The Wireless World

AND RADIO REVIEW

(21st Year of Publication)

No. 662. WEDNESDAY, MAY 4TH, 1932. VOL. XXX. No. 18.

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Editorial Offices: 116-117, FLEET STREET, LONDON, E.C.4. - - Editorial Telephone: City 9472 (5 lines).

Advertising and Publishing Offices: DORSET HOUSE, TUDOR STREET, LONDON, E.C.4.
Telephone: City 2846 (15 lines). Telegrams. "Ethaworld, Fleet, London."

COVENTRY: Hertford St. Telegrams: "Cyclist, Coventry." Telephone: 5210 Coventry.

BIRMINGHAM: Guildhall Bldgs., Navigation St. Telegrams: "Autopress, Birmingham." Telephone: 2970 Midland (3 lines).

MANCHESTER: 260, Deansgate. Telegrams: "Iliffe, Manchester." Telephone: Blackfriars 4412 (4 lines).

GLASGOW: 26B, Renfield Street, C.2. Telegrams: "Iliffe, Glasgow." Telephone: Central 4857.

PUBLISHED WEEKLY. ENTERED AS SECOND CLASS MATTER AT NEW YORK, N.Y.

Subscription Rates: Home, £1 1s. 8d.; Canada, £1 1s. 8d.; other countries abroad, £1 3s. 10d. per annum.

As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

EDITORIAL COMMENT.

Volume Level.

MR. NOEL ASHBRIDGE, the Chief Engineer of the B.B.C., must, we think, owe some of his well-deserved popularity to the disarming frankness with which he meets criticism on anything connected with the technical side of broadcasting.

We particularly welcome a letter from him published in this issue under Correspondence, which is in reply to editorial comment on the subject of "Volume Level," which appeared in our issue of April 13th. We had criticised the B.B.C. for inconsistency in volume level—that is to say, we complained that if we set the volume controls of our receivers at the commencement of an evening's programme and adjusted them to what was satisfactory for, say, the first musical item, we very often found that, as soon as an announcer came on, or some other speaker, his voice was received at a strength out of all proportion to the original, so that at once we had to cut down the volume in order to make it bearable to listen to, and, having done so, if the next item happened to be a musical one, we probably found the volume so low that the intensity had fallen almost to a whisper.

Mr. Ashbridge goes to some pains to explain that the question is not so simple as he believes our comments imply, and states that the reason for the variation in volume level is in order to meet the requirements of listeners living in areas where the field strength is low and reception difficult. He admits that, if it were not for the question of interference and for the fact that many receivers have no factor of safety at all, the B.B.C. would then broadcast speech at a lower level.

We are glad to find that the B.B.C. is aware of this shortcoming in their transmissions, because it leads us to believe that in time the ideal may be attained when it will be unnecessary to change the volume at our receivers at intervals throughout the programmes.

We may be accused of exaggerating the position, but it is our firm belief that much of the unpopularity of talks on wireless may be due to the psychological effect of the unnatural volume level at which speakers are broadcast as compared with the musical items. If at the close of a musical item a speaker came on with a quiet, conversational atmosphere about his delivery, we believe he would get a much better reception from listeners than when, having just listened to a pleasant musical item, a speaker comes on with a voice which sounds as if he were using a megaphone. Instinctively, his audience will say, "Shut that fellow off!"

Our Birthday Number.

OUR thanks to all our readers and friends who have contributed to a most successful Twenty-first Birthday celebration of *The Wireless World*.

From all sides congratulations and good wishes have poured in.

We would particularly like to thank those members of the wireless industry who have offered their congratulations either in their announcements in our Birthday Number or by letter. We wish, also, to thank our friends of the Press who have made kind references to us in their journals and so assisted in bringing *The Wireless World* to the notice of an interested public.

The outstanding impression of the reception of our Birthday Number is that *The Wireless World* has a very large circle of sincere friends, and this encourages us in the endeavour to make the paper even more acceptable in the future.

Broadcas-

Part I.
Can We Expect Perfection?

By H. A. HARTLEY.

THE art of radio reception has advanced very considerably during the last decade, and if a few years ago the more experimental and quasi-scientific side interested the listener, broadcasting is so much about us nowadays that the radio set has definitely taken its place in the home as an instrument of entertainment and instruction rather than as a somewhat complex toy. This change of outlook has resulted in the listener seeking rather for excellence of reproduction than the reception of multitudinous foreign stations, and the editorial and correspondence pages of this journal reflect the widespread interest in the subject.

We are all of us constantly meeting the man who gets "perfect reproduction," or the man who prefers his loud speaker, even if it be of very mature vintage, to any other he has heard. We also occasionally meet someone a little more candid than the majority of us, who, being fond of good music, will take the trouble to go to the concert hall, and, returning home, realise that his wireless set is not giving him the real thing, and wish very much that it did. Again, we are instructed on how much of the frequency range may be cut off without impairing the quality of reproduction. We are told that the ear will reconstruct something which is lacking and ought to be present; that, in order to recreate a symphony orchestra, it is necessary to reproduce it at full volume, and that, when all is said and done, *perfect* reproduction is an impossibility.

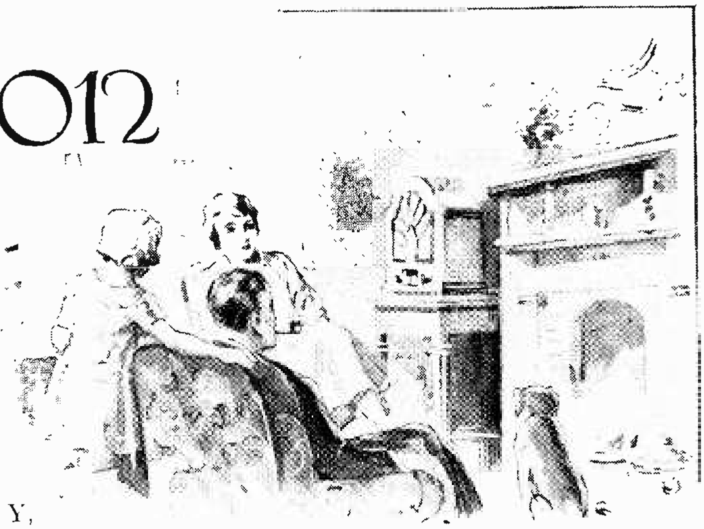
As greatly divergent opinions on the subject are held by various authorities, the listener unacquainted with the physics of the construction of musical sounds and their reproduction is rather at a loss when asked to adhere to any particular expression of opinion, and it is the function of these articles to explain to him what a musical sound is, the peculiar characteristics of the various musical instruments, and how far these sounds may or may not be distorted in their reception and amplification when broadcast, the "volume" of sound to be propagated from the loud speaker and, perhaps, some notes on loud speaker and receiver design. It is desired that the reader should assimilate the *facts* for himself, and form his final opinion when he has determined how near an approach to perfect reproduction he is content to accept for his entertainment.

"PERFECT reproduction" is so often claimed by enthusiastic amateurs that it is worth considering how near to such a desideratum it is possible to get with present-day apparatus. This article tackles the problem from the beginning, explaining what a musical sound is, the peculiar characteristics of various instruments and how these sounds may or may not be distorted in their reception or amplification. The real question emerges, how near an approach to perfect reproduction are we content to accept?

Sound is a vibratory motion which affects our sense of hearing. As it is primarily emitted by a vibrating body, requires a medium for its transmission (usually the air), takes time to travel from the source to the ear, and does not cause any forward motion of the carrying medium, which subsides into its original position when the sound has passed, we must conclude that the disturbance of the medium has some waveform. In effect, the vibrations of the sound-emitting body are transferred to the air and, finally, to the ear, in this manner. Let the line X in Fig. 1 represent the stretched membrane of a drum which, on being struck by the stick, vibrates between Y and Z. As X moves towards Z it momentarily compresses the layer of air in contact with it, which latter compresses the

Reproduction

"So so is good, very good, very excellent good; and yet it is not; it is but so so."
SHAKESPEARE. *As You Like It.* Act V., Sc. I.



next layer, and so on. X then moving towards Y, reduces the pressure on the air layer, and, the second layer being at a higher pressure, tends to move back in sympathy with X. This, in turn, allows the third layer to move back until all the air pushed by X travelling to Z is sucked back, as it were, by X receding to Y. The movement of X to Z, back to Y, and the return to the first position, completes one wave, which wave has been propagated along the line A B, representing the air medium until it reaches the ear, certain parts of which vibrate in sympathy.

The Nature of Sound.

The wave motion can be very clearly demonstrated by a device due to Crova, and is illustrated in Fig. 2. A card, about 9 inches in diameter, should have a small circle, say 3 mm. radius, described on its centre. Divide the circumference of the circle into twelve equal parts, and draw a series of circles, the first 1 cm. radius, thereafter increasing each radius by 4 mm., taking the twelve dividing points as centres. Thus, the first circle, 1 cm. radius, has the 1 o'clock position as centre, the second 1.4 cm. radius is centred on 2 o'clock, and so on, for two complete revolutions of the small circle, which will thus have twenty-four circles described about it. If, now, a pin be stuck through the centre, and the card be rotated in an anti-clockwise direction, the progressive compression and rarefaction of the successive "layers" is clearly seen. The effect is enhanced if a card with a narrow slit be held in front of the disc, the slit taking the position of a radius.

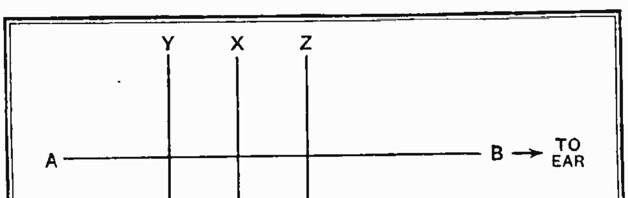


Fig. 1.—Diagram explaining wave motion. The line X represents the stretched membrane of a drum which vibrates between Y and Z.

It is important to realise that the disturbance of the medium in the case of sound waves is *longitudinal,* that is, the motion is a to-and-fro movement in the direction of propagation. One cannot compare the wave motion with that caused by throwing a stone into a pond, for in this latter case the longitudinal motion, as demonstrated by the ever-expanding circles, is also accompanied by a corrugation of the surface of the water, which represents a *transverse* motion. A longitudinal displacement can be represented by a curve, such as those in Fig. 3. Here the line A B C D E represents the time of the disturbance, and the curve A F C G E is a record of the amount of displacement of a particle of the medium at all instants in the complete cycle of movements.

Taking now our example illustrated by Fig. 1, let a particle of air at the surface of the membrane X be represented as A in Fig. 3, before the disturbance begins. X now moves towards Z, and at the point of maximum displacement of the membrane we have the maximum displacement of the particle of air, which is now at F, where F B represents the displacement, and A B the time required for the membrane to move to Z. X now retreats to Y, and at Y the particle of air can now be denoted on the curve by G, where F B + D G is equal to the distance of Z from Y. It is obvious that G must be *below* the axis A B C D E, as the displacement is in the reverse direction; also, since time does not go backwards, the time distance B D must be in the same direction and added to A B. At the point C, X was in its original position, before reaching Y, and at E, X has completed the whole cycle and is ready to commence the next.

Intermediate points on the curve A F C G E also

Broadcast Reproduction.—

represent intermediate distances that the air particle has covered between Y and Z. The greater the movement of X the greater is the displacement of air, and, as a consequence, the *louder* the emitted sound. The distance F B in Fig. 3 is called the *amplitude* of the sound, and indicates the loudness.[1] If the scale of the diagram be such that the distance A E is equal to 1/100 part of a second, it follows that 100 cycles will be completed in a second, and we say that the sound

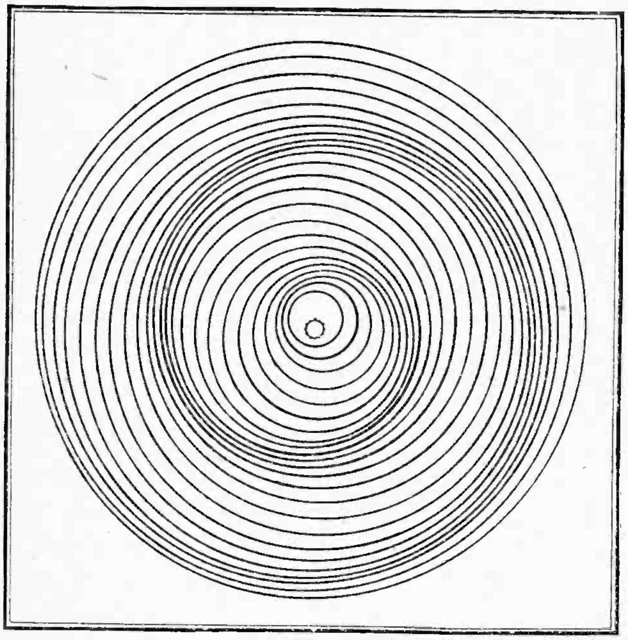


Fig. 2.—Crova's Disc. If this figure be rotated in an anti-clockwise direction, the progressive compression and rarefaction effect can be seen.

has a *frequency* of 100 cycles per second. In Fig. 3 the curve A H B J C K D L E has a frequency twice as great as, but an amplitude little more than half that of, the curve A F C G E. The *pitch* of a musical note is directly dependent on its frequency, as it is the frequency which determines where we will place it on the musical scale. It is not within the scope of these articles to treat of musical scales, temperaments and intervals, and the reader is referred to the bibliography at the end of these articles.

The Characteristics of Musical Sounds.

Diagrams have frequently been published in which the musical scale has been shown, together with the frequency range, or *compass*, of the various musical instruments, the general idea being to show what range of frequencies is required to reproduce all the instruments of music. In one or two cases a "harmonic range" has been included, but it is necessary to realise that such a diagram is misleading if the true facts of the case are not known. In Fig. 3 are two curves representing two sounds of different frequency, but such a curve represents only a pure tone, such as is sounded by a carefully designed tuning fork. Every musical instrument, as well as the human voice, owes its peculiar *quality* or *timbre* to the presence of what are variously called "harmonics" or "overtones," but which are more correctly styled *partials*. If a certain note be struck on a piano, for example C an octave below "middle" C, we hear the *fundamental* at the "fundamental" frequency, say 128 cycles per second, but we also hear fifteen other notes simultaneously, whose frequencies are 256, 384, 512, 640, 768, 896, 1,024, 1,152, 1,280, 1,408, 1,536, 1,664, 1,792, 2,176 and 3,304 cycles per second respectively.

The Band of Partials.

The presence of the fifteen partials referred to gives that particular note its own quality. If, now, we strike C an octave above middle C, we hear the fundamental at 512 cycles per second, and four partials whose frequencies are 1,024, 1,536, 2,048, and 2,560 cycles per second. Thus, it is obvious that the quality of the higher note must be different from that of the lower, irrespective of the difference in pitch, a fact which the reader can verify for himself by striking the two notes on the piano, and comparing them carefully. The wave-form of these two notes is illustrated in Figs. 4 and 5, which latter diagram also shows the analysis of the complicated wave-form into its simple components. Each musical instrument has its own particular "band" of partials for every note, and it is the presence or absence of these partials that enables one to distinguish between, say, a violin and a flute playing the same note.

In a case where the frequency response of the reproducing apparatus is such that a cut-off exists at about 3,000 cycles, it is impossible to distinguish the flute from the violin, a state of affairs which is very common among radio sets. The chart shows the frequency range of the fundamental notes of the chief musical

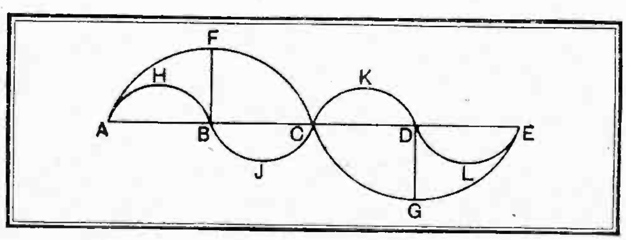


Fig. 3.—Curves representing the longitudinal displacement of a particle of the medium at all instants of a complete cycle.

instruments, and also the range of the partials. It is believed that this is the first occasion on which such a chart has been published, and the diagram enables one to see at a glance what proportion of the usual musical sounds is reproduced by apparatus of varying degrees of excellence. The frequency scale is not extended beyond 20,000 cycles, as the average adult ear is not susceptible to frequencies higher than this.

[1] This statement is not strictly true, but will be explained in greater detail in the next article.

THE FREQUENCIES WE NEED FOR PERFECT REPRODUCTION.

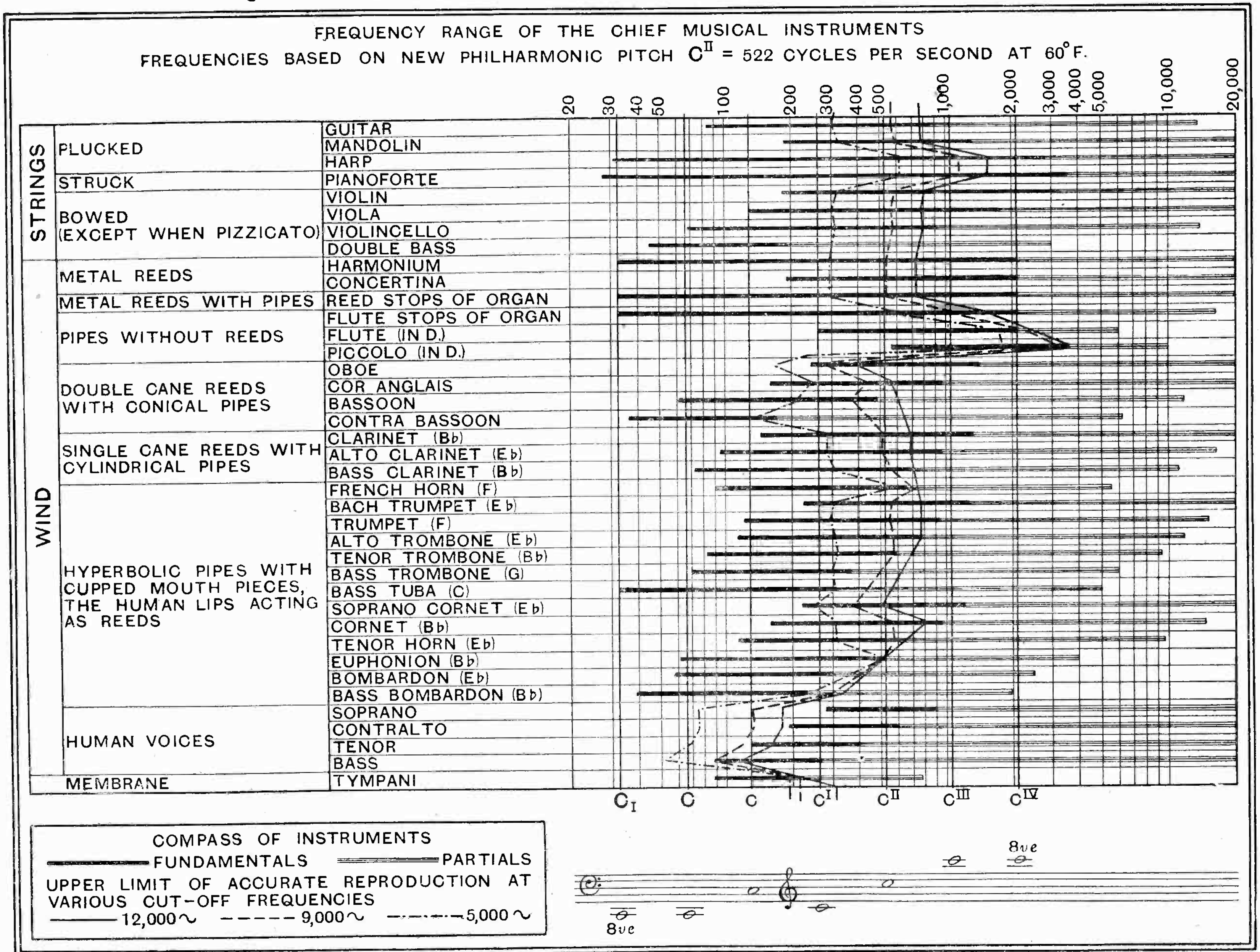


Chart giving the frequency range of the fundamental notes and the partials of the chief musical instruments. The frequency scale extends to 20,000 cycles, above which the human ear is not usually responsive.

Broadcast Reproduction.—
The chart, in effect, shows what one would actually hear in attending a choral and orchestral concert. How much of this is necessary and obtainable in the reproduction?

At this stage in the argument it is obvious that all this is necessary, since we must assume for the moment that the ear would detect any departure from perfection. It is often asserted that quite considerable liberties can be indulged in without any change being noticed by the ear, but, in the next article, it will be shown that, whilst absolute perfection is not necessary, the ear is not quite so accommodating as is generally supposed. For the time being, however, we must ascertain what proportion of the ideal frequency range can be obtained in our private auditorium. There is no technical difficulty in constructing a loud speaker and amplifier to reproduce all frequencies up to 20,000 cycles at more or less constant amplitude, but such an installation, in practice, is not necessary, as the frequency range of the B.B.C. regional stations extends only to 12,000 cycles. If, then, we can only receive up to 12,000 cycles, how is this going to affect our quality? In the chart are three lines running from top to bottom of the diagram showing what proportion of the compass of each instrument is rendered correctly by cut-off frequencies of 12,000, 9,000, and 5,000 cycles per second. On looking at what remains on the left of the 12,000 cycle limit, we find, considering only the chief instruments of the orchestra, that only one-sixth of the harp and piano, half of the violin, one-third of the viola, two-thirds of the oboe, one-third of the cor anglais and clarinet, and one-eighth of the trumpet are affected. As the second and third quarters of each compass are those most frequently used, the loss is not serious, except in the case of the violin and oboe. But no human voice is transmitted correctly, a fact that we must admit, and cannot improve on. Correct reproduction of a person speaking or singing has not yet been achieved on any radio apparatus, and so long as broadcasting remains as it is, never will be.

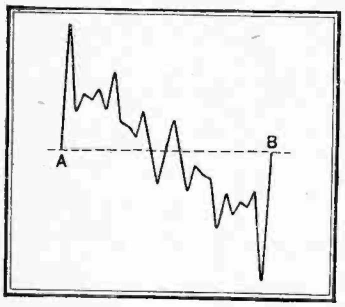


Fig. 4.—The waveform of middle C (256 cycles) on the piano.

Where Shall We Cut Off?

The adoption of an upper limit of 12,000 cycles will, unfortunately, be attended with other troubles, the most important of which is interference from distant stations, and unless a very carefully designed set, intended for reception of one local station only, be installed, then our 12,000 cycle limit must go by the board. So we come to the next suggested limit of 9,000 cycles, which figure represents the separation of the various broadcasting stations as at present arranged. In theory, the sideband transmission of each station completely overlaps the sideband of the next adjacent, but in practice this unhappy condition does not cause so much trouble as one might expect, and it is quite feasible to reproduce all frequencies up to 9,000 cycles, without undue interference. The third limit, of 5,000 cycles, is often advocated as the highest to which one need go, but an examination of the chart shows this to be useless for good results. A third of the piano, harp and trombone is lost, only one-sixth of the violin remains, the viola and clarinet are reduced by two-thirds, half of the 'cello, organ, bassoon, trumpet and tenor horn have gone, the oboe is spoiled throughout its whole compass, and the distortion of the human voice is so great as to be unpleasant to sensitive ears, and compels one to concentrate to a degree which makes the listening to a talk or play a definite effort which detracts considerably from the enjoyment of such broadcasts.

Our choice must be determined, to a great extent, by the kind of broadcasting to which we listen. If foreign stations are desired, then 5,000 cycles would, from the selectivity point of view, be all right, except that local reception would be ruined. It would appear to be best to design a receiver for the two Regional programmes only, taking advantage of the full width of the B.B.C. frequency range. Listeners outside, or nearly outside, the service area of the Regional stations will be forced to adopt the 9,000 cycle cut-off. The loss of 3,000 cycles is serious enough, although the difference between reproduction stopping at 12,000 and 9,000 cycles is not nearly so great as that between 9,000 and 5,000 cycles, as far as instrumental music is concerned. Assuming that the loud speaker and receiver are capable of reproducing up to 10,000 cycles at constant volume level, the cut-off at 9,000 cycles should be quite sharp, otherwise the heterodyne whistle set up by the adjacent station to London and North Regional and London National will be unpleasantly prominent. In the case of Midland Regional and North National the cut-off frequency would have to be about 8,000 cycles.

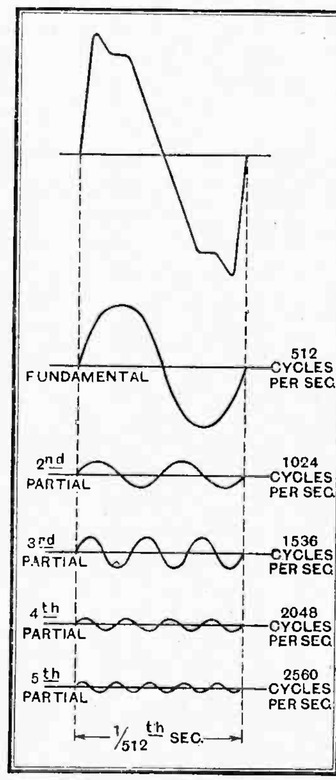


Fig. 5.—The octave above middle C (512 cycles) showing how the complicated waveform is composed of fundamental and four partials.

On the Track of Interference

A Trip with an Official of the German "Radio Aid" Association.

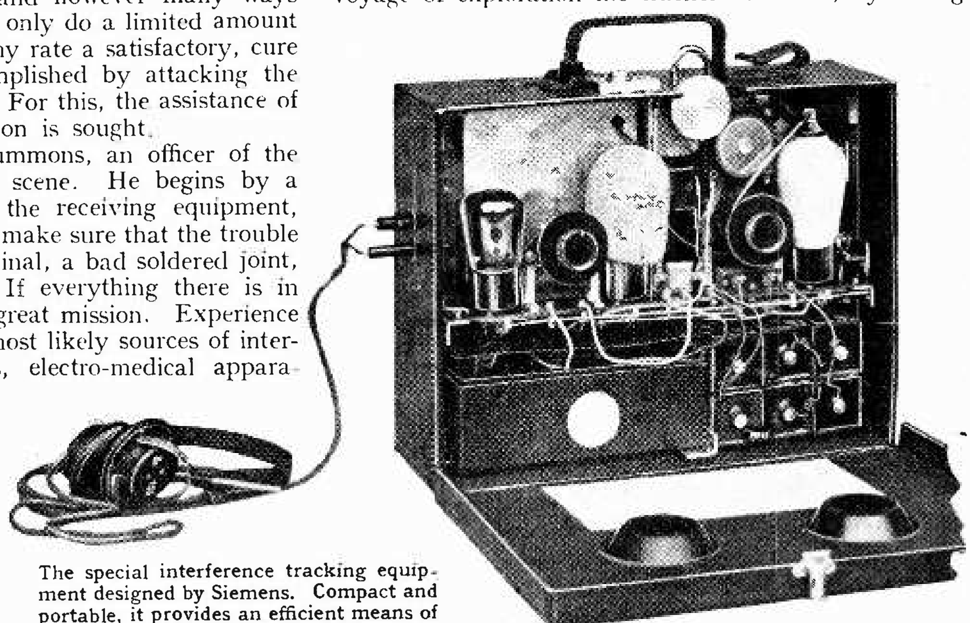
AN interesting description of how the bugbear of man-made static is dealt with in Germany. Well-organised battalions of "Interference Trackers" forming the "Radio Aid" organisation are now an integral part of broadcasting and are doing much to clear the ether of background noise.

By HERBERT ROSEN.

ONE of the most widely spread and beneficent organisations of German broadcasting, working right away from the limelight of publicity, are the Interference-Tracking battalions of the "Radio Aid" organisation. However many devices and attachments there may be to protect broadcast receivers from interference, and however many ways of connecting them, they can only do a limited amount of good; a complete, or at any rate a satisfactory, cure can generally only be accomplished by attacking the actual *source* of the trouble. For this, the assistance of the "Radio Aid" organisation is sought.

A day or two after the summons, an officer of the organisation appears on the scene. He begins by a quick but thorough test of the receiving equipment, including earth and aerial, to make sure that the trouble is not caused by a loose terminal, a bad soldered joint, or something of the kind. If everything there is in order, he then starts on his great mission. Experience has already taught him the most likely sources of interference—overhead tram-lines, electro-medical apparatus, domestic and kitchen electrical gadgets, and so on; he therefore keeps his eyes well open for such things as these, and if they are found in the very house itself, a condenser or a choke coil generally solves the problem at once.

But such a *dénouement* is usually too good to be true, and the source of trouble has to be sought elsewhere, and with much greater difficulty. To go from door to door, trusting merely to luck, would simply be asking for "trouble" in more than one sense; the official therefore makes use of a "tracking instrument," specially designed for his work, and comprising a radio receiver in suit-case form, for telephone head-gear reception, as shown in the title illustration. The principle on which the quest is based is that the disturbances are propagated along metallic conductors—especially along the electric light system—and can be traced to their source by the increasing loudness in the telephones as the source is approached. Before starting on his voyage of exploration the tracker finds out, by tuning his client's receiver, on about what wavelength the disturbance is most marked, and then adjusts his suitcase instrument to that wave. He then starts off, tele-



The special interference tracking equipment designed by Siemens. Compact and portable, it provides an efficient means of locating electrical disturbances.

On the Track of Interference.—
phones on head, his hat neatly carried in a clip provided for it (an example of German thoroughness!) and an exploring aerial—a little handle bearing a small coil—in the hand which is not carrying the suit-case. This little exploring aerial may be held at varying distances from the light mains, in this way providing a second means of gauging the strength of the "signals." For very loud signals the frame aerial built into the suit-case is sufficient.

A journey of exploration up the street—and perhaps even up side streets—finally leads to the identification of the house containing the source of trouble. A tracking card representing such a trip is carefully made out. The tracker may have to make many calls before finding the source of disturbance, and this is easier said than done; the actual task may need hours of patient investigation, whilst in some cases the electric light switch in the listener's own room may prove to be responsible!

In the immediate neighbourhood of the source of trouble it is inadvisable to use the frame aerial in the suit-case, because it is liable to give such strong signals that small variations cannot be detected. Here the exploring aerial is of particular service. A further point to be noticed is that the receiver should not be kept in action all the time, but only switched on at suitable moments; otherwise the ear grows insensitive to small variations in strength. The standard distance at which the exploring aerial is held from the lighting system at the various test points is about two feet.

The Siemens Tracking Set weighs only about ten pounds, and it is small and inconspicuous. The on-and-off switch and reaction coupling can both be worked by the hand carrying the instrument itself. The actual tuning is very simple, and is done almost entirely by the two rotating discs on the outside of the lid. Special dry batteries supply the valves, and a spare battery is carried in the case.

Once the source of disturbance has been discovered the next thing to do is to silence it. Here no general prescription can be given; every case must be treated on its own merits. Often a good earth lead, a condenser or a choke coil will do the trick; sometimes the actual receiving set is doctored—the aerial slung in another direction, or a fresh earth lead, less affected by the interference, is installed.

As regards the organisation and procedure, each broadcasting company runs a special office with several officials. An ordinary post-card giving details of the trouble is sufficient to set the machinery in action. The search is made, and the owner of the offending appliance is negotiated with; in many cases the actual means of curing the trouble is provided. In this way the ether is gradually being cleared of all such noises; hard work for the Radio Aid explorers, but peaceful and clear reception for many listeners!

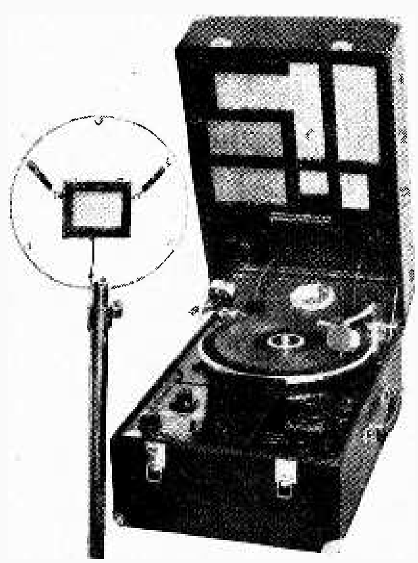
THE SCHACKTOGRAPH.

A Combined Broadcast Receiver, Electrical Gramophone, and Home Recorder.

THE average "home recording" outfit has to be specially connected up to a broadcast receiver, and disconnected when the receiver is to be used for its primary purpose. In the "Schacktograph," an instrument shown at the Leipzig New Year's Fair, this inconvenience is done away with and by merely changing a switch it becomes in turn an ordinary radio receiver with a 2.5-watt output capable of filling the largest room, an electrically reproducing gramophone for bought or home-made records, and a high quality home recorder working either from a special microphone or from the broadcast programme.

Mains Operated

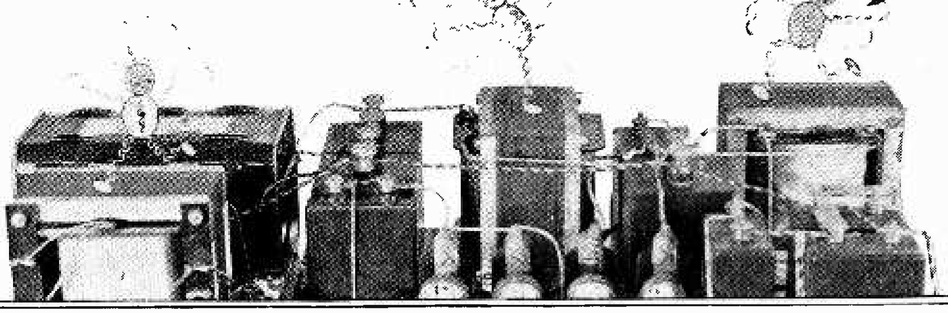
The instrument is only a little larger than an ordinary portable gramophone; it is mains driven, working off 110, 127, or 220-volt A.C. mains. The loud speaker in the lid is of a good electromagnetic type, but the mains unit also supplies the exciting current for a moving-coil speaker if this is added externally.


