hotter and hotter each day—the latest countries to join in the struggle being China and Japan. China has just notified two whole sets of frequencies in the broadcasting bands, for two 20-kW transmitters, one at Hankow, XGSA, and the other, XGSB, at Shanghai.

The channels reserved are as follows:—

XGSA.		XGSB.	
6.095 Mc/s	49.22 m.	6.105 Mc/s	49.14 m.
9.520 „	31.5 m.	9.505 „	31.55 m.
11.735 „	25.56 m.	11.875 „	25.26 m.
15.240 „	19.69 m.	15.190 „	19.75 m.
17.755 „	16.90 m.	17.785 „	16.87 m.
21.450 „	13.99 m.	21.510 „	13.95 m.

The frequencies notified by the new 50 kW Japanese station, which is supposed to come into operation this autumn, are as follows:—

JZH	6.095 Mc/s	49.22 m.
JZI	9.535 „	31.46 m.
JZJ	11.800 „	25.42 m.
JZK	15.160 „	19.79 m.
JZL	17.785 „	16.87 m.
JZM	21.520 „	13.94 m.

It is interesting to note that in some cases both China and Japan have notified the same frequencies (China has a priority of a few weeks in actual date of reservation), a fact which testifies to the great dearth of room in the overcrowded short-wave bands.

In the 18 Mc/s (17 m.) band, for example, there has never been room for more than four stations—and this very important band has been filled up for years—as follows: 17.79 Mc/s = GSG; 17.78 Mc/s = W3XAL; 17.77 Mc/s = PHI; 17.76 Mc/s = DJE.

The end channels, namely, 17.80 and 17.75 Mc/s, are not fully available for broadcasting, as they may also be used by services in the adjacent bands, and, indeed, IAC, Coltano, conducts a telegraphic service on 17.75 Mc/s.

A Possible Solution

It has recently been stated by a reliable authority that the world's oil supply may run out in twenty years' time, and unless a substitute available in large quantities can be found, will mean the disappearance of most internal-combustion engines, which may, in turn, of course, greatly influence the economic operation of broadcast transmitters and tend to reduce both the number of stations and the hours of broadcasting.

Before this happens, however, lack of channels, or lack of a properly organised plan, may result in so much interference in the short-wave bands that chaos will result and the air, instead of being full of Shakespearean sweet music, will be full of heterodyne whistles which will recall the state of the European "medium-wave" ether prior to the "Plan de Prague" and its predecessors.

It is known that the U.I.R. will press for an extension of the broadcasting bands at this Conference, but it is doubtful at the moment whether they will receive much support, because in many cases an extension of the bands will mean that certain commercial stations will have to find new frequencies.

To the average short-wave listener who knows Morse this would not seem to be a difficult matter because he knows that apparently wide open spaces exist outside the broadcasting bands, actually *every* short-wave channel (on a 10 or often 5 kc/s or less separation basis) from about 21 Mc/s downwards (13 m. up) has been reserved by some station which, however small and unimportant, would have the "right" of priority of operation, so that the newcomer, perhaps conducting an important point-to-point service, would be in an awkward situation if interference arose.

The title illustration is of the short-wave receiving gear used by Ethacomber who regularly contributes this section

Unless the whole of this system of reservation is revised, therefore, the commercial station prefers to stick on his "age-old" frequency and the broadcasting (and other bands) will remain unchanged.

Another point, for successful operation the separation between short-wave broadcasting stations should be at least 10 kc/s, and preferably greater; in any case stations separated by only 10 kc/s should not transmit to the same point at the same time. Telegraph stations can, and do in many cases, work with much smaller separations than 10 kc/s, yet many of them are so badly operated that in some cases separations are required equal to the *whole* of one broadcasting *band*.

Some countries demand, and get, a higher standard of operation from their amateur transmitters than they achieve from their own high-power stations.

There are some countries however, whose commercial stations are above suspicion, Great Britain, U.S.A., Germany and Japan being good examples, so it behoves these to see that the others toe the line at Cairo.

The successful solution of the problems which face Cairo in connection with the use of the available short-wave channels must greatly affect the future of the Empire broadcasting service, for with the advent of three new high-power transmitters at Daventry and 22 new aerial arrays, it is now entering on a new phase of its endeavour.

Let us hope that this country's representatives will work for wise and equitable solutions even if it means starting all over again in many cases, since failure will mean chaos on the short waves.

Passing from the future to the present, however, we find that the keynote of autumn reception conditions is once again the outstanding activity on "ten metres and below." Stations like W6MFI in Los Angeles have been coming over at full loud-speaker strength in the late afternoons, using only 350 watts or less, which is really low power for loud-speaker signals over a 6,000-mile route, when the transmitting aerial used is, we may assume, by no means a highly developed array.

Reception during Mid-October

Reviewing conditions in detail during the past fortnight, we find W2XAD and W3XAL (17.78 Mc/s) outperforming most of the other U.S. group. On Wednesday, October 7th, W2XAD was excellent at 8.15 p.m. and again at 7.20 p.m. on Thursday, and on both these occasions W3XAL was only about one merit lower, W2XAD having been excellent during the entire transmission period.

Late on Thursday night, however, saw a definite trend to winter conditions, 15 Mc/s being weak and fluttery by 10.30 p.m., whereas stations like WCC (Morse) on 8 Mc/s (36 m.) were coming in at R9+. Friday evening I spent on the ultra highs—and heard NSS on 32 Mc/s (9 m.) coming in at R7, working NPG and NPO with two different-keyed tones. NSS finally faded out at 7.20 p.m.

The strongest 28 Mc/s 'phone station on this occasion was W4BMR, and tuning to the lower frequencies at 7.30 p.m. JVM, Tokio, was intercepted, a very strong signal of good quality.

Good signals from NSS were again obtained on Monday and Tuesday, October 12th and 13th, but on Sunday afternoon ultra-short wave conditions seemed most to favour Russia and the East, one of the most outstanding signals being the half-wave of RIM Tashkent ('phone) on 31 Mc/s (9.6 m.) and W2HFS (and W6MFI, as previously mentioned). The Cuban station CO6OM on 28 Mc/s was also well heard working W2HFS.

The Newark police transmitter W2XEM on 31 Mc/s came on the air once, giving details of a stolen Hupmobile coupé (pronounced coup) No. DH399 Ohio!

Other interesting USW stations to look for are the 27 Mc/s (11 m.) stations on New York Harbour, which direct the berthing of incoming vessels.

Two new stations heard are Hong Kong ZBW3 on 15.19 Mc/s (19.7 m.), and Batavia YDC on 15.15 Mc/s (19.8 m.).

ETHACOMBER.

Listeners' Guide for

Outstanding Broadcasts at

FOR those who enjoy classical music there is a wealth of good programmes during November, including many first visits of eminent musicians.

The second in the series of fifteen Symphony Concerts to be given in the Queen's Hall by the B.B.C. Symphony Orchestra will be heard by National listeners on Wednesday from 8.15 till 9.20 and 9.40 till 10.25. Willem Mengelberg will conduct the B.B.C. Orchestra for the first time on this occasion. In the programme is included Richard Strauss' Tone Poem, "Ein Heldenleben," which is dedicated to the conductor. Paul Beard will be solo violinist and Myra Hess solo pianist.

The third of the Sunday Studio Orchestral Concerts is to be given Regionally at 9.5, and takes the form of a Liszt Commemoration, this being the fiftieth year after his death. Sir Henry J. Wood will be conducting the B.B.C. Orchestra (B), with the B.B.C. Women's Chorus (Chorus Master: Leslie Woodgate) and Egon Petri, solo pianist.

On Sunday will also be heard Regionally at 5.15 a relay from Paris of a concert by L'Orchestre Symphonique de Paris, with Marcel Dupré at the organ; he was last heard from the Promenade Concert on August 19th.

The Vienna Symphony Orchestra, conducted by Oswald Kabasta, are to give a concert from the studio on Monday at 7.30 (Reg.). This will be their first broadcast from London.

Percy Grainger is on another visit to England, and will conduct Section D of the B.B.C. Orchestra, with the B.B.C. Chorus (A), in a programme of his music. He is an Australian by birth, but has for the past twenty years made New York his home. The soloists will be Sybilla Marshal (soprano), Peter Fears (tenor), and Victor Harding (baritone), with the composer as solo pianist. This will be his first broadcast in England.

Details of the week's Television programmes will be found on p. 467.

[*Imperial War Museum photograph.*

CORONEL AND FALKLAND ISLANDS ACTIONS. These two great naval battles are to be the subject of a special broadcast on Sunday at 7 (Nat.). "Taffrail," Captain Henry Taprell Dorling, the well-known writer of nautical stories, is responsible for this programme. The picture shows the damage to the upper deck of H.M.S. Kent in the Falkland battle. Under the hatch cover is C.P.O. Layton, who received the D.S.M. after this action, and to the left of the hole in the bulkhead is Sergt. G. Mayes, R.M.L.I., who received the C.G.S.

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THEATRE ORGAN

MOST listeners will by now have heard the new B.B.C. Theatre Organ, the cost of which is a very closely guarded secret. When asked what the actual cost was, one of the officials of Compton's, the makers, said: "Well, the papers tell us £10,000. I hope it will be." Whether we like cinema organ music or not, we are to have regular transmissions at least twice a week on the new instrument. The two organists this week are Frederick Bayco to-night at 6.25 (Nat.) and Quentin Maclean Tuesday at 6 (Reg.).

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THE "TITANIC"

THIS week's instalment on Sunday at 5.40 (Reg.) in the "I Was There" series will be given by Commander Lightoller, who was Second Officer on the *Titanic* when she sailed on her maiden and fatal voyage across the Atlantic. He will tell of the events in the short history of the then biggest ship in the world from the time she left the shipbuilders' hands until she sunk after striking an iceberg on the night of April 14th-15th, 1912.

"LABURNUM GROVE"

THIS amusing comedy of J. B. Priestley's on suburban life, which had a very successful run at the Duchess Theatre, London, in 1934, is to be given to listeners on Tuesday at 8 (Reg.) and again on Thursday at 7.15 (Nat.). The Radfern family lead a very ordinary, almost humdrum life until Pater announces that he has for many years been at the head of a widespread organisation of forgers and counterfeiters. The dramatic and amusing situation has been skilfully dealt with by the author, and should prove ideal for broadcasting. Frederick Lloyd as Mr. Radfern and Mary Jerrold as his wife (her original part) head a very strong cast.

MORE DISCOVERIES by Carroll Levis will be brought to the microphone in his second amateur variety hour on Tuesday at 6.25 (Reg.). The three Sheffield boys here shown with Carroll Levis are Morris and Norman Vickers, 12-year-old twins, and Jack Stewart, who will appear in this programme.

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"... THE FIFTH OF NOVEMBER"

CHILDREN will not let us forget the event which took place three hundred and thirty-one years ago, and is commemorated on November 5th. In any case, the B.B.C. are to jog our memory with a special programme, "Gunpowder Treason," which aims at presenting graphically what was fortunately the dampest squib on record, to be broadcast on Thursday at 9.30 (Reg.). It should be a model of historical exactitude, for C. Whitaker-Wilson, the author, has been diligently searching for the truth. Earlier in the evening at 5 (Nat.) G. B. Harrison will talk on the Gunpowder Plot, and he will also be the hero in the later programme.

◈ ◈ ◈

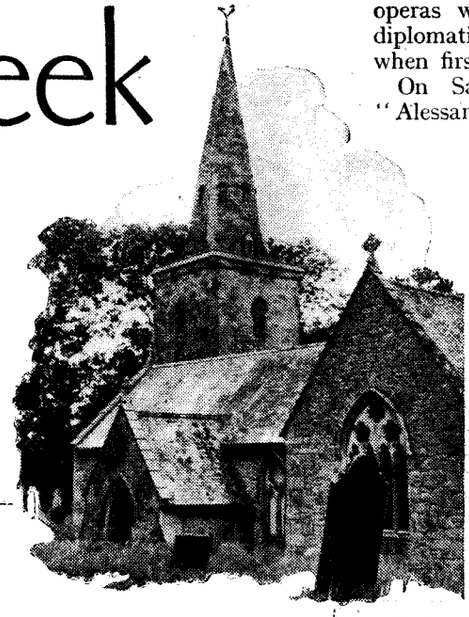
"WHEN THE PIE WAS OPENED. . . ."

THE first radio revue by the Two Leslies has been given the title of "Radio Pie," and it should certainly produce some good fare when opened for Regional listeners on Thursday at 7.30. The head chefs, Leslie Sarony and Leslie Holmes, have in-

the Week

Home and Abroad

cluded the following ingredients: Tommy Handley, Mario de Pietro (this will be the first time he has had a speaking part in radio), "The Singing Porter," a newcomer, Tessie O'Shea, Anne Ziegler, and Hugo. The Leslies have composed a new song, "Long Live the King," for the Coronation, and this will be heard for the first time in "Radio Pie," with the chorus sung by Steffani and his Twenty Singing Scholars and the B.B.C. Revue Chorus.