The complete "Schacktograph" Home Recording Equipment.

For home recording, ten-inch flexible, unbreakable discs of a gelatinous material are used, both sides being employed. These are claimed to be as durable as the ordinary records. In making a record it can be seen whether the input is of the right strength and quality by switching on the loud speaker. The gramophone turntable is driven by an A.C. motor. It is stated that a special model, omitting the broadcast receiver, is to be available for those who already have such a receiver.

Next Week's issue will contain reviews of the H.M.V. Table Radio-Gramophone D.C. Mains Model 501 and the new Climax A.C. Radio-Gramophone.

PUTTING HUM "On the Spot"



Systematic Tracing and Elimination in Mains Receivers.

By W. T. COCKING.

IT is often thought that hum is inevitable in an all-mains receiver. Nothing is so far from the truth, for, by careful design, it is always possible to reduce this disturbance to such a level that it is inaudible more than a foot or so from the loud speaker. Contrary to the general belief, the majority of the hum found in modern receivers is not due to inadequate smoothing of the H.T. supply, but is caused by interaction between components, the field supply of a moving-coil loud speaker, or a faulty valve. There are so many possible causes of hum, however, and it may occur simultaneously in so many different places, that haphazard methods of testing usually allow of little improvement being obtained. The first step towards silencing a receiver, therefore, is the location of each separate source of hum, for once the exact sources have been found the cures are usually obvious, and easily applied.

It is essential, therefore, to have a logical and scientific method of testing which, although it may at times prove tedious, will inevitably reveal the cause of the trouble. Such a method has been developed, and, for the purposes of illustrating its application, it will be assumed that the receiver has the circuit shown in Fig. 1. The method, however, is by no means restricted to receivers of this general type, for it is universally applicable, and the modifications necessary for other types of sets will become apparent as the procedure is followed.

ONE of the most frequent troubles encountered in mains receivers, and particularly in those of older design, is hum. In far too many cases this annoying background is tolerated merely because the user believes it to be inevitable, and that it is a part of the price to be paid for the undoubted advantages of mains operation. When properly designed, mains receivers can have practically as silent a background as that of a battery set. The systematic tracing of hum is dealt with in detail in this article.

The first step is obviously to make sure that the speaker itself is silent, for the field supply of a moving-coil loud speaker is a very common source of hum. Should the speaker be of a non-energised type, of course, it is very unlikely to introduce hum, and this stage of the testing can be omitted. To carry out this test we disconnect the primary of the output transformer at the points *c*, *d*, and join the anode of the valve directly to its positive H.T. source at *b*, so that the load on the mains equipment will remain constant. A resistance equal in value to the output-valve internal A.C. resistance, in the case of a triode, or of about 5,000 ohms in the case of the average pentode, should then be connected across the output-transformer primary.

The Speaker Field.

Where a choke-feed output circuit, or an auto-transformer is used, this should be treated as the transformer primary, as shown in Fig. 2, where the lettering corresponds to that of Fig. 1. Any hum now found can only be due to one of two causes: either the output transformer is interacting with some other component, or the speaker field is at fault, and the latter is by far the more likely. In general, there are two cures only for hum in the speaker field: we can employ a speaker fitted with a hum-neutralising coil,[1] or we can increase the smoothing of the field supply. The latter is usually the more convenient with an existing speaker, and in some cases an improvement can be effected merely by increasing the capacity of C_1; in general, however, it will be necessary to insert a choke of about 10H. inductance at the point "X" with a 2 mfd. or 4 mfd. condenser connected between *a* and E. This will usually remove the last traces of hum due to the field

[1] See note elsewhere in this issue entitled "Hum Neutralisation in Moving-coil Speakers."

Putting Hum "On the Spot."—

supply, but if it does not the effect of altering the position of the output transformer with respect to other components should be tried.

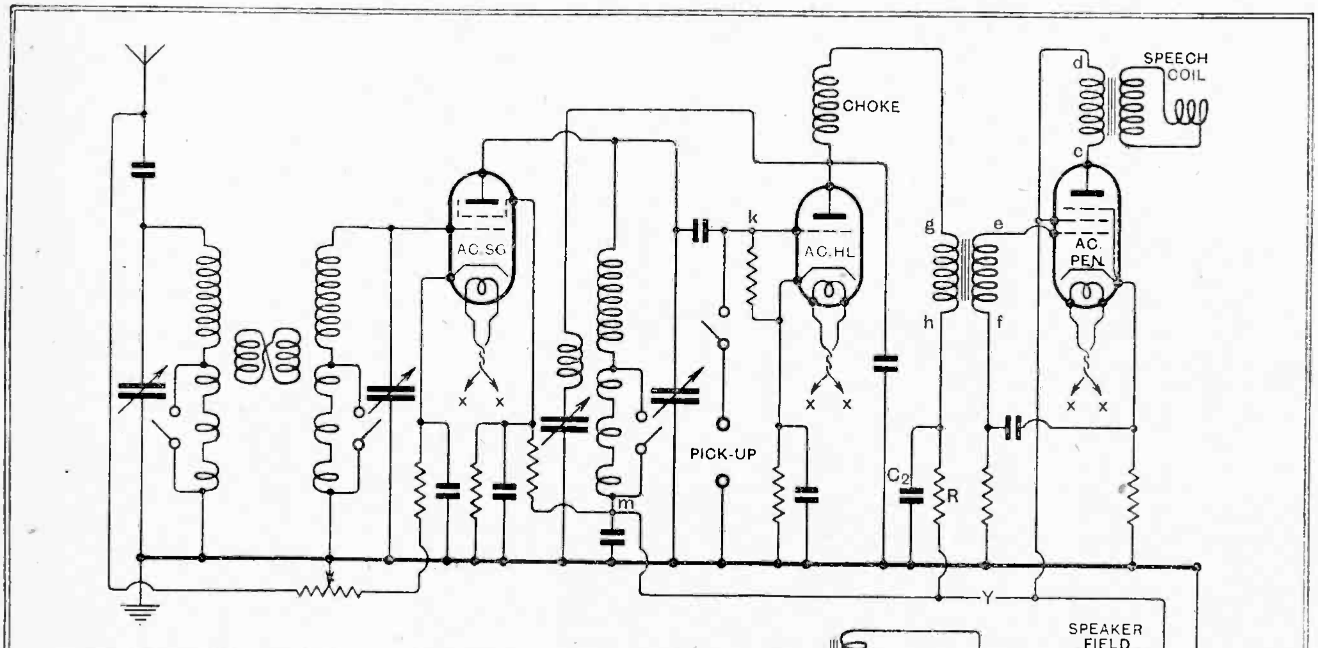
Any additional smoothing equipment which this test has shown to be necessary should now be permanently connected in circuits, and the output transformer reconnected in its normal way. In the case of a choke or auto-transformer output circuits, however, the valve anode should be left joined to *b*, the positive H.T. source. With this latter circuit there is a possibility of hum being due to a ripple on the H.T. supply flowing through the output choke, the speaker feed condenser, and the speaker itself to the output-valve cathode circuit. If hum be found, therefore, one should not omit to try returning the speaker, not to the valve cathode, as shown in Fig. 2, but directly to positive H.T., for this hum path is then eliminated. It should particularly be noted that this type of hum only occurs with output circuits similar to that of Fig. 2, and it is most likely to occur with the auto-transformer connections so often favoured with pentodes.

Orientation of the L.F. Transformer.

When silent operation has been established in the output-valve anode circuit the connections must be replaced so that the whole receiver is again operative, and we then proceed to isolate the output stage by short-circuiting the transformer secondary between the points *e*, *f*, of Fig. 1. In most cases no hum will be found with this short-circuit in position, and we are then free to go on with the next test. If there should be hum, however, it will be obvious that it can only be due to insufficient smoothing of the output-valve H.T. supply or to a faulty valve.

The next test is perhaps the most important in the whole series, for it shows up a common, and often unsuspected, source of hum. The short-circuit between *e* and *f* should be removed, the transformer primary disconnected at *g* and *h*, and a resistance, equal in value to the internal anode A.C. resistance of the preceding valve, connected across it. With the usual AC/HL, or similar type of valve, the resistance will have a value of about 10,000 ohms. Now, if hum be found with this resistance only connected to the transformer primary, and if this hum disappears on short-circuiting the transformer secondary, then it is certain that it is due to interaction between the L.F. transformer and the mains transformer or smoothing choke, or both.

The resistance should be left across the primary, and the secondary connected up by lengthy flexible leads, while any smoothing chokes should be removed from



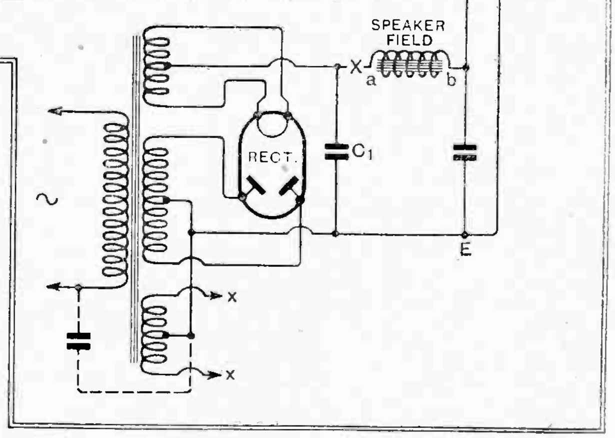
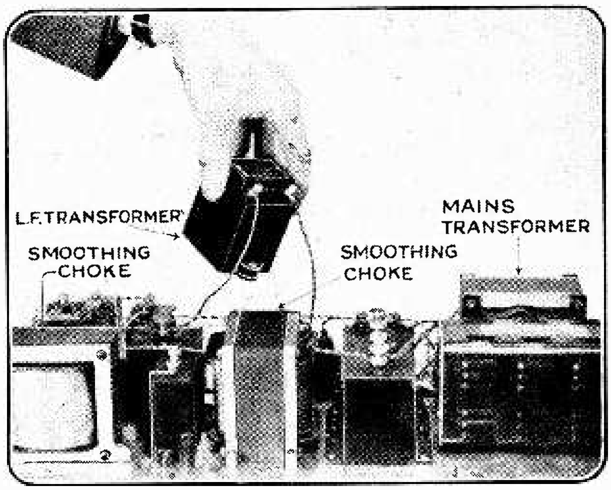


Fig. 1.—This typical and popular three-valve circuit is used for illustrating the testing procedure for the location of hum. The speaker field supply and the intervalve transformer are the two commonest sources of trouble.

Putting Hum ' On the Spot."—

the set and connected up by long leads. The transformer should then be turned into the position at which the hum is a minimum. A definite position of minimum hum can always be found, but if the components are too close together this minimum position may not give absolute silence. The position is quite critical, and a transformer may often assume a peculiar angle, so that mounting it in the new place may not be quite straightforward; there is, however, no alternative.

When the transformer has been correctly positioned the smoothing chokes should be brought back into their normal places, and if it be found that hum is then reintroduced it will be necessary to rotate the chokes to the position of minimum hum. When these optimum positions have all been found the set should be completely silent, and we are in a position to proceed to the detector stage. The transformer primary should be reconnected in circuit, and the detector grid joined directly to the earth line by a wire between k and E.



Hum can often be reduced to negligible limits by orienting the L.F. transformer with respect to the mains transformer and L.F. chokes.

Modulated Hum.

If hum be now found its most probable cause is insufficient smoothing of the detector H.T. supply, and an increase in the capacity of C_2, or a larger value of resistance for R, if this be permissible, may remove it. If the hum be at all serious, however, it will probably be necessary to introduce a choke at the point "Y" in Fig. 1, with the usual condenser following it. If all efforts to remove the trouble are of no avail the possibility of pick-up in the H.F. choke should not be overlooked; and, if the hum disappears on short-circuiting this component, it should be positioned as carefully as if it were an L.F. transformer.

When satisfied that everything is in order in the detector anode circuit, the short-circuit on its grid should be removed. If a fairly high-pitched hum then occurs, the trouble is probably electrostatic pick-up, and the whole detector, with its grid condenser and grid leak, should be screened. If, however, the hum is of a fairly low pitch, the tuned-anode coil should be disconnected from the H.T. supply at the point *m*, and connected instead to the earth line. The disappearance of hum when carrying out this test indicates that the H.F.-valve H.T. supply is at fault, and the usual remedies should be applied.

If the foregoing tests have been carefully carried out, and hum eliminated at each stage, it should now be found that the set is quite silent. In spite of this, however, hum may reappear when a signal is tuned in; this is a special type of hum, known as modulation hum, and is usually due to H.F. currents in the mains. In general, it may be eliminated by using a mains transformer with an electrostatically screened primary, or by connecting a 0.001 mfd. condenser between one side of the mains and earth, as shown dotted on Fig. 1. Another type of modulation hum may sometimes be removed by connecting 0.1 mfd. condensers (of the 1,000-volt type) between each anode of the mains rectifier and the centre tap of its filament heating winding.

When carrying out tests of this nature one should never overlook the possibility of a faulty valve, for this is a common source of trouble, and the end of a useful life of an indirectly heated valve is often marked by the appearance of hum. Fortunately, however, the hum is usually of a distinctive nature, and once it has been heard it is immediately recognisable. In any case, where either the pitch or intensity of the hum varies fairly rapidly, the detector or first L.F. valve is at once suspect.

Should, however, hum appear regularly at a certain interval, usually about half an hour to one hour after switching on, it is more likely that the loud speaker is at fault. If the moving coil is not properly centred it may touch the pole pieces when these expand under the influence of the heat generated in the field winding, and any tendency towards hum in the set is enormously accentuated.

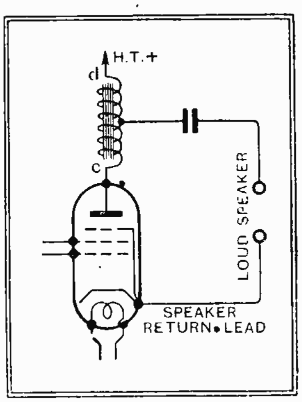


Fig. 2.—The usual auto-transformer coupled output circuit may introduce hum in sets where only a minimum of smoothing equipment is used. This hum may be eliminated by returning the speaker to positive H.T. instead of to the valve cathode as shown.

During the process of testing, therefore, one should not overlook the further possibilities of trouble which have just been outlined. Their variable nature, however, renders them readily distinguishable from the more usual types of hum which occur in the receiver itself, and for the location of which the tests are expressly designed.

In conclusion, it may be said that these tests are regularly employed by the writer, and have never yet failed to reveal the cause of any trouble. Since the

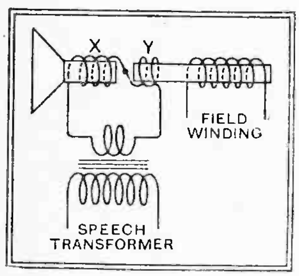
Putting Hum "On the Spot."—
complete series may occupy a considerable amount of time, any method of shortening the process is helpful. At the start, therefore, one may try short-circuiting the L.F. transformer secondary; if the hum disappears it is then obvious that it is occurring in the L.F. transformer itself, or at an earlier stage in the set, and the speaker and output stage tests can be omitted. If the hum remains, however, the output stage or the speaker is certainly the cause of the trouble. In most cases the hum will be diminished by the application of this short-circuit, but will not disappear completely, and there is then no alternative but to start at the beginning and go through with the whole series of tests.

HUM NEUTRALISATION IN MOVING-COIL SPEAKERS.

How the "Hum-bucking" Coil Works.

It is sometimes found that when the field winding of a moving-coil loud speaker forms the only smoothing inductance in the field circuit a certain amount of residual hum will be heard. Before accusing the speaker, however, care should be taken to ascertain that the receiver itself is delivering a hum-free signal. This can be done by disconnecting the speech coil from the set and connecting across it an artificial load approximately equal to the impedance of the output valve, and if hum is still audible it can safely be said that the ripple current in the field is responsible for the trouble (see article elsewhere in this issue entitled "Putting Hum on the Spot").

By increasing the smoothing equipment associated with the field coil a perfectly silent background can be obtained, but volts which are often precious would be dropped across any extra L.F. chokes. In the case where the field forms the second choke in the H.T. supply, and where the mains unit has been designed to deliver the necessary extra volts, there is no difficulty whatever in getting rid of the last traces of hum. When, however, for the sake of economy, the field is used as the sole smoothing choke in the H.T. feed, or separate excitation of the speaker from A.C. mains is attempted, using a high-voltage metal rectifier without the assistance of any auxiliary smoothing inductance, it may be found that the background is not sufficiently silent.



The connections of a hum-neutralising coil in a loud speaker. It is in series with the speech coil, but has a negligible effect on sensitivity.

It is in such cases that loud speakers with a hum-neutralising, or "hum-bucking," coil, as it is sometimes called, originally developed by the Magnavox Company, are useful, for, with the very minimum of field smoothing equipment, no hum is audible. There are certain speakers on the market to-day which are equipped with this device as standard, while in other cases the coil can be fitted by the makers to existing models without structural alteration.

The connections of the neutralising coil Y are shown in the diagram. It is joined in series with and wound in the opposite direction to the speech coil X, and, being held around the pole piece, is not free to move. The variation of magnetic flux in the field due to ripple current induces a hum voltage of equal amplitude and opposite phase in the two coils, and neutralisation is complete. As only the speech coil is free to move the cone, no hum is reproduced. The price paid for this advantage is a very small drop in sensitivity, which, in the case of a well-known speaker, does not decrease more than 0.5 decibel across the frequency scale—an inaudible reduction in intensity. W. I. G. P.

BOOK REVIEW.

RADIO TELEGRAPHY AND TELEPHONY. By Rudolph L. Duncan and Charles E. Drew. Pp. xi+1,046. with 527 Figures. (Second Edition.) John Wiley and Sons, New York. 1931. 45s.

To the large and growing public who like their wireless reading served without mathematics, this book may be confidently commended as a readable and complete account of all branches of radio with the exception of Television. Beginning with a simple description of the most elementary electrical and electromagnetic phenomena, the authors cover the wide fields of vacuum tubes, receiving circuits, transmitters, direction finding, and radio applications to aviation. The book is thoroughly up to date and contains much information on current American practice in such matters as broadcast transmitter design and two-way communication for aircraft, while even a short description of the variable-mu valve has been included.

It is perhaps inevitable that in a work of this nature, which is descriptive rather than scientific, the style should tend at times toward the prolix. On many occasions, too, one is irritated by complacent, though vague, references to other parts of the work. Thus, within a few pages, one comes across such remarks as the following: "Phase relations are fully discussed elsewhere"; "The nature of self-inductance is fully explained elsewhere"; and "Other sections have completely explained the use of a simple vector diagram." One may, however, be permitted to cast some doubt on the "completeness" of the explanations referred to, particularly in the case of the vector diagram. A vector is, after all, a mathematical conception, the advantages of which can only be *completely* understood by comparison with the sine and cosine calculus which it is designed to supplant.

The authors, who are well known in America as experienced instructors in the art of radio, have taken great pains to make clear by detailed diagrams and simple mechanical analogies the complicated workings of radio circuits, and there is no doubt that, within the obvious limitations imposed by the practical absence of mathematical symbols, they have succeeded to a remarkable degree in achieving this purpose.—W. A. B.

Unbiased
by "FREE GRID"

Too Much Flora and Fauna.

READERS of these notes will be familiar with the annual grouse which I am compelled to make at Exhibition time regarding the technical information—or rather the lack of it—available at the various stands, more particularly those of the valve manufacturers.

I have been turning this matter over in my mind some little time past, and endeavouring to scheme how to shake the manufacturers out of their lethargy and incite them into putting a technical man on their stands at the Exhibition. I have eventually decided that the best way of getting results is to appeal to the baser side of human nature as represented by the popular passion for collecting Silver Challenge Cups.

As you probably know—or more probably don't—one of the trade journals presents a cup for annual competition among exhibitors, it being awarded to the one whose stand is most prettily decked out. This not unnaturally leads manufacturers to clutter up their stands with flora and fauna in the shape of palms and girls occupying valuable space which might more profitably be taken up by technical experts.

The "Free Grid" Cup.

I have, therefore, practically made up my mind to present through the medium of this journal a larger and more imposing affair to be known as the "Free Grid Cup" for annual award to the manufacturer at whose stand the most informative replies can be obtained to technical questions. Whether the questioning should be done by me I have yet to decide, but I have already determined that marks will be deducted from any exhibitor at whose stand attempts are made to fob off questions with a bag of "literature."

Before deciding on details I shall be glad of opinions and suggestions from "W.W." readers concerning this matter. Please send me your suggestions as soon as possible.

Terror Firma?

IN view of my recent note concerning a mystery station broadcasting in an unknown tongue, subsequently identified as Manx, it is interesting to read that negotiations are in progress for constructing a broadcasting station on one of the smaller of the Channel Islands. It seems to me, however, that in view of its remoteness even from our South-Western shores, the station's efforts will be largely wasted unless they are intended for French listeners. Perhaps the sponsors of the station are the firm who, as I mentioned the other day, were considering the question of converting an ocean liner into a high-power broadcasting station. If so, they have evidently taken to heart my warning concerning the effects of a rough sea on temperamental *prime donne*.

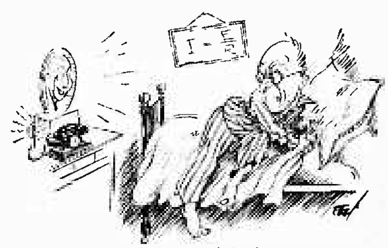
This Ultra-selectivity.

MANUFACTURERS seem more and more inclined to put their new sets and other good things upon the market at all seasons of the year instead of bottling them all up until Exhibition time, and then finding themselves so overwhelmed with orders that the goods cannot be delivered before Christmas. What moves me to make this profound observation is a recent opportunity of examining several pieces of new apparatus which are "coming shortly." I have not yet been able to test any new sets, but I am told that in practically all cases selectivity is very much improved and that care has been taken by manufacturers to see that any high note loss sustained thereby is correctly compensated in the L.F. amplifier.

One American set which I examined recently had, in addition to the usual stationary hair-line, a mirror associated with the dial in order to avoid incorrect tuning due to parallax errors; the receiver is of the expensive type usually termed by the Yanks "custom built," or, in other words, not mass produced, but—to use a good old English word—"bespoke," and each model is carefully calibrated before being sent out. Apparently, if you do not tune in with deadly accuracy by means of the mirror, distortion arises. This is quite sound theory, of course, but I must say that I think the makers are a little bit optimistic.

A Parisian Wonder.

IF what I have been reading in a provincial journal is true, the telephone service in this country is an absolute back number compared with that existing in France, and



Practical joker with twopence to waste.

the sooner some "live" M.P. questions the P.M.G. about it in the House the better. It appears that, to quote the exact words I have been reading, "it is now possible in Paris for people who talk in the 'phone to see as well as to hear each other."

I have not been in the so-called gay city for several months, but I certainly think that in spite of Mr. Chamberlain's stern admonition about foreign travel, I shall have to slip across and see the new wonder. I take it that in the interests of propriety such attachments will be forbidden on bedroom telephone extensions when the device eventually reaches this country, as I, for one, have no desire to be seen in my deshabille by any irresponsible practical joker with twopence to waste on a nocturnal call.

Mains Transportable Receiver

TYPE MM

A High-grade Self-contained Receiver for A.C. Mains.

IN designing the type MM Transportable the makers had in view three principal objects: (1) The production of a receiver which, under modern reception conditions, could be relied upon to provide alternative programmes from the majority of the well-known Continental broadcasting stations in addition to those of the B.B.C. (2) A high degree of quality in the reproduction of both speech and music, combined with absence of background noise whether from mains hum, valve noises, or heterodyne whistles. (3) An entirely self-contained instrument with moving-coil loud speaker and frame aerial, both built inside the cabinet.

It will be seen from the sketch on the opposite page that the chassis is a development of the well-known Pye type Q battery portable, which was recently reviewed in this journal. The employment of indirectly heated valves, however, has enabled an equivalent, if not a better, performance to be obtained with three stages instead of the four employed in the type Q portable. Mazda valves are used throughout. An AC/SG functions as the H.F. amplifier, with one of the high-efficiency AC2/HL valves in the detector stage and an AC/Pen in the output stage. Simple tuned-anode coupling is used following the screen-grid valve, and reaction is obtained by means of the usual combined magnetic and capacitative method, the reaction coil in this case being coupled to the tuned-anode circuit. There is provision for an external aerial, and energy is transferred to the frame aerial by a separate winding consisting of one or two turns round the frame.

The method of volume control is interesting in that the reaction control is coupled to the variable grid-bias resistance in the cathode lead of the screen-grid valve. Thus the volume control starts from minimum, with the screen-grid valve overbiased and reaction at zero, and reaches maximum with the valve correctly biased and reaction at the point of oscillation. Gramophone pick-up sockets are connected in the grid circuit of the detector, and the bias of the latter valve is automatically adjusted to the correct value for amplification when the combined radio-gram and wave-range switch is adjusted to the gramophone position. Following the detector is a nickel iron-cored intervalve transformer, parallel fed and connected as an auto-transformer.

FEATURES.

General. — *Self-contained A.C. mains transportable. Moving-coil loud speaker. Frame or outside aerial. Weight 36 lb.*

Circuit. — *Screen-grid H.F. (tuned anode), power grid detector, pentode output valve with tone compensator and low-pass filter (cut-off, 5,000 cycles). Full-wave metal rectifier. Indirectly heated valves.*

Controls. — *(1) Main tuning, calibrated in wavelengths. (2) Trimmer. (3) Volume (combined reaction screen grid valve bias). (4) Combined wave-range and radio-gram switch.*

Price. — *17 guineas.*

Makers. — *Pye Radio Ltd., Radio Works, Cambridge.*

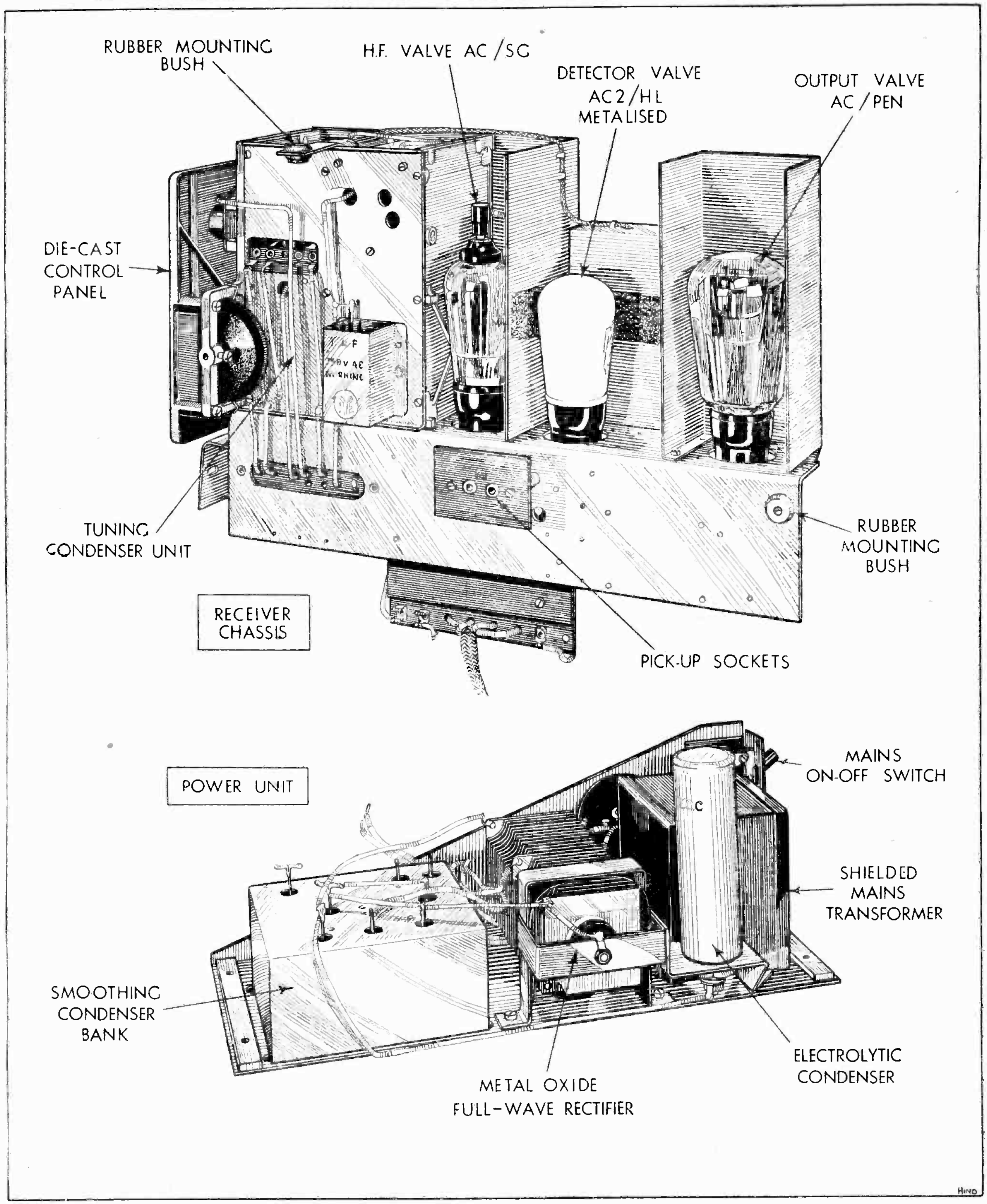
Tone Compensation.

The connections of the AC/Pen output valve, which feeds the moving-coil loud speaker through a step-down transformer, are particularly interesting in that a special tone-compensation circuit is connected in parallel with the anode circuit of the valve. This circuit performs the dual function of correcting any excessive high-note response in the pentode, and also provides a sharp cut-off at 5,000 cycles. The cut-off at this frequency entirely eliminates background hiss, and effectually disposes of the majority of heterodyne whistles from adjacent carriers without appreciably affecting the quality of reproduction.

All the components associated with the supply of smoothed H.T. current and raw A.C. for the filament heaters are assembled as a separate unit mounted in the base of the cabinet. A metal-oxide rectifier of the voltage-doubler type is employed, and the loud speaker field winding is used in conjunction with a reservoir condenser of the electrolytic type for smoothing.

On the score of workmanship and finish the chassis earns the very highest praise. The aluminium screening is cleanly cut, and the wiring is neatly arranged in accordance with a special colour code by means of which wires carrying H.F., L.F., and supply currents can be readily identified. As in the type Q portable, the gang condenser, the volume control, and the combined radio-gram and wave-range switch are mounted in a compact unit behind the die-cast control panel, which is finished in matt brown. The whole chassis is suspended on rubber

A MODEL OF CLEAN DESIGN AND WORKMANSHIP.



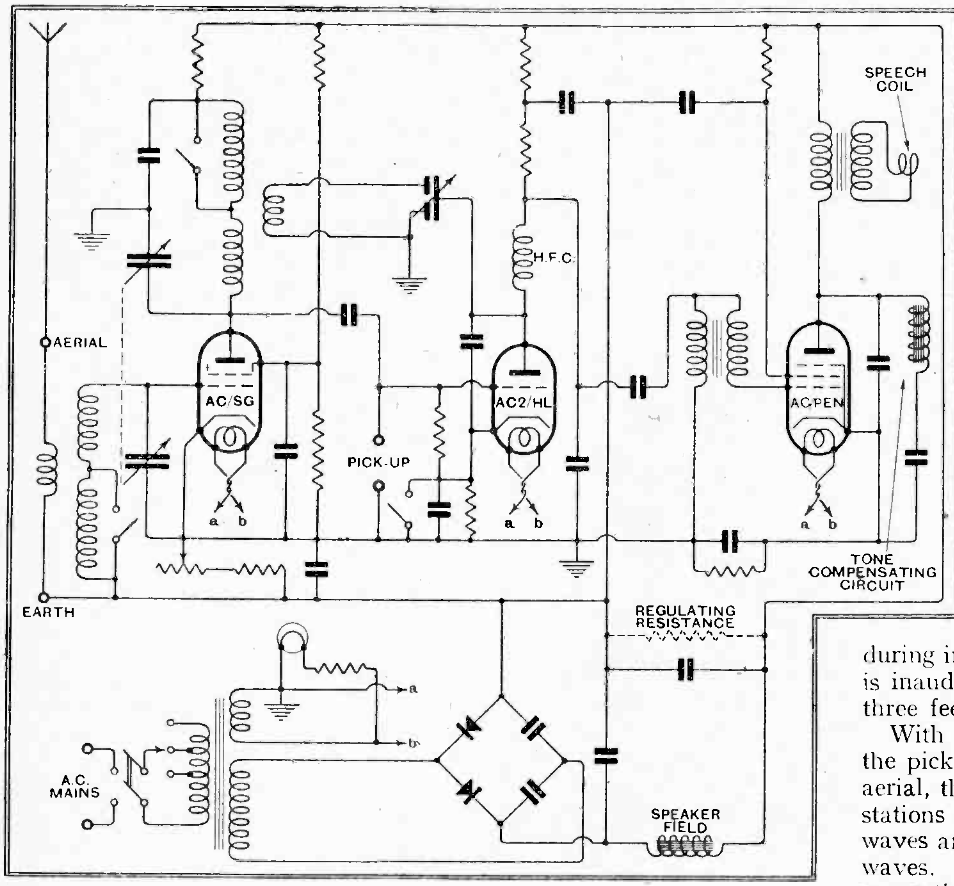
General view of receiver chassis and power supply unit. The chassis is suspended in the cabinet on rubber bushes.

Pye Mains Transportable Receiver.—bushes inside the cabinet, and tests made at the Pye works with a special vibrating machine have proved conclusively that no damage can possibly result from the shocks which are likely to be experienced in the normal transport and use of the set. The power unit is neatly constructed, and adequate ventilation is provided for the metal rectifier. The mains transformer, which is adjustable for 200-215-, 216-235-, and 236-250-volt mains, is completely screened, and is connected to the mains through a combined quick-break switch and knife-contact mains plug.

The volume control and combined wave-range and radio-gram switch are mounted in the top left-hand and right-hand corners of the panel respectively. An external volume control is required for the gramophone pick-up, and the volume control in the receiver should be set at minimum and the tuning control adjusted to the top of the medium band when reproducing gramophone records to prevent radio interference.

Excellent Quality of Reproduction.

Looking back on the performance of the set during the period it has been in our hands, there can be no doubt that the quality of reproduction is the feature which has created the most lasting impression. The tone is full-bodied without showing any evidence of a bass resonance, and the highest musical frequencies come through crisply without being strident. Were it not for the absence of background noise and the reduction in heterodyne interference, it would be difficult to detect the 5,000-cycle cut-off provided by the tone compensator associated with the output valve. In view of the success with which high-frequency interference has been disposed of, it is gratifying to find that mains hum has been dealt with equally effectively. Even during intervals in the programme hum is inaudible outside a radius of two or three feet from the loud speaker fret.



Circuit diagram of the Pye type MM transportable. The input circuit consists of a frame aerial with coupling coil for external aerial and earth.

With the set working solely from the pick-up on the self-contained frame aerial, the reception of fifteen to twenty stations can be relied upon on medium waves and eight or ten stations on long waves. Making use of the directional properties of the frame, the band width occupied by the Brookmans Park transmitters could be reduced in Central London to about fifteen metres. On long waves the selectivity is sufficient to give easy separation of Daventry and Radio-Paris, and, under favourable conditions, Königswusterhausen can be received between these two stations. An external aerial considerably increases the range, but the selectivity is naturally reduced. Nevertheless, there is no difficulty in separating the London Regional and National transmissions at a distance of five miles from Brookmans Park on a 50ft. outdoor aerial.

The controls are simple, and the main tuning dial is operated by an edgewise drum mounted in the bottom right-hand corner of the panel. The dial is calibrated in wavelengths, and is illuminated by a dial light ingeniously mounted on a rotatable star wheel which facilitates easy replacement. Matching the mains-unit control on the left-hand side is a trimming control marked with suitable graduations. This control is provided to ensure accurate ganging at different parts of the wave-range, but the performance of the set depends only to a secondary degree on the setting of this control, and there is no fear of a station being overlooked if the trimmer does not happen to be accurately adjusted.

The complete set weighs only 36 lb., and lifting handles form part of the design of the cabinet, which is made in polished figured walnut, with the characteristic Pye loud speaker grille.

NEWS of the WEEK.

Current Events in Brief Review.

Post Office and Relay Stations.

THE Post Office, it is understood, is taking steps to prevent a recurrence of certain irregular transmissions by local relay stations. It has come to the notice of the authorities that several of the relay stations have been departing from the terms of their licence by including in their transmissions items such as local dance bands and vocalists, which do not figure in the ordinary broadcast programmes. Such practice, it is contended, is an infringement of the monopoly of the B.B.C. The relay stations, of which there are about 120 in various parts of the country, work under a Post Office licence which allows them to select programmes of any transmitting station, either British or foreign, but expressly forbids them to originate programmes of their own.

Ireland's One Per Cent.

DESPITE the introduction of sponsored programmes, the Irish Free State wireless estimates for the coming year assume a deficit of £7,620. The estimated revenue from licences is given as £16,000; from advertisements, £5,000; and from Customs tax on wireless apparatus, £60,000.

The number of licences issued during the year 1931-1932 was 28,683, the number of valve sets being 24,968, and crystal sets 3,715. This indicates that only 1 per cent. of the population is at present interested in wireless broadcasting. The revenue from sponsored programmes was estimated at £1,500.

Senator Connolly, the Minister for Posts and Telegraphs, announces that it is hoped to have the high-power station at Athlone temporarily in action in time for the broadcasting of the Eucharistic Congress ceremonies in July.

A Listeners' Strike?

FOR the first time in European radio history, a really effective protest has been registered by listeners. The sad news reaches us from our Danish correspondent, who reports that figures just issued show that 50 per cent. of the licensed listeners in 1931 have failed to renew their licences. Only 250,000 have paid for subscription, and the enemies of State-controlled broadcasting declare that this is on account of the poor quality of the programmes. On the other hand, the station directors themselves declare that the sole reason is the serious money shortage. Possibly the truth lies between these two contentions.

"Small Ads." at Whitsun.

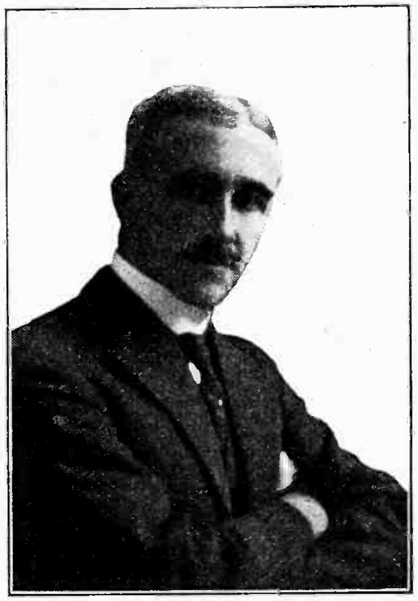
THE advent of the Whitsun holidays necessitates slight alterations in our printing arrangements. Miscellaneous advertisements for our issue of May 18th should therefore be received not later than by first post on Wednesday, May 11th.

Radio at Paris Fair.

DESPITE the financial crisis in the French radio trade, it is understood that wireless has a good representation at the Foire de Paris, which opens to-day at the Porte de Versailles, Paris. The Fair remains open until May 19th.

A Practical Pioneer.

A MAN who can be rightly regarded as one of the first practical wireless engineers in this country figures in the news this week. He is Mr. R. N. Vyvyan, who has retired from the service of the Marconi Company. After building the first high-power wireless station at Poldhu in 1900, he built a similar transmitter in America, and the two stations effected wireless telegraphic communication between the U.S.A. and Europe for the first time. In 1908, after six years' service in Canada, he returned to England and began advocating a scheme for wireless Imperial communication. The first contract for a chain of stations was made with the Post Office in 1912, and work was proceeding under Mr. Vyvyan's direction when the war broke out.



MR. R. N. VYVYAN, who has retired from the Marconi service after many years as engineer-in-chief.

The construction of secret service stations occupied his time in the early part of the war. Later he obtained a contract from the Admiralty for the construction of fourteen Empire radio stations, the whole scheme being put into effect in nine months. After service in the Royal Flying Corps Mr. Vyvyan went to America on a British war mission. In 1919 he was appointed engineer-in-chief of the Marconi Company. The invention of beam wireless led to new contracts, and Mr. Vyvyan became responsible for the engineering design, construction, and organisation of the beam stations. In the summer of 1930 he was appointed engineer-in-chief of Imperial and International Communications, Ltd., while retaining his appointment with the Marconi Company.

Mr. Vyvyan will continue to serve the Marconi Company as consulting engineer. Meanwhile, he is interesting himself in other radio consultative work and particularly in radio diffusion.

When the Pye was Opened.

TO Pye Radio, Ltd., we offer our warm congratulations on concluding a financial year which has broken all records, business showing an increase of over 60 per cent. compared with the preceding year, the net profit being £122,676. Even in an admittedly good year for radio, such results testify to the company's unremitting efforts to provide the public with attractive and reliable apparatus at an economic figure.

"Radio House" for Paris.

PARIS may have its "Radio House" in the very near future. A project which seems likely to be carried through provides for the establishment of broadcasting headquarters in the building in the Place de la Bourse formerly occupied by the Chamber of Commerce.

Too Nervous?

WHERE is Oslo's lady announcer? An unconfirmed report reaches us that the "speakerine" who was appointed to the post has returned to private life after being found "too nervous" to sustain her duties at the microphone.

New Aircraft Radio Chain.

WIRELESS plays an important part in the organisation of the new weekly African air mail service from Croydon which was inaugurated on Wednesday last. Along the 8,000 miles route from Britain to the Cape, which is now open for passengers as well as mails, seventeen specially equipped wireless stations keep in touch with the aircraft while in flight.

The "Gambrell-Halford."

THE "Gambrell-Halford" is the full name of the superheterodyne radiogramophone described in our issue of April 20th, and the makers, Halford Radio, Ltd., of 39, Sackville Street, London, W.1, ask us to state that a seven-valve D.C. version of the set is also supplied.

WIRELESS ENCYCLOPEDIA

No. 13

Brief Definitions with Expanded Explanations.

WHEN a condenser of C microfarads is connected across a coil of L microhenrys inductance, as shown in Fig. 1, the wavelength to which the circuit is tuned is given in metres by the well-known expression $\lambda = 1885\sqrt{LC}$. Assuming the inductance to be constant and the capacity variable, it is clear from this expression that the wavelength is proportional to the square of the capacity. Now, if the tuning condenser is of the "square law" type, the capacity at any setting is proportional to the square of the angle of rotation from the "zero" position, and, since the wavelength is proportional to the *square root* of the capacity, it follows that the wavelength to which the circuit is tuned is directly proportional to the angle of rotation of the condenser rotor from "zero." This, of course, implies that there are no stray capacities in parallel with the main condenser.

The graph showing the relationship between wavelength and condenser scale reading is a straight line passing through the origin O if produced downwards, as shown in Fig. 2. The actual curve, however,

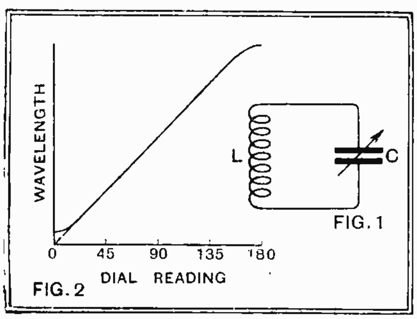


Fig. 1.—Simple tuned circuit. Fig. 2.—Wavelength calibration with square-law condenser.

bends at the lower end because it is impossible to design a condenser with zero minimum capacity; but this does not in any way upset the theory if the condenser is correctly designed.

The point at issue here is the fact that over practically the whole tuning range, *a given change in condenser setting produces a definite change in wavelength.*

GANGING (of tuned circuits). The name applied to the system of mechanically coupling together the variable condensers of two or more tuned circuits, enabling simultaneous tuning of all circuits to be effected by means of a single control knob.

It is quite obvious that if there were two identical coils tuned by two similar condensers, both of the latter would have to be set to the same angular position to tune the circuits to a given wavelength, assuming no stray capacities to be present to upset matters. But in practice the tuned circuits comprise integral parts of a complete receiving circuit, and it is impossible to retain the simple conditions already considered.

As an example, a simple band-pass filter with two tuned circuits will be chosen, the arrangement being as shown in Fig. 3. Here the loading of the aerial upsets the first tuned circuit, and the grid-to-cathode capacity of the valve affects the second. Coil screens or cans will also affect the inductance values of the coils.

Stray Capacities.

Let us first consider that the inductance values of the coils are changed from the normal value L to new effective values L_1 and L_2, as shown, neglecting for the moment the effects of stray capacities. To tune to the same wavelength condenser C_1 will have to be set to an angle θ_1, and C_2 to an angle θ_2. Now, it can be shown quite simply that if each condenser rotor is revolved by an angle a to $(\theta_1 + a)$ and $(\theta_2 + a)$ respectively, the wavelength of each circuit will be increased by the same amount when square-law condensers are used, despite the inequality of the inductances. Thus, by accurately ganging the condensers at any one wavelength, the ganging will hold good over the whole range, still assuming there are no stray capacities.

In practice, however, it is a moderately easy matter to obtain coils whose inductances are matched to within one per cent. or so of each other under working conditions, and the condensers can be ganged so that their capacities are equal for all settings of the common spindle. But usually the stray capacities thrown in parallel with the tuning condensers are not equal, and special provision has to be made to compensate for their effects. This is

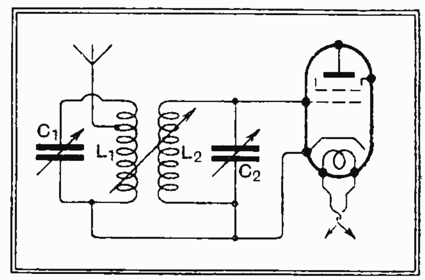


Fig. 3.—Two tuned circuits comprising a simple band-pass filter. Conditions for ganging C_1 and C_2 are considered in the text.

done by connecting across each main condenser an auxiliary "trimming" condenser whose capacity can be adjusted. These trimming condensers are set so that the total extra capacity in parallel with each main condenser is the same; with the main condensers set at, or near, the minimum capacity, each circuit is tuned to a signal by adjusting its trimming condenser. Then, if the circuits are tuned to a signal near the top of the wavelength range, by rotating the common spindle of the main condensers, it should be found that both circuits are fairly accurately in tune.

Modern gang condensers usually have trimmers incorporated, and the end vanes of the rotor of each section of the main condenser are sometimes slotted radially to allow final accurate matching to be effected over the capacity range, this being done usually by the manufacturers.

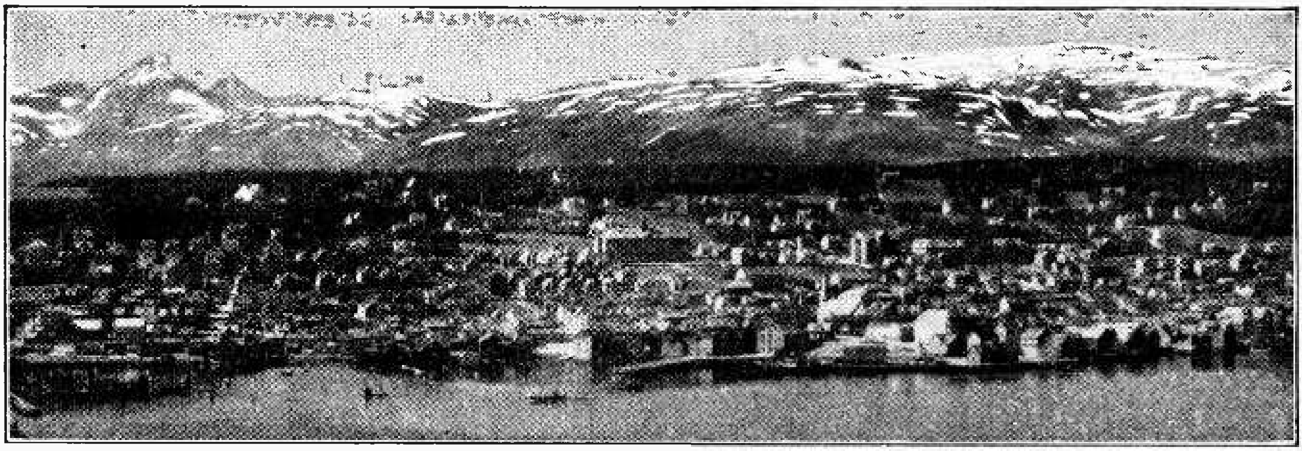


Photo.: Wilse.] A general view of Tromsö, North Norway. [By courtesy of the Norwegian State Railways.

TIMING WIRELESS ECHOES.

Professor Appleton's Expedition to the Arctic.

IN the middle of July of this year a party of British scientists will proceed to Norway to carry out a series of special wireless experiments within the Arctic Circle. This expedition, together with another which is going to Fort Rae, in Canada, for the study of meteorological and magnetic conditions in the Arctic, constitute the British contribution to the special work to be carried out during the International Polar Year, August 1932—August 1933. Similar expeditions, both radio and meteorological, are being sent out by other countries so that there will be a unique opportunity of solving many of the outstanding problems involving wireless transmission and magnetic and meteorological conditions.

Probing the Upper Atmosphere.

It is very gratifying to note that the proposals for carrying out wireless experiments within the Arctic Circle originated in connection with the researches carried out in this country under the auspices of the Radio Research Board of the Department of Scientific and Industrial Research. These researches have shown that it is possible to probe the electrical regions of the upper atmosphere using wireless waves projected vertically upwards. The waves are reflected back and by timing them and observing their characteristics when they arrive again at the ground one can deduce the density of the upper-atmospheric ionisation and the way it is stratified. The Radio Research Board experiments, which were the first of their kind, have shown that the electricity is distributed chiefly in two layers. The lower of these layers, situated at a height of about sixty miles above the ground, is the well-known Kennelly-Heaviside layer of which we have heard so much in recent years. This is the layer which reflects the long and medium wavelengths used in broadcasting and causes the fading of these signals at night. The upper, or Appleton, layer, which extends from 130 miles upwards, was discovered by Professor E. V. Appleton in 1927, and is responsible for the reflection of short waves such as are used in beam transmission.

THE two electrical layers—known as the Kennelly-Heaviside and the Appleton—which permeate the upper atmosphere are shortly to be subjected to interesting radio tests carried out in the Arctic Circle by a party of British scientists, including Prof. E. V. Appleton, F.R.S., whose work is already well known to readers.

Up to the present the properties of these two ionised layers, the existence of which has recently been confirmed by radio engineers in America and Italy, have been studied only in temperate regions. The electrical density of both layers is found to be greater by night than by day, the electrification being restored every day by the action of the sun. During the night-time it steadily disappears. At present it is only possible to speculate concerning the nature of the solar radiation which causes this day-time replenishing of electricity. Is it due to ultra-violet light or is it due to the action of swiftly moving atoms shot out by the sun? At present most of the evidence is in favour of Professor S. Chapman's theory that ultra-violet light causes the Appleton layer and that high-speed particles are the cause of the Kennelly-Heaviside layer.

Ultra-Violet Light.

Professor Appleton, who is himself to lead the British wireless expedition to Tromsö, is of opinion that wireless experiments carried out within the Arctic Circle should throw valuable light on these points, since the effect of ultra-violet light should be less, and the effect of moving particles greater, the nearer one proceeds to the North Pole. Another problem on which the work of the

Timing Wireless Echoes.—

expedition is expected to throw light is that of the connection between wireless and the aurora. It is a very striking fact that the bottom of auroral displays comes down to a height of sixty miles, which is just the height of the Kennelly-Heaviside layer. Is the same agency responsible for the aurora and the Kennelly-Heaviside layer?

The site of Tromsö, in Norway (69 deg. N., 19 deg. E.), was chosen because of its suitability for auroral observations; there is an auroral observatory already there. Although a watch will be kept on long-distance transmissions, the chief work of the party will be concerned with transmissions from a special local station sending out signals consisting of short pulses. By photographic and cathode-ray recording the echo pulses from the upper atmosphere will be studied.

According to present arrangements the party setting out in July will consist of Professor Appleton and Mr. G. Builder, of King's College, and Mr. R. Naismith and Mr. W. C. Brown, of the Radio Research Station, Slough. This party will erect the stations required and carry out the initial experiments. In the light of these the full programme of observations to be carried out during the rest of the Polar Year will be finally decided on and carried out by two observers who will be left there. A preliminary survey of the conditions at Tromsö has already been made on behalf of the party by Mr. R. A. Watson Watt, of the Radio Research Station, Slough.

TRANSMITTERS' NOTES.

The Spring "Call Book."

The spring edition of the Radio Amateur Call Book Magazine is now available, and copies may be obtained from Mr. F. T. Carter, Flat A, Gleneagle Mansions, Streatham. Owing to the present rate of exchange with U.S.A., the price has had to be raised to 5s. 6d., post free. The present issue has been increased to 200 pages.

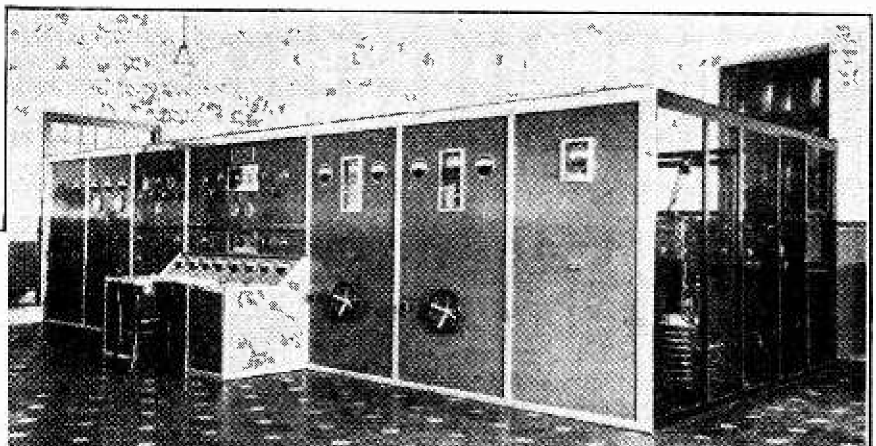
A W.A.C. Ace.

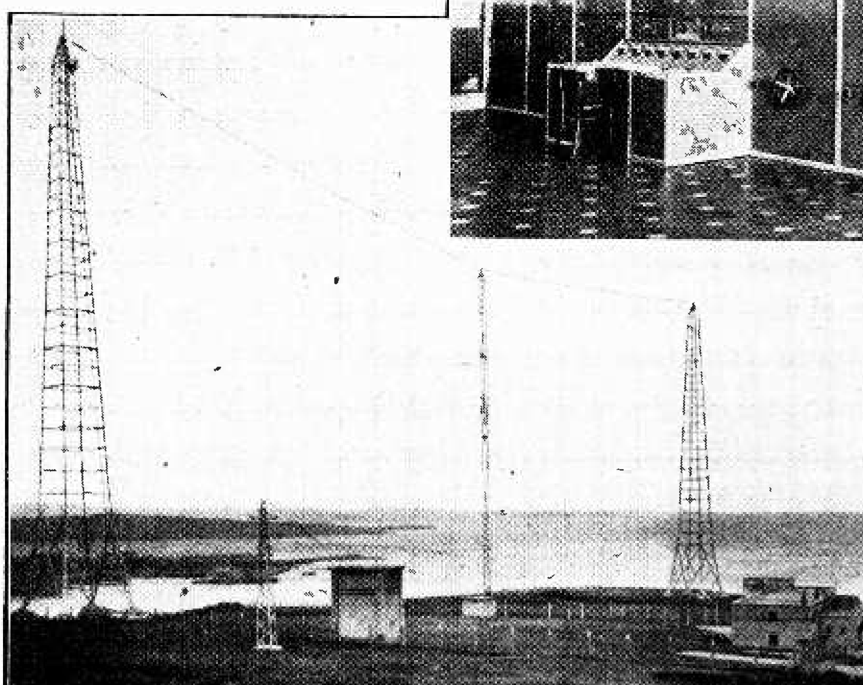
Mr. H. L. O'Heffernan (G5BY), the first British amateur to gain the W.A.C. certificate for telephony, has recently achieved a lightning record in working all continents on telephony in three consecutive nights between March 14th and 16th. The reports received on his signals were: Africa R8, QSA5; Asia R7, QSA5; North America R7, QSA5; Oceania R5, QSA4; South America R4, QSA3.

Short Waves and Eruptions.

A correspondent remarks on the startling change in short-wave working following the volcanic disturbances in South America. Writing on April 14th, he says: "During the late afternoon and early evening there has been a great abundance of stations on both 7 and 14 mc., and most signals are tremendously strong. Nearly all stations heard are situated in Europe; and countries such as France, Holland, Belgium, etc., which a week ago were not audible in the evenings, have been coming through very well indeed: in fact, last night there were so many strong signals on 7 mc. at about 19.00 G.M.T. that it was almost impossible to receive any station without interference from two or more other stations at the same time. Unfortunately, I was not able to get on the air late on Tuesday night, but 2BHT told me that he heard dozens of U.S.A. stations and quite a number of Cuban, Canadian, Panama, and others. The most peculiar thing was that he logged an Indian and an Australian station after 23.00 G.M.T. on 7 mc., and I think that this reception is most unusual. Although it is purely conjecture on my part, the only theory that I can suggest to explain this sudden change in conditions is that the volcanic dust which is being blown into the air is acting as a reflector, a kind of premature Heaviside layer, and thus many stations are heard that would have skipped had they reached the actual Heaviside layer. I may be totally wrong in this respect, but it is the only theory which comes to mind at the moment to explain the unusual conditions."

It will be interesting to learn whether other readers have had similar experience.





ON THE ADRIATIC. The new Marconi 15-kilowatt broadcasting station at Trieste (Italy) occupies a commanding site. The upper picture shows the transmitter, which operates on 247.7 metres.

BROADCAST BREVITIES.

By Our Special Correspondent.

Queen's Hall for B.B.C.?

HAVE the B.B.C. lost the chance of obtaining the Queen's Hall at a low cost? That they are now casting an acquisitive eye over the building no one doubts, following the rather painful discovery that the concert studio in Broadcasting House is not nearly large enough for its purpose. (It is unable to accommodate the B.B.C. National Orchestra, hence the decision to retain the "warehouse" studio for at least another two years.)

A Missed Bargain.

In 1927, at the time when the B.B.C. "rescued" the Promenade Concerts, the Queen's Hall could probably have been bought for £30,000, a sum which has been spent six times over in the mere furnishing of Broadcasting House. But conditions have changed, and I should be very much surprised if the B.B.C. could still secure a real bargain.

Luxury In New Headquarters.

By the way, tales recalling the Arabian Nights reach me concerning the luxury (there can be no other word if the tales are true) which has been permitted in fitting out certain of the office apartments in Broadcasting House. Naturally these stories revolve around the more sacred parts of the building which, at present, no journalist has been permitted to enter. I hear of offices resembling drawing-rooms, of dummy windows, filled with stained glass, let into the walls and illuminated from behind.

First Impressions.

What, on chance visits, I have already been able to see in Broadcasting House has struck me as tasteful and efficient-looking, without being too palatial. In other words, the building appears well designed to represent the dignity and importance of British broadcasting.

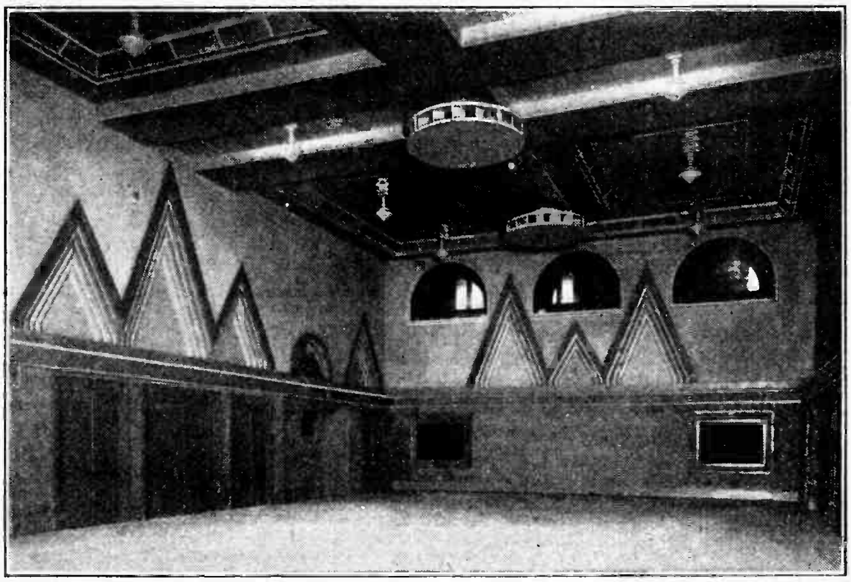
Dedicated.

The consecration of the religious studio having been found impossible, owing to the existence of a vaudeville studio underneath, the officials have overcome the difficulty by having it dedicated. The ceremony was conducted a few days ago by the Rev. Pat McCormick.

Since then M. Stephan has been using the religious studio for his French talks to schools.

Broadcasting in Danger.

BROADCASTING seems in danger of "missing the boat" at the Madrid Conference in August. A Berlin friend tells me of a communiqué just issued by the German Ministry of Posts which mentions that the coming conference will not concern itself with European wavelength problems. "The only broadcasting matter to be considered," says the report, "is whether the wavebands at present reserved for broadcasting in all parts of the world should be widened or contracted, depending upon the needs of more vital radio services."



DE PROFUNDIS. One of the underground studios in the magnificent new "Radio House" in Rome. Note the rotating ventilators in the roof.

Fighting for Recognition.

It seems to me that the B.B.C. and other European broadcasting officials have in front of them a hard fight, in which the (to us) important question of kilocycle separation will be quite submerged in the larger problem of securing suitable recognition of broadcasting by the Governments of the world.

Scottish Regional Tests.

THE new Scottish transmitter at Westerglen, near Falkirk, is now radiating its first transmissions intended for public reception, on a wavelength of 376.4 metres. Normal service conditions are being observed, so the general performance should be the same now as when the transmitter replaces the existing stations at Glasgow, Edinburgh, and Dundee.

When to Hear the New Transmitter.

The present schedule (Sundays excepted) is as follows:—

Mornings: 11.5 a.m. to 11.45 a.m.

Nights: Mondays, Wednesdays, and Fridays: 11.15 to 12 midnight. Tuesdays, Thursdays, and Saturdays: 12.15 a.m. to 1 a.m.

These reception tests will be continued for a short time until the transmitter begins to radiate portions of the daily programme.

The Royal Command Performance.

ON May 30th listeners will hear the Variety Artists' Benevolent Fund Command Performance relayed from the London Palladium. This event has been broadcast on several previous occasions and is the greatest event of the vaudeville year. Music-hall artists seek eagerly to be included in the programme, which, prior to the performance, is submitted for Their Majesties' approval.

Sunday Dinner Broadcasts.

BEFORE "economy" became a household word six months ago, it was indicated in these columns that a change in Sunday broadcasting was imminent. When, however, financial saving became the order of the day, the question was shelved.

From 12.30 p.m. Onwards.

Still anxious to meet the desires of listeners, the B.B.C. Governors have now consented to the introduction of light musical programmes on Sundays between 12.30 to 3 p.m., on and after June 5th next.

What Sort of Programme?

Visions of slow foxtrots and subdued vaudeville can be dismissed at once. The Corporation remains determined not to alter in any way the general character of the Sunday programmes, despite rumours to the contrary, but I am given to understand that the musical accompaniment to our Sunday dinner will not be dull or heavy.

What of the Paris Broadcasts?

I suppose that the majority of British listeners will welcome the innovation. Others will almost certainly tune into Paris as usual, the truth being that, the B.B.C. grapes having been so long withheld, many people have learnt to support life without them and seek their rare and refreshing fruit elsewhere.

Any Port in a Storm.

If, as *The Wireless World* recently forecast, the British programmes from "Radio Paris" are curtailed, the B.B.C. will prove a useful standby.

Nuts to Crack.

Instructive Problems and their Solution.

THE present series has been started by *The Wireless World* for the benefit of readers who like to work out little problems for themselves and be sure that the results they obtain are correct. At frequent intervals wireless problems are presented, and in the following instalment the answers are given with the methods of working them out, and hints on possible points of difficulty. Problems 38 to 40 have been previously given, and below the answers appear, whilst another set of problems is included this week for treatment in the next instalment.

QUESTION 38.—**The working grid bias of a certain amplifying valve is 5 volts negative. When the plate potential is 100 volts the steady anode current is 3.45 mA., but when the plate volts are increased to 120 the anode current is 6.25 mA. What numerical information can be drawn from these figures?**

Answer— Anode A.C. resistance = 7,143 ohms.
Anode power dissipation in first case = 0.345 watt.
Anode power dissipation in second case = 0.75 watt.

Since the working value of grid bias is specified, it may be taken that for the given values of anode voltage the valve is working on the "straight" part of its characteristic. With this constant grid bias, an increase of 20 in the working value of mean plate voltage is found to result in an increase of 2.8 mA. or 0.0028 A. of anode current. Accordingly,

$$\text{Anode A.C. resistance} = \frac{\text{Increase of anode volts}}{\text{Increase of anode current}} = \frac{20}{0.0028} = 7{,}143 \text{ ohms (assuming grid volts constant).}$$

The figures given may also be used to ascertain the power dissipation at the anode for the two plate voltages cited. The anode dissipation represents the mean power expended in the valve by the steady electron current from filament to anode; it is given in watts by the product $E \times I$, where E is the mean anode potential in volts and I is the mean anode current in amperes.

When anode potential = 100 volts, dissipation = 100×0.00345, which equals 0.345 watt.

When anode potential = 120 volts, dissipation = 120×0.00625, which equals 0.75 watt.

QUESTION 39.—**A four-valve set is supplied with L.T. current from a 6-volt accumulator. The two H.F. and detector valves each take 0.1 amp. at 2 volts, while the power valve takes 0.25 amp. at 6 volts. If the earlier valve filaments are arranged in parallel, what should be the value of the voltage limiting resistance employed, and what is the total current taken from the accumulator?**

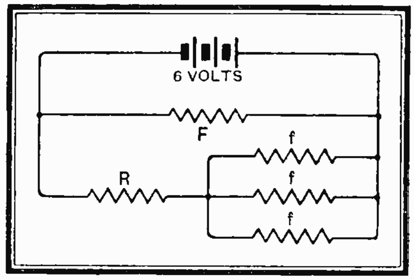
Answer—13.33 ohms; 0.55 ampere.