ST. HILARY CHURCH, CORNWALL, whence comes the miracle play by Bernard Walke, "The Eve of All Souls," produced by Filson Young on Monday at 9.35 (Nat.)

HIGHLIGHTS OF THE WEEK

FRIDAY, OCTOBER 30th.

Nat., 6.25, Frederick Bayco at the Theatre Organ. 7.30, B.B.C. Dance Orchestra. 8, "The Kentucky Minstrels."
Reg., 7.30, "The Trial of Mrs. M'Lachlan." 8.45, "The Three-Cornered Hat."
Abroad.
Hamburg, 7.10, "The Mikado."

SATURDAY, OCTOBER 31st.

Nat., 7.30, "In Town To-night." 8.15, B.B.C. Orchestra (C). 9.20, Music-Hall, including Jenny Howard, Bebe Daniels and Ben Lyon.
Reg., 3.35, Television Feature Programme. 4.15, "The Kentucky Minstrels." 8, Harpsichord Recital—Ernest Lush. 8.15, "All Saints."
Abroad.
Brussels No. II, 8, Lehár's "Frederica."

SUNDAY, NOVEMBER 1st.

Nat., 4.30, "Music of the Hours"—records of Midland chime tunes. 4.45, Flute Recital—George Ackroyd. 7, Coronel and Falkland Islands. ¶The London Palladium Orchestra.
Reg., 5.15, Relay from Paris. 5.40, "I Was There." 7.55, Service from Bradford Cathedral. 9.5, Sunday Orchestral Concert.
Abroad.
Leipzig, 7, Gala Operetta Concert.

MONDAY, NOVEMBER 2nd.

Nat., 6.40, B.B.C. Orchestra (E) and Oda Slobodskaya. ¶"Entertainment Parade"—3. 9.35, "The Eve of All Souls" from St. Hilary.

Monday, November 2nd (*continued*).

Reg., 7.30, The Vienna Symphony Orchestra. 8.30, George Graves in "Princess Caprice."
Abroad.
Hamburg and most German Stations, 7.10, Reminiscences by Survivors of the Coronel Battle.

TUESDAY, NOVEMBER 3rd.

Nat., 8, Van Phillips and his Two Orchestras. ¶Recital: Peter Dawson. 9.40, "Princess Caprice."
Reg., 6, Quentin Maclean at the Theatre Organ. 6.25, Carroll Levis and his Discoveries. 8, "Laburnum Grove."
Abroad.
Kalundborg, 7.30, Norwegian Music.

WEDNESDAY, NOVEMBER 4th.

Nat., 7, The Alfredo Campoli Trio. 8.15 and 9.40, From the Queen's Hall.
Reg., 7.30, The World Goes By. 8.15, "Kick Off"—Football Musical Comedy.
Abroad.
Radio-Paris, 8, "Le Fiancé de Margot"—one-act operetta (Planquette).

THURSDAY, NOVEMBER 5th.

Nat., 7.15, "Laburnum Grove." ¶Orchestre Raymonde.
Reg., 6, Military Band and Tudor Davies. 7.30, "Radio Pie." 8.15, Percy Grainger's Music. 9.30, "The Gunpowder Treason."
Abroad.
Kalundborg, 7.10, Seventh Thursday Concert. Conductor: Malko.

"ALL SAINTS"

ON Saturday, the eve of All Saints' Day, is to be broadcast, at 8.15 (Reg.), a programme dealing with the religious significance of the day. It is in the hands of R. Ellis Roberts, Robin Whitworth, and Trevor Harvey, who have made a name for themselves with such programmes as "Unto Us" and "Maundy Thursday."

Contrary to popular belief, All Saints' Day refers to those not on the calendar and not collectively to those who have days of their own.

OPERA

OUR immortal "Mikado," which comes from Hamburg at 7.10, is the only opera broadcast to be found in Friday's programmes. It is interesting to recall that this most popular of all the Gilbert and Sullivan operas was the subject of a diplomatic protest from Japan when first produced in 1885.

On Saturday, Flotow's "Alessandro Stradella" comes from Königsberg. This opera was a failure when produced at Covent Garden in 1864, and was taken off after only two days. The only other opera on Saturday is Mulè's "Dafni" from Milan. Mulè is a representative example of Italy's living composers.

Paris (PTT) and the regional stations are giving a Milhaud opera, "Les malheurs d'Orphée," on Sunday at 8.30.

Tuesday's only opera broadcast is Mussorgsky's "Boris Godunov," which is the *émission fédérale* taken from Paris (PTT) by most of the regional stations. Usually, Rimsky-Korsakov's arrangement of the opera is staged, but this time the original version, as it left Mussorgsky's hand in 1874 is for some unknown reason preferred. To those who know the revised version this courageous revival of the original should be interesting.

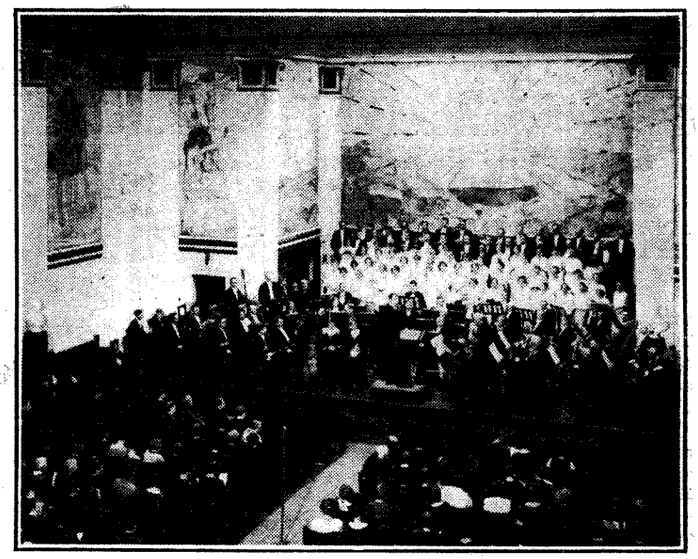
SYNCOPATED OPERA

AN interesting musical feature in the coming week's programmes from abroad is a concert by the Danish Wireless Orchestra on Monday at 9.25 from Kalundborg. The programme comprises a selection of music from syncopated operas and works of a similar character. The overture of Paul Hindemith's "Neues vom Tage" (News of the Day) will be heard, together with a special suite arrangement by Helge Bonnen, a prominent Danish pianist, of Kurt Weill's music to the opera "Der Jasager" (The Boy who Said Yes). The Danish Wireless Orchestra will be directed by their new conductor, Erik Tuxen, who recently jumped from the dance-band world into the realms of serious music.

SWEDISH CONCERT

A SYMPHONY concert of particular interest will be broadcast to-night (Friday) at 7 from Gothenburg by all Swedish stations. The concert is relayed from the new, ultra-modern hall of Göteborgs Orkesterförening, which, acoustically, has been designed with a particular view to broadcasting, and seats nearly 1,400. The Orkesterförening Orchestra will be conducted by the Swedish Royal Opera Chief, Nils Grevillius, with the famous French pianist, Alfred Cortot, as a soloist.

THE AUDITOR.



NORWEGIAN MUSIC will be broadcast for an hour from the Aula of the Oslo University on Tuesday at 7.30, by all Scandinavian stations. The orchestra of Filharmonisk Selskap here seen rehearsing in the Aula, directed by Hugo Kramm, will play three representative works. The Norwegian instrument, the Harding fiddle, will be heard in the incidental music to the fairy play, "Fossegrimen."

Components for the Short-Wave Set Constructor

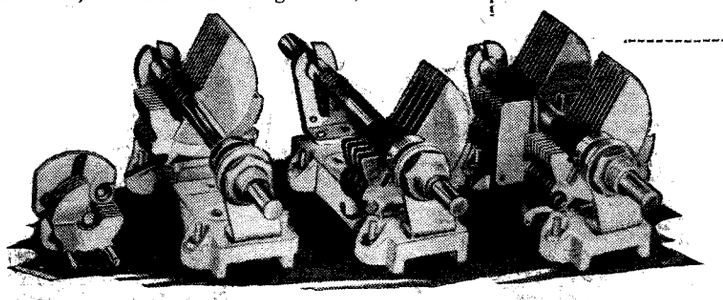
A REVIEW OF THE UP-TO-DATE SPECIAL APPARATUS

THE technique adopted in the design of a short-wave receiver need not necessarily be much different from that followed in an ordinary broadcast set, for if it were the all-wave receiver would not have come into being. For best results, however, special care has to be taken in the choice of the components, for the radio frequencies are sufficiently high for dielectric losses to become a serious matter if unsuitable insulating materials are employed.

Though short-wave signals can be tuned in with variable condensers of the size used on the normal broadcast bands, the practice demands the use of an exceptionally good slow-motion drive having a very high reduction ratio and no backlash in the mechanism. Even with this help the tuning is very critical, so that in short-wave sets it is customary to employ variable condensers not larger than about 0.00015 mfds.

These condensers are usually fitted with special insulating material, so that not only is the advantage gained of easier operation, but losses are also reduced to a minimum.

In most of the latest types provision is made for ganging two or more condensers, though ganged assemblies with two or three sections, and built as a single unit, are now available. Examples of these are found in the Polar range of condensers, the Type E being made as a two-gang unit with each section of 0.00016 mfd., and having a small screen between the two sets of fixed vanes. The Type E is also available as a single unit of 0.00016 mfd. capacity, and both styles are fitted with brass vanes and a Frequentite base.



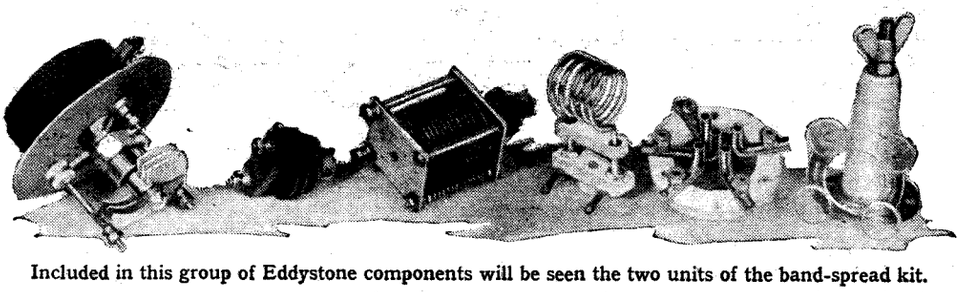
Polar short-wave condensers showing single and dual Type E, special USW model and air dielectric trimmer.

Raymart market a two-gang condenser assembled on a Steatite base, as well as a series of short and ultra-short wave models in sizes ranging from 15 m-mfds. to 250 m-mfds. (0.000015 mfd. to 0.00025 mfd.). The rotor spindle projects sufficiently at the back to take a coupling for ganging two or more single units.

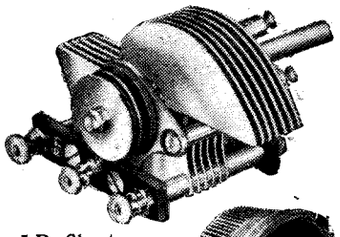
Stratton and Co. have a long range of special short-wave condensers, among which are some two- and three-gang types. Most of this firm's short-wave condensers can now be ganged, as in the latest pattern Microdenser the spindle has been lengthened and reduced to a $\frac{1}{4}$-inch, so that a flexible coupler, or other ganging device, may be fitted. It is made in three sizes, viz., 22.5, 45.5 and 103 m-mfds. The "Scientific" SW condenser, which is also an Eddystone product, has the same shaped vanes as the Microdenser, but is fitted with a back bearing and an extension to the spindle. Both styles are insulated with a material described as Calit, which is claimed to be very satisfactory at the high and the ultra-high radio frequencies.

Students of short-wave technique will be familiar with the scheme known as band-spread. Its purpose is to simplify the tuning by opening out a small part of the range covered by the main tuning condenser so that it can be explored by a smaller condenser.

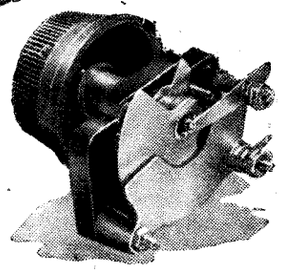
This can be effected by fitting two separate tuning condensers and wiring them in parallel. For example, one may be of 150 m-mfds. and the other of 15 m-mfds. Eddystone have evolved a special kit for this purpose which they describe as the Band-Spread Tuning Outfit. It consists of a "tank" condenser in which the capacity is changed in steps, each step being approximately of 14 m-mfds. There are ten changes between minimum and maximum. Joined in parallel with the "tank" unit is a small variable condenser having a capacity slightly greater than each step of the "tank," and tuning is effected on this unit.



Included in this group of Eddystone components will be seen the two units of the band-spread kit.