The scheme of connections is shown in the accompanying figure, in which F represents the filament of the power valve and f, f, f those of the earlier valves. R represents the value of the voltage reducing resistance. Each filament f consumes 0.1 amp., and therefore 0.3 amp. must pass through R. Now, the working voltage across the three filaments f is 2 volts, leaving a balance of 4 volts to be dropped across R. Hence the value of R is obtained from the equation

$$R = \frac{E}{I} = \frac{4}{0.3} = 13.33 \text{ ohms.}$$

The total current drawn from the accumulator is

The resistance network referred to in Question 39. Valve filaments are shown as F and f.



evidently the sum of that passing through R and that taken by the power valve, i.e., it is $0.3 + 0.25$ or 0.55 ampere.

QUESTION 40.—**Two stages of resistance amplification are arranged so that the external load resistances have each four times the value of the anode A.C. resistances of the valves. The magnification factor of each valve is 15. What is the overall voltage magnification of the amplifier?**

Answer—144.

The formula used to calculate the actual voltage magnification of a single stage resistance-coupled amplifier is: Magnification = $R/(R+R_0) \times \mu$ where R denotes the value of the external load resistance and R_0 and μ are the anode A.C. resistance and magnification factor of the valve.

In the present example the actual values of R and R_0 are not given, but, as will appear, these are not necessary for the solution of the problem when the ratio of R to R_0 is known. This ratio $\frac{R}{R_0} = 4$, or $R = 4R_0$, while $\mu = 15$.

For one stage of the amplifier, therefore,

$$\text{Magnification} = \frac{4R_0}{4R_0 + R_0} \times 15 = \frac{4}{5} \times 15 = 12.$$

Since the effect of the second stage is simply to amplify the voltages attained by the first stage in the same proportion, we may estimate the overall voltage amplification of the two stages as $12 \times 12 = 144$.

NEXT SERIES OF PROBLEMS.

QUESTION 41.—**At 256 cycles per second a certain loud speaker has an impedance of 5,000 ohms. What would be a suitable turns ratio for transformer coupling at this frequency to a power valve whose A.C. resistance is 2,500 ohms?**

QUESTION 42.—**A resistance of 1,000 ohms is placed across a dry battery of 120 volts, and the P.D. of the battery is simultaneously found to be 100 volts. What is the internal resistance of the battery?**

QUESTION 43.—**A power valve whose μ is 4 and A.C. resistance 3,000 ohms works into a load of 3,000 ohms. If the R.M.S. voltage input at the grid is 33 volts, what is the A.C. power in the load?**

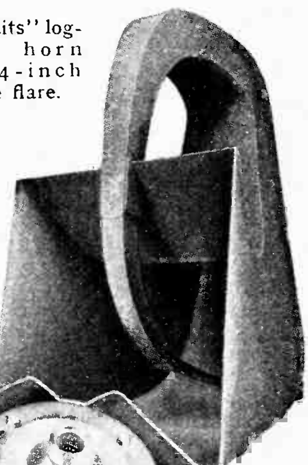
NUTCRACKER.

Laboratory Tests

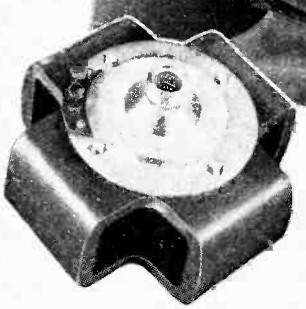
ON NEW RADIO PRODUCTS.

A NEW LOGARITHMIC HORN UNIT.

Made by Messrs. L. S. Units, 46a, Lonsdale Road, Barnes, London, S.W., this unit is equipped with a massive cross-type permanent magnet having a diameter of $7\frac{1}{2}$in. The moving-coil has an impedance of approximately 12 ohms, and the air chamber above the diaphragm is fitted with a specially shaped central cone, which deflects the pressure waves into the throat of the horn. A specially designed folded logarithmic horn with a 24in. square flare has been produced for this unit. Our tests were carried out with this combination, and the first thing to attract attention was the exceptionally high sensitivity and acoustic efficiency. The general level, judged when listening to music, was approximately two decibels higher than that of any moving-coil-cone loud speaker so far tested.

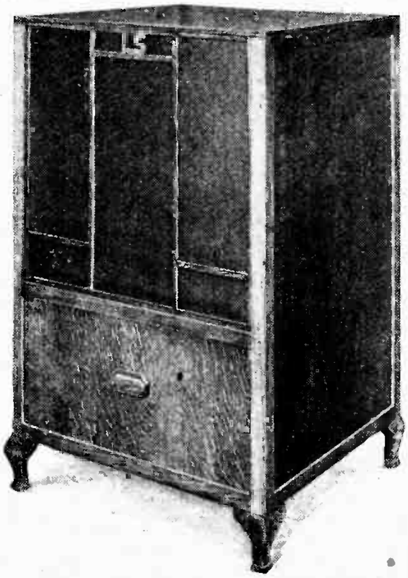


"L.S. Units" logarithmic horn with 24-inch square flare.



(Left) The permanent magnet moving coil unit.

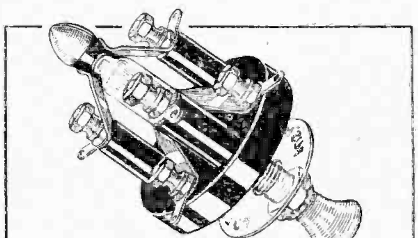
Frequency tests revealed a low-frequency cut-off at 80 cycles, but the effect of this in the general reproduction was partly masked by a resonance at 100 cycles, with the result that there is no apparent lack of bass response. In the middle and upper registers the output is well maintained up to 5,000 cycles, and there is an appreciable response above this up to 12,000 cycles, though at a considerably reduced level. There can be no doubt that where it is possible to accommodate the logarithmic horn this type of loud speaker is well worth consideration as an alternative to the moving-coil cone, as the sound output obtained for a given input is definitely superior. The price of the moving-coil unit is £6 10s., and the horn costs £3 15s. A complete loud speaker in cabinet form is also available at £14 10s.



"L.S. Units" loud speaker in cabinet form.

PIONEER SIX-POINT SWITCH.

Made by the Pioneer Manufacturing Co., Cromwell House, Fulwood Place, London, E.C.1, this switch consists of two distinctly separate sets, each with three-spring contacts, and when the plunger is pulled out each set is joined together by separate contacts on the spindle. It can be described as a dual three-point switch, and would seem suitable for wave-change purposes where two separate circuits are used, as it obviates the need for ganged switches. A square section spindle is fitted which facilitates screwing home the knob after mounting the switch on the panel. The price of this model is 2s. 9d.



Pioneer dual three-point switch.

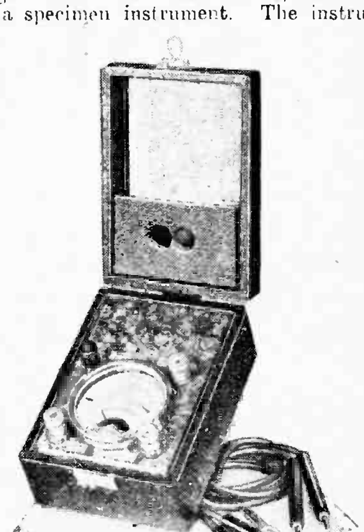
PIFCO ALL-IN-ONE RADIOMETER.

This is a D.C. multi-range measuring and testing instrument providing facilities for measuring high- and low-tension voltages, anode current, and making continuity tests of circuits and valves. The two voltage ranges read 0-250 and 0-6 volts respectively, while the current range is from 0 to 40 mA. A three-volt battery consisting of two small cells is housed in a recess in the back of the case; this provides the required potential for testing valve filaments and when making continuity tests.

To ascertain if a valve filament is intact it is necessary only to insert the valve in the holder provided, while for continuity tests the two leads supplied are plugged into the filament sockets of the valve-holder and the free ends employed to pick up connections between various parts of the circuit.

Considering the price of the instrument is but 42s., the order of accuracy attained on all ranges is exceptionally high. Indeed, the limitations imposed by the accuracy with which the scale can be read represents the largest error recorded at any part of the scale. Close reading is greatly facilitated by a parallax mirror by the aid of which the 6-volt scale can be read accurately to one-tenth of a volt, while on the 250-volt range the error will be of the order of 1 per cent. at full scale.

Over the milliamp. range it is just possible to read to within the nearest 0.5 mA. with certainty, which represents the largest error met with during our test of a specimen instrument. The instructions regarding the use of the milliamp. range must be adhered to and the special spade connector provided must be used, as this serves as a link to connect the stem of the terminal with the metal base and so brings into circuit a shunt resistance. On both the 6-volt and the 250-volt ranges two milliamps. give a full-scale deflection, so that the internal resistance works out at 500 ohms per volt in both cases.

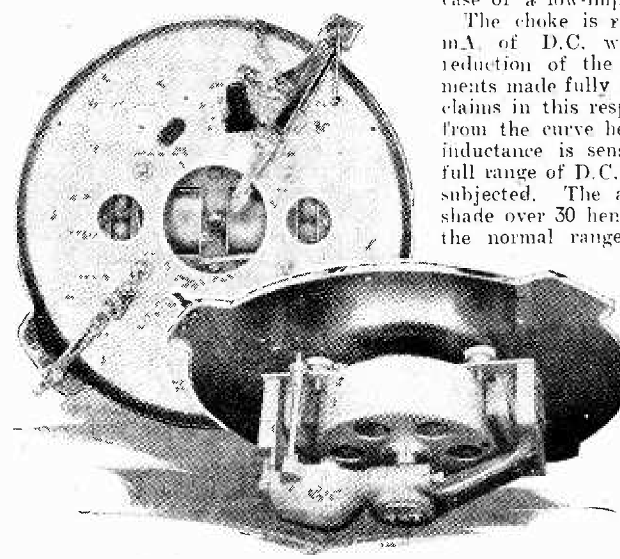


Pifco multi-range measuring and testing instrument.

The instrument is of foreign manufacture, and supplies are obtainable from the Provincial Incandescent Fittings Co., Ltd., Pifco House, High Street, Manchester.

PAILLARD TWO-SPEED GRAMOPHONE MOTOR.

This motor is of the induction type, and is available with windings suitable either for 200-250 or 100-150 volt A.C. mains. The special feature of the design is the

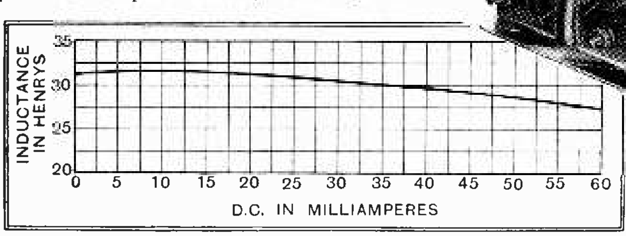


Paillard two-speed induction gramophone motor.

provision of a control on the governor by means of which the turntable can be run at the regulation speed of 78 r.p.m. for ordinary records or at 33 r.p.m. for special records, such as those used in conjunction with talking films. The indicator control is carefully adjusted at the works, and tests revealed that the above-mentioned speeds are maintained to within 1 r.p.m. The workmanship is well up to the standard one expects in motors of Swiss manufacture, and the torque is sufficient to play records of the deepest cut without appreciable diminution of speed. The price, as illustrated with metal base plate, is £5 15s., or without base plate £5 5s., and supplies are obtainable from the Apollo Gramophone Co., Ltd., Apollo House, 4-5, Bunhill Row, London, E.C.1.

CLARKE'S ATLAS PENTODE OUTPUT CHOKE.

This L.F. choke has been designed especially for use in conjunction with pentode output valves, and is in

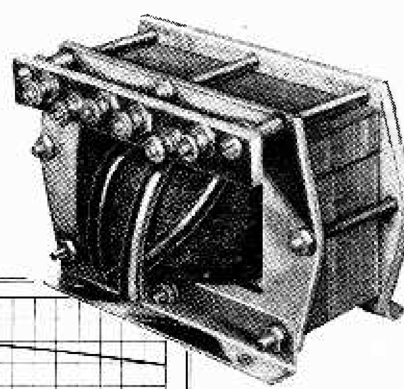


Inductance curve of Clarke's Atlas tapped pentode output choke.

effect an auto-transformer affording the choice of nine different ratios between 1 : 5 and 1 : 1 inclusive. Satisfactory matching of the valve and loud speaker is possible, even though the impedance of the latter is between 320 ohms and 8,000 ohms. Where low-resistance loud speakers are used the special transformer usually supplied must be retained, as provision is not made for matching in the case of a low-impedance speech coil.

The choke is rated to carry up to 60 mA. of D.C. without any substantial reduction of the inductance. Measurements made fully substantiate the maker's claims in this respect, as it will be seen from the curve here reproduced that the inductance is sensibly constant over the full range of D.C. to which the choke was subjected. The average inductance is a shade over 30 henrys, which is ample for the normal range of pentode valves in use to-day. The D.C. resistance of the sample tested is 430 ohms.

The makers are H. Clarke and Co. (M/cr.), Ltd., Atlas Works, Old Trafford, Manchester, and the unshrouded model type C.P., as illustrated, sells at the modest figure of 17s. 6d.



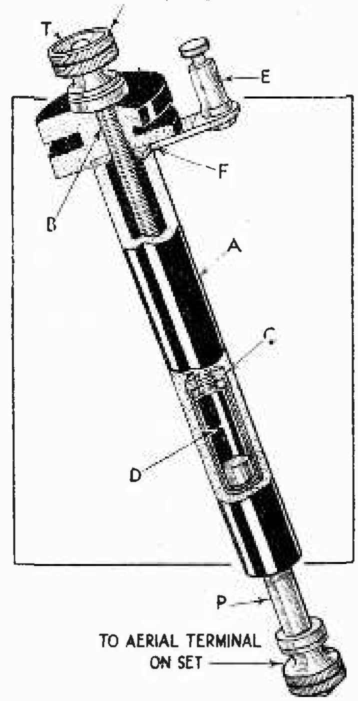
Clarke's Atlas Model C.P. unshrouded variable ratio pentode output choke.

PRESSLAND SAFETY LEAD-IN.

Made by Pressland Products, Ltd., Hampton-on-Thames, Middlesex, this lead-in tube possesses two distinctive features. Not only does it ensure complete immunity from danger in the event of a lightning discharge striking the aerial, but it affords a means of varying the selectivity, since it incorporates what is in effect a small variable condenser. The illustration shows the general form of construction, A being the ebonite body, in one end of which is a brass tube C, and screwed into this is a brass rod B, terminating in the outside aerial terminal T. This rod passes through a large clearance hole in the lug F which serves as a lightning spark-gap; the small terminal E being joined to the earth connection.

An ebonite sleeve D is inserted in the brass tube C, so that as the plunger P is pushed in the capacity between these two increases, but when fully in the tip of the plunger butts against the extension of the rod B, short circuits the condenser, and gives a straight-through connection between the aerial and the set.

The maximum capacity available is 0.000124 mfd., while the minimum value, allowing sufficient of the plunger inserted to give it support, is 0.00002 mfd.



Construction of Pressland safety lead-in tube with selectivity device.

The price of this model is 3s. 6d., and there is, also, another model without the safety gap costing 2s. 6d.

o o o o

CHANGE OF ADDRESS.

Ward and Goldstone, Ltd., and Remax, Ltd., who have been associated in the London district for some years, have decided to act independently in the future.

Ward and Goldstone, Ltd., have acquired, therefore, new premises at 5, Percy Street, London, W.C.1, to which address all correspondence should be addressed.

o o o o

CATALOGUES RECEIVED.

Loewe Radio Co., Ltd., 4, Fountain Road, Tottenham, London, N.15, now manufacture quite an extensive range of components, full details of which are given in their latest catalogue.

The latest catalogue recently issued by Radio Instruments, Ltd., Purley Way, Croydon, contains 40 pages of descriptive matter dealing with their extensive range of components and receivers. It is well illustrated, and much useful data are given in the form of curves.

CORRESPONDENCE

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

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

"The Wireless World" 21st Birthday.

I CANNOT allow this important event to pass without sending you my most sincere congratulations for the editorial staff's considerable contribution to the wonderful progress made since I was handling advertisements for *The Wireless World* when it was only published fortnightly.

From my clients' point of view, I can assure you that the integrity of your journal and its reliability in the matter placed before its readers has secured their unfailing support for any announcements they have desired to make to the ever-growing number of radio enthusiasts who regularly buy Britain's oldest wireless journal. PARRS ADVERTISING LIMITED,

London, W.C.2. H. Freeman, Director.

I SHOULD like on behalf of the Halifax Wireless Club to congratulate *The Wireless World* on attaining its majority and to wish it and its staff "many many happy returns."

I can truthfully say that I have not missed an issue since the beginning of 1919 and have always found it full of good things.

The main points I like about your paper are its consistency, its freedom from "stunts" and the general reliability of and modesty of claims for its designs.

We all hope for its combined success in the future.

LOUIS J. WOOD,

The Halifax Wireless Club Hon. Sec.

Volume Level.

From Mr. Noel Ashbridge, Chief Engineer of the B.B.C.

I HAVE read with interest the editorial comment which appears in your issue of April 13th. I gather that you consider the mean depth of modulation should be adjusted in accordance with the type of programme item being broadcast, so that the strength produced in the listener's room is strictly consistent with the nature of the programme. You also state that the B.B.C. is in the habit of broadcasting speech items at greater strength than musical items.

I venture to suggest that the whole question is not quite so simple as would appear from your comments. Ideally, one could so adjust modulation that the highest average modulation consistent with distortionless output was only used in the case of those items which would be expected to make the most noise, such as a symphony orchestra. Starting from that basis one would then presumably adjust all items to be in proportion, the weakest item being, perhaps, a woman's voice. If this were done it would be found that the mean modulation, for example, with a woman's voice, would be barely above the "mush" level so far as a large number of listeners are concerned, and one would have the unfortunate state of affairs that interference was at its worst during speech, when intelligibility should be at its highest. It is perfectly true that if every listener lived in an area of field strength greater than, say, 10mV. per metre, such an arrangement might perhaps be practicable, at any rate to a considerable extent. It must be remembered, however, that there are thousands of listeners living in areas where the field strength is low and where reception is difficult, both from the point of view of the absolute strength and from the point of view of interference of all kinds. For this reason it is essential that the degree of modulation during speech shall be kept reasonably high. By this I do not mean that the average modulation should be as high as during a symphony concert. The actual state of affairs is that speech is broadcast at such a level that the peaks are approximately 6 decibels below the peaks of band items, etc. Naturally, the speech will be louder than the soft passages of music, but if it were cut down any more I am afraid it would be at the expense of thousands of listeners living in the outer limits of the service area. At the same time I do not think anyone would wish the soft and loud passages of music to be levelled up merely to get over this difficulty. However, if it were not for the question of interference, and the fact that many receivers have no factor of safety at all, we should broadcast speech at a still lower level.

Finally, I would like to suggest that some of your remarks are not applicable to average conditions, and the fact remains that very few complaints are received on this subject.

London, W.C.2. N. ASHBRIDGE.

Automatic Grid Bias.

I REGRET that in my article on automatic grid bias in your issue of April 13th, Fig. 6, showing a grid-bias system for a push-pull output, was given incorrectly. As shown, R_1, R_2, C form a bridge circuit, and assuming balanced valves, R_2 plays no part; therefore the recommended alternative—omission of R_2 and the use of electrolytic condensers at C—is in fact the only satisfactory alternative, unless a transformer with two separate secondaries is available. M. G. SCROGGIE.

London, S.E.19.

Quality and Frequency Range.

THE letter from Mr. L. R. Merdler in your issue of April 13th contains much that is misleading, but it does, at least, advance an idea, which is more than many of the 5,000 cycle school have done. His idea seems to be that the artist, the transmitter, and the receiver be considered a source of entertainment for the listener, and as such is susceptible to certain limitations which should be realised and allowed for.

We get enough "canned music" in the gramophone and the "talkies," and since radio is capable of something much better than this, why should we not have it? A restriction of the frequency band is advocated only by those who cannot design for better performance, who, since they cannot see how to improve their apparatus, advise that apparatus should not be improved. Surely it cannot be "in the best interests for future progress" that radio should be spoiled for the sake of the incompetents?

I would point out one or two false premises in Mr. Merdler's letter. It is unnecessary for a piano maker to make pianos of inordinate length; the piano as made has a *fundamental* frequency range as great as the orchestra, and the *fundamental* frequencies can be reproduced almost perfectly by apparatus having a top cut-off at 5,000 cycles. However, the piano, in common with nearly all other instruments, has a *harmonic* range up to 15,000 or 20,000 cycles, and it is the harmonics which give each instrument its particular quality of tone. For artists "to develop a new technique to play upon this most modern of new musical instruments"—by which I suppose he means that sounds should be emitted in the studio only if they can be reproduced by a 5,000-cycle limit receiver—implies that all music which has ever been composed must not be broadcast; that new broadcast music should be written between about two octaves' range, or that electrical oscillators giving pure notes be used instead of musical instruments; that all speakers should have their mouths more or less filled with food; that no incidental noises to plays be allowed; that vaudeville be consigned to eternal silence; and that a whole host of our favourite broadcast items be discontinued. I venture to suppose that this kind of technique would not be in the best interests of radio.

A receiver and loud speaker to reproduce up to 10,000 cycles need cost no more, nor be bulkier than the ordinary set and speaker; the improved reproduction obtained from this extended frequency range is obvious to anyone who has heard it, so why *are* radio sets made with a 5,000-cycle limit? I can see no other answer but—technical incompetence.

Isleworth. H. A. HARTLEY.

The Directly Fed Transformer.

IN the issue of *The Wireless World* dated March 23rd, 1932, you published a letter from Mr. H. H. Dyer, in which he makes an interesting claim on behalf of the directly fed transformer as an inter-valve coupler.

Mr. Dyer states that the effect of the coupling condenser in the cases of resistance, choke, or parallel fed transformer is to ruin attack.

As one whose sole interest in or knowledge of radio or electricity has been derived from about six years', more or less, intelligent reading of *The Wireless World*, it is with considerable diffidence that I question the fundamental soundness of the reasoning of an engineer of Mr. Dyer's qualification; but it appears to me that since the earth return of the directly fed transformer must be completed through a condenser, the A.C. current in this method is subjected to the same form of distortion as in the other methods. Similar considerations seemingly apply to the output stage.

It would appear that the only case in which Mr. Dyer's claim could be sustained is when each valve is fed from a separate H.T. accumulator, in which case shunting condensers could be omitted. H. L. TAYLOR.

Barnet, Herts.

Variable Selectivity.

I AM a comparative novice in things "wireless," and so perhaps this admission will prevent the shouts of derision from your expert readers if I mention what is perhaps a simple matter.

Is it not possible to design a receiver with *variable* selectivity? The modern band-pass tuning results in side-band cutting at 8 kc., and in cases below this. This is, of course, necessary on some parts of the dial if we are to have passable selectivity, but in some cases a 10 kc. separation would be sufficient and would give us better quality of reception. Also we are not all under the shadow of a broadcast transmitter, and it does seem to me a pity to cut quality all the time whether ultra-selectivity is required or not. NOVICE.

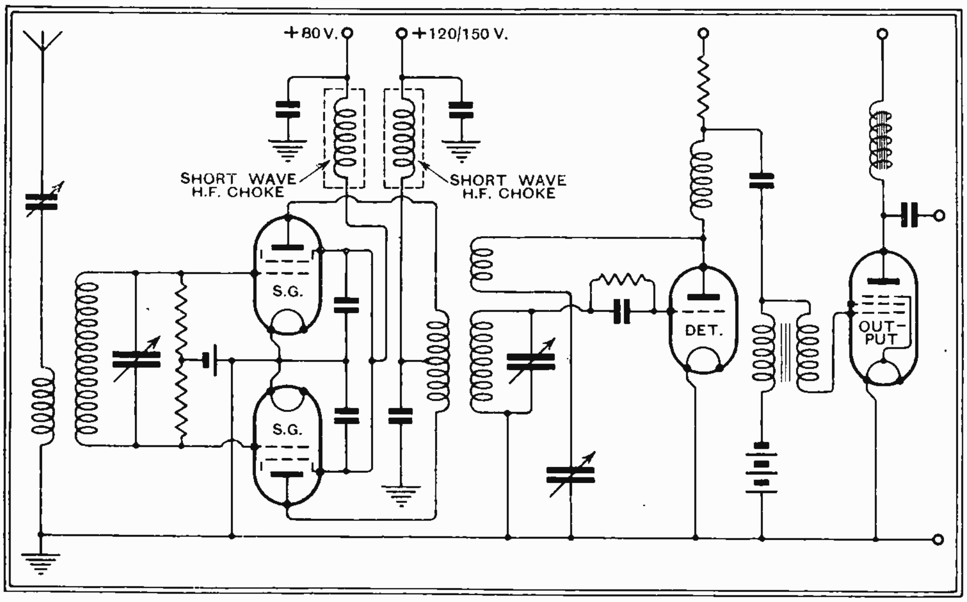
100 Division or 180 Degree Scales?

IT seems to me that some attempt should be made to settle this question. I feel sure that a consensus of opinion from readers of *The Wireless World* would be of the utmost value, and one on which we could safely standardise.

London, W.C.2. LT.-COL. G. D. OZANNE, Wingrove and Rogers, Ltd.

H.F. Push-pull.

ONE of the chief advantages of the push-pull circuit is that it almost entirely eradicates feed-back. For this reason it has been embodied in the new push-pull power grid detection system, where its adoption permits of additional benefits. Why not use it in connection with the design of H.F. stages? The accompanying circuit shows a suggested arrangement of two screen-grid valves in push-pull. It is doubtful whether the unselective single circuit H.F. couplings used in many cases at present render increase of effective valve amplification at all advisable, unless efficient constant square-peak band-pass coils are substituted. The new push-pull arrangement suggested would seem to meet crying needs in the direction of short wave H.F. amplification. The great preventive of effective amplification here, hitherto, has been the enormously increased tendency towards feed-back, found when dealing with these high frequencies. Push-pull circuits should allow of a substantial improvement.



Furthermore, if the new 7-metre band begins to fill up with local phone and television stations and with stations maintained by big shops, emporiums, schools, churches, etc., as seems possible in a locality like London, a double superheterodyne receiver might become necessary to gain the required selectivity—with the first I.F. stage working on thirty metres or so and the second, for which the ordinary broadcast set would come in handy, working on the long waves. In such a set the 30-metre I.F. stage would have to pull its weight, and here push-pull would seem to solve the difficulty.

In constructing an experimental push-pull short-wave stage, the S.G. valves, which may be of the variable-mu type, had better be mounted with the screening grid terminals as close together as possible. These should be joined by a short lead whose centre is immediately connected to one terminal of the decoupling choke, which must be an efficient short wave component. Also, each screening-grid terminal must be connected immediately to one terminal of a *mica* 0.01 mfd., or higher value, fixed condenser, whose other terminal must be connected immediately to the cathode of the same particular valve.

Layout of parts must be for efficiency and not, as often happens, for looks. Decoupling should be complete and thorough.

Careful attention to these matters should ensure good results, and a respectable increase in amplification may be looked for. The writer will be interested to hear of any results obtained by experimenters in this direction.

Glengormley, Belfast. R. M. SIBBETT.

Where are the Oscillators?

I HAVE read with interest the letter appearing in your issue of April 13th from your correspondent, E. Lytton Brooks.

No doubt by this time certain of your other contributors will have rushed into print with words to the effect that such sets as oscillate on the aerial are out of date, and the neighbours of Mr. E. Lytton Brooks should obtain up-to-date sets, which, it is generally taken for granted, do not cause interference.

I thought so—until it recently came to my notice where violent and prolonged oscillations were causing interference, and upon location the interfering set was found to be a supposedly latest five-valve superheterodyne, not, however, of British origin.

The set is of the permanently oscillating and interfering type, supposedly up to date, but obviously a confounded nuisance to all the neighbours of anyone who purchases such a thing.

Davyhulme, Manchester. H. A. R.

READERS' PROBLEMS.

When Anode Volts are Needed.

A READER notices that the anode voltage applied to the detector of the "Power Radio-Gram" is slightly less than that customary when "power grid" detection is employed. He asks whether any advantage (in quality of reproduction) would be gained, at the expense of a certain amount of magnification, by fitting a detector coupling resistance of lower value, and thus increasing the working anode voltage of this valve.

The anode voltage requirements of a power grid detector are bound up with the signal input voltage with which the valve is called upon to deal. In the "Power Radio-Gram" this is not large, as an intermediate L.F. stage is employed between the detector and output valve. Without this stage, much more anode voltage would certainly be needed, but, as it is, no advantage would result from the proposed change.

The Complete Anode Circuit.

THE conductive anode circuit of a valve, whatever its function, comprises the anode circuit load, a decoupling resistance (if fitted), and the source of H.T. supply. But the circuit does not end here, and it must not be forgotten that a conductive path must exist between the valve cathode and the negative H.T. terminal.

We are inclined to think that neglect of the last-mentioned part of the circuit is responsible for the failure of a correspondent to "clear" a fault in his H.F. stage. He describes at length the measures that have been taken in testing, and has confirmed the fact that the H.F. valve and all associated components are in order by using them temporarily in another set of similar design. He states that the correct voltage (allowing for extra current drawn by the meter) is found to exist between the anode terminal of the valve and the metal chassis.

But this does not mean of necessity that H.T. voltage is applied between anode and cathode of the valve. This is of the indirectly heated type, connections being as in Fig. 1 (a). If a disconnection exists between the cathode terminal and bias resistor, in the resistor itself, or between the resistor and the earth line, there will be an interruption in the anode circuit which will account entirely for a failure to obtain H.F. amplification. These details should be checked, and it should be borne in mind that the continuity of the external anode circuit of any valve is best tested either by taking a current reading or measuring the voltage between the anode and cathode terminals of its holder.

It should be added that when the valve is biased as in Fig. 1 (b), our reader's test is much more likely to be conclusive.

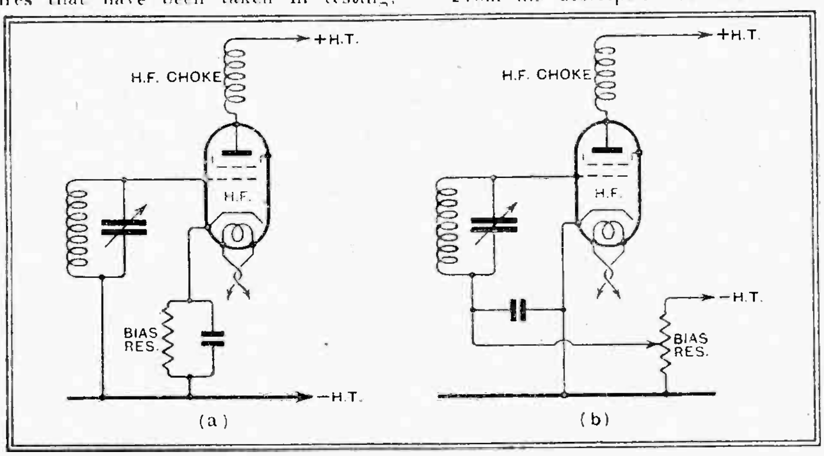


Fig. 1.—When testing the continuity of an anode circuit there is a tendency to forget that it comprises the cathode (or filament) connections of the valve.

Volume Level.

THE evils of side-band cutting, in the matter of attenuating high notes, are well known, but there is a subsidiary effect that is not generally appreciated; the apparent level of volume is reduced considerably when the higher modulation frequencies are not passed in due proportion to the L.F. amplifier.

For instance, a reader who is using an output valve which is rated to deliver 2,000 milliwatts to the loud speaker tells us that painfully obvious signs of overloading are observed long before volume reaches a "realistic" level. He adds that reproduction is dull and "lifeless," and that the anode current of the output valve is normal.

From his description of the "H.F." end of the set, we are strongly inclined to think that excessive high note loss is taking place, with the result that the output valve is overloaded by low-frequency signals; impulses in the middle register, and rather higher, which largely determine the apparent volume, are not present in anything approaching equal strength.

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

Aerial for the "Monodial."

WE are asked whether the "Monodial Super" would give satisfactory results with a relatively inefficient indoor aerial (described by our correspondent), or whether it would be worth while to erect an outside aerial, which can be done in this case fairly easily.

We are here dealing with an unusually sensitive set, and the total number of stations receivable with it is not greatly influenced by the efficiency of the aerial. Indeed, conditions in the ether are seldom good enough to allow full use to be made of a highly-efficient collector.

But there is another aspect to the question; an inefficient aerial implies the need for using a great deal of the amplifying power of the set for long-distance reception, and this will inevitably be responsible for a certain amount of valve hiss or background noise. With a good aerial, the necessary amount of amplification, for equal signal strength would be much less, and so the background would be quieter. All this applies, to some extent, to every kind of set.

In Spite of a Broken Winding.

IT is quite possible for a superheterodyne receiver to give signals—of a sort—even when a complete disconnection exists in the secondary winding of an intermediate-frequency transformer. When this happens, there always remains a certain amount of capacity between the two coils, which acts as a very inefficient form of coupling.

Writing to us on the subject of a superheterodyne which is not giving good results, a reader states that there "does not appear to be continuity" through the second L.F. transformer secondary, but he supposes that this component must be in order, as the set provides audible signals. He would be well advised to make a conclusive test of the winding and its connections; unless continuity exists, proper results cannot be obtained

Double Condensers.

HIGH-CAPACITY paper condensers, consisting of two or more elements built into a single case, are in fairly common use. Almost invariably, one side of each element is joined internally to a common terminal; when the condenser is put to its normal use in by-pass or decoupling circuits, this terminal is connected to earth.