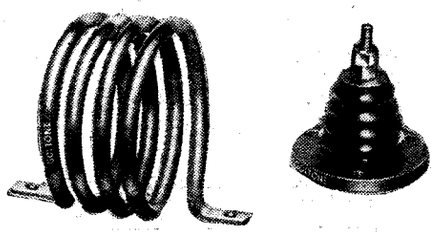
J.B. Short-wave Special condenser.



Colvern short-wave trimming condenser.

The band-spread condenser has a built-in reduction mechanism giving a 9 to 1 reduction, and it is fitted with a large dial and cursor; the "tank" unit is provided with a knob and indicator plate engraved 0-10, and corresponding to the ten steps on this unit.

Sydney S. Bird (Cyldon) makes a 0.00015 mfd. condenser which can be assembled as a ganged unit with each section completely insulated from the others. Short and ultra-short wave condensers are included, also in the range of J.B. products, while other firms that make this class of component are British Television Supplies, Bulgin, Colvern, Graham Farish, Lissen and Premier Supply Stores.



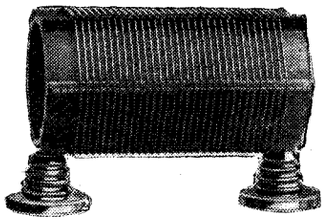
Goltone transmitting coil and stand-off insulator.

Coils also play a very important part in the efficient operation of a short-wave set. Dielectric losses must necessarily be kept as small as possible, and here again the use of special insulating materials for the formers and mounts has become customary practice.

Coils wound with wire of such a thickness that they are self-supporting, so far as the spacing of the turns is concerned, are doubtless the ideal, but it is not usually convenient to employ them in receivers owing to their bulk. They are used, however, in transmitting apparatus, where maximum efficiency has to be attained and size and convenience are quite secondary matters.

Components for the Short-wave Constructor—

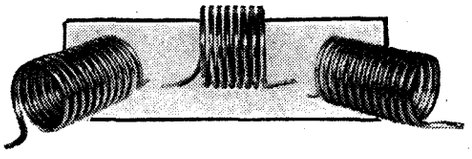
Transmitting inductances made in this way usually employ copper tube of about ¼-inch diameter, and the ends of the coils are flattened and drilled so that they can be mounted on high-grade insulating pillars.



Quartz Crystal Co.'s 10-watt transmitting inductance wound on 4in.-diameter ribbed former.

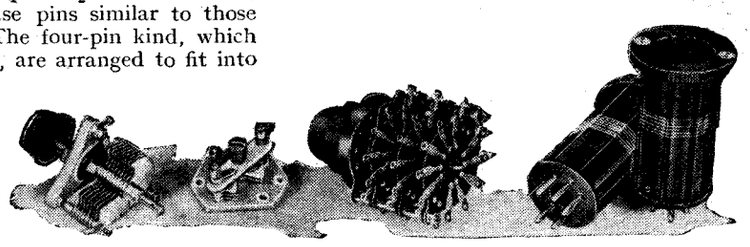
They are included among the short-wave products of Eddystone, Goltone, Quartz Crystal Co., Radio Development Co. (Epoch) and Raymart, among others.

For receiving purposes the plug-in type of coil is greatly favoured. This arrangement makes for the greatest flexibility, and is unquestionably very efficient, though some excellent low-loss switches are now becoming available which makes possible the assembly of coil units giving several wave-bands in the most convenient manner.

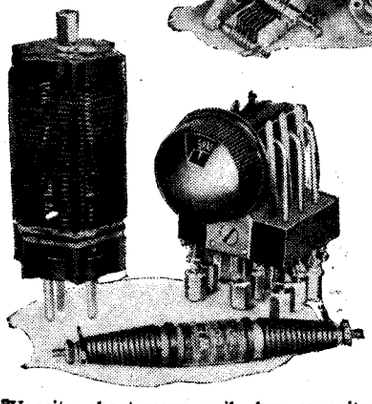


Self-supporting coils wound with ¼in. copper tube made by Epoch.

The plug-in variety of coil is obtainable in many different forms. Aerialite, B.T.S., Eddystone, Epoch, Premier Supply Stores and Raymart wind them on moulded ribbed formers of about 1¼ to 1½in. in diameter, and fitted with base pins similar to those used on valves. The four-pin kind, which have two windings, are arranged to fit into



Selection of B.T.S. short-wave components.



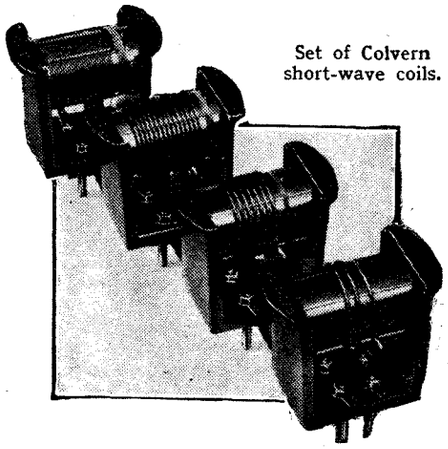
Wearite short-wave coil, low-capacity switch and RF choke.

a standard valveholder, but the six-pin variety, on which three windings are accommodated, usually requires a special holder. Most makers now adopt the same plan of connections so that coils are interchangeable.

Though enamelled copper wire is largely used for this style of coil, some are actually wound with silver-plated wire with the view to reducing coil losses. The lowest-range coil in the Premier Supply Stores series being a case in point.

Wearite has a series of plug-in four-pin coils wound on 1½-inch diameter formers of skeleton construction. The coils, being largely air-spaced, should be quite efficient.

The Colvern series of coils, though of the plug-in variety, differ from most others in that the coil former is mounted horizontally in a saddle-type holder on which is fitted the pins. This method of assembly gives slightly shorter leads between pins and winding than is possible with the orthodox vertical assembly.

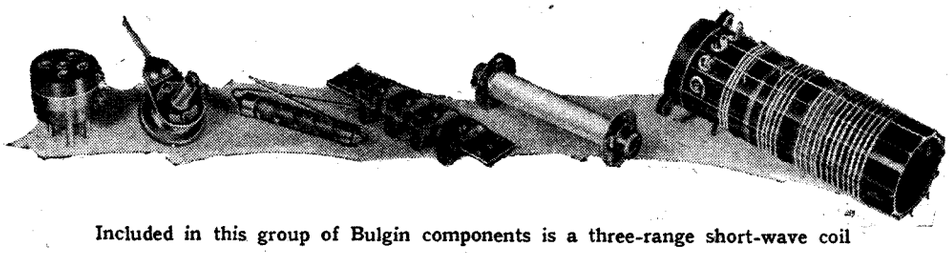


Set of Colvern short-wave coils.

Another maker that adopts the horizontal coil assembly is Formo. These coils are distinguished by the fact that the whole of the coil former, its mounting and base, are made of a high grade ceramic material. The shortest range coil covering the 12- to 25-metre band is wound with silver-plated copper strip; for the others heavy gauge enamelled copper wire is used.

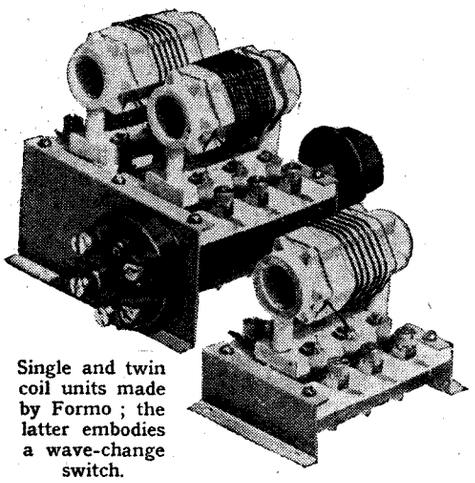
Formo coils have spring-type contacts which fit into a suitably shaped base mounting. This fitting, incidentally, is made either for a single coil or it can be obtained to accommodate two coils, and a wave-band switch is then included.

Coils wound on ceramic formers but as yet not provided with a base fitting, so far as we are aware, are obtainable from Burne-Jones.



Included in this group of Bulgin components is a three-range short-wave coil

Among the variety of coil units available are some that cover the whole of the useful part of the short-wave band with one coil assembly. Two-, three- and sometimes four-range coils, as these are described, have all the windings on a single former, and portions of the winding are included as required, the idle turns usually being short-circuited.

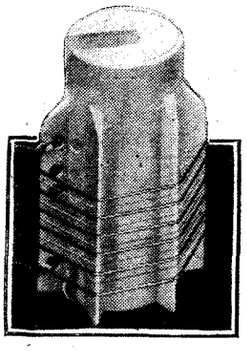


Single and twin coil units made by Formo; the latter embodies a wave-change switch.

Aeronautical and General Instruments make such a coil. Known as the R.I. Antinodal Short Wave Coil it covers a range of 12 to 80 metres.

There is one among Bulgin's components that gives three ranges and tunes from 12 to 95 metres with a 0.0001 mfd. condenser, and the Premier Supply Stores also make one with three ranges covering 15 to 80 metres with a 0.00015 mfd. condenser.

A coil unit in which special care has been taken to minimise losses that might be introduced with orthodox switching methods has been evolved by Lissen. It is known as the HiQ Rotary coil unit, and covers a band of 4.8 to 91 metres in four ranges. Its principal feature of merit is that only the coil actually in use is joined to the switch contacts, the others being entirely removed from the circuit. This is achieved by mounting all the coils in a rotary frame, and when the drum is turned to bring the required coil into use, lugs on its former make contact with four fixed springs attached to a block of ceramic material.



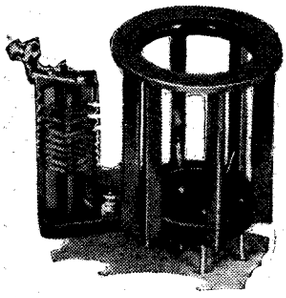
Magnum short-wave coil wound on a Frequentite former.

Blank formers are available for winding special coils, while if required a 75 to 175 metre coil can be included in place of one of the other short-wave coils.

The majority of the firms mentioned in connection with coils also supply blank formers, either threaded for space windings or with plain ribs, so that the experimenter can wind coils for any special requirement.

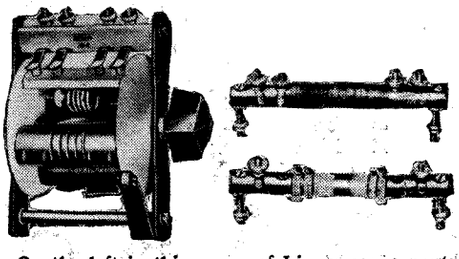
Components for the Short-wave Set Constructor—

A larger diameter former than now customarily employed is obtainable from Goltone. This is a six-ribbed skeleton type with base pins, and will be found very useful for winding coils for some of the stages in a transmitter. The Quartz Crystal Co. make coils on large formers of this type for use in low-power transmitters.



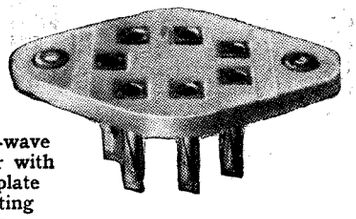
Skeleton former of large diameter made by Goltone. Their short-wave RF choke is also shown.

Though strictly speaking not a short-wave component, mention might be made here of coil assemblies and units that include one or more short-wave bands. The City Accumulator Co. make one covering wave ranges of 10 to 30, 25 to 75, 200 to 550 and 900 to 2,000 metres. It is designed for superheterodyne sets with an IF of 456 kc/s. It includes waveband switches and all padding condensers.



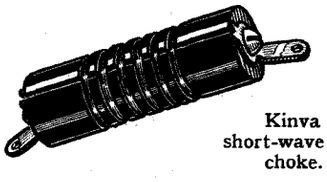
On the left in this group of Lissen components is shown their Hi Q Four-range Rotary Coil Unit.

Bulgin make some four wave-band coil units; one model is for superheterodyne sets and covers a range of 15 to 35, 30 to 85, 200 to 550, and 1,000 to 2,100 metres. External switches and padding condensers are required. The IF to be used is 450 or 465 kc/s. The other model is for straight all-wave sets with or without RF stages.



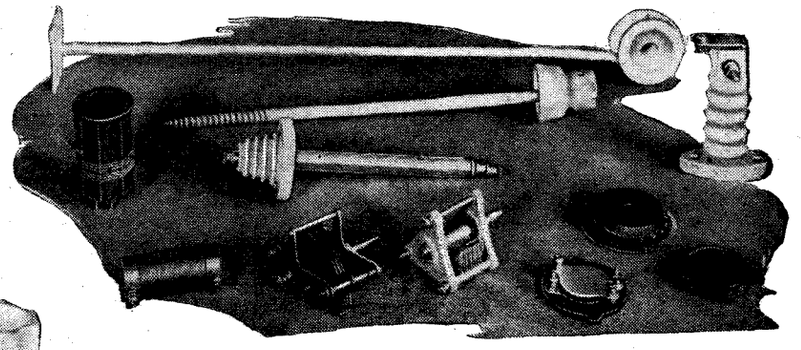
Clix short-wave valveholder with ceramic plate and floating sockets.