Apart from this use, a number of different capacities can be obtained by making the appropriate connections to the external terminals. A case of this sort

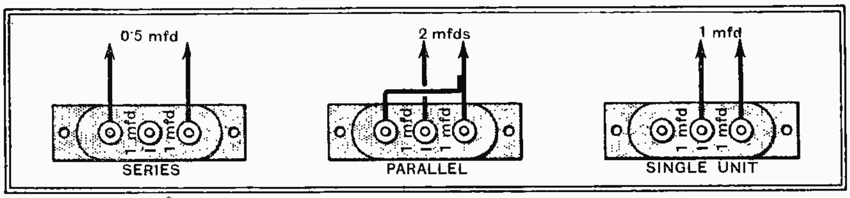


Fig. 2.—Three different values of capacity may be obtained by making the appropriate connections to a double condenser.

is brought up by a reader, who has a condenser consisting of two elements of 1 mfd. each. He asks how the component should be connected to give an effective capacity of 0.5 mfd., which he requires for use in a parallel-fed L.F. transformer circuit.

An effective capacity of half a microfarad will be obtained when the two elements are connected in series as shown in the accompanying diagram, from which it will be seen that the "common" terminal is ignored. For the sake of completeness, and for the benefit of other readers who may wish to use a condenser of this sort for other purposes, we also show in the diagram the necessary connections for obtaining the sum of the individual capacities of the elements by connecting them in parallel.

Stable or Unstable?

A CORRESPONDENT states that his "2-H.F." set works extremely well on wavelengths above 300 metres, but that no station whatsoever of lower wavelength is receivable. By transferring the aerial to the tuned grid circuit of the detector (with a small condenser interposed) this disability is removed, wavelengths of from 200 metres upwards being heard at good strength. Information is requested as to the probable cause and cure of this trouble.

In the absence of full details regarding the receiver, the obvious thing to say is that the inductance—or the stray capacity—associated with one of the tuned circuits before the detector stage must be much too high. But if this were responsible it would probably have been equally obvious to our reader, and we are inclined to suspect that the real cause is the still-too-prevalent trouble of instability at the lower end of the wave-range. No mention of this is made in our correspondent's letter.

Sometimes the detector-grid circuit becomes choked when the H.F. amplifier is in a state of violent self-oscillation, and the usual signs of instability, such as heterodyne notes, etc., are not evident. However, the change from stability to instability is not usually very sudden, and, somewhere in the region of 300 metres, we expect there is a position on the tuning scale where the fact that the H.F. amplifier is oscillating "gently" will be plain if a careful test be made.

Wave-range Switches.

A READER tells us that his receiver only gives good results on the long-wave band, after what he describes as a certain amount of "juggling" with the wave-change switch knob. This would indicate a faulty switch, but he argues that if the switch contact is poor the trouble should manifest itself on the medium band. In the set in question switching is arranged in the conventional manner by short-circuiting the long-wave sections of the windings. The switches are inaccessible, being built into the coils, and our correspondent is unwilling to dismantle them until he is quite sure that the effect described is not due to some entirely different cause.

We agree that the most common wave-range switch fault is in the form of a failure to effect a short-circuit in the medium-wave position. But in the present case it would appear fairly certain that the switch contacts are insufficiently spaced, and so they often fail to separate properly. We fear that it will be necessary to dismantle the built-in switches, and to bend the contact springs apart.

Eliminating the Frequency Changer.

WE are asked to describe the correct method of procedure in making a preliminary test of the "Single Dial Super" by eliminating the frequency changer and I.F. amplifier. Our querist has made several minor alterations to the published design; he has also adopted a different layout, and he suspects that his failure to obtain entirely satisfactory results is due to one of these causes or to the use of an unsuitable component.

It is always a good plan to make a test in this way, and we suggest that the set should first be arranged to work as a simple combination of band-pass filter, detector, and pentode output stage. In this condition the local station should be receivable at fair strength. The necessary alterations are made as follows:—Disconnect terminal No. 1 of L_2 from the 0.01 mfd. condenser, and join this coil terminal directly to the 0.0002 mfd. grid condenser, after having disconnected the condenser from the I.F. transformer secondary. The grid leak should be joined between grid and positive filament terminals of the second detector.

"THE WIRELESS WORLD"

Information Bureau.

CONDITIONS OF THE SERVICE.

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

(2) Communications should be addressed to *The Wireless World* Information Bureau, Dorset House, Tudor Street, E.C.4, and must be accompanied by a remittance of 5s. to cover the cost of the service. The enquirer's name and address should be written in block letters at the top of all communications.

(3) The fee of 5s. covers the reply to any wireless technical difficulty, but in special cases, where the enquiry may involve a considerable amount of investigation, an increased fee may be necessary. In such cases a special quotation will be made.

(4) Questions should be clearly written and concisely worded in order to avoid delay. Where enquiries relate to trouble experienced in receivers built to specifications in *The Wireless World* a complete account should be given of the trouble, and especially the symptoms.

(5) Where reference is made to published articles or descriptions of apparatus, the title of the article, the date of publication in *The Wireless World*, and the page reference number should be given, in order to facilitate reply.

(6) Full circuit diagrams, constructional details of apparatus, or values of components for home-designed receivers cannot normally be supplied, but circuit diagrams sent in with queries will be checked and criticised.

(7) Particular makes of components cannot, in general, be recommended, but advice will be given as to the suitability of an individual component for a particular purpose specified by the enquirer.

The Wireless World
AND RADIO REVIEW
(21st Year of Publication)

No. 663. WEDNESDAY, MAY 11TH, 1932. VOL. XXX. No. 19.

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Advertising and Publishing Offices: DORSET HOUSE, TUDOR STREET, LONDON, E.C.4.
Telephone: City 2846 (15 lines). Telegrams: "Ethaworld, Fleet, London."
COVENTRY: Hertford St. Telegrams: "Cyclist, Coventry." Telephone: 5210 Coventry.
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GLASGOW: 26B, Renfield Street, C.2. Telegrams: "Iliffe, Glasgow." Telephone: Central 4857.
PUBLISHED WEEKLY. ENTERED AS SECOND CLASS MATTER AT NEW YORK, N.Y.
Subscription Rates: Home, £1 1s. 8d.; Canada, £1 1s. 8d.; other countries abroad, £1 3s. 10d. per annum.

FREQUENCY RANGE AND QUALITY.

FEW subjects put up for debate through the columns of *The Wireless World* have provoked so much interest as the question of frequency range and quality of reproduction, and it is particularly interesting to read the correspondence on this subject now being published. It would be quite impossible to attempt to publish all the communications which have been received on this subject, so that we have had to pick out those letters which seem to be of special interest and leave unpublished a large number which, in their subject matter, really overlap those which we have selected.

The General View.

The general opinion, with one or two outstanding exceptions, appears to be that, in broadcast transmission, we should strive to obtain as wide a frequency range as possible, in order to ensure faithful reproduction. But, as broadcasting is organised to-day, we have got to compromise somewhere, and it is on this point, of deciding between the ideals of quality and the very practical problem of accommodating broadcasting stations in the ether, that we have to make our compromise. Most of us want to strive after the ideal, but we must be careful to see that we are not, in fact, "crying for the moon." If our broadcast transmitters were capable of putting out the full range of the audio-frequency spectrum, how far should we then be in a position to benefit from it? Great strides have, we know, been made during the last two or three years in the design of broadcast receiving apparatus, and we may anticipate progress at at least an equal rate in years to come; but, taking our position to-day, we should find that only a limited number of receiving equipments, at a cost far beyond the means of more than a few individuals, would be capable of even approaching the point where they could do justice to ideal transmissions. Again, lest we tend to argue the necessity for better and better reproduction to a point where it becomes an absurdity, we must stop a moment to consider the effect of the acoustic conditions of the room in which the broadcast reception is to take place, and, perhaps more important still, the physical ability of the individual listener to do justice to these ideals.

Room Acoustics—

The acoustics of the room will influence reproduction to a very marked extent. Reflection from walls, standing waves, and absorption of certain frequencies at the expense of others, due to the nature of furnishings, all combine to influence the result, and straight-line frequency response, if present in the reproducer, would, in the vast majority of rooms, cease to be anything like straight-line by the time it reached the individual listener's ears.

—And Our Ears?

And then what about our ears? It has been stated, on good authority, that four out of five people over forty years of age have impaired hearing, and the defects in hearing are mostly of a nature which affect our frequency-response curve, so that we arrive eventually at a position where the majority of individual listeners might expect to have to adjust the frequency-response curve of their broadcast reproducer to suit their individual ears before it could be said that they were listening to a faithful reproduction of the original broadcast.

Putting Back the High Notes

Modern Methods of Correction for Sideband Cutting.

By W. T. COCKING.

IT seems by now to be fairly well understood that no matter how great be the amount of sideband cutting in a selective receiver the high audible frequencies can always be brought back to their correct relative strength by employing the principle of compensation in the low-frequency circuits. Since this is the case it is not absolutely essential to employ band-pass filters in high-quality receivers, although in many cases they provide the most convenient means of obtaining high selectivity without a loss of quality.

Be that as it may, there can be no doubt that compensation will become increasingly used in future receivers, and, in fact, it may with advantage be added to many existing sets, particularly those of the older type in which a considerable high-note loss exists. It is of considerable importance, therefore, that the various methods by which the required compensation can be obtained should be understood, for they are so simple that they can rapidly and easily be applied to existing receivers and amplifiers which suffer from high-note loss.

It should be clearly understood at the start that all compensating circuits, with one exception only, act, not by increasing the amplification of the high frequencies above normal, but by reducing the amplification of the low frequencies to a sub-normal value. From the point of view of compensation, of course, this is unimportant, but in practice it leads to low efficiency, and, in extreme cases, an additional stage of L.F. amplification may be required. The only circuit which will, in itself, act to give increased amplification of high frequencies, is, unfortunately, only useful where a very moderate amount of compensation is needed, and is thus of smaller value than alternative methods.

THERE are many receivers in use to-day in which a good measure of selectivity is obtained without the use of band-pass filters, as a result of which sideband cutting and high-note loss must inevitably take place. Fortunately the higher audible frequencies can be restored in their correct proportion by comparatively simple compensating circuits which are here described in detail.

Let us consider, first of all, the application of compensation to a resistance-coupled amplifier, the skeleton circuit of which is shown in Fig. 1. For our purposes, we can consider that the amplification is the same at all audible frequencies, as, in actual fact, it will be if it be properly designed with this end in view. Now, it is well known that the stage amplification obtainable depends upon the relative values of the coupling resistance R and the valve internal anode A.C. resistance, and that the greater the value of R the greater is the amplification, until the limiting factor is reached when the amplification is nearly equal to the amplification factor of the valve itself.

Now, suppose that we wish to amplify a frequency of about 5,000 cycles ten times as much as the low frequencies below 1,000 cycles, and that the amplification of these frequencies below 1,000 cycles is to be sensibly uniform. This is quite a likely case, when a considerable amount of sideband cutting is present in the H.F. circuits of the receiver. It is obvious that we can immediately reduce the amplification to one-tenth of the valve amplification factor by using a low value of coupling resistance R; with a 10,000 ohm valve, such as the AC/HL, for instance, we should require a coupling resistance of only 1,110 ohms. The amplification, however, would still be constant at all frequencies.

The Inductive Circuit.

If, now, we insert in series with the coupling resistance an inductance L (Fig. 2) of such value that its reactance at low frequencies is negligible in comparison with the value of the resistance R, and its reactance at high frequencies is high in comparison with the

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internal resistance of the valve, then we shall obtain at least some measure of compensation. It is obvious that at low frequencies the amplification will be unaffected by the presence of the inductance, and so will be determined only by the value of the resistance R, while at high frequencies it will be the inductance which determines the amount of amplification.

This is clearly brought out by curve 3 of Fig. 3, which shows the amplification to be expected when a choke of 0.3 H. is used with an anode coupling resistance of 1,000 ohms and a valve with an internal resistance of 10,000 ohms. It will be seen that, for our present purpose, the curve is not ideal, since it is not flat for frequencies below 1,000 cycles; the amplification at 1,000 cycles is twice that at 100 cycles. In addition, the amplification at frequencies around 5,000 cycles is only about 6.8 times that at low frequencies, so that the compensation ratio is too low.

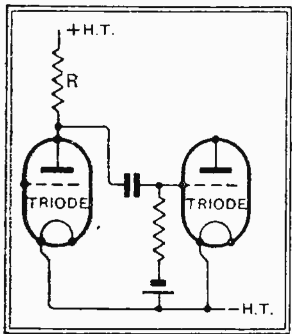


Fig. 1.—The usual resistance - capacity circuit in which the amplification is approximately uniform over the audible frequency range.

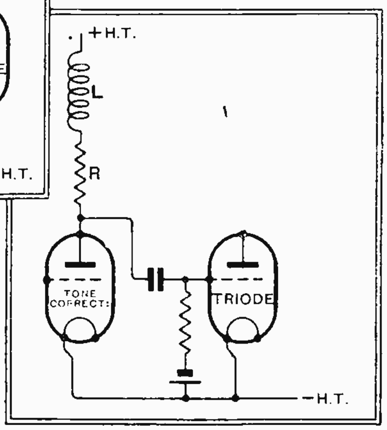


Fig. 2.—The addition of a low-inductance choke L with a low value of resistance R, turns the resistance-coupled circuit into a simple tone corrector.

The Parallel Resonant Circuit.

In seeking to improve these results our first aim must be to increase the compensation ratio without further reducing the efficiency, and so we must strive to obtain the highest possible amplification at the highest frequency which we wish to reproduce. Suppose, therefore, that we shunt the choke in the circuit of Fig. 2 by a condenser C of such value that the circuit resonates at the highest frequency. Provided that the choke resistance is reasonably low, the impedance of the circuit, which is shown in Fig. 4, will be very high at resonance, and the stage amplification at resonance will be practically equal to the valve amplification factor.

A condenser of 0.003 mfd. shunted across the same 0.3 H. choke will give a resonance frequency of 5,300 cycles, and the results to be expected under the same conditions as before are shown by curve 1 of Fig. 3. It will be seen that curves 1 and 3 are almost the same for frequencies below 1,000 cycles, but that curve 1 shows the full amplification at 5,300 cycles. We have thus obtained a compensation ratio of 10:1, and so partially fulfilled our initial conditions; the amplification at 1,000 cycles, however, is still greater than we require.

Such a compensation curve would only be suitable for cases where sideband cutting extended far into the sideband range, and would give excessive amplification of the middle frequencies with average receivers. Now, it is obvious that, provided always that the choke resistance is negligible, whatever ratio of inductance to capacity we employ, the amplification at resonance will remain the same. The amplification at low frequencies, however, is determined by the value of the resistance R; an alteration of the ratio of inductance to capacity, therefore, should have the effect of altering the amplification only at frequencies a little different from resonance.

If we use a choke of 0.1 H. inductance, with a capacity of 0.009 mfd., we shall still have the same resonance frequency, but the amplification will vary in accordance with curve 2 of Fig. 3. It will be seen that this curve is very close to our requirements, for the amplification ratio is still 10:1, and the curve is now flat for all frequencies below 1,000 cycles.

It will be seen, therefore, that with this parallel-resonance circuit the characteristics are controlled by the following factors: The compensation ratio is governed by the ratio of the valve resistance to the coupling resistance R, and the greater this ratio, the greater is the compensation ratio. An adjustable tone control can thus be secured by employing a variable resistance for R. The frequency at which the maximum amplification takes place is controlled in the usual manner of such resonant circuits by the LC product. The actual amplification at resonance is independent of the L/C ratio, provided that the choke resistance

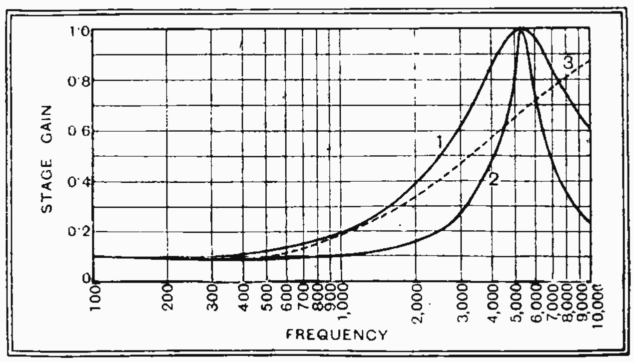


Fig. 3.—The characteristics of tone correctors; curve 1 is for the parallel resonant circuit with a choke of 0.3 H. and a condenser of 0.003 mfd.; curve 2 is for 0.1 H. and 0.009 mfd.; while curve 3 is for a 0.3 H. choke in the inductance correcting circuit. The vertical scale must be multiplied by the amplification factor of the valve to give stage gain.

is negligible, which will be the case if a well-designed air-core inductance is used. The range of frequencies over which the amplification is uniform is controlled by the L/C ratio, and the smaller this ratio the

Putting Back the High Notes.—
greater the band of frequencies over which even amplification is secured.

Transformer Coupling.

So far, compensation has only been considered in resistance-coupled amplifiers, but, in practice, it is in transformer-coupled circuits that it will find its greatest application, owing to their greater efficiency. Fortunately, the circuits for transformer coupling are in no way different from those for resistance coupling, and either of the circuits discussed may be used merely by connecting them across the transformer primary. A parallel resonant compensating circuit is shown connected across a transformer primary in Fig. 5, and, with most transformers, the overall frequency characteristic will be the same as that for the compensating circuit in a resistance-coupled amplifier.

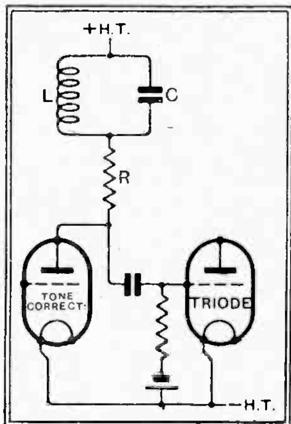


Fig. 4.—A somewhat higher degree of correction, and a more useful characteristic can be obtained by tuning the choke with the condenser C.

It should be noted, however, that, as the resistance R is low in value, the transformer will amplify much lower frequencies than usual, and hence, for the same bass reproduction, a transformer with a lower primary inductance can be used. This opens up a possibility of using transformers with a higher step-up ratio, and so partially overcoming the low efficiency of compensating circuits. Whether or not this will prove practicable remains to be seen, for there is a possibility, with high step-up ratios, that the self-capacity of the secondary winding may appreciably modify the tone-corrector characteristics.

Practical Applications.

It will thus be seen that, to a large extent, we can discuss tone correctors without reference to the type of L.F. amplification which is adopted. Which of the two compensating circuits that we have discussed is of the greater practical use will not depend upon the L.F. circuit design, but only upon the type of compensation which we require. If, for instance, the high-note loss for which we wish to correct is caused by excessive shunt capacity in the L.F. circuits, or by sideband cutting extending well into the frequency range, the inductive corrector will be more suitable than the parallel resonant circuit. On the other hand, if the high-note loss is due to a loosely coupled band-pass filter with a very sharp cut-off, such as might be employed in a superheterodyne, then the parallel resonant circuit will be better than the inductive circuit, since the compensation ratio will increase rapidly at the higher frequencies just where it is most required.

The parallel resonant corrector has one advantage over other methods in that the compensation ratio falls rapidly once the frequency of maximum amplification is passed. This means, in practice, that the circuit will form an efficient filter, and help to eliminate heterodyne whistles.

With all compensating circuits there is one danger which must not be overlooked, and this is connected with the low value of load impedance which, at certain frequencies, is presented to the valve in whose anode circuit the corrector is connected. It is well known that a high load impedance exercises a large straightening effect upon the valve characteristics, and enables it to handle a larger input without distortion than it could in the absence of such an impedance.

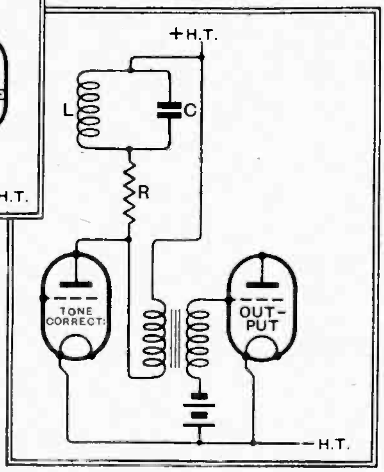


Fig. 5.—The connections of the parallel resonant compensating circuit are here shown for transformer intervalve coupling.

Now, with tone-correcting circuits, the valve load impedance is small for low frequencies; with the circuits and values given in this article it is low for all frequencies below about 3,000 cycles. As a result, a valve employed as a tone corrector cannot handle such a large input as if it were used in the ordinary way as an efficient amplifier. The compensating circuit, therefore, should always be connected as early as possible in the chain of amplifying valves, where the signal potentials are the smallest. In practice, it is a wise plan to connect the compensating circuit immediately after the detector.

It will be seen, therefore, that, provided care is taken in the choice of the correct type of compensating circuit for any given case, its application is very simple and straightforward. Owing to the ease with which the compensation ratio can be adjusted, there is no need, in the majority of cases, to calculate the values of the series resistance R, for it will usually be most convenient to make this adjustable. It can then be set at the correct value by ear, and, if desired, the variable resistance can be mounted on the panel and used as a tone control.

In conclusion, it should not be overlooked that the addition of a compensating circuit to an existing amplifier will inevitably reduce the amplification by the amount of the compensation ratio. It may be necessary, therefore, to include an additional stage of resistance-coupled amplification to make up for the loss introduced by the tone corrector; in some cases, however, it may be sufficient to substitute a transformer stage.

UNBIASED

By FREE GRID.

Moistening the Magnets.

I WONDER if any knowledgeable reader can tell me how it is that moisture has such an evil effect on loud speaker magnets? That it has an evil effect I know from bitter experience, but I confess that I do not know why.

The question arises because of an unfortunate experience which I have had with a succession of loud speakers affixed in my bathroom. Being a believer in the old nursery adage which declares that "he shall have music wherever he goes," or words to that effect, as they say in the Police Court, I have not overlooked the Temple of Hygeia in pursuing my policy of having a loud speaker in every room.

Hilversum, at any rate, is always on when I am performing my morning ablutions, and if I tire of him, one of the little Grid Leaks has standing orders to be ready to put on bathing records at my word of command over my network of house wiring. My plaint is that after a comparatively short period of use the loud speaker commences to wilt. At first I not unnaturally thought it was due to the cone becoming damp, but I speedily disposed of this by trying a horn loud speaker, which behaved in exactly the same manner. Next I suspected that the windings were becoming impregnated with damp, but although a new winding effected some improvement it was not until I had had the instrument remagnetised and found that it returned to its old pristine figure that I realised the cause.

Hilversum in the Temple of Hygeia.

Subsequent tests in the steamy atmosphere of Mrs. Free Grid's kitchen confirmed this result, the condensation of steam on the magnets speedily sapping their strength. (Don't suggest the use of *condenser* loud speaker!)

I have solved the problem by using an old large horn Magnavox loud speaker of 1922 vintage, and it is doing exceedingly well, having neither paper cone nor permanent magnets to wilt.

A Bass Allegation.

I WAS surprised to learn from one of the more prominent persons in the radio industry, who certainly ought to know what he is talking about, that when broadcasting gramophone records the B.B.C. uses a special filter deliberately to *reduce* the bass. I am still more surprised to learn the reason why they are alleged to be doing this, namely, because the bass is already so noticeable in radio gramophones. If this be true it simply means that the B.B.C. are favouring those listeners who have the good fortune to be able to afford one of these luxury instruments. It is, however, absurd to suppose that a radio gramophone reproduces the bass to a greater extent than any good wireless set, for after all, the turntable, motor and pick-up, which are the only things that distinguish it from an ordinary good wireless set, are out of action when the instrument is used to listen to a broadcast gramophone recital.

I can scarcely believe, however, that the B.B.C. are doing anything so foolish. The bass available from a gramophone record is attenuated enough as it is, and we have all been struggling for years to improve matters by using special bass booster circuits and pick-ups that have a rising characteristic at the lower end of the musical register. Surely, then, the B.B.C. are not deliberately thwarting our efforts in this matter and leading us on a wild-goose chase.

Women and Wave-meters.

I SEE that according to a report in a Midland newspaper a learned professor has been pleading that in future women should enlist the aid of radio when buying summer frocks. They should choose their garments with scientific accuracy by means of wavelength measurements instead of chattering about colours as they do at present. In this way, he states, they would be sure of getting the exact shade they wanted. According to his ideas, instead of talking of a delicate shade

Bringing science to the sales.

of pink, they would order garments whose wavelength in the etheric spectrum was 0.000,000,000,734 metres, neither more nor less.

In cases of dispute, instead of arguing the case expensively before a High Court judge, who usually betrays his abysmal ignorance of the issue before him by asking such elementary questions as "What is a camisole?" the contending parties would simply visit the N.P.L. where a laboratory meter would be able to settle the exact wavelength of the material.

As one not without experience, my earnest advice to the professor is to leave women entirely out of his calculations; if he honestly thinks that science and the average woman can be made to have anything in common, then the sooner his education is completed the better.

HIGH FREQUENCY or LOW?

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

Pre-detector *versus* Post-detector Amplification.

FOR given conditions a certain minimum overall amplification in a receiver is necessary. Whether high or low frequency amplification should preponderate is the question discussed in this article. Perhaps the key to the position is held by the detector, whose definite signal handling capacity must help to determine which kind of amplification shall be used.

PRIOR to the advent of the screen-grid valve in the autumn of 1927, the bulk of the amplification in any of the larger sets took place after the detector, for the very sound reason that to provide really high gain before it was too difficult for the ordinary set-builder, whether amateur or commercial. Though at first the new valve gave results no better than those obtained from a neutralised triode, it was soon improved, and it became possible to design receivers in which there was sufficient high-frequency amplification to provide the detector valve with strong signals from even distant stations. The "Kilo-Mag Four," described in *The Wireless World* in October, 1928, was one of the earliest long-range receivers in which a detector, operating in this case on the anode-bend principle, fed the output valve direct through a low-ratio transformer without the interposition of a low-frequency stage. Two stages of screen-grid amplification provided the detector with the necessary signals to enable it to do this.

More recently the power-type grid detector, which gives almost distortionless rectification when operated by a strong signal, has come into prominence, and has almost completely ousted both anode-bend and ordinary leaky-grid rectification in all but the simplest sets. It is not merely that the power detector will handle strong signals if called upon to do so; it must have them if its undoubted advantages are to be fully realised. The modern four-valve receiver, therefore, is built on the general lines of the "Kilo-Mag Four"—two high-frequency stages, detector, and output, as suggested in Fig. 3. Put more generally, the present tendency is to perform as much amplification as possible before the detector is reached, and as little as possible after it.

Carried to its logical conclusion, one arrives at receivers such as the "Variable-Mu Three," in which, as in Fig. 4, the detector serves also as the output valve. This is power detection at its very best from the point of view of quality, but some may consider it uneconomical in that the valve gives a little more than a quarter of the output it could yield if handling low-frequency signals only. For the majority of receivers it is probable that the present almost universal custom of feeding the output valve directly from the detector provides the fullest development that pre-detector amplification will reach.

Is this present practice justified? Have we not sacrificed some advantages in losing the intermediate low-frequency stage that at one time was always included in any receiver intended to operate a loud speaker? With a three-valve set such as Fig. 1 there is little choice; a high-frequency stage, a detector, and an output valve is an almost inevitable arrangement. The difficulty of deciding arises when we expand into a four-valve set; shall the fourth valve go in before or after the detector?

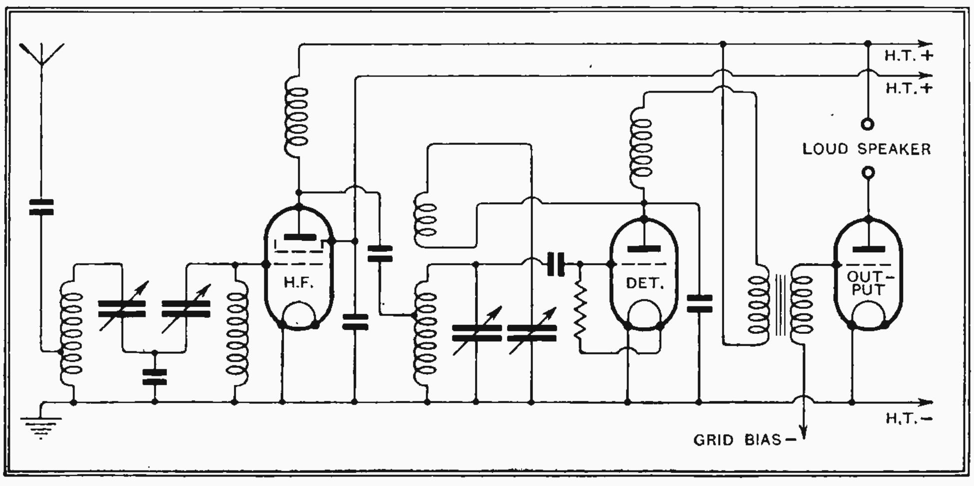


Fig. 1.—With various modifications, a circuit on the lines shown here is the almost invariable choice when the valves are to number three. A possible alternative is shown in Fig. 4.

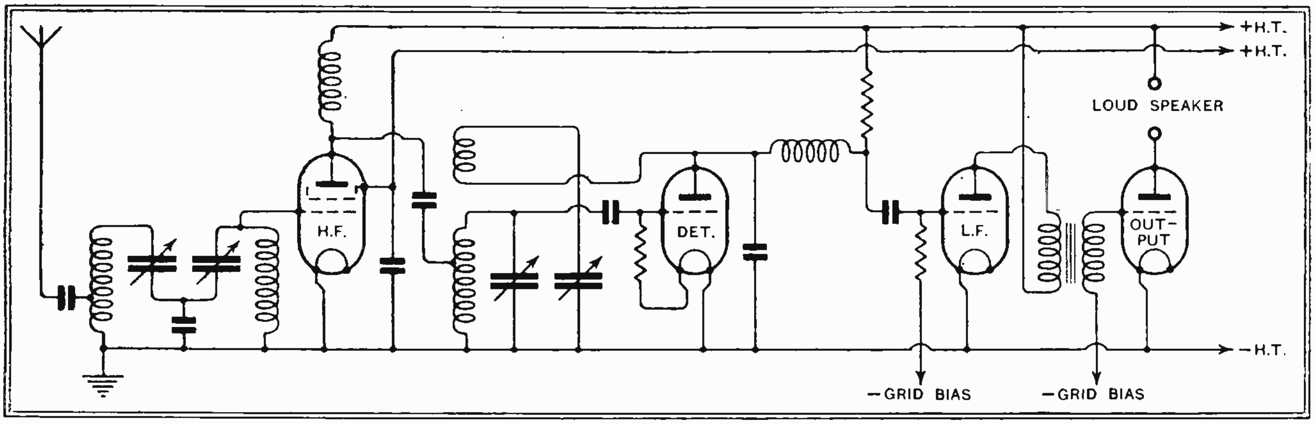


Fig. 2.—One of the two types of four-valve set. Developed from Fig. 1 by interposing an intermediate L.F. stage between detector and output valve.

We will begin by drawing attention to the advantages of keeping post-detector amplification down to a minimum, and increasing the gain in the high-frequency amplifier to give the increased sensitivity expected of a four-valve set, making a circuit on the lines of Fig. 3.

In the first place, there is a gain in selectivity. Extra amplification at high frequency normally implies extra tuned circuits, and every additional tuned circuit contributes an additional barrier against the unwanted intrusion of the local station. The band-pass filter offers possibility of variation here; a set with three tuning condensers may have a filter followed by one stage of amplification, or it may have a simple aerial circuit followed by two stages. Assuming that variable-mu valves are used, the selectivity will be much the same in the two cases.

More important, perhaps, than the direct influence on selectivity is the indirect effect brought about by the behaviour of the detector valve. If this valve is given so strong a signal from the wanted station that it is loaded up to its limit, a small accompanying signal from an unwanted station appears to be largely demodulated, so that interference is not serious. With the same true selectivity, as determined by the tuned circuits, the apparent selectivity will be less if the signal applied to the detector is small, for the demodulation of the unwanted station will be less complete. The balance of advantage is thus quite definitely in favour of a strong signal at the detector, with but little amplification after it.

That the power detector introduces very little distortion during the process of rectification is undeniable; the fact that this advantage can only be had by supplying the detector with a strong signal is another very compelling reason for putting in the fourth valve as a high-frequency amplifier.

Arising out of the fact that the overall amplification at low frequency will then be small there is the advantage that the low-frequency interaction between stages is very unlikely if no intermediate L.F. stage is used. Decoupling and other devices can often be dispensed with altogether, especially if a choke-filter output is used. In mains sets the limitation of low-frequency amplification means also that hum will not be troublesome, and makes it unnecessary to use more

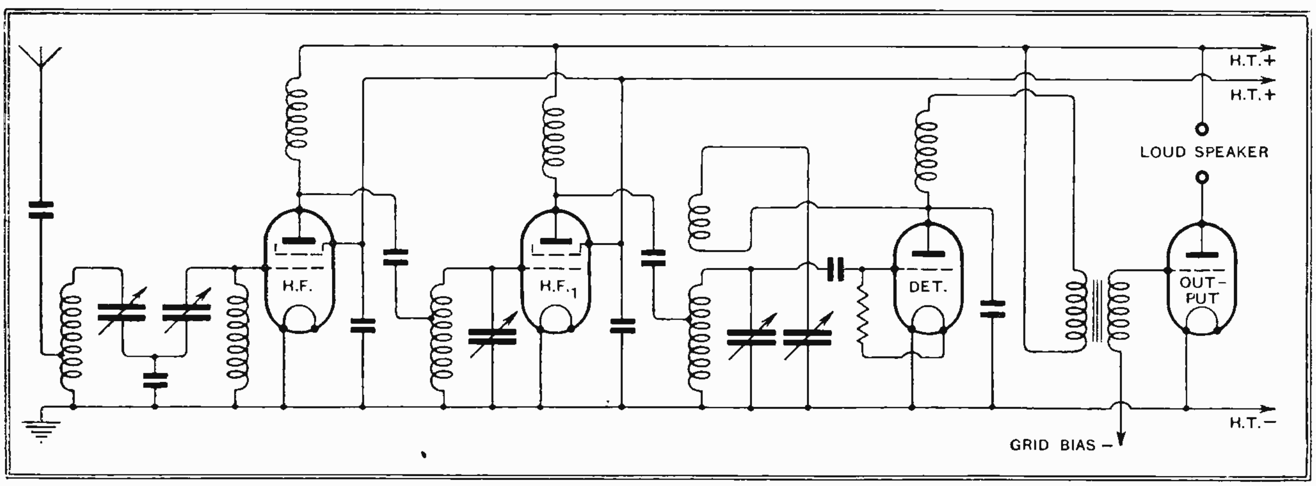


Fig. 3.—A second type of four-valve set. This is developed from Fig. 1 by interposing a second H.F. stage between detector and aerial.

High Frequency or Low?

than very rudimentary smoothing. Hum in the anode current supplied to the high-frequency amplifier will only get through to the detector if the screen-grid valves are rectifying, and so putting the hum on the received carrier in the form of modulation. With variable-mu valves this does not occur, and, though it would be going too far to omit the smoothing altogether, it is found that surprisingly great liberties can be taken in this direction.

Although it is an incontrovertible fact that the components associated with a low-frequency stage are cheaper than those necessary if a high-frequency stage is added, the extra smoothing that the former usually makes necessary may compensate, or even more than compensate, for this apparent economy.

There are disadvantages, too, in a high-frequency stage, and the difficulties of satisfactory design sometimes makes one sigh for the trouble-free and automatic amplification that the alternative low-frequency stage so conveniently provides. We have already noticed the extra selectivity of the high-frequency stage, but this has to be paid for in the provision of tuning apparatus and in the very great additional danger of stray reaction and instability that the addition of a second H.F. stage brings in its train. These difficulties may add a good deal to the cost of a set, both in material and workmanship, by virtue of the greater need for screening and careful isolation of one tuned circuit from another. In addition, the second screen-grid valve cannot safely be made to work at maximum efficiency unless the screening is exceptionally thorough so that the gain due to its addition, though very large, may not be quite all that one would desire. If the fourth valve were to follow the detector these limitations would, naturally, not be felt.

Another difficulty that tends to arise when the intermediate L.F. stage is omitted is detector overload. This is peculiarly prominent with the grid detector, and a good deal of care has to be expended in making sure that the output valve can be fully loaded before the detector "packs up" and begins to distort. This one point may even make it necessary to provide the receiver with a higher anode voltage than is required by the output valve, the additional volts being needed solely to enable the detector to handle a large enough signal. If the fourth valve is inserted after the detector, as in Fig. 2, this difficulty cannot possibly arise, because the detector output does not need to exceed a trifling fraction of a volt.

Avoid Overloading the Detector.

This trouble of detector overload is perhaps the greatest argument in favour of output valves with very high values of mutual conductance; though they have their disadvantages, yet, by demanding only a small signal voltage for full output, they do very considerably ease the difficulty of designing the detector stage. The present fashion for using pentodes in the last socket is probably attributable far more to the need for an output valve that will operate on a signal voltage that the detector will readily provide than to any inherent merit in the pentode itself.

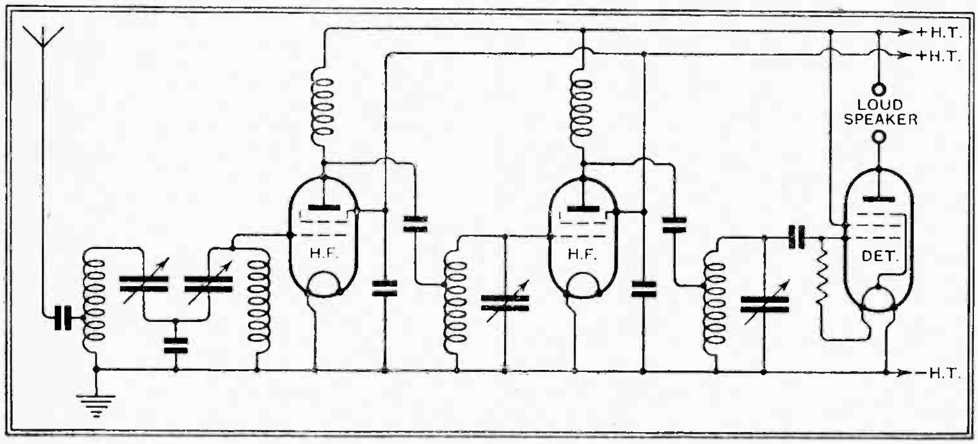


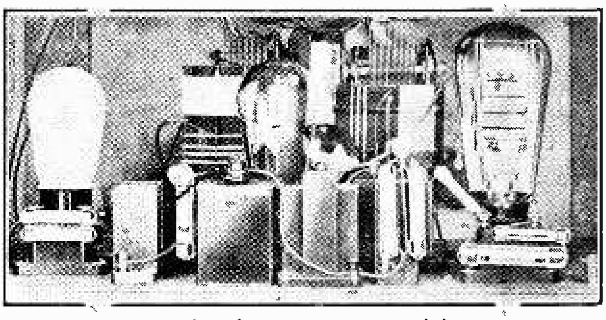
Fig. 4.—A variation of the usual three-valve circuit, in which the detector is also the output valve. There are therefore two H.F. stages. An ideal arrangement, but inclined to be a little uneconomical.

The problem of detector overload, which is the most difficult point in the design of any receiver in which no intermediate L.F. stage is used, is at its very worst in a superheterodyne. To prevent currents of intermediate frequency from getting into the loud speaker leads, which would almost inevitably result in instability and bad quality, it is necessary to insert a choke in the anode circuit of the detector, while the need for keeping the high notes precludes the use of a by-pass condenser of capacity great enough to act, even approximately, as a complete short-circuit to the I.F. currents. As a result, there is a high I.F. load in the anode circuit of the valve, which means that the L.F. output it will handle is reduced well below that with which it can deal in a set using ordinary H.F. stages. The use of an anode-bend detector, even at the cost of a little quality, is perhaps a better solution than the introduction of an intermediate L.F. stage in a set whose overall amplification is probably quite high enough without it. Alternatively, the detector may be followed by a high-ratio transformer and a pentode, which will just barely get the signals it requires before the detector packs up.

One's only consolation lies in the fact that a detector which can only just load up the output valve does provide a safeguard against an ear-shattering crash if one inadvertently tunes to the local station with the volume control full up; instead, one gets horribly distorted signals at so extremely small a volume that they are not seriously offensive.

High Frequency or Low?

If one wished to add a valve to one of *The Wireless World* Superselective receivers there would be three possible ways of doing it, as indicated schematically in Fig. 5. The extra valve might go in as a high-frequency amplifier preceding the frequency-changer, as a second intermediate amplifier before the second detector, or, last of all, as an intermediate L.F. stage.



Two low-frequency stages giving a large overall amplification were enbodied in the "Power Radio-gram" recently described in *The Wireless World.*

A highly specialised receiver—"The Variable-mu Three"—in which practically all the amplification is derived from H.F. stages.

The writer would have no hesitation in voting for the fundamental H.F. stage as his choice of the three possibilities. In this position it, or the tuned circuit accompanying it, would provide an additional safeguard against the intrusion of whistles[1], for these, whatever their source, can always be prevented if signals from unwanted stations can be kept off the grid of the first detector. In any case, one would hardly add a valve to such a set at all unless it were to enable a small indoor aerial to be used; an amplifier operating on the original signal-frequency would then be the most logical substitute for a strong signal derived from a full-size aerial.

By including the extra valve as an intermediate-frequency amplifier there would be a gain in adjacent-channel selectivity (which is already quite adequate), as well as an increase in general sensitivity. There would, however, be no extra safeguard against the stray whistles to which all superheterodynes are prone; indeed, the extra amplification would make these more prominent. The main drawback to this use of the valve would be found in the tremendous increase of background noise, most of which arises in the oscillator, that would accompany higher amplification after the frequency-changer.

It is hard to find any excuse, save that of avoiding possible detector overload, for using the extra valve after the second detector. Only if it were desired to use a high-power output valve, requiring a strong signal to fill it up, would it be possible to claim that the valve would do better work as an intermediate L.F. stage than if it were added earlier in the set.

Reviewing the various points touched upon in the course of these notes, it seems that the balance is decidedly in favour of doing as much amplification as possible before the detector, and dispensing as far as possible with amplification after it. With the superheterodyne in mind, one might say that in increasing the sensitivity of a set one should always add the

[1] "Why the Whistles?" *The Wireless World*, March 2, 1932.

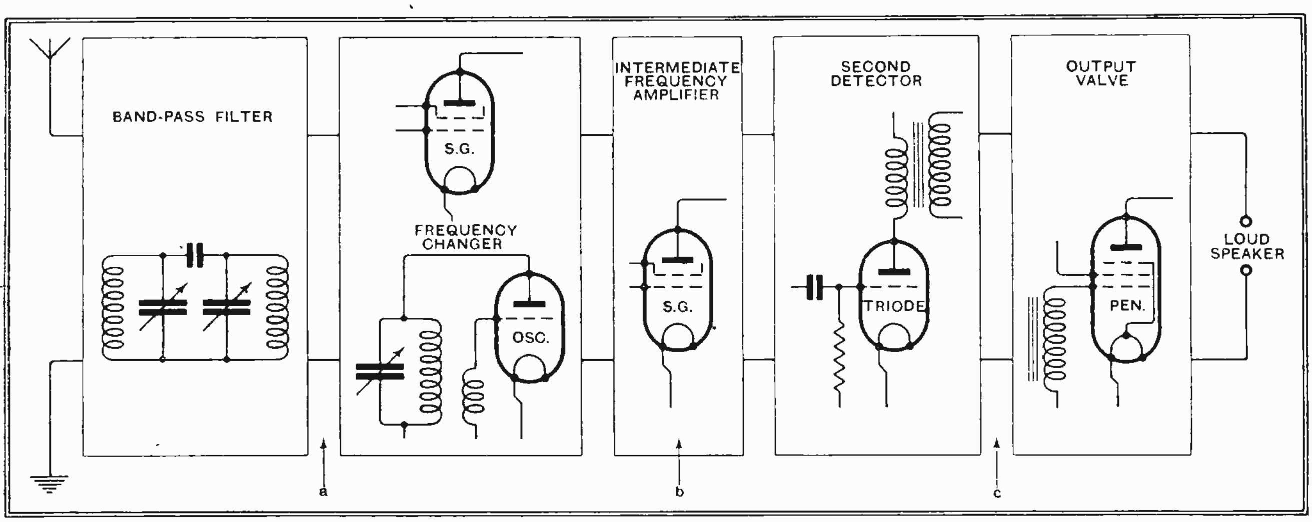


Fig. 5.—Schematic diagram of a superheterodyne—e.g. *The Wireless World* "Superselective" series. If it is desired to add a valve there are three possibilities: it may be inserted at a, b or c.

High Frequency or Low?—

extra amplification as early in the chain as possible.

In all this discussion, however, we have restricted ourselves to receivers in which tone-correction is not used. With the Autotone, or any other type of "stenodic" receiver, which is capable of providing an enormous degree of selectivity in a single stage, the main advantage of pre-detector amplification tends to disappear, while the need for tone-correction makes the use of at least one intermediate L.F. stage essential. In the future we may perhaps find that the principle of tone-correction will become more widely used and the importance of pre-detector amplification will diminish, being replaced by post-detector stages with special frequency characteristics.

Nuts to Crack.

Instructive Problems and their Solution.

THE present series has been started by *The Wireless World* for the benefit of readers who like to work out little problems for themselves and be sure that the results they obtain are correct. At frequent intervals wireless problems are presented, and in the following instalment the answers are given with the methods of working them out, and hints on possible points of difficulty. Problems 41 to 43 have been previously given, and below the answers appear, whilst another set of problems is included this week for treatment in the next instalment.

QUESTION 41.—**At 256 cycles per second a certain loud speaker has an impedance of 5,000 ohms. What would be a suitable turns ratio for transformer coupling at this frequency to a power valve whose A.C. resistance is 2,500 ohms?**

Answer—1 : 1 ratio.

To obtain the maximum amount of undistorted power from the output valve, the load in its anode circuit should have roughly twice the value of the anode A.C. resistance of the valve. In practice, this is a very difficult matter to secure, since, in the case of most loud speakers other than those of the moving-coil type, the impedance varies greatly with frequency. Consequently a compromise must be struck, and it is usual to arrange matters from the point of view of *one* stated frequency—in the case cited, 256 cycles per second—at which the loud speaker is "matched" to the output valve.

In cases where the speaker is coupled to the valve through an output transformer, the same rule applies. The load now considered is, of course, that actually imposed on the anode circuit when the transformer and speaker are coupled up. If T denote the ratio of the number of turns on the secondary to those on the primary, while Z is the loud speaker impedance at the working frequency, we may regard the combination of transformer and speaker as throwing a load of Z/T^2 into the anode circuit. With moving-coil speakers of low resistance, step-down transformers are, of course, used, and T is therefore fractional. We thus see how a speaker of only a few ohms impedance may, if T be properly chosen, act in the anode circuit as a load of some thousands of ohms.

In the present case the equivalent load operative in the anode circuit is $5{,}000/T^2$ ohms, where T, the turns ratio, is still unknown. But we know that this load should be twice the A.C. resistance of the valve, i.e., twice 2,500 ohms or 5,000 ohms.

Hence $5{,}000/T^2 = 5{,}000$ and therefore $T = 1$.

Thus the secondary turns should equal the primary turns, i.e., a one-to-one transformer is required.

QUESTION 42.—**A resistance of 1,000 ohms is placed across a dry battery of 120 volts, and the P.D. of the battery is simultaneously found to be 100 volts. What is the internal resistance of the battery?**

Answer—200 ohms.

This question affords a good illustration of the distinction between E.M.F. and P.D. in connection with D.C. circuits. Without going deeply into definitions, it is perhaps easiest to think of the E.M.F. as the *total* actuating force in a circuit (which may be closed or open) while the P.D. is, as its name implies, the difference between two forces, or net force operating between two given points of the circuit. In our example, the E.M.F. of the battery is given as 120 volts; this is the total "electrical force" or "voltage" which the battery supplies to any circuit in which it is connected. How comes it, then, it may be asked, that the P.D. across its terminals in the case cited is only 100 volts?

To answer this we must remember that the battery has itself a certain resistance to electric current; let us call this "internal" resistance r ohms. Then it will be seen that the 120 volts E.M.F. of the battery is called upon to send current not only through the external resistance of 1,000 ohms, but also through the r ohms of internal resistance. By Ohm's Law, therefore, the current passing through the circuit will be given by the quotient of the E.M.F. and the sum of these resistances, i.e., by $120/(1{,}000+r)$ amperes.

Now, the P.D. between the two terminals of the battery is, of course, the same as that across the 1,000 ohms external resistance. Again by Ohm's Law, this P.D. in volts is given by the product of the resistance and the current flowing, i.e.,

$$\text{P.D. across external resistance} = R \times I$$
$$= 1{,}000 \times 120/(1{,}000+r) \text{ volts.}$$

But we are given that this P.D. is 100 volts; therefore

$$1{,}000 \times 120/(1{,}000+r) = 100.$$

Solving for r

$$1{,}000 + r = 1{,}200; \quad \therefore \; r = 200 \text{ ohms.}$$

The current flowing is thus 120/1,200 amps. = 0.1 amp. It is now easy to see that the voltage drop caused by the passage of this current through the battery internal resistance is $IR = 0.1 \times 200$, i.e., 20 volts. The discrepancy between the known value of E.M.F. and the measured P.D. is thus explained.

QUESTION 43.—**A power valve whose μ is 4 and A.C. resistance 3,000 ohms works into a load of 3,000 ohms. If the R.M.S. voltage input at the grid is 33 volts, what is the A.C. power in the load?**

Answer—1,452 *milliwatts.*

The R.M.S. alternating voltage introduced into the plate circuit of the valve is, by definition $\mu \times$ R.M.S. grid input voltage, i.e., 4×33 or 132 R.M.S. volts. This may be regarded as the total *alternating* " force " or E.M.F. acting in the plate circuit, and is analogous to the steady battery E.M.F. in the D.C. case considered in Question 42. In the present case, the alternating E.M.F. has to overcome (*a*) the internal A.C. resistance or " differential resistance " of the valve, and (*b*) the external impedance which the anode circuit offers to A.C. To avoid complicated calculations, (*b*) is usually considered to be a pure resistance, though in strictness it should be pointed out that this is often very wide of the mark. In the present problem both (*a*) and (*b*) have values of 3,000 ohms, so that the total resistance in the anode circuit is 6,000 ohms. The R.M.S. value of the alternating component of the anode current is thus E/R or 132/6,000, i.e., 22 mA. R.M.S. Since, however, the load resistance is exactly half the total circuit resistance, the effective voltage across it will be half the available alternating E.M.F., i.e., 66 volts R.M.S. The A.C. power taken by the load is then given by the product of the two R.M.S. values of voltage and current, i.e.,

A.C. power in load $= E_{eff.} \times I_{eff.} = 66 \times 22/1{,}000$ watts $= 1{,}452$ milliwatts.

This figure could also have been obtained by taking the product $R \times I^2_{eff.}$ where R is the load resistance of 3,000 ohms.

NEXT SERIES OF PROBLEMS.

QUESTION 44.—**What is the natural wavelength of an aerial of which the inductance is 10 μH. and the capacity 0.00025 mfd.? If a tuning inductance of 150 μH. is placed in series with it, what is now the resonant wavelength?**

QUESTION 45.—**If we assume that the total inductance of the aerial circuit in the above question is concentrated in the tuning coil, what parallel capacity is required to tune to 500 metres?**

QUESTION 46.—**A certain receiver consumes 46 mA. at 250 volts, the current being supplied through a smoothing choke of 25 H. If the actual D.C. output from the eliminator is at 270 volts, what is the resistance of the choke? The H.F. and det. valves are supplied with 8 mA. through a special smoothing choke of 200 H. and 3,000 ohms. What is the voltage drop in the special choke?**

NUTCRACKER.

A NEW CONDENSER MICROPHONE.

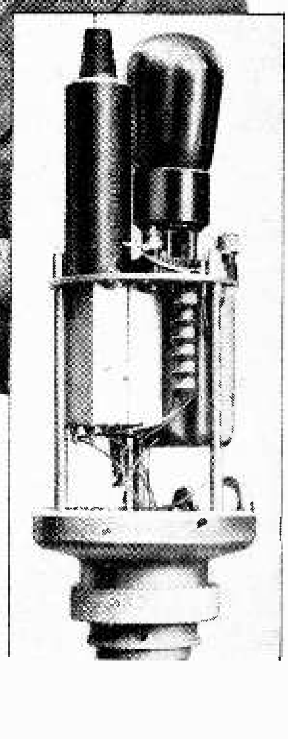
By Our Berlin Correspondent.

GEORG NEUMANN, of Berlin, the constructor of the special gramophone recorders used by the German stations for preserving programmes, has just obtained a contract to supply a number of his new condenser microphones to the Reich Rundfunk Gesellschaft. The most important advantage of the new instrument is its extreme sensitivity. The diaphragm, which is just one-thousandth to 1,500th of a millimetre in thickness, weighs less than the air chamber behind it, and thus the resonance frequency of the microphone is a direct function of the air chamber, and not of the diaphragm. Thus, the air chamber can be given a suitable natural frequency high above that reproduced by loud speakers; actually, in the new model the frequency is in the neighbourhood of 11,000 cycles.

Straight-line Frequency Response.

Condenser microphones are usually considered to have two drawbacks. The first stage amplifier has to be very close to the microphone; moreover, condenser microphones are not usually very sensitive. On the other hand, their frequency response is of the straight-line type, and they are not subject to non-linear distortion. In the Neumann instrument the first stage amplifier is so small that it can be easily fixed immediately below the microphone, as seen in the photograph. The output of the amplifier is taken through a transformer, and, if necessary, a very long flex lead, which carries a potential of 40 volts.

It is claimed that the Neumann condenser microphone gives a straight-line frequency response from 30 to 10,000 cycles.



The size of the Neumann condenser microphone is apparent from the upper photograph. The lower picture shows the microphone amplifier with the casing removed.

NEWS of the WEEK.

Current Events in Brief Review.

Dilemma at Luxembourg.

THE new publicity station at Luxembourg now possesses every facility for launching its sponsored programme campaign, except a wavelength. It has been found that the 1,250 wavelength originally intended for the station will have to be abandoned as its use interferes seriously with the radio aviation services on the Continent.

At the time of writing Radio Luxembourg is still searching for a niche in the ether.

Delay at Leipzig.

THE revolutionary design in the aerials of the new German high-power stations at Leipzig and Breslau is said to be necessitating further tests, and the opening of these two transmitters is likely to be delayed until next month. We understand that Frankfurt (390 metres) and Leipzig (259.3 metres) will exchange wavelengths when the new transmitters are in operation. The present Leipzig transmitter will probably work as a relay at Trier, near the French frontier, where reception of Frankfurt is very poor.

Practical Steps in Belfast.

WE extend our best wishes to the Belfast City Electrical Engineer, who hopes, at a cost of £69 10s., to eliminate interference to radio reception caused by the Belfast electricity supply. The Electricity Committee has sanctioned the installation of a number of 10-microfarad electrolytic condensers at twelve of the sub-stations.

Post Office Static Hunt.

ENCOURAGED by the Postmaster-General, Sir Kingsley Wood, M.P., who is himself keenly interested in wireless, the Post Office Engineering Department is hard at work on a campaign to reduce electrical interference with broadcast reception, and we understand that a special section is now engaged on tracking down the causes of various troubles resulting from radiations of trams, lifts, neon signs and domestic apparatus. It is understood that a report will shortly be published, and that some interesting revelations may be expected.

The R.A.F. Display.

WIRELESS is expected to play an important part in the 13th Royal Air Force Display at Hendon on Saturday, June 25th. Several new features will be presented, the nature of which is at present being kept secret. Nearly 200 aircraft will take part.

The proceeds of the display (after meeting expenses) are given to approved service charities.

Early Risers, Please Note!

AFTER many attempts, the Prague broadcasting authorities have succeeded in recording the crow of a particularly strong-voiced cock, and this is now used as a signal of greeting every morning at 6 o'clock.

Marchese Marconi Honoured

MARCHESE MARCONI'S thirty-seven years of work for wireless was recalled on May 3rd when, in the Institution of Civil Engineers, he was presented with the Kelvin medal for 1932 by Lord Rutherford. This was the fifth triennial award of the medal, which is presented

THE KELVIN MEDAL. Lord Rutherford presenting the medal to Marchese Marconi at the Institution of Civil Engineers.

to those who have carried on investigations of the kind with which the late Lord Kelvin was identified. In presenting the medal, Lord Rutherford said that in an age of great scientific advance no development had excited more interest than the practical application of electrical waves for signalling through the ether. The Marchese Marconi had done more than any other man to make possible this wonderful system of rapid world-wide intercommunication.

Another Broadcasting House.

DESPITE the strictest budget economy in Germany, the broadcasting authorities of Koenigsberg and Heilsberg have been voted three-quarters of a million marks by the Reichs-Rundfunk Gesellschaft for the erection of a new broadcasting house.

More Power from Radio Paris.

CONSIDERING its high power, the new Radio Paris transmitter has not been making a very great stir in the European ether, but we understand that important changes now in progress should result in very much more powerful radiation. New valves are being installed which will result in the doubling of the existing power output. Within the next few weeks the station should have an aerial power of 120 kilowatts.

A New Way With Pirates.

MORE than 1,200 radio "pirates" in Morocco have been induced to register their sets following the offer of a free subscription for six months to a local broadcasting journal. Consequently the Radio Maroc station now has an extra 62,500 francs—or nearly £700—for the improvement of its programmes.

This raises the question whether, instead of conducting an expensive detector van campaign, the British Post Office would find it more economical to offer to repentant pirates free valves, spare accumulators, or tickets to the Olympia Radio Show.

Radio in British Mines.

WITH a portable wireless set at the bottom of a Wakefield coal mine 1,500 feet deep, a party of engineers a few days ago tuned in perfectly to a programme relayed by the North Regional transmitter. The test was part of a series of experiments which are being conducted to determine the value of wireless as a possible substitute for wire signalling in mines, both for emergency and entertainment purposes.

As reported in *The Wireless World* at the time, wireless proved of immense value following a recent disaster in a Russian mine when a number of entombed workers were cheered by messages broadcast from a nearby station until the rescue party were able to release them.

If the installation of wireless in British coal mines served no further purpose than this, its use would be more than justified.

The Voice of Spain.

DAILY between 12.30 and 2 a.m. (G.M.T.) Spain is now broadcasting to "all Europe" by means of the Marconi beam station at Aranjuez (Madrid) on a wavelength of 30.4 metres. The station directors, "Transradio Espanola," are seeking to give other peoples an idea of the artistic and intellectual life of Spain, and for this purpose the finest artistes are being engaged, and it is hoped that British listeners will take at least an occasional opportunity of listening to the transmissions.

Into the Highways and Byways.

SPAIN'S determination to become more "radio conscious" in the near future has already been mentioned in these columns. The campaign does not consist simply in the development of a chain of powerful broadcasting stations; the authorities realise that high-power stations are useless unless there are listeners to enjoy the programmes. Consequently what are described as "pedagogic missions" are touring the rural districts with radio-equipped vans complete with cinematograph projectors and gramophone amplifiers. Within the next few months it is confidently predicted that no Spanish village will lack wireless sets.

Portugal Prepares Plans.

PORTUGAL, following the example of Spain, is enthusiastic over the development of a broadcasting service. This week a special conference is being held in Lisbon to determine a new broadcasting policy. Delegates are attending from all parts of the country, and during their stay in the capital they will have the opportunity of visiting an exhibition of the latest radio apparatus.

The order for the first official broadcasting station in Portugal has just been placed with Standard Telephones and Cables, Ltd. The new transmitter, which is to be erected at Lisbon, will be manufactured in the company's Hendon works. It will have a total aerial power of 20 kW.

The Mysterious Tick.

WHAT he first imagined was an entirely new trouble in wireless reception was recently noticed by a reader of our French contemporary, *La T.S.F. Revue*. While listening to a broadcast talk, a peculiar ticking sound was heard. He examined the set and the loud speaker without discovering anything wrong. He then felt for his watch, but found that he had left it in another room; then suddenly he realised that he was hearing the watch of the man at the microphone. This story has at least a ring of truth in it, and it would be interesting to know whether any British listener has ever made a similar discovery.

Efficiency in School Wireless Sets.

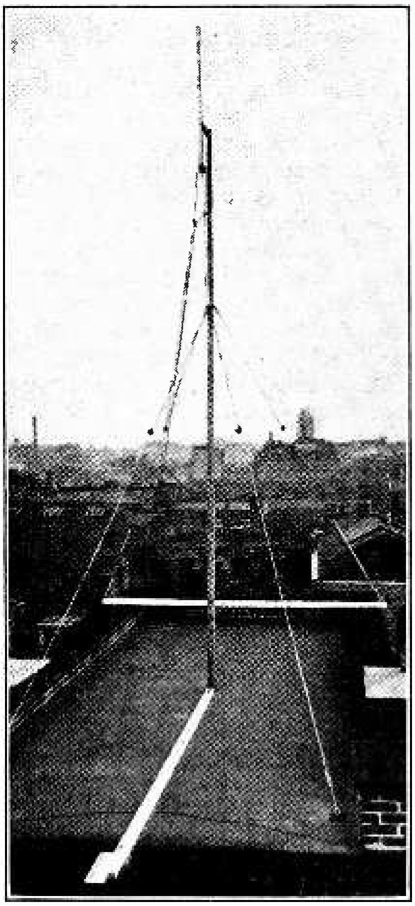
THE dangers attaching to the use of inefficient or obsolete radio apparatus in schools is fully recognised by the Central Council for School Broadcasting, and education authorities and schools are being advised to install only such apparatus as has been approved by the Council. The Council proposes to issue shortly an approved list of the names and addresses of radio manufacturers, and special attention will be drawn to those makers whose apparatus has been tested at the National Physical Laboratory. Manufacturers desiring to have their names included in the Council's list should apply to the Secretary of the Central Council for School Broadcasting, Broadcasting House, London, W.1.

Bad for the Burglar.

A SPEAKING safe is described in the *Neues Wiener Journal*. This new invention, which is being tested in an Austrian electrical works, includes an electric amplifier. When the door of the safe is opened a concealed loud speaker shouts "Help!"

Another Invention.

SPRING, which is said to encourage a certain type of poet, seems also to be the season for budding inventors. A Hanover engineer announces the invention of a wireless device for aircraft which should enable a pilot automatically to switch on the lights of an aerodrome before coming to earth.



ULTRA - SHORT WAVES OVER LONDON. The new aerial on the roof of the Baird Company's office in Long Acre. A successful demonstration of television on a wavelength of 6 metres was carried out on April 29th.

Election Amplifier Silenced.

A CHARMING story concerning the use of the gramophone amplifier by the Hitlerite party comes from Berlin. It was announced that at a certain political meeting, Herr Goebels, one of the champions of the Hitler party, would engage in public debate with Dr. Brüning. A large crowd rushed to the meeting to find that the only trace of the German Chancellor was his voice emanating from an amplifier which was reproducing one of Dr. Brüning's election records. At the end of the "speech" Herr Goebels made a crushing reply. Naturally, the gramophone remained dumb, and, according to our correspondent, "it was a great evening for Hitlerism!"

This experience demonstrates the danger of gramophone electioneering, which has also been used extensively by the French Premier, M. Tardieu.

Geraniums as Radio Valves.

A NEWS item which at first sight appears to belong to the "sea serpent" or "giant gooseberry" category, emanates from the French Academy of Science.

In a recent communication to the Academy, M. Nada Marinesco claims that the rise of the sap in the capillaries of vegetables shows a difference of potential between two points of a stalk. For instance, geraniums, fuchsia and other saps hold negative charges, the positive charges remaining on the inner surfaces of the capillary. On applying electromotive forces to the plants, M. Marinesco found that the sap ascended more easily than it descended, the negative charges, therefore, being more pronounced towards the top than at the bottom of the plant.

By tracing a curve or graph of the phenomenon, M. Marinesco claims to have discovered the characteristic of a wireless detector. It is sufficient, he states, to insert a few centimetres of geranium stalk between the plate circuit of an H.F. valve and the grid circuit of the first L.F. stage to produce an efficient detector; by exposing the plant to short-wave oscillations the sap rises with greater speed, and, apparently, if the radiation is too powerful the stalk is capable of bursting into flame.

Seven Years of Television.

AT a meeting at 7 o'clock this evening (Wednesday) of the Television Society at University College, Gower Street, London, W.C.1, Mr. R. W. Corkling, A.M.I.E.E., will lecture on "Seven Years' Experimental Research and Investigation in Television." The lecture will be illustrated with lantern slides.

Frenchmen Who Like British Programmes.

THE French campaign against British broadcasting from Radio Paris and other stations has taken a new turn with the discovery that quite a number of French listeners really enjoy the sponsored programmes. Writing in the *Haut-Parleur*, a correspondent says: "From 1914 to 1918 the English language was—for very obvious reasons—congenial to our ears. We did not then dream of ridiculing the millions of Englishmen and Americans who came to help us. It would be more becoming on our part to avoid wounding friends without whose help, perhaps, we should have had to put up with another language."

H.M.V. Table Radiogramophone

Model 501 for D.C. Mains

ALTHOUGH the demise of direct current was forecast some years ago, recent events appear to have given it a new lease of life, and a few manufacturers, fully appreciating this fact, set themselves the task of developing D.C. versions of most of their popular models. A case in point is the H.M.V. Model 501 table radio gramophone, the D.C. model embodying all the principal features of its A.C. counterpart; the external appearance and the general form of construction are identical, and they differ only in so far as it is necessary to accommodate the instrument to a direct current supply. Thus, the three-valve circuit consisting of an H.F.-Det.-Pentode arrangement is retained and calls for little comment here, since the salient features were dealt with elsewhere.

Indirectly heated D.C. valves of the 0.25-amp. type are used, their filaments being connected in series as a matter of course, while the surplus volts are dissipated in a resistance, one portion of which is tapped and serves as the adjustment for various supply voltages. As the H.T. is derived from a D.C. source a simple smoothing circuit suffices to remove all trace of ripple, an electrolytic condenser serving a similar function for the filament supply.

Background noise and mains hum have been reduced to bare audibility, and there is not the slightest trace of interference from the electric gramophone motor.

The performance of the D.C. model compares very favourably indeed with its A.C. counterpart, and range, selectivity and quality of reproduction are comparable in every respect. It exhibits that high standard of workmanship and finish associated with all H.M.V. products, and where a full-size radio gramophone cannot be accommodated conveniently, the Model 501 will be found a most satisfactory substitute.

FEATURES.