The B.T.S. all-wave tuner also includes two short-wave ranges. This unit is for embodying in a straight set with a tuned RF stage and by means of switching covers wave-ranges of 16 to 29, 27 to 57, 200 to 550, and 900 to 2,100 metres.

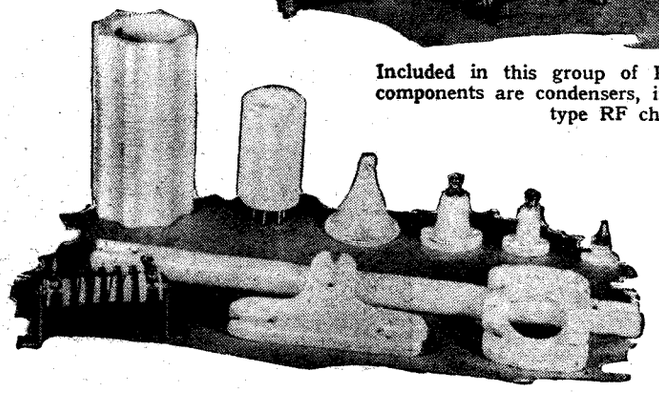


Kinva short-wave RF choke.

An all-wave coil unit including one short-wave range is obtainable from R. A. Rothermel. It is known as the Radio-Heart and embodies the gang condenser, RF and FC valve holders. All padding and tracking condensers are included, and the wave ranges are 16.5 to 52.6, 167 to 555, and 780 to 2,140 metres.



Included in this group of Premier Supply Stores' components are condensers, insulators and solenoid-type RF chokes.



Range of stand-off insulators made by Raymart. Shown also is their transmitting RF choke.

As it is customary to use an IF of about 450 kc/s. in short-wave and all-wave superheterodyne receivers, mention may be made in passing of those firms supplying transformers for this frequency. They are B.T.S., Bulgin, Eddystone, Raymart, Sound Sales and Wearite.

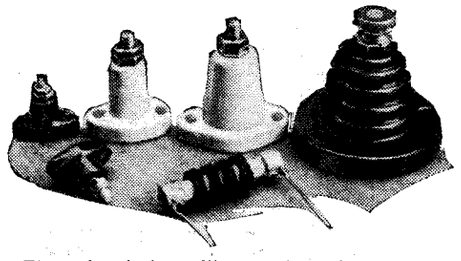
Whilst coils and condensers are possibly the key components in short-wave receivers there are many small items that individually may not introduce any apparent losses, provided average grade materials are employed, yet taken collectively their combined losses may quite likely attain an appreciable value. This really applies more to the construction of low power transmitters than to receivers.

The mica condensers and resistances used in short-wave receivers are not made specially for the purpose, or perhaps it would be more accurate to say that such components of this type that are made are not as yet available to the home constructor.

The experimenter must, therefore, make use of standard parts, but some discretion can be exercised in the choice of valve-holders.

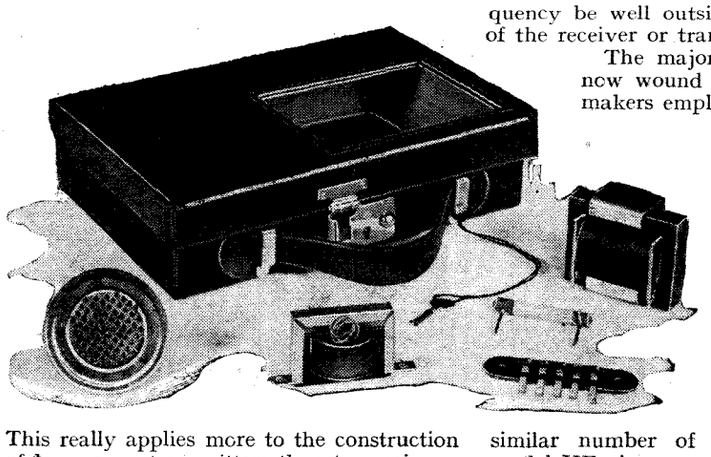
Lectro Linx make both chassis and baseboard mounting types, the former having a ceramic plate. Bulgin include both kinds among their short-wave components, and so do Stratton, B.T.S., Epoch, Graham Farish, Quartz Crystal Co., and Raymart.

Wherever it is necessary to employ RF chokes they should, of course, be of the short-wave type. Though the inductance of the winding is an important factor it is also necessary that the self-capacity of the choke be very small, and it is most essential that its resonant frequency be well outside the working range of the receiver or transmitter.



These insulating pillars and section-wound RF choke are products of N. E. Read.

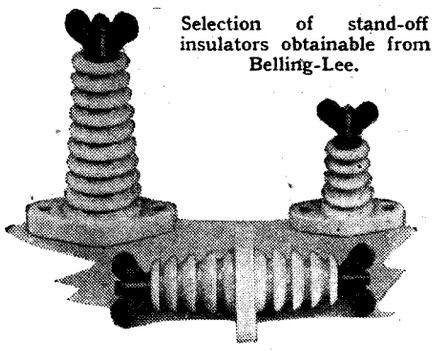
The majority of RF chokes are now wound in sections, and some makers employ sections with a dis-similar number of turns. The Wearite model HF3 is an example of this practice; the choke is wound on a slotted former with the turns at each end tapering to a smaller diameter and well spaced.



Some of the short-wave components made by Transreceivers. A miniature attaché case for portable ultra-short-wave sets and the like is included.

Components for the Short-Wave Set Constructor—

Goltone adopts section-winding, each section having a different number of turns. Some of the Raymart models are solenoid-wound, while others are sectionalised, the sections being of the self-supporting wave-wound variety on a former of ceramic material. This firm markets some of very low DC resistance for use in transmitting circuits.



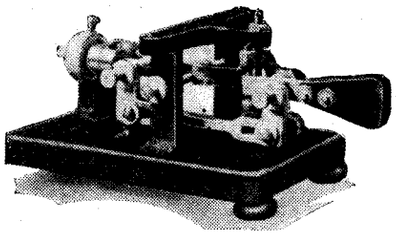
Selection of stand-off insulators obtainable from Belling-Lee.

RF chokes of very low DC resistance and designed especially for transmitting circuits are also made by Bulgin, but this firm have in addition quite an extensive range of receiving chokes. There are sectional-wound models, solenoid-type models, and a special low-capacity choke for ultra-short wave sets.

Postlethwaite include short and ultra-short wave models among their Kinva products, while Graham Farish have developed a sectional-wound model using a Frequentite tube as the supporting former.

A screened all-wave type, one with four close-coupled honeycomb-wound coils on a DL9 former, and an ultra-short wave model with spaced turns are included in the Eddystone range, while many more of similar pattern are to be found among the products of Lissen, Premier Supply Stores, Quartz Crystal Co., N. E. Read, and Transreceivers.

In all short-wave apparatus care must always be taken to keep stray capacities as small as possible, and as metal chassis are now almost universal it is often necessary



Mackey senior transmitting key, a product of N. E. Read.

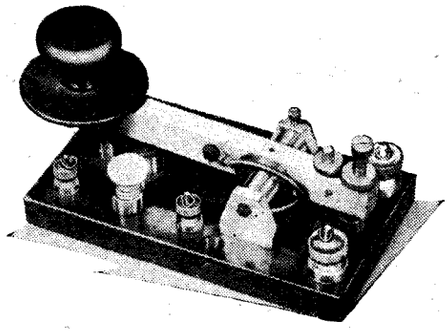
to mount certain of the components so that they are not in direct contact with the metal. This is very conveniently arranged by the use of small stand-off insulators. Insulators of this kind are used extensively in the construction of transmitters. In this case they serve the dual purpose of raising the parts above the metal and also providing the required insulation, both to the high DC and RF potential present in such apparatus.

Pillars for this purpose are available in a variety of sizes and shapes. Stratton include them from ⅜in. high. to 2½in. high, the smaller ones are made of Frequentite, while the larger are made of white DL9 material. Another firm that has a very long range of insulators of this kind is Raymart. Pillars from ½in. to 3½in. high are available.

The Premier Supply Stores has a wide variety of sizes, so also has Bulgin and N. E. Read. The last-mentioned firm specialise largely in transmitting parts and accessories, and among their products is a Morse key of rather novel design. It is known as the Mackey model and differs from the familiar pattern in that it is operated by a sideways movement. For some years it has been quite popular among amateurs in the U.S.A., where it is often referred to as a "Bug" key. There is a senior and a junior model.

N. E. Read supply the orthodox pattern signal key as well for those who prefer it. It is solidly made from brass and has ¼in. silver contacts. Morse keys of this type can be obtained also from Electradix Radios.

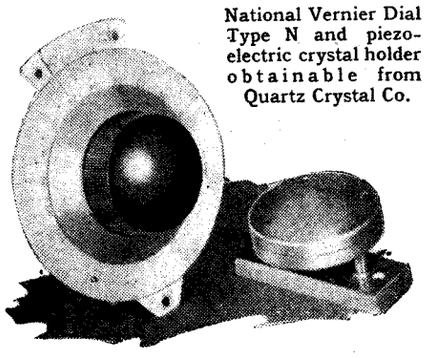
As occasional references have been made to components and units that though not exclusively short-wave are used in conjunction with short-wave sets, it will not be out of place to include here aerial equipment designed for all-wave sets. As only a brief mention is possible it must suffice to say that aerials of this pattern can be obtained from Aerialite, B.T.S., Belling-Lee, Bulgin, Goltone, Pye, Rothermel, and the New London Electron Works.



Orthodox pattern morse key supplied by Electradix Radios.

With very few exceptions all the firms engaged in the production and marketing of short-wave apparatus include among their products all the necessary equipment for aerials. Insulators for outdoor use are included, while some have a selection of parts designed primarily for the ultra-short waves.

Of more than usual interest, however, is a device that originates from the U.S.A., and is marketed in this country by Epoch (Radio Development Co.). It is known as the Johnson Q Antenna, and its function is to match low-impedance feeder lines to a half-

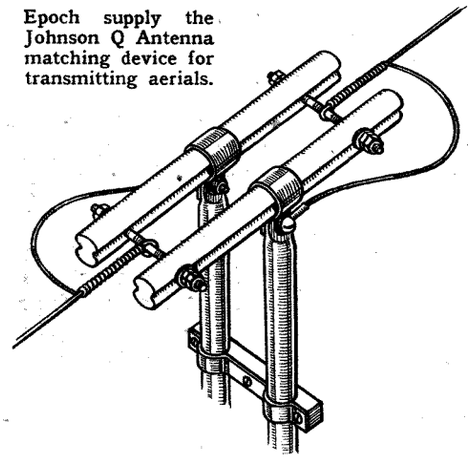


National Vernier Dial Type N and piezo-electric crystal holder obtainable from Quartz Crystal Co.

wave transmitting aerial so that the maximum efficiency is derived from the system.

Though most of the worthwhile short-wave broadcast stations can now be tuned-in on a loud speaker, for the more serious side of short-wave listening, such as amateur experimental and DX work, headphones are at times almost indispensable.

Epoch supply the Johnson Q Antenna matching device for transmitting aerials.



The modern headphone is quite comfortable to wear even for long spells of listening, and it goes without saying that the sensitivity is very high.

For many years now S. G. Brown have been making headphones, one of their most famous models being the Type A which has been in existence for some twenty years. Although the fundamental principle of the design is the same, many improvements have been effected since it was first introduced, though one of its main features, namely, the adjustable magnets and tuned reed, which enables very high sensitivity to be obtained for CW reception, is still retained. The usual resistance of this type is 2,000 ohms per earpiece.

Headphones made by S. G. Brown; the Type A is shown in the centre.

Two other models are made by Brown, and both of these are eminently suitable for the many purposes to which they are put by the amateur experimenter.

Headphones are also obtainable from Electradix Radios and from Ericsson Telephones.

The Australian SW Programmes

THE transmission times of the Sydney VK2ME and the Melbourne VK3ME short-wave stations for the month of November will be as follows:—

Sydney.—Sunday: 0600-0800; 0930-1330. Monday: 1400-1600.

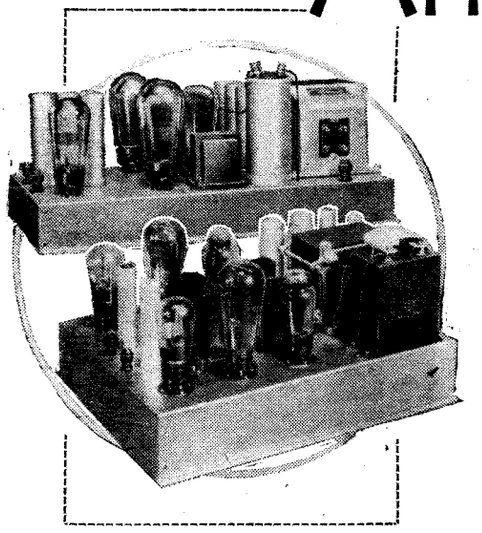
Melbourne.—Monday to Saturday: 0900 to 1200.