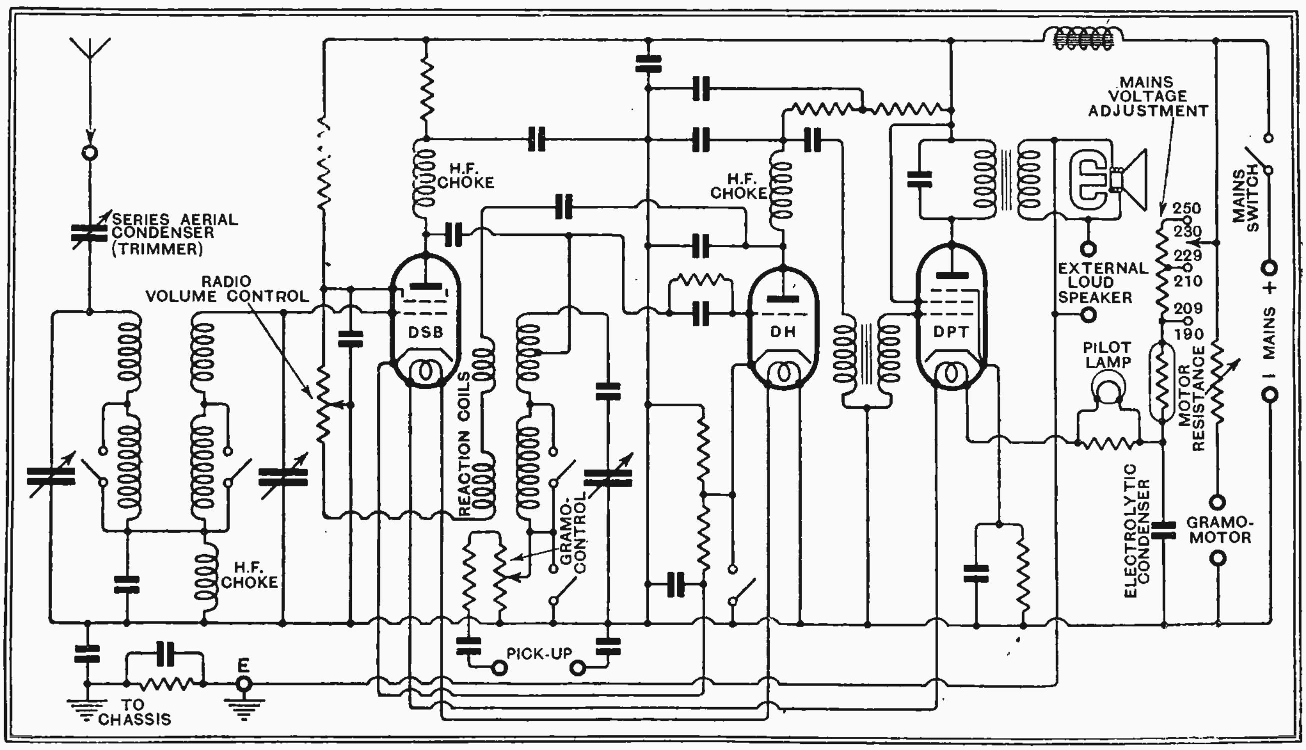
Circuit. — *Three valves, screen-grid H.F. band-pass filter, grid detector, pentode output.*

Controls. — *(1) Ganged control with illuminated dial, wavelength calibration. (2) Aerial tuning control. (3) Wave-change, radio-gramophone and mains switch. (4) Combined reaction and volume control.*

General. — *Permanent-magnet moving-coil loud speaker. Electric commutator motor. Provision for extra loud speaker.*

Price. — *29 guineas.*

Makers. — *The Gramophone Co., Ltd., Hayes, Middlesex.*



Theoretical circuit of H.M.V. Model 501 D.C. radio gramophone.

. . . . a new

HEAVY DUTY PENTODE—

THE

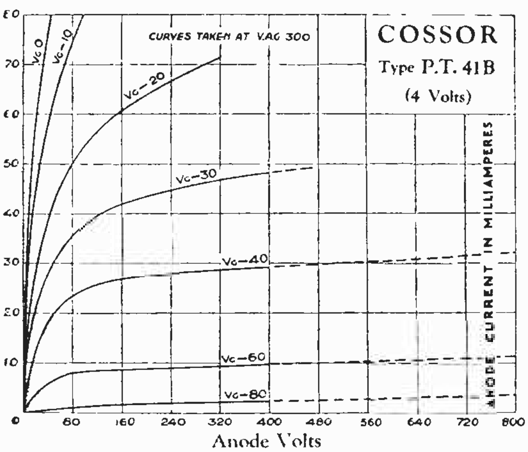
COSSOR

P.T. 41 B.

Cossor P.T. 41 B

Filament volts: 4. Filament current: 1 amp. Maximum Screen volts: 300. Maximum Anode volts: 400. Mutual Conductance (taken at Va. 100, Vag. 100 and Vg. 0), 2.25 m.a/v. Maximum Anode Dissipation: 12 watts. PRICE - - 22/6

DESIGNED for use as a directly heated Pentode Output Valve, the new Cossor P.T. 41B has a maximum anode dissipation of 12 watts. Due to the efficiency of its pentode characteristic an exceptionally large proportion of this dissipation may be realised as undistorted output. For an output valve of this type the Cossor P.T. 41B possesses remarkable efficiency. Full instructions for its correct operation are given in Folder No. L.72, a copy of which will be sent post free on application.



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Our range of super-hets **(D.C. & A.C.)** *includes Receivers — Radiograms or chassis only. Demonstrations without obligation. Illustrated Literature on request. Write Dept. A/2.*

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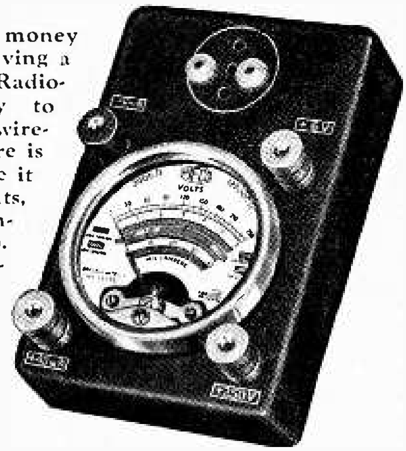

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PERMANENT MAGNET MOVING COIL SPEAKER

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Although offered at the amazingly low price of 20/- the B.O.B. has a wonderful depth of tone and reproduces speech and music with clarity and brilliance. It will function perfectly with the smallest power valve, yet is capable of handling 1 watt undistorted A.C. without distress.

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"I am astonished at the result."
"Reproduction of the very highest quality."
"Reproduction of speech is quite up to the high standard you have set with your more expensive speakers."
"A superb M.C Speaker at a price within the reach of all."
"Reproduction of broadcast music is excellent."

LANCHESTER MOVING COIL SPEAKERS include full range of models at prices from £3.3.0 downwards.

WIRELESS WORLD TEST REPORT ON the "SPECIAL SENIOR" Model, price £3.3.0:—

"Magnet system . . . of generous dimensions . . . improved sensitivity . . . Characteristic, which is practically level between 100 and 1,000 cycles, actually rises about 5 decibels from 100 down to 50 cycles. This imparts a full, round tone to the reproduction . . . Speech is of the natural and unforced quality associated with Lanchester Speakers . . . rendering of music is entirely satisfying."—*Wireless World, April 13.*

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LANCHESTER'S LABORATORIES (TRADE MARK L L L LIMITED)

TYSELEY ... BIRMINGHAM

The new Mullard detector valve with low interelectrode capacity.

NEW DETECTOR VALVE.

Mullard Introduce Modified 904V. with Small Input Damping.

IT has long been known that any calculation of stage amplification which does not take into account the important effect of valve capacities is often so erroneous as to be worthless. In a low-frequency resistance-coupled stage, for instance, we may use a valve of high amplification factor together with a coupling resistance of large value and glibly work out, according to the well-known simple formula, that the signal voltage will emerge magnified, say, some thirty times. Actually, at the higher audible frequencies there may be no amplification at all because the working valve capacity will shunt away the energy and our calculation, at any rate so far as high notes are concerned, gives a figure which is thirty times too high.

The influence on amplification of valve capacity, generally known as the "Miller effect," is even more marked in a high-frequency amplifier. Here the energy fed back through the anode-grid capacity may be large enough and in the right phase to cause uncontrollable self-oscillation, and respectable H.F. stage gain becomes possible only by decreasing the Miller effect, either by neutralising or by the use of the screen-grid valve.

Under working conditions the anode-grid capacity is reflected back to the input circuit as a much larger capacity depending upon the effective amplification of the valve. There is, in addition, a resistance component thrown back which in the case of a detector is out of phase with the signal, and can be looked upon as having a damping or anti-reaction effect. The two effects—capacity and resistance—are generally lumped together and called "input impedance," and it is with this that we are primarily concerned in this review.

Valve capacity in the detector stage has hitherto not had its due share of attention, for, although harmful effects are known to exist, they are often masked by the reaction control which is left to make up for sundry losses. With two stages of modern H.F. amplification, deliberate reaction is not usually employed, and the damping of the tuned circuit immediately preceding the detector is only too obvious when it comes to balance the various members of a ganged tuning condenser. Assuming that we have a receiver with four tuned circuits, of which two are used as a pre-selector, the trimming of the aerial circuit will be flat, that of the next two circuits really critical, whilst that of the fourth next to the detector will be quite flat; in fact, one always feels that this circuit is contributing little to the overall selectivity.

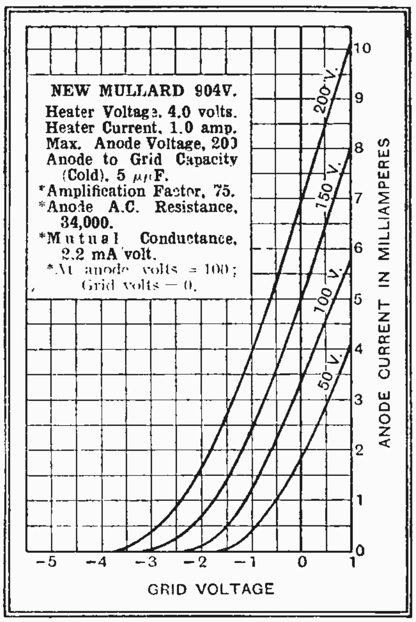


Fig. 1.—Characteristics of the new Mullard 904V. detector valve. The anode-grid capacity has been reduced to 5 μμF. with the result that the input impedance is considerably decreased.

The damping or load imposed by the detector on its input grid circuit is, in the case of a power-grid detector, very large, and any new valve design which aims at reducing this is to be warmly welcomed. Measurement shows that a typical indirectly heated three-electrode detector throws a shunt resistance across the preceding circuit of about 50,000 to 60,000 ohms, partly due to grid current and partly to Miller effect, so that, however "good" the tuning coil, its dynamic resistance at resonance will always be below this value.

It is with a keen appreciation of these limitations that the Mullard Company have developed a new detector valve styled the 904V. having characteristics which are considerably modified when compared with those of an earlier valve bearing the same type number. By careful design the anode-to-grid capacity (when measured in a cold valve) has been reduced to the low figure of 5 micromicrofarads, decreasing the total input damping to half the normal figure, namely, 100,000 ohms. The selectivity of the preceding tuned circuit is considerably improved and the undistorted output, allowing only 5 per cent. second harmonic, is greater, and this in spite of a reduction of mutual conductance from 6.5 to 2.2.

From the foregoing it would appear that current views on the very steep slope detector may have to be modified. The effect of increasing the mutual conductance is to increase the grid-cathode conductance which may be interpreted as an increase in damping. Add to this the increase in Miller effect or input impedance, which is nearly proportional to the mutual conductance g

New Detector Valve.—
in a detector stage, and we find that the total damping increases approximately as g^2. There appears to be a certain value of g above which the disadvantages of damping and reduced input outweigh any advantages of greater amplification.

In Fig. 1 are given various operating data for the new 904V. About 170 volts should be applied actually to the anode, giving a current of

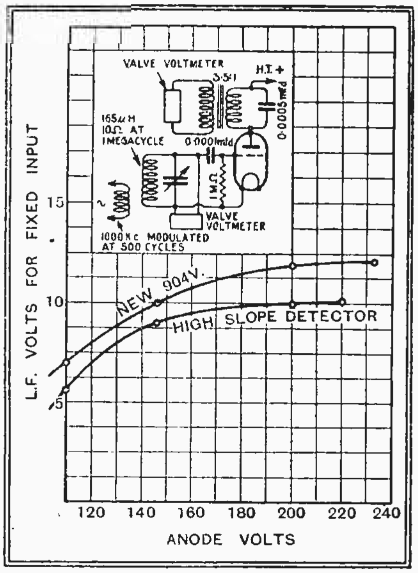


Fig. 2.—Curves comparing the L.F. volts output of the new 904V. with a steep-slope detector ($g = 6.5$) under fixed input conditions. The input damping with the valve of low mutual conductance is so much smaller that it gives greater detector efficiency. Depth of modulation = 80%.

about 6 mA., which should not be depressed below 4.9 mA. by a signal to keep the output within the 5 per cent. distortion limits. The grid condenser should have a value of 0.0001 mfd., the leak 0.5 or 1.0 megohm, and the grid return lead must be taken directly to cathode. It should be noted that the working A.C. resistance with a high anode voltage and approximately zero grid is about 25,000 ohms, this being a suitable value for coupling by a transformer of fairly high primary inductance or by an R.C. stage with 60,000-ohm anode resistance.

The relative L.F. volts developed across a $3\frac{1}{2}$-to-1 transformer for the new 904V. and a high slope detector with g equal to nearly 7 are shown in Fig. 2. Although the input excitation from the oscillator source was kept constant, the output from the valve with low mutual conductance and intentionally reduced valve capacity was greater.

The Mullard Company should be congratulated on tackling detector valve design from a new angle and translating theory into practical achievement.

NON-INTERFERING TRAFFIC SIGNALS.

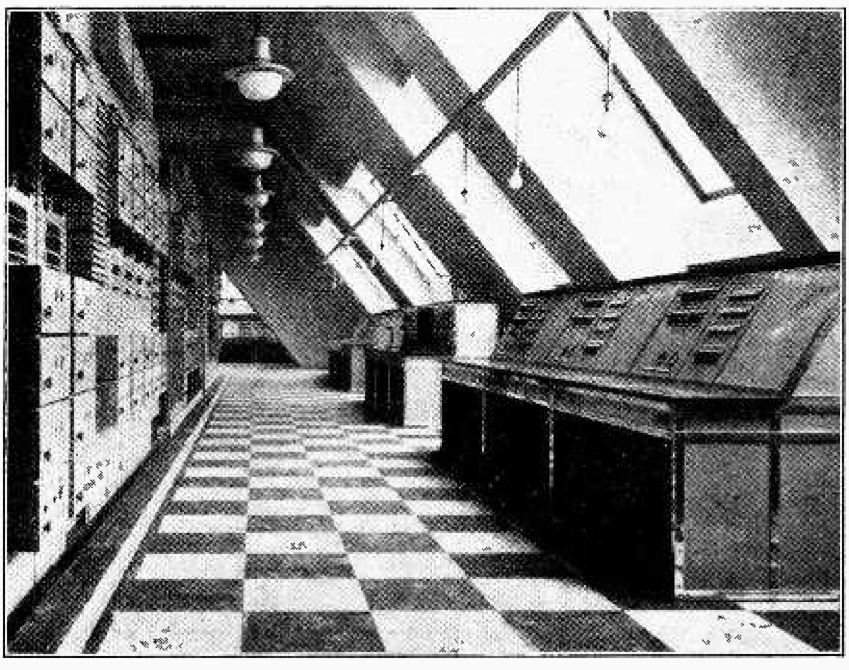
IN *The Wireless World* for April 20th mention was made of the fact that the Post Office authorities are actively engaged in developing anti-interference devices for attachment to industrial and domestic electrical apparatus. It was stated that satisfactory means of overcoming interference from automatic "stop-caution-go" traffic signals have been evolved.

These traffic "robots" are notoriously bad offenders, sometimes radiating impulses which disturb broadcast reception over a radius of as much as 100 yards. The interference is of a high-frequency nature, and the small electric motor which operates the various lamp switch contacts is generally held to be responsible, at any rate when it is fed from a D.C. supply.

Our attention has been drawn to the fact that there is now manufactured in this country a traffic control system which is claimed to generate no interference, and so does not require any preventive devices. Known as the "L.S.E.," it is made by Laurence, Scott, and Electromotors, Ltd., of Norwich and Manchester, who state that their products have been tested by Post Office engineers, who could find no interference even when their detecting apparatus was set up in close proximity to the controller.

This freedom from radiation is attributed to the absence of a motor to drive the automatic switching mechanism. In the L.S.E. system a slow-moving reciprocating magnetic arrangement is employed to actuate a series of drum-type contacts. Energy is actually derived from the movement of a plunger, working in a solenoid coil so that sparking is avoided.

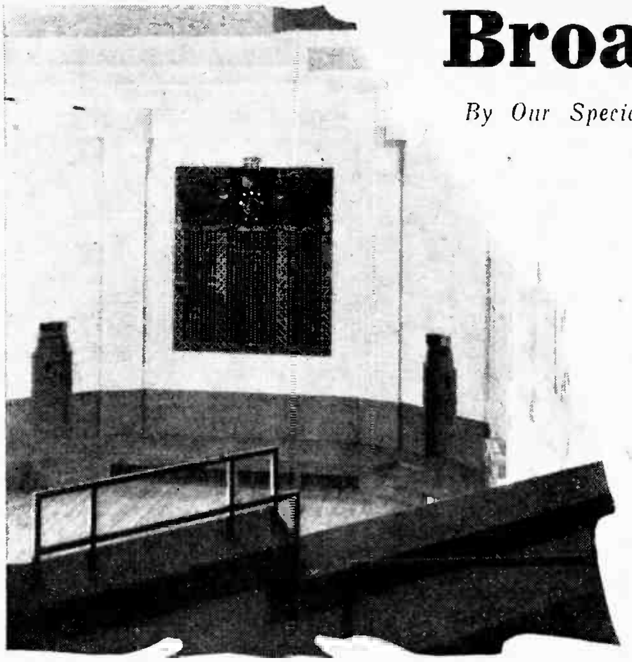
THE NEW NERVE CENTRE.



The control room at Broadcasting House, which has now superseded the old "control" at Savoy Hill, is designed on the most modern lines to facilitate the rapid and efficient handling of lines from all over the country.

Broadcast Brevities

By *Our Special Correspondent.*



SEEN FROM "THE GODS." A gallery view of the much-discussed concert studio at Broadcasting House, which has been found to be too small to accommodate the B.B.C. National Symphony Orchestra. The studio closely resembles a theatre.

The New Studios.

"THE net result is about as deplorable as it could very well be," writes one of my correspondents on the subject of the transmissions from the new studios at Broadcasting House. This piece of hyperbole is not typical of the general run of opinion, and I do not suppose that the writer would expect us to accept his remarks literally. If things were really deplorable, all listendom (good word, that!) would be up in arms.

Turmoil in Portland Place.

The truth is that, at the moment of writing, Broadcasting House is rather like your house or mine when the furniture removers, the painters and the plumbers are still in half possession. It is at such times that the householder trips over pails and sits on chairs that are not there.

Last week, for instance, in Studio 8a, Walton O'Donnell had to conduct a military band performance in a gale of cold ozone from an imperfectly adjusted ventilator.

A Month's Respite.

This sort of happening may help to explain why transmissions are so "deplorable," and I think it would be fair to the B.B.C. to allow them a little time in which to settle down.

It will be time to shout if there is no improvement in a month or six weeks' time.

What the Architect Thinks.

Col. Val Myer, the architect, has the true artist's diffidence about his own creation. In the entrance hall of Broadcasting House last week he told me that, although the criticism he had already received was entirely favourable, there were points about the building which he would change if such a thing were still possible.

The Conjurer.

Whatever Col. Val Myer may say, critics will maintain a respectful silence in the presence of one who can squeeze a quart into a pint pot. It is a tight squeeze, but Val Myer has done it.

A Scottish Mystery.

IT is always a mystery to me that the Scottish people should be so lukewarm in their appreciation of broadcasting. Fresh confirmation of this lack of enthusiasm comes with the inauguration of test transmissions from Scottish Regional. One would imagine that the B.B.C. postbag would be full following the first tests with Scotland's own high-power station; on the contrary, reports at the time of writing (after two successive tests) are stated to be meagre.

Early to Bed?

The possible explanation in this case is that Scotland goes to bed early, and that 11.15 p.m. is an uncouth time for anyone to be still astir even by his own fireside.

Those reckless ones who *have* sent reports seem to be favourably disposed towards the new transmitter, but it ought to be made clear that no one north of the Grampians expects to be satisfied with anything short of a high-power station in the Inverness district.

Europe's Sponsored Programmes.

HOME truths leaked out at the recent Canadian Broadcasting Conference, at which Mr. Gladstone Murray was the B.B.C.'s official representative.

The astonishing growth in advertisement programmes in the last few months was made clear by the revelation that, in Europe alone, twelve countries now permit sponsored broadcasts. The countries are Estonia, France, Germany, Irish Free State, Italy, Luxembourg, Norway, Poland, Rumania, Spain, Turkey and Yugo-Slavia.

Declining the Honour.

The European countries which still oppose the practice are Austria, Belgium, Czecho-Slovakia, Denmark, Finland, Hungary, Latvia, Lithuania, Holland, Portugal, Sweden, Switzerland, and, of course, the United Kingdom.

I see that Mr. Gladstone Murray was asked whether British firms bought time from the Continental stations. He replied that many had done so, but that the number was falling off, as the results were not profitable.

Could the same be said if the B.B.C. were to broadcast advertisements?

How the Money Goes.

The British representative also disclosed an interesting fact concerning the percentage cost of broadcasting programmes, administration, and other items for a typical 14-hour day. The programmes themselves, it appears, absorb 63 per cent. of the total cost. The maintenance of plant and power supply absorb 17 per cent., and administration 6 per cent. Depreciation and sundry other items swallow up the rest.

Sir Thomas Beecham.

SIR THOMAS BEECHAM will conduct the studio broadcast of Delius's opera, "A Village Romeo and Juliet," on May 20th. This will be given from Number Ten, the "warehouse" studio, which, incidentally, is to be retained by the B.B.C. for some part of its orchestral work for a considerable time ahead.

The cast in "Romeo and Juliet" will include Dora Labbette, Kate Winter, Jan van der Gucht, Dennis Noble, and Arthur Cranmer.

Hamlet Broadcast.

ANOTHER Sunday play broadcast is included in the National programmes for June 5th, namely, "Hamlet." A notable cast is being engaged for the performance.

Don't Spill the Beans.

DESPITE prophecies to the contrary, the Press and Broadcasting remain fairly good friends, and probably the bond of brotherhood has been strengthened by the B.B.C.'s recent announcement concerning the public use of broadcast programmes.

Listeners have been reminded that "no unauthorised outside use may be made of a broadcast programme. In particular, the copyright of all broadcast commentaries, and of all news supplied by the News Agencies, is strictly reserved. These broadcasts are for the private use of owners of receiving sets only, and may not be communicated to the public by loud speaker, lantern slide, printed slip or other device."

Radio dealers now have to be snappy with the switch.

WIRELESS ENCYCLOPEDIA

No. 14

Brief Definitions with Expanded Explanations.

***GRID BIAS.** The mean electrical potential which is imparted to the grid of a thermionic valve, relative to the cathode, or, in the case of a battery valve, to the negative end of the filament, to obtain the most efficient operation.*

IN order that a triode shall act as an efficient amplifier of electrical vibrations the conditions must be so arranged that any variations of potential at the grid will set up similar but magnified variations of potential difference between the terminals of an external impedance connected in the anode circuit. These conditions are in general fulfilled if the mean grid potential or "grid bias" is adjusted at such a figure that a small change in its value is accompanied by a proportionate change in anode current, the anode potential being maintained constant. This implies that the

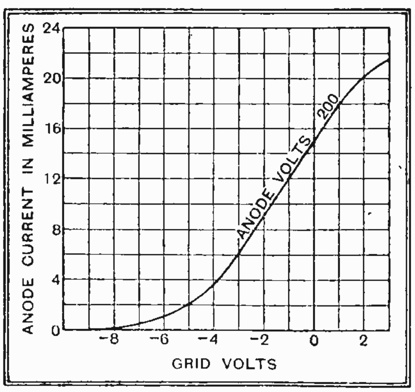


Fig. 1. Grid voltage-anode current curve of a three-electrode amplifying valve.

valve should be operated so that the grid voltage variations to be amplified occur over the straightest part of the grid voltage/anode current characteristic curve of the valve with the particular value of anode H.T. voltage employed. A typical curve of this kind is shown in Fig. 1, which relates to one particular value of anode voltage; there is a separate curve for each anode voltage.

The anode current flowing internally between the anode and cathode (or filament) of the valve is comprised of a stream of electrons passing from the hot cathode to the relatively positive anode, and these electrons in the space between anode and cathode constitute a negative electrical charge called the *space charge*. The electric field produced by the space charge exerts the main controlling effect on the current passing. The grid is an open mesh or spiral of wire surrounding the cathode, and is situated in the region where the space charge is most intense. By applying various potentials or charges to the grid the resultant field in the inter-electrode space is varied, and in this way the anode current can be varied at will between zero and the maximum possible value. The more highly positive the potential of the grid is made the greater is its neutralising effect on the normal space charge and the higher is the current permitted to pass, until the upper limit is reached.

Grid Current Damping.

Providing the grid potential is made sufficiently negative with respect to the cathode, it does not capture any of the electrons issuing from the cathode and no "grid current" flows. In the case of most indirectly heated cathode valves no grid current will flow if the grid potential is made greater than about one volt negative. Grid current has a damping effect on a tuned grid circuit, and is to be avoided except when the valve in question is being employed as a leaky grid detector. Fortunately, a negative bias exceeding one volt will usually render the valve operative over the straight part of its working characteristic curve. For instance, for the valve to which the curve of Fig. 1 refers a negative grid bias of two volts gives an operating point on a reasonably straight part of the curve.

For ordinary screen-grid high-frequency amplifying valves the grid volts/anode current curves have no straight portion within the somewhat limited range of negative grid voltages, and so partial rectification and consequent liability of cross-modulation effects arise.

In the case of filament valves it has been usual since their inception to employ a special grid bias battery for obtaining the necessary negative potential for the grid. This battery is connected on the filament side of the grid circuit proper as shown at G.B. in Fig. 2 (a), the positive pole of the battery being connected to the negative leg of the filament. The grid battery carries no current and its life should be equal to the normal "shelf life."

Modern valves with indirectly heated cathodes for mains operation lend themselves to an easy method of obtaining the necessary grid bias without the use of batteries: a resistance R is connected in the cathode lead, as in Fig. 2 (b). The anode current passing down through the valve leaves via this resistance, and

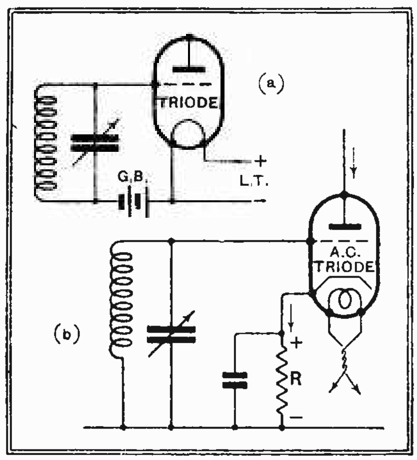


Fig. 2.- Method of obtaining grid bias (a) by means of a battery G.B. and (b) "free" or automatic grid bias, by means of a bias resistance R in the cathode lead.

a potential difference is therefore set up across its ends. It will be seen that the cathode is joined to the positive side and the grid to the negative side of the bias resistance, which is shunted by a condenser to suppress any alternating voltages that might otherwise arise. Thus the grid potential is made negative with respect to that of the cathode.

BROADCAST REPRODUCTION

"Such harmony is in immortal souls;
But whilst this muddy vesture of decay
Doth grossly close it in, we cannot hear it."

SHAKESPEARE. *Merchant of Venice*, Act V, Sc. I.

Part II. The Response Limits of the Human Ear.

By H. A. HARTLEY.

IN the previous article we have seen that, in order to get perfect reproduction of the various musical instruments, we require to have apparatus capable of propagating frequencies over a range of 20 to 20,000 hertz,[1] but considerations of freedom from interference compelled us to restrict the upper limit to 9,000 hertz. Now, the average human ear has a frequency range of approximately the wider of these, and while we found that the greater part of the orchestra was fairly well covered with the imposition of an upper cut-off at 9,000 hertz, we must determine what effect this will have on the ear, and whether it is necessary to have the bass reproduced as low as 20 hertz.

The human ear is an immensely complicated piece of mechanism, and while it would be desirable to give an outline of its functioning at this point, so that the physics of the phenomena we shall discuss be properly understood, considerations of space compel the reader to be referred to the bibliography, wherein he will find particulars of works which give a description of the actions that are presumed to take place when the ear is set in motion by sound waves. We will assume that the ear is capable of vibrating in sympathy with pure tones having a frequency between 20 and 20,000 hertz, and that it will also respond to two or more pure tones simultaneously impressed on the ear drum.

THE ear is not so accommodating as is generally supposed. Curves are given showing the distinction between loudness and intensity effects, and the behaviour of the ear when dealing with sounds of different frequencies. The chart published in our last issue, giving the frequency ranges of practically all musical instruments, will be found useful in studying the author's explanations.

If the intensity of a sound be continually decreased it will reach a value when the ear is not affected by the presence of the sound. The difference between *loudness* and *intensity* should be clearly recognised. The intensity of a sound is a definite physical quantity which indicates the rate of supply of energy, and is proportional to the amplitude of the sound wave. Loudness refers, subjectively, to the degree of sensation, and depends on the intensity of the sound as well as the sensitivity of the ear at the particular frequency. If the frequency be near either limit of audibility, the loudness may be feeble, although the intensity may be great.

The Auditory Limits of the Ear.

The point at which the sound is just audible is called the *threshold of audibility*. If the intensity be increased until the sound produces feeling, the *threshold of feeling* is reached, and further increase in intensity will cause pain and damage the hearing mechanism. The thresholds of feeling and audibility vary enormously in different persons, and it may be assumed that no two persons will hear the same piece of music in an exactly similar manner. An average value is given in Fig. 6, from data and experiments by Fletcher, Wegel and others, but any particular person may diverge by as much as 20 decibels at certain frequencies. The decibel can be explained as follows: if P_1 and P_2 are two different amounts of power being compared, the difference in power level is equal to $\log_{10} P_1/P_2$ *bels*. The tenth part of a bel is called a *decibel*, and is a unit widely used in acoustic work. If we are discussing speech, for example, the average power can be taken at zero, then very loud

[1] A "hertz" represents one cycle per second.

Broadcast Reproduction. –

speech would be +20 decibels, and a soft whisper –40 decibels. The range of speech power is then 60 decibels. The smallest change in intensity that can be detected by the ear is about 1 decibel, but this, of course, depends on the frequency of the sound. (See *The Wireless World, December* 16th, 1931, p. 680, for the intensity of various familiar sounds expressed in bels.) It is seen that the threshold both of feeling and audibility depends on the frequency, and it is fairly obvious that the points formed by the intersection of the two curves include the range of frequencies over which the ear is sensitive.

The area enclosed by the curves is called the "auditory sensation area," and any selected points in this area will cause auditory sensations, the points representing sounds having an intensity and frequency indicated by the ordinates and abscissæ. For example, the average ear would hear a pure tone of 2,000 hertz quite comfortably if the intensity was such that the air pressure on the ear was no more than 0.001 dynes per cm². Lowering the frequency to 200 hertz calls for more than ten times the pressure to obtain the same degree of loudness, while at 20 hertz the pressure must be raised to no less than 20 dynes for the note to be just audible. Increasing the pressure only results in pain, whereas the ear would not resent a pressure of 1,000 dynes if we return to our original frequency of 2,000. It will be noticed that the ear is most sensitive at frequencies of 2,000 to 3,000 hertz, and as many moving-coil speakers have a pronounced resonance somewhere round this frequency, it follows that such a loud speaker is bound to give an unbalanced effect to any music reproduced through its medium.

It has been pointed out that the minimum perceptible change in intensity was approximately one decibel, but was dependent on the frequency. It will be necessary to look into this a little more closely.

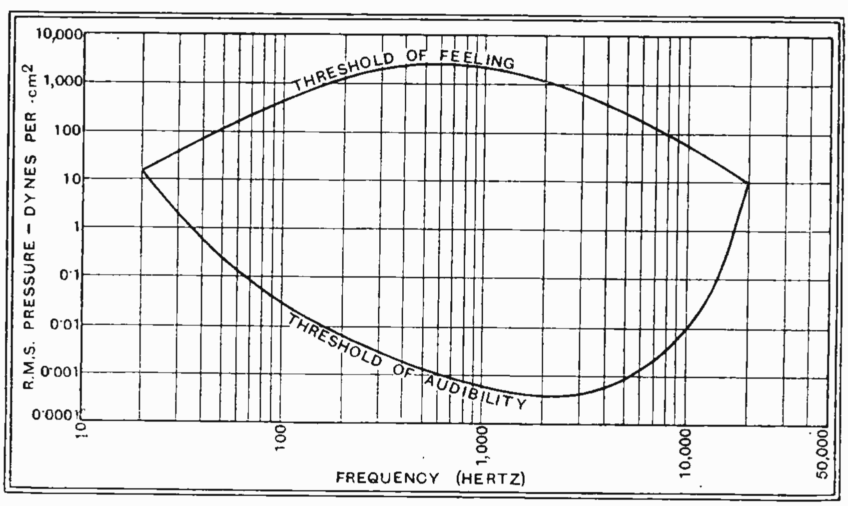


Fig. 6.—The auditory sensation area of the ear, showing how its sensitivity varies as the frequency.

Fig. 7 gives the results of several experiments carried out by R. R. Reisz, in which he determined the least change in intensity perceptible by the ear at various frequencies and intensities. In the diagram the term "differential sensitivity" refers to the minimum perceptible difference in intensity, and introduces us to Weber's Law, which states that, in order to produce a perceptible increase in intensity of a sensation an equal fraction must be added to the previous intensity of the stimulus, whatever its value. Another way of expressing the same idea is that the magnitude of the sensation (loudness) produced is proportional to the logarithm of the stimulus (intensity). If ΔI is equal to the just perceptible increase in intensity, and I equals the original intensity, then $\Delta I/I$ will be the differential sensitivity.