Sydney will be found on 31.28 metres (9,590 kc/s), and Melbourne on 31.55 metres (9,510 kc/s).

Resistance-Coupled Amplifiers

PART I.—The Fundamental Operating Conditions

By W. T. COCKING



IN spite of the fact that resistance coupling is one of the oldest forms of intervalve coupling and is still very widely used, its operating principles are by no means as generally understood as they should be. The choice of suitable values of components is not difficult and has received a good deal of attention in the past, but misunderstandings still arise. The circuit is one which it is easy to treat in all its aspects from a combined mathematical and graphical viewpoint so that it is at first surprising that there should be any misconception about it. The writer, however, believes that the difficulties which arise are due to a failure to grasp the actual physical processes upon which the operation depends, and in this series of articles it is proposed to deal thoroughly with all aspects of this system of intervalve coupling.

In practically every case the purpose for which we use a resistance-coupled stage is amplification—we have a certain input voltage and we require an output voltage which is a faithful copy of it save that it is of greater magnitude. Now, suppose we take a valve and connect it as shown in Fig. 1 with a resistance R in its anode circuit. The current flowing in the anode circuit depends upon the HT battery voltage, the value of the resistance R and upon the valve. The valve affects the current in two ways—first, through its construction, and, secondly, through its grid potential. For the present, we can ignore the former and say merely that with a given valve the current depends on the grid potential. With triodes under any normal conditions, the application of a negative voltage to the grid causes a reduction in the anode current.

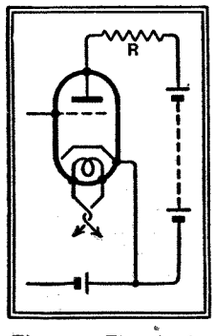


Fig. 1.—The basic circuit of a resistance-coupled amplifier.

Now, with the arrangement of Fig. 1, suppose that we use an HT battery of 200 volts and apply -3 volts grid bias to the valve; then when R has a value of 100,000 ohms the anode current might be 1 mA. It is easy to see that there is then a drop of 100 volts across the resistance, so that the anode of the valve is 100 volts positive with respect to its cathode. Now suppose that the valve characteristics are such that changing the grid potential by 1 volt in a positive direction, that is, to -2 volts, causes the anode current to increase to 1.2 mA. There is now a fall of potential of 120 volts in R, and the anode voltage of the valve is consequently $200-120=80$ volts.

Making the grid 1 volt less negative has thus resulted in lowering the anode potential by 20 volts, so that the gain of the stage is 20 times. If we had increased the negative grid potential by 1 volt, making a potential of -4 volts, the anode current would have become perhaps 0.8 mA, so that there would have been only 80 volts dropped across R and the anode voltage would have risen to 120 volts.

It is not usually convenient to speak of the actual voltages existing at any moment but rather to deal with the change of voltage from the normal condition. In the case of the grid potential, we may have a normal bias of -3 volts, and under the influence of the signal the grid potential may change from -2 volts to -4 volts. When we speak of this condition, however, we say that the grid has a mean potential of -3 volts and that it varies by ± 1 volt; the change to -2 volts being thought of as due to an input of $+1$ volt, and the change to -4 volts as being caused by an input of -1 volt.

Similarly in the anode circuit we do not under most circumstances think of the anode potential as varying between 80 and 120 volts, but we consider that it has the mean value of 100 volts and varies by ± 20 volts. The convenience of this will be evident later when we discuss the input circuit of the following valve. Now, one important point has already come out of this discussion, and it is this—when the input is $+1$ volt the output is -20 volts, and when the input is -1 volt the output is $+20$ volts. We can say, therefore, that a resistance-coupled stage gives a phase change of 180 degrees. This change of phase is independent of frequency, so that it is not distortion in any sense, and in normal operation for sound reproduction it is only of any importance in so far as it effects feed-back from other stages.

It is possible by a very simple graphical construction to determine quite accurately the conditions existing in a resistance stage such as that of Fig. 1. A set of anode-volts—anode-current curves for the particular valve to be employed is required, and one such for the Marconi or Osram MHL4 is shown in Fig. 2. We take one point, A, on the anode-voltage scale corresponding to the voltage of the HT supply and another point, B, on the current scale corresponding to the current which would flow if the HT supply were joined directly across the resistance. Suppose we have a supply of 290 volts and we intend to use a resistance of 25,000 ohms; our point A is at 290 volts and our point B is at $290/25{,}000=0.0116$ A $=11.6$

IN the series of articles of which this is the first, the operation of AF resistance-coupled amplifiers is dealt with in detail. The underlying principles are fully discussed and ways of calculating circuit performance are treated as well as the converse problem of determining the values of components necessary to give the required performance.

Resistance-Coupled Amplifiers—

mA. All we have to do now is to join these two points by a straight line, and from the intersections of this line with the valve curves we can read off the anode current and voltage for any grid voltage. If for any reason we decide to change the voltage of the HT supply, the load line must be drawn from the new value, but it will still be parallel with AB. If the load resistance is given a new value, however, the line representing it will have a different slope.

Under the conditions represented in Fig. 2 a normal value of grid bias might be -4 volts, giving the mean operating point C with an anode current of 5.76 mA, and an anode potential of 146 volts. The supply of 290 volts is thus divided across the valve and resistance, giving 146 volts on the valve and 144 volts dropped in the resistance. Now if we apply an input of $+2$ volt, the grid potential changes to $-4+2=-2$ volt, and the valve is at the point D the anode current has become 6.87 mA and the voltage 118, so that the voltage has fallen by 146-118=28 volts from its normal value. We thus say that for an input of $+2$ volts the output is -28 volts, and the amplification is obviously $28/2=14$ times. If we change the grid potential to -6 volts by applying an input of -2 volts ($-4-2=-6$) the operating point becomes E and the anode current is 4.64 mA with a voltage of 174. The anode voltage rises 174-146=28 volts, and we say that for an input of -2 volts the output is $+28$ volts; again the amplification is 14 times.

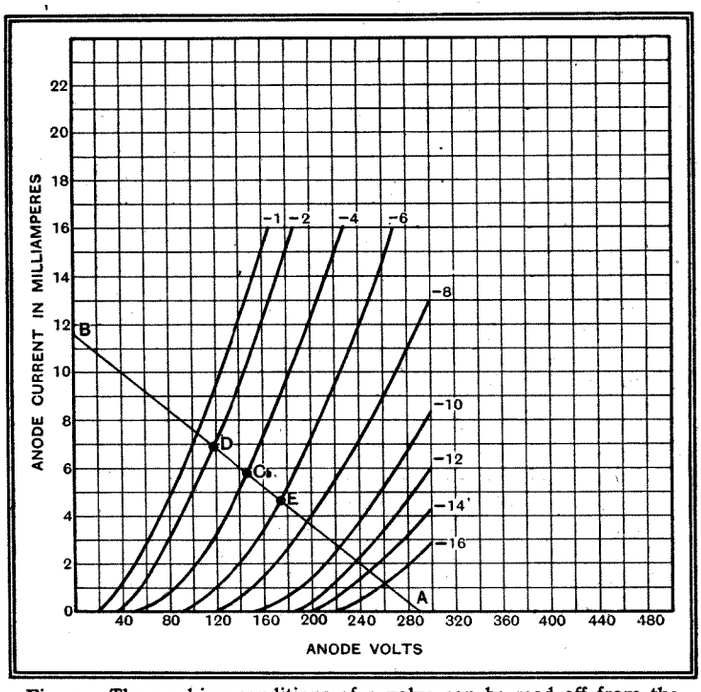


Fig. 2.—The working conditions of a valve can be read off from the valve characteristics by drawing the load line AB upon them.

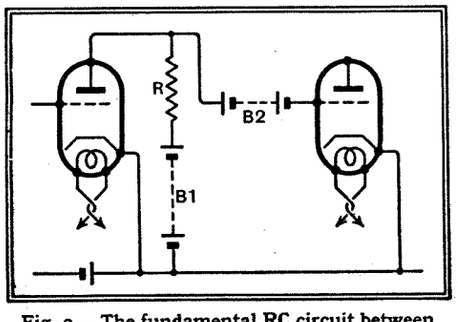


Fig. 3.—The fundamental RC circuit between two valves.

It may be remarked that in many cases it will be found that the change in anode voltage obtained for a given change in grid voltage is different for positive values of input than for negative. This shows that amplitude distortion is present and it will be shown later how to calculate the amount of such distortion. In general, complete freedom from such distortion can rarely be obtained, but the differences between the positive and negative values can be too small to be determined graphically, as in the case above. The distortion is then very small indeed and can be ignored.

We have seen how with a resistance coupling a change of grid voltage causes a change of anode voltage and as long as only resistances are involved the changes may be of any character and at any speed, and the output will faithfully follow the input. The input can thus be AC of any frequency, and just as the input will be an alternating voltage fluctuating about the mean value of the bias, so will the output be an alternating voltage fluctuating about the mean anode voltage. It will be clear, moreover, that, as so far considered, the amplifier will respond to steady voltages. If we change the grid potential by a certain amount, the anode potential changes by a greater amount but it remains at its new value as long as the grid potential is kept at this different value. An amplifier of this type is called a DC amplifier.

A valve following the first could have its grid connected directly to the first anode if it were not for the positive voltage on the anode. We can, however, use the arrangement of Fig. 3, in which a battery B2 is inserted in the grid lead of the second valve to offset the anode voltage of the first. Suppose both valves are the same and require -4 volts bias and that B1 is 290 volts; as we have already seen, the anode potential of the first valve is 146 volts, so that if the grid of the second valve is to be -4 volts with respect to its cathode, the battery B2 must be of $-146-4=-150$ volts.

An amplifier of this type is quite practicable and has no lower limit to the frequency response. Stray capacities, however, place an upper limit. This amplifier or modifications of it are the only ones capable of responding to a steady DC input, and this feature, which is sometimes useful, is the great practical drawback to its use for normal purposes. Very small changes in battery voltages will completely upset the operating conditions. Thus, suppose three stages are used, each giving a gain of 14 times and having a nominal bias of -4 volts, then if the voltage of the bias battery for the first valve falls by 0.1 volt, an amount which is not large enough to have any serious effect on this stage itself, the grid bias on the second valve will be 1.4 volts more negative than normal, and that on the third 19.6 volts more positive. The grid of the third valve will, in fact, be $19.6-4=15.6$ volts positive with respect to the cathode and the operation will be very seriously affected.

It is actually very difficult to maintain normal operation with direct-coupled amplifiers, and their use is consequently avoided wherever possible. The use of a condenser and resistance in place of the battery B2 isolates the grid of the second valve from the anode of the first, and the operating conditions of the second valve are consequently unaffected by changes in those of the first. It is, however, possible for *rapid* changes in anode voltage to be communicated to the grid, and it is this aspect of the amplifier which we shall investigate in Part II.

TELEVISION PROGRAMMES

The principal items only of each day's programmes are given. During this week the Baird system is being used. Transmission times are from 3-4 and 9-10 p.m. daily.

Vision 6.67 m. Sound 7.23 m.

MONDAY, NOVEMBER 2nd.

3, Opening ceremony by the Postmaster-General. **3.15,** British Movietone News. **3.30,** The Lai Founs (Chinese Jugglers), Adele Dixon, Buck and Bubbles and the Television Orchestra.

9, B.B.C. Film, "Television Comes to London." **9.20,** "Picture Page," magazine of novelties. **9.50,** British Movietone News.

TUESDAY, NOVEMBER 3rd.

3.5, Thoroughbred Alsatian Dogs. **3.15,** British Movietone News. **3.25,** "The Golden Hind" (Prizewinning Model of Drake's famous ship described by the maker). **3.45,** Bebe Daniels and Ben Lyon (stars from Hollywood).

9.5–9.25, Afternoon programme (3.5–3.25) repeated. **9.45,** Manuela Del Rio—Spanish dances.

WEDNESDAY, NOVEMBER 4th.

3.5, Martin Taubman demonstrating the "Electronde." **3.20,** British Movietone News. **3.35,** B.B.C. Dance Orchestra.

9.5, British Movietone News. **9.15,** "Tempo and Taps"—Rosalind Wade demonstrating tap dancing. **9.40,** Martin Taubman with the "Electronde."

THURSDAY, NOVEMBER 5th.

3.5, British Movietone News. **3.20,** The Mercury Ballet and Television Orchestra. **3.45,** Film, "Television Comes to London."

9.5, British Movietone News. **9.15,** Prize Chrysanthemums from the Chrysanthemum Society's Show. **9.35,** The Mercury Ballet and Television Orchestra.

SHORT-WAVE STATIONS OF

(Stations with an Aerial Power of 20 kW. and above are shown in heavy type)

Station.	Call Sign.	kc/s.	Tuning Positions.	Metres.	kW.
Sourabaya (Dutch East Indies)	YDB7	1,530	.....	196.18	0.07
Soekaboeni (Dutch East Indies)	YDA4	1,550	.....	193.55	0.02
Malang (Dutch East Indies) ...	YDB6	1,570	.....	191.08	0.1
Batavia (Dutch East Indies) ...	YDD3	1,585	.....	189.27	0.05
Solo (Dutch East Indies) ...	YDB5	1,595	.....	188.09	0.02
U.S.A. Police	—	1,596	.....	180.45	—
Tjepoe (Dutch East Indies) ...	YDB4	1,615	.....	185.76	0.02
Buitenzorg (Dutch East Indies)...	YDA3	1,640	.....	182.92	0.02
Tjokjakarta (Dutch East Indies)	YDB3	1,660	.....	180.72	0.1
U.S.A. Police	—	1,666	.....	180.07	—
U.S.A. Police	—	1,674	.....	179.21	—
U.S.A. Police	—	1,706	.....	175.73	—
U.S.A. Police	—	1,712	.....	175.23	—
U.S.A. Amateurs	—	1,715–2,000	.....	175.00–150.00	—
British Amateurs	—	1,730–1,985	.....	173.40–151.10	—
Liepaja (Latvia)	—	1,734	.....	173.00	0.1
Small craft, including Yachts, Trawlers, Lifeboats and Lifeships	—	1,837.10	.....	163.30	—
U.S.A. Police	—	2,000–2,100	.....	150.00–142.85	—
British Police	—	2,054.79	.....	146.00	—
Semarang (Dutch East Indies)...	YDB2	2,170	.....	138.25	0.15
Tjokjakarta (Dutch East Indies)	YDE5	2,350	.....	127.66	0.15
Batavia (Dutch East Indies) ...	YDA2	2,385	.....	125.79	0.15
Bandoeng (Dutch East Indies)...	—	2,500	.....	120.00	0.07
Semarang (Dutch East Indies)...	YDE3	2,710	.....	110.70	0.15
U.S.A. Police	—	2,750–2,850	.....	109.09–105.26	—
Cheribon (Dutch East Indies) ...	YDA6	2,870	.....	104.53	0.01
Bandoeng (Dutch East Indies)...	—	2,910	.....	103.09	0.12
Tandjonk Priok (Dutch E. Indies)	YDA	3,040	.....	98.68	10
Sourabaya (Dutch East Indies)...	YDE5	3,150	.....	95.23	0.15
Pekalongan (Dutch East Indies)	YDA7	3,270	.....	91.74	0.01
U.S.A. Amateurs	—	3,500–4,000	.....	85.70–75.00	—
Aircraft of all types	—	4,000–17,647.05	.....	75.00–17.00	—
Aircraft Land Stations	—	4,000–18,750.00	.....	75.00–16.00	—
Khabarovsk (U.S.S.R.)	**RW15**	4,273	.....	70.20	20
Solo (Dutch East Indies) ...	YDE2	4,810	.....	63.37	0.1
San Cristobal (Venezuela) ...	YV10RSC	5,720	.....	52.45	—
Lima (Peru)	OAX4D	5,780	.....	51.90	—
Caracas (Venezuela)	YV2RC	5,804	.....	51.69	1
San Jose de Costa Rica (Costa Rica)	TIGPH	5,822	.....	51.53	—
Maracaibo (Venezuela)	YV5RMO	5,850	.....	51.28	—
San Pedro de Macoris (Dominica)	HI1J	5,865	.....	51.15	0.04
Tegucigalpa (Honduras)... ...	HRN	5,875	.....	51.06	—
Quito (Ecuador)	HCK	5,885	.....	50.98	0.3
Barquisimeto (Venezuela) ...	YV8RB	5,895	.....	50.89	0.2
Port au Prince (Haiti)	HH2S	5,920	.....	50.68	0.1
Medellin (Colombia)	HJ4ABB	5,927	.....	50.62	—
Guatemala City (Guatemala) ...	TG2X	5,940	.....	50.51	—
Bogota (Colombia)	HJN	5,950	.....	50.42	1
Vatican City (Vatican State) ...	HVJ	5,976	.....	50.20	15
Bucaramanga (Colombia) ...	HJ2ABD	5,988	.....	50.10	—
Georgetown (British Guiana) ...	VP3MR	5,995	.....	50.04	—
Moscow (U.S.S.R.)	**RNE**	6,001	.....	49.99	20
Montreal (Canada)	**CFCX**	6,005	.....	49.96	75
Colon (Panama)	HP5K	6,005	.....	49.96	—
Havana (Cuba)	COCO	6,008	.....	49.93	0.3
Bogota (Colombia)	HJ3ABH	6,010	.....	49.92	1
Santiago de los Caballeros (Dominica)	HI3U	6,017	.....	49.86	0.02
Santa Marta (Colombia)... ...	HJ1ABJ	6,017	.....	49.86	1
Zeesen (Germany)	DJC	6,020	.....	49.83	5
Singapore (Malaya)	ZHI	6,020	.....	49.83	0.09
Medellin (Colombia)	HJ4ABP	6,028	.....	49.77	1
Panama (Panama)	HP5B	6,032	.....	49.74	0.1
Miami (U.S.A.)	W4XB	6,040	.....	49.67	2.5
Tandjonk Priok (Dutch E. Indies)	YDA	6,040	.....	49.67	10
Boston (U.S.A.)	W1XAL	6,040	.....	49.67	10
Barranquilla (Colombia) ...	HJ1ABG	6,042	.....	49.65	1
Santiago (Dominica)	HI9B	6,047	.....	49.61	0.1
Daventry (Great Britain) ...	GSA	6,050	.....	49.59	15
Bogota (Colombia)	HJ3ABD	6,055	.....	49.55	1
Skamlebaek (Denmark)	OXY	6,060	.....	49.50	0.5
Philadelphia (U.S.A.)	W3XAU	6,060	.....	49.50	1
Cincinnati (U.S.A.)	W8XAL	6,060	.....	49.50	10
Bogota (Colombia)	HJ3ABF	6,069	.....	49.43	1
Vienna (Austria)	OER2	6,070	.....	49.42	0.25
Maracaibo (Venezuela)	YV7RMO	6,071	.....	49.42	—
Zeesen (Germany)	**DJM**	6,079	.....	49.35	50
Penang (Malaya)	ZHI	6,080	.....	49.34	0.05
Colon (Panama)	HP5F	6,080	.....	49.34	0.2
Chicago (U.S.A.)	W9XAA	6,080	.....	49.34	0.5
Nairobi (Kenya)	VQ7LO	6,082	.....	49.33	0.5
Rome (Italy)	**I2RO**	6,085	.....	49.30	25
Cali (Colombia)	HJ5ABD	6,087	.....	49.28	1
Toronto (Canada)	CRCX	6,090	.....	49.26	1
Johannesburg (South Africa) ...	ZTJ	6,097	.....	49.20	5
Medellin (Colombia)	HJ4ABE	6,099	.....	49.19	1
Chicago (U.S.A.)	W9XF	6,100	.....	49.18	10
Bound Brook (U.S.A.)	**W3XAL**	6,100	.....	49.18	35
Belgrade (Yugoslavia)	—	6,100	.....	49.18	0.3
Manizales (Colombia)	HJ4ABD	6,107	.....	49.12	1
Daventry (Great Britain) ...	GSL	6,110	.....	49.10	15
Calcutta (India)	VUC	6,110	.....	49.10	0.5
Prague (Podebrady) (Czechoslovakia)	**OLR**	6,115	.....	49.06	34
Wayne (U.S.A.)	W2XE	6,120	.....	49.02	1
Bogota (Colombia)	HJ3ABX	6,122	.....	49.00	1
Montevideo (Uruguay)	CXA4	6,125	.....	48.98	—
Havana (Cuba)	COCD	6,127	.....	48.96	0.15
Barranquilla (Colombia) ...	HJ1ABB	6,129	.....	48.95	1
Halifax (Canada)...	CJHX	6,130	.....	48.94	0.5
Georgetown (British Guiana) ...	VP3MG	6,130	.....	48.94	—
Port au Prince (Haiti)	HH2W	6,135	.....	48.89	0.03
Pittsburgh (U.S.A.)	**W8XK**	6,140	.....	48.86	40
Santiago de Cuba (Cuba) ...	COKG	6,147	.....	48.80	—
Pereira (Colombia)	HJ4ABU	6,147	.....	48.80	1
Winnipeg (Canada)	CJRO	6,150	.....	48.78	2
Santiago (Dominica)	HI5N	6,150	.....	48.78	0.1
Santiago (Chile)	CB615	6,153	.....	48.76	0.15
Caracas (Venezuela)	YV3RC	6,154	.....	48.75	0.2
Santiago de los Caballeros (Dominica)	HI1A	6,190	.....	48.47	0.05
La Ceiba (Honduras)	HRV	6,235	.....	48.12	—
Trujillo City (Dominica) ...	HI8Q	6,240	.....	48.08	0.02
Trujillo City (Dominica) ...	HIN	6,244	.....	48.05	—
Lima (Peru)	OAX4G	6,258	.....	47.94	—
Sancti Spiritus (Cuba)	CO9WR	6,280	.....	47.77	—
Trujillo City (Dominica) ...	HIG	6,280	.....	47.77	0.05
Maracay (Venezuela)	YV12RM	6,298	.....	47.63	—
Trujillo City (Dominica) ...	HIZ	6,307	.....	47.57	0.1
Trujillo City (Dominica) ...	HIX	6,335	.....	47.36	1
Port au Prince (Haiti)	—	6,343	.....	47.29	—
Caracas (Venezuela)	YV4RC	6,377	.....	47.04	0.3
Caracas (Venezuela)	YV9RC	6,400	.....	46.87	—
San Jose de Costa Rica (Costa Rica)	TIPG	6,410	.....	46.80	1
Puerto Plata (Dominica) ...	HI1S	6,420	.....	46.73	0.02
Trujillo City (Dominica) ...	HI4V	6,478	.....	46.31	0.02
Trujillo City (Dominica) ...	HIL	6,500	.....	46.15	0.02

THE WORLD

Arranged in Order of Frequency and Wavelength

Station.	Call Sign.	kc/s.	Tuning Positions.	Metres.	kW.
Valencia (Venezuela)	YV6RV	6,518	.....	46.03	—
Rabat (Morocco)	CNR	8,035	.....	37.33	10
Bolivar City (Venezuela) ...	YViiRB	6,546	.....	45.83	—
San Jose de Costa Rica (Costa Rica)	TIRCC	6,552	.....	45.79	—
Trujillo City (Dominica) ...	HI4D	6,557	.....	45.75	0.02
Riobamba (Ecuador)	—	6,625	.....	45.28	2
Trujillo City (Dominica) ...	HIT	6,630	.....	45.25	0.1
Lima (Peru)	OAX7A	6,653	.....	45.09	—
San Jose de Costa Rica (Costa Rica)	TIEP	6,690	.....	44.84	—
Moscow (U.S.S.R.)	RTV	6,725	.....	44.61	15
La Romana (Dominica) ...	HI3C	6,733	.....	44.56	0.02
San Pedro de Macoris (Dominica)	HIH	6,776	.....	44.27	0.07
Bandoeng (Dutch East Indies)...	YDA1	6,800	.....	44.12	1.5
Trujillo City (Dominica) ...	HI7P	6,803	.....	44.10	0.02
U.S.A. Amateurs	—	7,000–7,300	.....	42.90–41.10	—
Mexico (Mexico)	**XECR**	7,390	.....	40.60	20
Tokio (Japan)	**JVP**	7,510	.....	39.95	20
Moscow (U.S.S.R.)	**RKI**	7,520	.....	39.89	25
Prangins (Radio Nations) (Switzerland)	**HBP(SDN)**	7,797	.....	38.48	20
Moscow (Koupavna) (U.S.S.R.) .	RCC	7,800	.....	38.46	15
Gamaguey (Cuba)	CO9JQ	8,665	.....	34.62	0.1
Quito (Ecuador)	HCJB	8,945	.....	33.54	0.15
Budapest (Hungary)	HAT4	9,130	.....	32.86	6
Havana (Cuba)	COCH	9,435	.....	31.80	0.15
Rio de Janeiro (Brazil)	PRF5	9,500	.....	31.58	12
Cartagena (Colombia)	HJ1ABE	9,500	.....	31.58	1
Buenaventura (Colombia) ...	HJU	9,500	.....	31.58	1
Daventry (Great Britain) ...	GSB	9,510	.....	31.55	15
Melbourne (Australia)	VK3ME	9,510	.....	31.55	3.5
Jeloy (Norway)	LKJ	9,525	.....	31.49	1.5
Schenectady (U.S.A.)	**W2XAF**	9,530	.....	31.48	40
Zeesen (Germany)	**DJN**	9,540	.....	31.45	50
Zeesen (Germany)	DJA	9,560	.....	31.38	5
Bombay (India)	VUB	9,565	.....	31.36	4.5
Millis (U.S.A.)	W1XK	9,570	.....	31.35	10
Lyndhurst (Australia)	VK3LR	9,580	.....	31.32	1
Daventry (Great Britain) ...	GSC	9,580	.....	31.32	15
Sydney (Australia)	VK2ME	9,590	.....	31.28	16
Philadelphia (U.S.A.)	W3XAU	9,590	.....	31.28	1
Eindhoven (Holland)	PCJ	9,590	.....	31.28	12
Radio Nations (Switzerland) ...	**HBL**	9,595	.....	31.27	20
Santiago de Chile (Chile) ...	CB960	9,600	.....	31.25	0.1
Moscow (U.S.S.R.)	**RAN**	9,600	.....	31.25	20
Panama (Panama)	HP5J	9,605	.....	31.23	0.2
Cartagena (Colombia)	HJ1ABP	9,616	.....	31.20	1
Rome (Italy)	**12RO3**	9,635	.....	31.12	25
Port au Prince (Haiti)	HH3W	9,645	.....	31.10	0.1
Sourabaya (Dutch East Indies)...	YDB1	9,657	.....	31.07	1
Lisbon (Portugal)	CT1AA	9,660	.....	31.06	—
Buenos Aires (Argentina) ...	LRX	9,660	.....	31.06	5
Havana (Cuba)	COCQ	9,750	.....	30.77	—
Madrid (Spain)	EAQ	9,860	.....	30.43	10
Lisbon (Portugal)	CSW	9,930	.....	30.21	—
Santiago de Chile (Chile) ...	CEC	10,230	.....	29.33	0.8
Vandoeng (Dutch East Indies)...	PMN	10,260	.....	29.24	1.5
Ruysselede (Belgium)	ORK	10,330	.....	29.04	11
Teneriffe (Spain)	**EAJ43**	10,365	.....	28.94	20
Tokio (Japan)	**JVN**	10,660	.....	28.14	20
Santiago de Chile (Chile) ...	CEC	10,670	.....	28.12	4
Tokio (Japan)	**JVM**	10,740	.....	27.93	20
Bandoeng (Dutch East Indies)...	PLP	11,000	.....	27.27	1.5
Stockholm (Sweden)	—	11,705	.....	25.63	—
Paris (Radio-Colonial) (France)...	TPA4	11,715	.....	25.61	12
Winnipeg (Canada)	CJRX	11,722	.....	25.60	2
Huizen (Holland)	**PH1**	11,730	.....	25.57	20
Daventry (Great Britain) ...	GSD	11,750	.....	25.53	15
Prague (Podebrady) (Czechoslovakia)	**OLR**	11,760	.....	25.51	34
Zeesen (Germany)	DJD	11,770	.....	25.49	5
Boston (U.S.A.)	W1XAL	11,790	.....	25.45	10
Zeesen (Germany)	**DJO**	11,795	.....	25.43	50
Vienna (Austria)	OER3	11,801	.....	25.42	1.5
Rome (Italy)	**12RO4**	11,810	.....	25.40	25
Rabat (Morocco)	CNR	12,830	.....	23.39	10
Daventry (Great Britain) ...	GSN	11,820	.....	25.38	15
Wayne (U.S.A.)	W2XE	11,830	.....	25.36	1
Zeesen (Germany)	**DJP**	11,855	.....	25.31	50
Daventry (Great Britain) ...	GSE	11,860	.....	25.29	15
Pittsburgh (U.S.A.)	**W8XK**	11,870	.....	25.27	40
Prague (Podebrady) (Czechoslovakia)	**OLR**	11,875	.....	25.26	34
Paris (Radio Colonial) (France)...	TPA3	11,885	.....	25.24	12
Moscow (U.S.S.R.)	**RNE**	12,002	.....	25.00	20
Reykjavik (Iceland)	TFJ	12,235	.....	24.52	7
Warsaw (Poland)	**SPW**	13,635	.....	22.00	20
U.S.A. Amateurs	—	14,000–14,400	.....	21.43–20.83	—
British Amateurs	—	14,030–14,370	.....	21.38–20.88	—
Moscow (U.S.S.R.)	RTV	14,580	.....	20.58	15
Tokio (Japan)	**JVH**	14,600	.....	20.55	20
Sofia (Bulgaria)	LZA	14,885	.....	20.15	7
Moscow (U.S.S.R.)	**RK1**	15,040	.....	19.95	25
Zeesen (Germany)	DJL	15,110	.....	19.85	5
Vatican City (Vatican State) ...	HVJ	15,120	.....	19.84	10
Daventry (Great Britain) ...	GSF	15,140	.....	19.82	10
Batavia (Dutch East Indies) ...	—	15,150	.....	19.80	3
Daventry (Great Britain) ...	GSO	15,180	.....	19.76	10
Zeesen (Germany)	DJB	15,200	.....	19.74	5
Pittsburgh (U.S.A.)	**W8XK**	15,210	.....	19.72	40
Eindhoven (Holland)	PCJ	15,220	.....	19.71	12
Prague (Podebrady) (Czechoslovakia)	**OLR**	15,230	.....	19.70	34
Paris (Radio Colonial) (France)...	TPA2	15,240	.....	19.69	10
Daventry (Great Britain) ...	GS1	15,260	.....	19.66	10
Wayne (U.S.A.)	W2XE	15,270	.....	19.64	1
Zeesen (Germany)	**DJQ**	15,280	.....	19.63	50
Buenos Aires (Argentina) ...	LRU	15,290	.....	19.62	5
Daventry (Great Britain) ...	GSP	15,310	.....	19.60	10
Schenectady (U.S.A.)	**W2XAD**	15,330	.....	19.57	40
Zeesen (Germany)	**DJR**	15,340	.....	19.56	50
Budapest (Hungary)	HAS3	15,370	.....	19.51	6
Bound Brook (U.S.A.)	W3XL	17,310	.....	17.33	—
Zeesen (Germany)	DJE	17,760	.....	16.89	5
Wayne (U.S.A.)	W2XE	17,760	.....	16.89	1
Huizen (Holland)	**PHI**	17,770	.....	16.88	20
Bound Brook (U.S.A.)	**W3XAL**	17,780	.....	16.87	35
Daventry (Great Britain) ...	GSG	17,790	.....	16.86	10
Prangins (Radio Nations) (Switzerland)	**HBH**	18,480	.....	16.25	20
Bandoeng (Dutch East Indies)...	**PMA**	19,345	.....	15.51	60
Zeesen (Germany)	**DJS**	21,450	.....	13.97	20
Prague (Podebrady) (Czechoslovakia)	**OLR**	21,450	.....	13.97	34
Daventry (Great Britain) ...	GSH	21,470	.....	13.97	10
Wayne (U.S.A.)	W2XE	21,520	.....	13.94	1
Daventry (Great Britain) ...	GSJ	21,530	.....	13.93	10
Pittsburgh (U.S.A.)	**W8XK**	21,540	.....	13.93	40
British Amateurs	—	28,050–29,950	.....	10.70–10.02	—
U.S.A. Police	—	30,000–42,000	.....	10.00–7.14	—
Alexandra Palace, Sound ...	—	41,500	.....	7.23	3
Alexandra Palace, Vision ...	—	45,000	.....	6.67	17
British Amateurs	—	56,070–59,930	.....	5.35–5.00	—

Broadcast Brevities

NEWS FROM PORTLAND PLACE

Animated Weather Charts

THE Air Ministry is co-operating with the B.B.C. to develop an interesting idea in the presentation of weather charts by television. Each day a plain map of the British Isles will be shown, and on this isobars and other meteorological indications will be drawn from data furnished by the Air Ministry observation posts all over the country.

This and the accompanying commentary should give televiewers a much clearer understanding of those depressions over Iceland and their implications than listeners have been able to obtain in fourteen years of sound broadcasting.

The B.B.C.'s "Documentary"

ALTHOUGH it will take only fifteen minutes to show, the B.B.C. documentary film, "Television Comes to London," has been on the stocks for practically a year. Major L. G. Barbrook, who has been responsible for the photography, began his task in the fogs and rain of November last as it was necessary to secure a continuous record of the constructional work no matter what the weather. Many of the "shots" were taken from positions which even the most hard-boiled mast-climbers conceded to be dangerous. The results will be seen by televiewers on Monday evening next.

Finding the Music

Six months ago there cropped up the problem of choosing a suitable musical accompaniment. The B.B.C. Music Library was ransacked in the search for something sufficiently "modernistic" to harmonise with the ultra-modernity of the subject, but it seemed that no musical visionaries of to-day were really televisionary. And then, as so often happens, it was found that one of the older masters had said all that was necessary. Anton Dvorák's "New World" Symphony has been woven into the sound track of the television film to make a perfect pattern of action and music. The commentary to the film has been written by that pioneer of broadcasting, Cecil Lewis, and is spoken by the television announcer, Leslie Mitchell.

Pageantry on the Ether

IN this modern world there are few countries which still offer scope for pomp and pageantry. Britain is one of them, so it is hardly surprising that many foreign listeners invariably tune in the broadcasts of the Lord Mayor's Show.

Norway is evincing special interest this year; a commentator from Oslo is coming over to occupy a privileged window seat in the Mansion House. His description of the procession will be conveyed by landline to a recording studio in the West End and within thirty-six hours the records should be in the hands of the Oslo engineers for radiation over the Scandinavian broadcasting systems.

America Too

America, too, is keenly interested. The Prime Minister's speech at the Guildhall banquet is to be relayed over the Columbia network. It will be picked up from the Empire Transmission 4 and the C.B.S. engineers will have a choice of three wavelengths: 19.82, 25.53 and 31.55 metres.

Breakfast Broadcast

IF, as is hoped, the B.B.C. gives us running commentaries on the Test matches in Australia, it may be necessary to broadcast these at breakfast-time. Only in this way would it be possible to put over a direct account before stumps are drawn each day.

The opening match at Brisbane begins in the first week of December. Nothing could be more heartening on those dull winter mornings than a bright ball-by-ball description of play on the cricket field, (and it is understood that the B.B.C. is not unmindful of this fact).

TEST MATCH RELAYS.—Mr. Norman M. Sheppard of the Australian Broadcasting Commission who selects the programmes to be re-broadcast by the National Short-wave Stations. Test match relays will figure prominently in his choice for the stations that can be picked up in this country.

A Gliding Broadcast

INTEREST in gliding is not confined to those who glide—a fact evident when one sees the crowds of week-end motorists thronging the hillside above the London Gliding Club's ground on Dunstable Downs.

The other day Mr. Joly de Lotbinière, the Outside Broadcast Director, himself went up in a two-seater glider and was so thrilled by his experience that he at once arranged to broadcast a first-hand account of a novice's sensations when gliding for the first time.

The broadcast, scheduled for November 14th, should appeal to many who have not realised how gliding can bring aviation within the reach of nearly everyone weighing less than 30 stone.

The Regionals

IT is learned from Mr. C. A. Siepmann, who was Director of Regional Relations until his recent appointment as Director of Programme Planning, that whilst touring the regions during his previous appointment he found local listeners were resentful towards the "London drift" in the Regional programmes. This state of affairs should no longer exist, for most of the recommendations contained in his recent report have already been adopted.

Preserving Local Interests

The chance of dialects dying will now be more remote, for local interests are to be fostered and less of the regions' programmes are to be filled by London items. The percentage of regional material which is at present incorporated in evening programmes varies from 22 per cent. to 36 per cent.

During the past year an increase of something like 20 per cent. has been made in Regional financial allocations, which must, of course, be reflected in the matter broadcast. The amount allowed for each region is allocated after the quarterly meeting of Regional Programme Directors, at which each presents a budget for the ensuing quarter.

It has become more and more obvious that London is including a much larger proportion of programmes such as only the Regionals could provide; for instance, the "Harry Hopeful Series," "West Country Calendar," and "March of the 45." This is surely a good thing, for Londoners are apt to become very London-minded.

That Microphone Manner

PEOPLE still declare that B.B.C. announcing methods stifle individuality. Yet Stuart Hibberd's recent return from three months' leave has changed the lives of whole families, to judge from the bales of "Welcome Home" letters that have reached Broadcasting House.

Hibberd's extraordinary appeal must lie in the manner rather than the matter, for his announcements are couched in the same terms as those of his colleagues.

Feminine Fame

AN all-feminine show, with a mere touch of masculinity, is scheduled for November 10th, when the National transmitter will radiate "Feminine Fame," a satirical revue of old favourites. Both the book and the lyrics are by Joan Young, and the music has been composed by Nena Smith.

The "bill" includes Hermione Gingold, Gwen Lewis, Martita Hunt, Joan Young, Olga Martin and Molly O'Callogan. Rae Jenkins will play a muted viola.

Apart from the Variety Orchestra, which will be in support, only two men step into the picture. Ronnie Munro is responsible for the musical arrangements; Douglas Moodie compères and produces the show.

Paris in the 'Eighties

"GAY Paree" at the time of the Great Exhibition in 1889 will provide the background for Lance Sieveking's next radio dramatisation.

Sieveking, whose productions always bear a highly original stamp, has taken Mrs. Belloc Lowndes' novel, "The End of her Honeymoon," for presentation as a radio version in the National programme on November 17th.

Heard on the "All-Wave"

By "CATHODE RAY"

THIS is not going to include a violent attack on the use of the term "all-wave" to refer to receivers which, in general are far from strictly conforming to that description; there are so many misleading radio terms already in currency that it is pretty hopeless to try to keep another one out, especially when it comes from America.

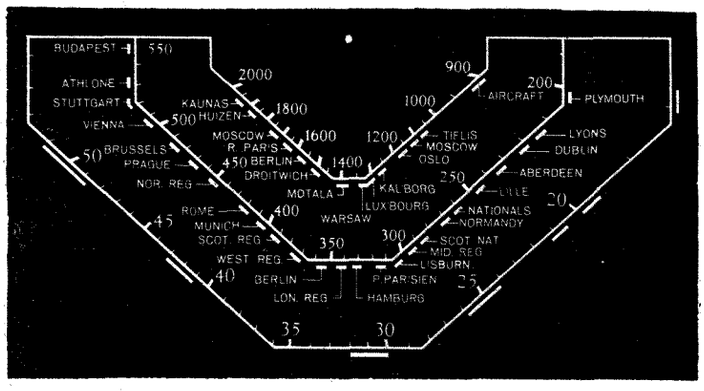
No, I am accepting the "all-wave" set as a *fait accompli*, both in the dictionary and in the dealer's window. Publicity put it there, it seems, rather than demand; or at any rate the supply created the demand, so far as the raw listening public is concerned. Short-wave reception is an acquired taste; and the ordinary unguided listener let loose on an all-wave set is likely, after the first attempt, to stick closely to the familiar "M" and "L."

Anticipating this, all but the more reckless advertisers qualify their stories of "The World at Your Finger Tips!" with warnings that consistent reception at all times must not be expected.

Some guidance as to the features that *are* to be expected may be helpful.

The chief thing which, if not previously understood, leads to an unfavourable first impression is that only a small proportion of the short wavebands generally provided in receivers are allocated to broadcasting. To be exact, the six broadcast bands between 13 and 50 metres occupy officially only 6.6 per cent. of a uniform wavelength scale, or 5.3 per cent. of a frequency scale. The accompanying table shows how these bands are distributed and how this result is arrived at on each scale.

WHY THERE IS SO MUCH MORSE



A typical example of the dial markings to be found on an all-wave receiver. The lower range covers a band of approximately 16-60 metres, and, compared with the medium range above it, the broadcast bands as indicated appear to be meagre.

SHORT-WAVE BROADCAST BANDS.

Frequency : kc/s.		Approximate Wavelength : Metres.	
6,000–6,150 ...	...width 150	48.8–50	...width 1.2
9,500–9,600	100	31.25–31.6	0.35
11,700–11,900	200	25.2–25.6	0.4
15,100–15,350	250	19.55–19.85	0.3
17,750–17,800	50	16.85–16.9	0.05
21,450–21,550	100	13.9–14.0	0.1
Total for broadcasting ...	850		2.4
Total for all purposes, 6,000 to 22,000= ...	16,000	13.65 to 50 metres= ...	36.35
Proportion for broadcasting	5.3%		6.6%

As has often been emphasised, it is only by reckoning in frequencies that the true proportions can be seen; but the use of wavelengths is unfortunately still so common that they have to be included in the table. Take the 15,100-15,350 kc/s band. It is equivalent to 0.3 metre, which on the long-wave scale would be almost negligible—certainly not nearly enough to accommodate a single station. Yet by reckoning in frequencies it can be seen at once that it leaves room for 28 channels, each of 9 kc/s width.

That is by the way. I was pointing out that something like nineteen-twentieths of the short-wave tuning scales are devoted to non-broadcasting services, so it is not surprising if the novice feels as if he has lost his way. This is the more so because it is not that the short-wave broadcast bands are narrow—actually they provide nearly as many separate channels as the whole of the medium wave band—but that the non-broadcasting bands are relatively enormous.

In some ways, of course, things would be much easier if all of the broadcasting allocations were lumped together, instead of being split up into numerous thin slices sandwiched between huge chunks of less digestible material. But the whole point of short waves—or most of it, anyway—is that they provide a sort of geological section, different strata of which are each valuable for certain special purposes. One wavelength is suitable for a certain range in daylight; another is useless in daylight but effective at night; others are better for working over longer or shorter distances. So every sort of body that is interested in radio—governments, post offices, military, police, shipping, aircraft, and amateur, as well as broadcasting authorities—wants slices at as frequent intervals as possible.

One or two specialised receivers are provided with elaborate "bandspread" devices to magnify the wanted bands until they occupy most or all of the scale width. But this is a very exceptional feature. On the ordinary short-wave scales the broadcast bands ought to be marked in red or otherwise prominently identified, to spare the owner the tedious task of searching through more than 15,000 kc/s of extraneous matter. Even so, the guidance afforded by the usual station names is necessarily lacking, because the space is too narrow for them.

It is perhaps fair to assume that a receiver that is capable of giving a really good short-wave performance is a superhet. That being so, a further source of confusion is the second channel or image. Improvements in design have almost banished it from the longer wavebands, but many superhets still give two tuning points for most short-wave stations. The individual broadcast bands being so narrow, the image tuning points of all stations within them fall outside. This prevents interference between one station and the image of another, and it might be quite useful as giving a second chance to receive each station, but, unfortunately, it is liable to introduce strong interference from non-broadcast stations. The confusion I had in mind, however, arises out of the possibility of inadvertently tuning to the second channel of a station and thereby getting poorer reception than need be. So one has always to make sure which tuning point is in use. In spite of what I have said about images falling outside the broadcast bands, it is not always safe to assume that a tuning point within the marked band is the correct one, and all outside are images; because, first, the marked bands are so narrow that it would require more than ordinary manufacturing precision to ensure sufficient scale accuracy; and, secondly, because there are certain broadcasting stations outside the official bands.

Heard on the "All-Wave"—

The kilocycle separation between the proper tuning point and the image is, of course, twice the intermediate frequency. The more generally favoured intermediate frequency—except among the cheaper models—is about 470 kc/s, so the separation is rather less than one megacycle (1,000 kc/s). Where the 110-120 kc/s IF is adopted the separation is a quarter of this, and the two channels are likely to be of almost equal strength.

Another point: Although the general custom is to make the image lower in frequency (higher in wavelength) than the primary response, it is not uncommon—particularly near the minimum wavelength—for the tuner tracking to go so far astray as to reverse the positions and make what should be the image actually the stronger reception.

A description of the many things other than broadcasting that are to be heard on short waves, and also some of the effects and phenomena peculiar to short-wave reception, will follow later.

RANDOM RADIATIONS

By "DIALLIST"

A "Suppressor" Point

POSSIBLY you've come across cases of people who suffered from mains-borne interference, took your advice to fit a suitable "suppressor," and then complained that matters were nearly, if not quite, as bad as ever. Certainly I have, and in every instance where this has occurred I've found that the suppressor was connected at the wrong point. It is surprising to find how many people believe that so long as you have a suppressor its position is of no great importance. Not long ago I was chatting with one of the Big Noises in a firm which was about to put on the market a very sensitive "all-wave" superhet. "Don't you think," I suggested mildly, "that it might be as well to mention in your 'book of the words' that in many localities a suppressor will be needed?" He assured me that it was quite unnecessary since they were thinking of incorporating a suppressor in the set itself.

It Does Matter

Often the suppressor can do its job properly only if it is so placed that it excludes interference impulses not just from the set, but from the whole wiring of the house. If, for example, you were to place a suppressor in the set you would still leave the whole of the lighting and power circuits of the house carrying interfering RF pulses. These are radiated from the wires of both circuits and picked up by the aerial, the internal wiring and even the valves of the receiving set. The most certain method is to locate the suppressor as near the entry of the mains into the house as you possibly can, connecting it with very short leads. You can't go beyond the meter, for that is not your territory; but you can go right up to the meter, and if you do so and use a suppressor of the right kind you can ensure that a minimum of mains-borne interference comes into your home and that unwanted noises are not picked up from the radiations of lighting and power circuits.

Room for Bigger Batteries, Please!

A GROUSE that I often hear from owners of battery sets containing four or five valves is that there is no room inside the cabinets for batteries of large enough capacity to make for really economical working. This is a point that manufacturers might well bear in mind, for the set whose HTB has to be renewed at frequent intervals is far from popular with listeners.

One way out of the difficulty is to make or have made a battery box of some wood which goes well with that of the cabinet. The box can be so designed that it serves as a kind of plinth, the cabinet standing upon it. By using the veneered plywood with a beading at the edges the battery box can be made very cheaply—and, in any case, it soon saves its cost. If the HT leads of the set are too short for the plugs at their ends to reach the sockets of the battery in the box they can be lengthened very easily.

The American Elections

WITH the short-wave set, or on the 19 to 60 metre band of an "all-wave" receiver, you should be able to have great fun during the next few days, when the American election campaign works up to its climax. In the States oratory is still oratory and, since there is no law of libel as we understand it, spades are called spades in a manner that is a revelation to us. Already there have been wireless "incidents"; there will be more before the battle royal comes to its end. To us, who are merely detached observers and listeners, such things are viewed mainly from their amusing side. But in the land of the great open spaces, where men are men, etc., etc., they can be deadly serious. Anyhow, make use of W2XAD, W2XAF, W8XK and other big short-wave stations whilst the warfare is raging and I'm sure that you'll reap your reward. It must be *some* satisfaction to be able to tell the other fellow *via* the microphone and a huge network of broadcasting stations exactly what you think of him!

Price of Sets in U.S.A.

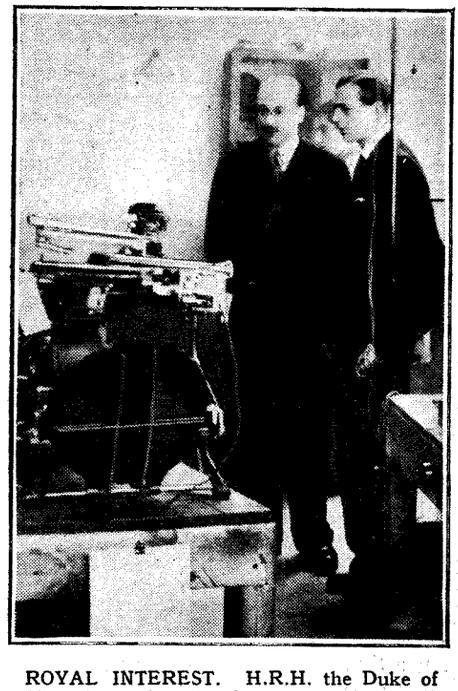
ONE often hears it said that American sets cost a good deal less than ours, though they contain more valves. From one point of view, mass-production methods on the grand scale have brought prices down to remarkable levels. But, as usual, one point of view does not give the whole story. If you convert dollar prices into pounds they certainly do seem low. One representative firm, for example, makes AC mains "all-wave" superhets with from five to twelve valves in addition to the rectifier, and prices range from 50 to 150 dollars, equivalent, roughly, to from £10 to £30. But wireless sets are not the only things that are mass produced in the United States. To get at the real cost of wireless sets in the two countries the fairest method is perhaps to compare their prices with those of motor cars of the "family bus" type. If you do so you find that the American listener pays from one-twelfth to one-quarter as much for his receiver as he does for his car. We, on the other hand, spend on ours from one-twentieth to one-tenth the price of the equivalent kind of car.

You would find the position very similar if you compared the cost of radio receivers with that of refrigerators, vacuum cleaners and all sorts of semi-luxury domestic fitments in the two countries. It follows that when the American man-in-the-street is preparing his private budget the amount that he has to spend on his wireless set may seem a heavier item to him than it does to his opposite number on this side of the Atlantic. He has come to accept the idea that, expressed in terms of motor cars and other such things that make life more pleasant, the wireless set must be rather expensive. We hold just the opposite view. That is one of the reasons why in the average American home the set is a bigger affair, at any rate in the matter of cabinet-work, than it is in ours.

Amateur Transmitters

HAVE you noticed how well American amateurs are often to be heard on the 21-metre band in the evenings just now? Two of them that have given specially loud and clear reception are W2HUQ and W2ZC. Both these transmitters are situated in New York. W2ZC, by the way, is a bit of a linguist. He calls Europe in English, French, German, Spanish, Italian and Swedish!

Evening is not the only time when the American amateurs are to be heard. When conditions are favourable they are often to be picked up in the early afternoons. Friends tell me that they are having a good deal of success at the moment with Australian and New Zealand amateurs. I can't say that I am. It may be something to do with the lie of my short-wave aerial, but I have hardly ever had very good results with either amateurs or official broadcasting stations in the Antipodes.



ROYAL INTEREST. H.R.H. the Duke of Kent inspecting the Anson record-changer during a recent visit to the Anson factory at Brentford.