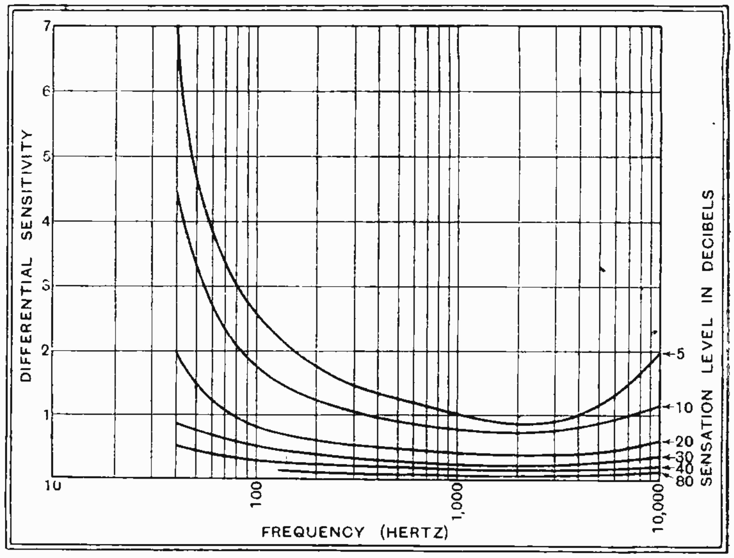


Fig. 7.—Showing how the ear reacts differently to the frequency band as the volume is decreased beyond a certain value.

The "sensation level" of a sound is the number of decibels it is above the threshold of audibility. Fig. 7 illustrates the phenomenon with which we are all acquainted, in that reduction of the volume of sound emitted by the loud speaker is accompanied by a much greater decrease in volume of the bass than of the treble. We see that, if our sensation level is low, in other words, if we have a set which will not deliver much undistorted power, then no matter how good our receiver and loud speaker may be in reproducing the frequency range electrically, we are bound to get a large bass cut-off and a smaller treble cut-off between the loud speaker and the brain. It would be interesting to know whether any radio engineer has ever designed a low power set with compensation for this pecu-

Broadcast Reproduction.—liarity of the ear. The diagram indicates that a sensation level of at least thirty decibels is necessary to get balanced reproduction of orchestral music; the size of output valve to give this will be investigated later. A further consideration which governs the minimum necessary sensation level is connected with the control of volume by the B.B.C.

Apparatus, whether transmitters or receivers, would be very costly if called upon to reproduce faithfully the loudest sounds normally experienced by the ear, so that, for commercial purposes, the transmitter, in particular, is designed to handle a certain maximum intensity beyond which limit sound intensities would be distorted. On the other hand, there is always a certain amount of background noise incoming to the receiver and created in the listener's room. Interference to the signal received, a clock ticking, a fire or gas jet burning, all prevent the ear from hearing the faintest sounds. A concert hall containing a large number of people is considerably quieter during the playing of very soft music than is the average living room in which one is listening to the same music broadcast. So the minimum volume transmitted must be greater than the minimum volume impressed on the microphone. In practice, the intensity ratio of a symphony orchestra is about 1,000,000 to 1, or 60 decibels, and this is contracted by the B.B.C. control room to 1,000 to 1, or 30 decibels. If, therefore, the effective sensation level of the loudest passages broadcast is 30 decibels, it follows that our reproducing equipment must also create a 30-decibel level if we are to hear the softest passages at all, assuming no background noise. An increase in sensation level will, of course, permit us to hear the very quiet sounds with greater ease, and is necessary if background noise be present.

It should be remembered that this discussion applies to pure tones only, and as all sounds broadcast are more or less complex, it does not follow that a 30 decibel level will be adequate in practice. The relation between sensation level and intensity is dependent on the character of the sound; for the moment this can be expressed as: Sensation level (in decibels) = $10 \log_{10} \times$ Intensity (in microwatts per sq. cm.). If the intensity be such that 1 microwatt flows through 1 sq. cm., which is taken as the comparison intensity, then the sensation level (often called phonic level) will be zero, and which corresponds to the intensity on the ear drum if the pressure of the sound wave is 20 dynes per sq. cm. It will be noticed, from Fig. 6, that, at this pressure, the ear has its widest frequency response.

Interference, Masking Effects and Subjective Tones.

The *Principle of Superposition* states that the passage of sound waves through a medium is in no way affected by the passage of other sound waves through the same part of the medium. This entitles us to say that if a given particle of air be acted upon by two sound waves, then the resultant displacement of the particle is obtained by adding the separate displacements vectorially, and is true so long as the sound waves are small. If the two waves have the same frequency, have amplitudes a_1 and a_2, and are ϕ° out of phase, the resultant amplitude is equal to $\sqrt{a_1^2 + a_2^2 + 2a_1a_2 \cos \phi}$. If the two waves are in opposite phase, that is, if a_1 is at greatest positive value when a_2 is at greatest negative value, then $\phi = 180^\circ$, $\cos \phi = -1$ and the above expression reduces to $a_1 - a_2$. If the amplitudes of the two waves are equal, then the resultant amplitude becomes zero, which means that two sound waves of equal frequency and amplitude, but 180° out of phase, produce, in effect, no sound at all. This phenomenon is known as *interference*, and can easily be demonstrated with an ordinary tuning fork. When the fork is struck the prongs alternately approach and recede from each other, and, if the prongs are separating, a compression of the air starts from the outer surface of each and proceeds in the direction of separation. At the same time a rarefaction of the air starts from between the prongs and proceeds at right angles to the direction of separation. In directions other than those mentioned there will be more or less interference as the vibrations are opposite in phase but equal in frequency and amplitude, and if the ear be allowed to pass across these regions, the sound will appear to be lost at certain points. The simplest way of doing this is to strike the fork and hold

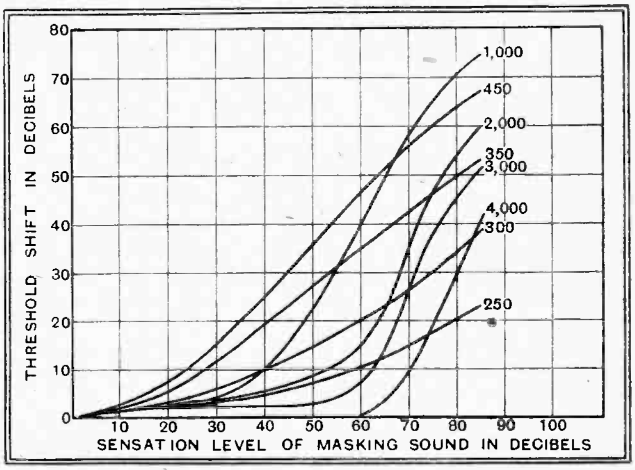


Fig. 8.—Masking effect of a 400-hertz sound on other sounds of various frequencies. The figures at the ends of the curves denote the frequencies of the masked sounds.

it near one ear, when twirling the fork between the fingers will result in the sound being intermittent, there being four points of silence in each revolution. It should be noted that the alternations of sound and silence occur only at certain points relative to the fork, and that, moreover, the speed of the alternations is dependent on the speed of rotation of the fork.

If, now, there is a very slight difference in frequency of the two waves, a different state of affairs is produced. It will be evident that, at any particular point in the air we have, at the time when the amplitude a_1 is added to the amplitude a_2, the maximum amplitude of displacement of the air, but as the frequency of the two waves is slightly different, the moment when a_1 is at maximum on its next alternation is not the moment when a_2 is at maximum. Thus we have additive and subtractive effects succeeding each other as the one sound gains half

Broadcast Reproduction.—

a vibration on the other, with the result that a new tone is created which grows alternately loud and soft at a number of times per second equal to the difference of the two component frequencies, and whose frequency is equal to the arithmetic mean of the component frequencies. Such tones periodically varying in strength are called *beats*.

How One Frequency Masks Another.

We have seen that if a certain amount of noise or sound be impressed on the ear, then the ear is not so sensitive to other sounds. If one sound A is being heard, and another sound B is gradually increased in intensity until A is no longer heard, then B is said to mask A. In general, it has been contended that a sound of low frequency can completely obliterate a sound of higher frequency, but a sound cannot mask one of lower frequency. As the matter is of importance in acoustics, the Bell Telephone Laboratories undertook a series of experiments to determine exactly how far this contention was true. It was found that while a low frequency note requires to be raised to a high intensity to mask a high frequency note, it is easy to mask any sound by one of slightly higher frequency. In Fig. 8 are curves showing the masking effect of a 400 hertz note on notes of various frequencies. If the intensity of the masking sound is kept constant, the threshold shift denotes the amount the masked sound has to be raised above its threshold value when no masking sound is present, to be just audible.

In the diagram it will be seen that a 400 hertz sound has to be increased to 60 decibels before it begins to mask a sound of 4,000 hertz, but as the frequency of the latter approaches that of the former, so the masking effect is more pronounced. The fact that certain of the curves intersect shows that the ear will notice a difference in the quality of a complex tone as the intensity is raised or lowered. For example, take a complex tone with components of frequencies 300, 400, 2,000 and 3,000 hertz at levels of 10, 50, 10, and 10 decibels respectively; the ear will not hear the 300 component. If the level of the tone be raised by 20 decibels, so that the components are now at levels of 30, 70, 30 and 30, the 300 hertz component appears, but the 2,000 vanishes. Raising the level a further 10 decibels eliminates the 3,000 hertz component also. The general effect is that, as the intensity of a complex tone is raised, so the lower pitched components become more noticeable owing to the masking of the higher frequencies.

It was stated that the principle of superposition only held good if the amplitudes of the component waves were small, and we will now consider the case of loud and well sustained sounds. If two such sounds are emitted simultaneously new tones, *combinational* or *subjective tones* are formed, one at a frequency equal to the difference between the component frequencies, and called the *differential tone*, and another at a frequency which is the sum of the component frequencies and called the *summational tone*. A homely example of the former is found in the police whistle, which consists of two pipes giving tones of different frequency and which are sounded together by blowing; the differential tone which results is considerably lower in pitch than either of the components. This differential sound is not a beat, as it is only heard if the whistle is blown vigorously. A further type of summational tone is found when only one sound excites the ear; upper partials are created in number varying with the frequency and intensity of the sound. At 1,000 hertz, the second partial will appear if the sensation level is about 50 decibels, and the third, fourth and fifth will be added if the level is raised to 80 decibels. Four octaves below this a level of only 25 decibels is required to produce the same number of partials.

If, now, we take the case of two sounds of fairly large intensity and having frequencies f_1 and f_2 sounded together, a large number of subjective tones will be created, for, in addition to the differential and summational tones from the two primes, we will have similar tones from the primes and partials, and partials combining with partials to produce others; a series of this nature is generated:—f_1; f_2; f_1+f_2; f_1-f_2; $2f_1$; $2f_2$; $2f_1+f_2$; $2f_1-f_2$; $2f_2+f_1$; $2f_2-f_1$; $2f_1+2f_2$; $2f_1-2f_2$; $3f_1$; $3f_2$; and so on. If the two original sounds are complex tones it is easy to perceive that the situation becomes very complex and one's imagination boggles at the attempt to estimate the number of different sounds produced by a whole orchestra at any particular instant. Of course, among these multitudinous sounds produced, some are masked by others, so that, in practice, the total number will be much less than that obtained if masking were not present. The number masked will depend on the total volume, as we have already seen.

The Behaviour of the Ear to Complex Tones.

We are now in a position to consider the effects of frequency distortion (unequal reproduction of the frequency range) upon the ear. Experiments have proved that if the fundamental frequency of a complex tone be removed by a suitable filter (which may be an imperfect loud speaker) the differential tone created by the upper partials will be clearly heard at the fundamental frequency. Thus, one may hear sounds below the lower limit of the reproducing apparatus, and many writers have jumped to the conclusion that a very low cut-off frequency is not essential to secure good broadcast reproduction. But we have seen that matters are not nearly so simple as this. Suppose a musical instrument is sounding a note of 50 hertz, and this has partials at 100, 150, 200, and so on. Taking the first two frequencies only, for simplicity, the subjective tones produced will be of frequencies 50 and 150 hertz for small amplitudes, in addition to the original tones, so the fundamental 50 hertz note will get a boost and a new 150 hertz note is created, which will aid the third partial. If the loud speaker cannot reproduce a 50 hertz note, the first two frequencies are 100 and 150, which produce 50 and 250. This gives a series 50, 100, 150, and 250, but the amplitudes of these component frequencies are obviously very different from those produced by the 50 hertz fundamental and its second partial. If the amplitudes are large, the divergence between the respective amplitudes of the reproduced partials becomes

Broadcast Reproduction.—

greater, as the table A shows; column A gives the frequencies of subjective tones formed by the fundamental at 50 hertz and second partial; column B those formed by the second and third partials, the fundamental being eliminated by a cut-off. Although only the fundamental and second and third partials are considered, it is obvious that amplitude distortion of all three is considerable in column B.

TABLE A.

Subjective Tone.	A.	B.
f_1	50	100
f_2	100	150
$f_2 + f_1$	150	250
$f_2 - f_1$	50	50
$2f_1$	100	200
$2f_2$	200	300
$2f_1 + f_2$	200	350
$2f_1 - f_2$	—	50
$2f_2 + f_1$	250	400
$2f_2 - f_1$	150	200
$2f_2 + 2f_1$	300	500
$2f_2 \quad 2f_1$	100	100
$3f_1$	150	300
$3f_2$	300	450
$3f_1 + f_2$	250	450
$3f_1 - f_2$	50	150
and so on.		

So we arrive at the very definite conclusion that a bass cut-off in the reproducing equipment will cause serious amplitude distortion, not only of the fundamental frequencies, but also of certain of the upper partials, and this is aggravated by the alteration in masking that takes place simultaneously. The incorrect reproduction caused by a bass cut-off is most noticeable to a trained musical ear, and the conclusion we have reached adequately explains the feeling most of us have had that, although the bass appears to be, and actually *is*, there, the result is not truthful. It is suggested that an examination of the chart given last week will show that the reproducing apparatus should have no falling off in output down to 32 cycles per second. As the higher frequencies do not mask lower notes to anything like the same amount as in the case above, a top cut-off is not so detrimental to good reproduction on this count, but it must not be forgotten that elimination of the frequencies above 5,000 will, in addition to impairing the brilliance of reproduction, cause frequency distortion by the absence of the differential tones of those frequencies which have been removed. It was pointed out in the previous article that 9,000 cycles per second was the utmost that one could do with if interference from other stations was to be avoided, so we have then, as the minimum frequency range for good reproduction of orchestral music, 32 to 9,000 cycles per second.

Verily, the ear is not so accommodating as is generally supposed!

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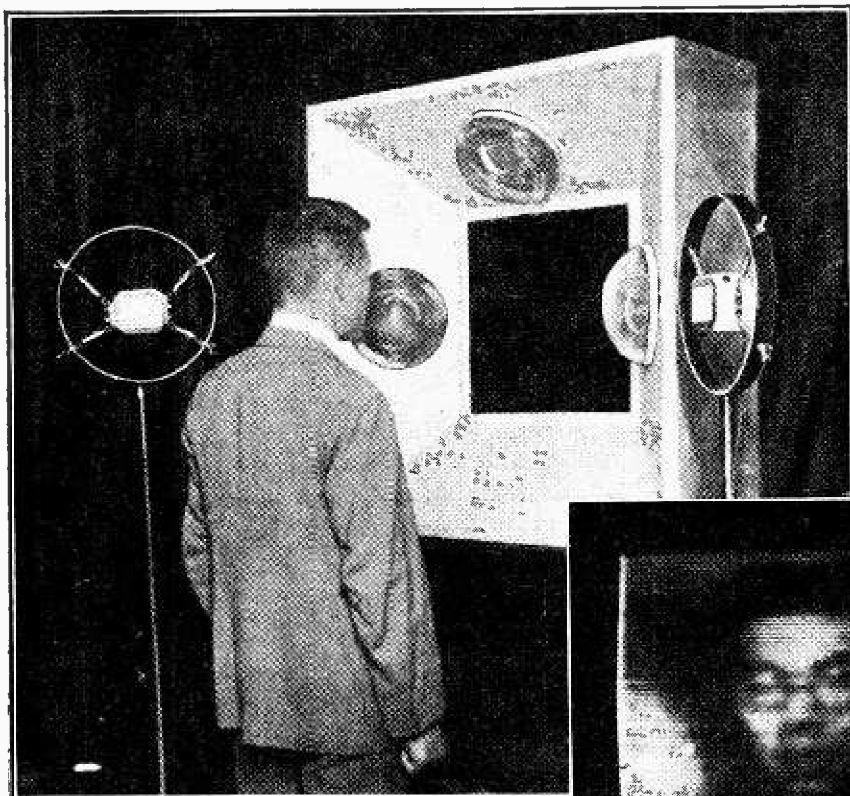
E. H. Barton: Text-Book of Sound. (Experimental, musical and mathematical.)

D. C. Miller: Science of Musical Sounds. (Graphical.)

I. B. Crandall: Vibrating Systems and Sounds. (Mathematical.)

H. Fletcher: Speech and Hearing. (Much information about experiments in the Bell Telephone Laboratories.)

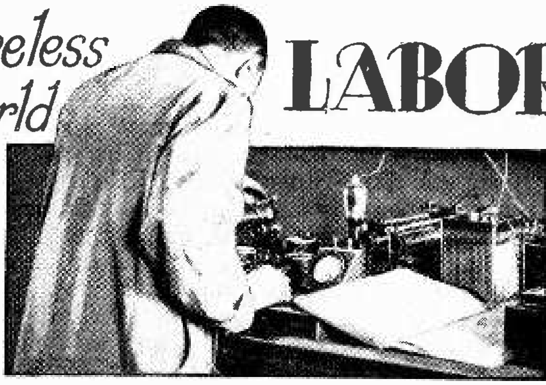
The opportunity is taken of correcting a slight error appearing in the inscription under Fig. 4 of last week's article. The waveform represents the octave below middle C (128 cycles).



TELEVISION IN JAPAN. Professor Kenjiro Takayanagi's television apparatus on view at the Exhibition of Inventions, Tokyo. Since November last, according to a correspondent, it has been possible to transmit 20 pictures per second, using 10,000 impulses per picture.

Recognisable portraits have been transmitted on a wavelength of 84.5 metres.

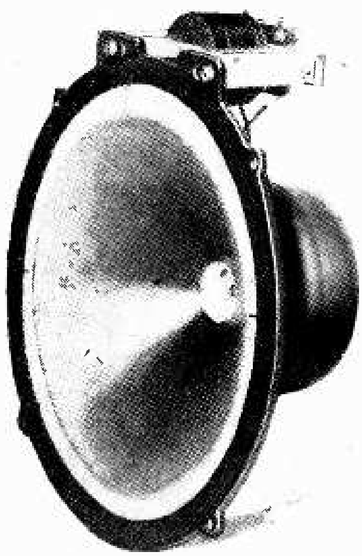
Wireless World LABORATORY TESTS



Review of New Radio Products.

"MOTOR" PERMANENT MAGNET MOVING COIL.

This unit is marketed by the Tekade Radio & Electric, Ltd., 147, Farringdon Road, London, E.C.1, and is the first of an entirely new range of "Motor" loud speakers which will be manufactured throughout this country. The permanent magnet is of the totally enclosed type, and is provided with an air gap of 1 mm. The 8in. diameter cone carries a low resistance speech coil with an average impedance of 10 ohms and an output transformer is incorporated in the chassis. Two types of transformer are available, one with a 30 : 1 ratio, for pentode valve, and the other, with three tappings giving ratios of 15 : 1, 20 : 1, and 25 : 1, for power valves.



"Motor" permanent magnet moving-coil loud speaker including output transformer.

On test the sensitivity was found to be well up to the standard of this type of unit, and the quality was excellent on both speech and music. The useful frequency response extends from below 50 cycles to 7,000 cycles. Between 50 and 1,000 cycles the output is aurally uniform. There is a slight resonance at 1,400 cycles and the output then increases by five or six decibels between 2,000 and 4,000 cycles, returning to the average level at about 6,000 cycles.

In our opinion, the outstanding feature of this reproducer is the exceptionally well-maintained output in the bass below 100 cycles, where the majority of moving coils for this type generally show a decided falling-off. The bass response is not attained by an artificially introduced resonance, but would appear to be due to the careful design of the field magnet. An important consequence of this feature of the performance is that the bass is sustained even when the loud speaker is working at low volume levels. The price of the complete chassis, including transformer, is 70s.

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C.A.V. H.T. BATTERY. Type H.T.D.4.

This is a standard capacity size dry cell H.T. battery rated at 120 volts and suitable for light discharge work, such as for use with a receiver requiring between 6 and 8 mA. of H.T. current. The overall dimensions are $8\frac{1}{2}$in. × $6\frac{7}{8}$in. × $2\frac{7}{8}$in. high, and the price is 11s. Tappings are provided at 12-volt intervals.

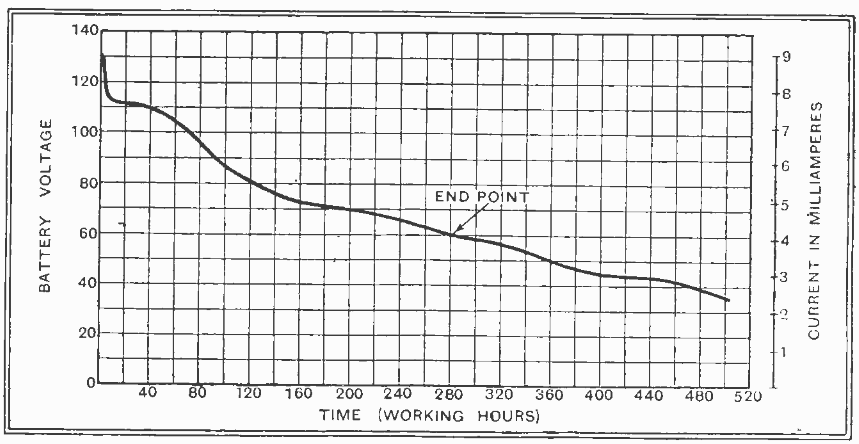
The sample submitted for test was discharged intermittently, doing duty for periods of four hours, with similar time intervals for recuperation. In the discharge curve shown on the graph the rest periods have been omitted for convenience, and only the actual working time shown. During the test the current flowing through the loading resistance was measured during the middle of the discharge period, so that the curve shows the mean value of the voltage throughout the life of the battery.

There is no marked cut-off point anywhere on the curve, as it can be seen that the voltage falls fairly steadily throughout, apart from an accelerated fall during the early stages.

C.A.V. model H.T.D.4 120-volt H.T. battery for light discharge work.

It is customary to regard the useful life of this style of battery as being up to the point where the potential of each cell has dropped to 0.75 volt, which, in the battery under review, takes place after 280 hours actual working time. This gives a total of 138 watt-hours for the battery, and, as there are eighty cells in all, each cell contributes 1.7 watt-hours, which is well above the minimum capacity laid down by the British Engineering Standards Association for cells of this size.

If it is assumed that the set is in use for twenty hours per week, and the current drawn from the battery in the earlier stages of its life does not exceed 8 mA., then about four months' useful



Discharge curve of C.A.V. 120-volt standard capacity dry-cell H.T. battery.

work can be expected, since the recuperation periods will be of longer duration than is possible during our tests.

The other sizes made in this series are 60 volts, 66 volts, and 99 volts, the prices being 5s. 6d., 6s., and 9s. respectively.

The makers are C. A. Vandervell, Ltd., Well Street, Birmingham.

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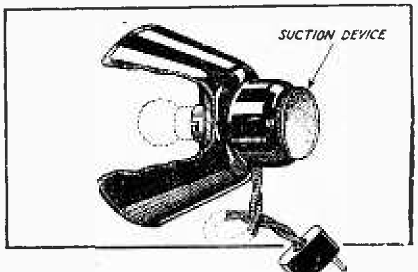
WORKSHOP INSPECTION LAMP.

A handy inspection lamp is a very useful addition to the home constructor's workshop equipment, for there are many occasions when it is necessary to direct a beam of light into dark corners of a set when making adjustments or effecting repairs. The ServeUlite inspection lamp, made by Thomas A. Rose & Sons, Ltd., 25, Milton Street, London, E.C.2, is particularly well suited for this purpose, for it can be attached instantly to woodwork, metal, or glass, a special suction device being fitted for this purpose.

It is made of bakelite and embodies a small S.B.C. lamp-holder for either 2-, 4-, or 6-volt bulbs, and complete with a length of flex and a small two-pin plug costs but 4s. 6d.



ServeUlite inspection lamp for workshop use.

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SOLOIDEX.

This is a liquid preparation which, added to ordinary accumulator acid in the proportion of one part of Soloidex to three parts of acid, converts the electrolyte into a jelly form, thereby rendering the accumulator unspillable. On solidifying the electrolyte takes on a cellular structure with the acid in suspension, and the accumulator functions in exactly the same manner as formerly, with the added advantage that creeping of the acid is eliminated, and as the plates are embedded in a solid mass the paste in the lead grids cannot loosen and cause internal short-circuits.

Soloidex should be mixed with acid of 1.250 s.g., being added slowly and well mixed, using an earthenware jar for the purpose. The mixture is poured into the cell when the battery is fully discharged, and must be left for at least three hours to solidify, after which the battery is charged at the rate determined by the capacity.

This preparation is sold in 4-oz., 8-oz., 1-pint, and 1-gallon sizes, costing 9d., 1s. 6d., 3s. 6d., and 25s. respectively, and is suitable for treating wireless, motor cycle and motor car batteries. The makers are Concess and Co., Ltd., 28-30, Eagle Street, London, W.C.1.

NEWS FROM THE CLUBS.

The Autotone in Birmingham.

Mr. F. L. Devereux, B.Sc., of *The Wireless World*, gave a lecture and demonstration on the Autotone at the last meeting of Slade Radio, Birmingham.

The members, of whom there was a record attendance, were greatly interested in the description of the essential points of the receiver, and in the demonstration, which showed the merits of tone correction used with a very highly selective receiver.

Hon. Secretary: 110, Hillaries Road, Gravelly Hill, Birmingham.

New Society at Kettering.

Nearly sixty enthusiasts have joined the new Kettering Radio and Physical Society, which was formed on April 18th. Two members, Mr. J. C. Lee and Mr. R. J. Pankhurst, already own transmitters with radiating aerials, and another member possesses a transmitter with an artificial aerial. It is hoped that the Society will soon have its own transmitting licence. During the summer Field Days are to be held, direction-finding with portable apparatus being the main attraction. At the opening meeting, Mr. J. C. Lee lectured on the topical subject of "Selectivity."

Hon. Secretary: Mr. R. J. Pankhurst, 9, Shakespeare Road, Kettering, Northants.

North Middlesex D.F. Competition.

Amateur transmission on 160 metres with portable apparatus formed the subject of a lecture and demonstration given recently before the North Middlesex Radio Society by Mr. L. C. Holton, one of its oldest members. The lecturer, referring to the early circuits, said that for flexibility and also reliability it was probably impossible to beat the "Hartley." He compared his apparatus with the Society's portable transmitter, and indicated several interesting modifications in his own equipment.

The Society's first Field Day of the year, which takes the form of a direction-finding competition, is to be held on Sunday, May 22nd.

Hon. Secretary: Mr. M. P. Young, 40, Park View, Wynchgate, N.12.

A Short-wave Evening.

Short-wave apparatus was given the place of honour at the recent exhibition meeting of the Kentish Town and District Radio Society. The walls of the club room were covered with QSL cards from all parts of the world, and the apparatus on view included two transmitters, five short-wave receivers, transmitting inductances for all amateur wavebands, special short-wave condensers, quartz crystals, relays, and other interesting pieces of apparatus. During a demonstration morse signals picked up from distant stations were made to light lamps.

Hon. Secretary: Mr. Eric A. C. Jones, 2BOC, 46, Lady Margaret Road, Kentish Town, N.W.5.

Fundamentals.

Mr. H. Bevan Swift, President of the Radio Society of Great Britain, lectured on "Fundamentals" at a recent meeting of the South Croydon and District Radio Society. Why, asked Mr. Swift, did we wind a certain number of turns on our aerial coils? and he proceeded to discuss precisely what happened at the input to a set. Although the lecture dealt with first principles, the members found how useful it could be to renew their understanding of points which are so often forgotten. The lecturer offered a host of valuable hints and answered numerous questions.

Hon. Secretary: Mr. E. L. Cumbers, 14, Campden Road, S. Croydon.

A Comprehensive Discussion.

A wide range of topics was covered in a general discussion at a recent meeting of the Croydon Wireless and Physical Society. Among the subjects dealt with were the design of L.F. chokes, band-pass tuning, tone correction, the difference between frequency and amplitude distortion, and the variations in quality of programmes transmitted from Savoy Hill and Langham Place.

Visitors will be warmly welcomed at the next meeting of the Society, which will be held on Monday, May 23rd.

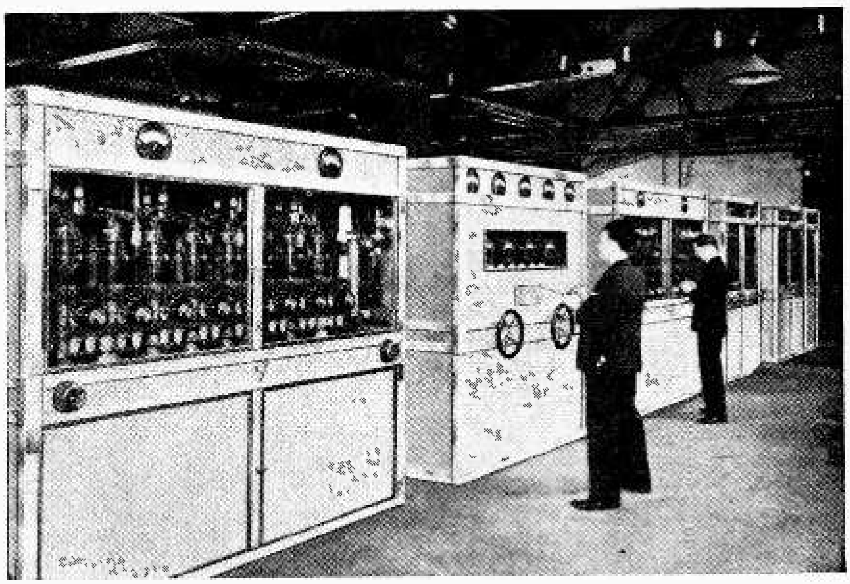
Hon. Secretary: Mr. H. T. P. Gee, 51-52, Chancery Lane, London, W.C.2.

D.F. the Most Popular Attraction.

At the recent annual general meeting of the Golders Green and Hendon Radio Society it was revealed that direction finding proved the most popular attraction during the past year.

A direction-finding competition open to any member of any radio society will be held on Sunday, June 12th, near St. Albans. Five prizes will be awarded.

Hon. Secretary: Mr. W. A. Hudson, 22, The Parade, Golders Green, N.W.11.



IRELAND'S NEW BROADCASTING STATION. Final tests at the Marconi Works, Chelmsford, of the 60 kW. transmitter which is shortly to be installed at Athlone. The six units from right to left are: Drive unit, modulated amplifier, intermediate amplifier, power amplifier, closed oscillatory circuit and second power amplifier.

CLIMAX RADIO GRAMOPHONE

An Inexpensive A.C. Mains Radio-gramophone in Compact Form.

FEATURES.

Circuit.—*Three valves, screen - grid H.F., power grid detector and pentode output valve. H.T. from a full-wave rectifier.*

Main Controls.—*(1) Single-dial tuning with trimmer. (2) Reaction. (3) Wave-change.*

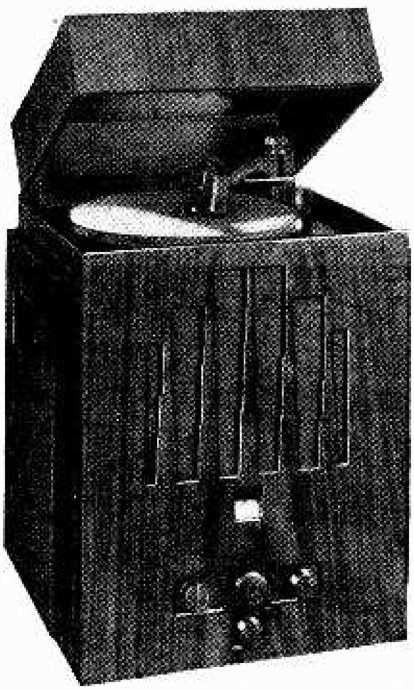
Subsidiary Controls.—*(1) Volume selectivity. (2) Output from pick-up. (3) Radio-gramophone switch. (4) Mains switch.*

General.—*Moving-coil loud speaker. Provision for mains aerial.*

Price.—*22 guineas.*

Makers.—*Climax Radio Electric Ltd., Haverstock Works, Parkhill Road, Hampstead, London, N.W.3.*

IN view of our usual conception of a radio-gramophone, the mention of which conjures up visions of a comparatively large piece of furniture, it is difficult to conceive a small transportable cabinet measuring 20in. by 12¾in. by 11½in. high serving the same purpose. Initial tests with the Climax model 44A, however, soon dispel any doubt as to its claims for inclusion in this category, for it is not merely a compromise but a fully fledged radio-gramophone in miniature which, at the price of 22 guineas, bids fair to set a new standard in receivers of this type.



Portability and compactness are two features of this Climax radio-gramophone.

It is operated entirely from the A.C. mains, and embodies the same chassis, but with a few minor alterations to suit the larger cabinet, as is fitted to the model 33A. This, it will be recalled, consists of an H.F.-Det.-Pentode arrangement with tuned grid coupling between the first two valves, and transformer coupling between the detector and output stages. A few improvements have been made; for example, the H.T. voltage has been raised slightly, resulting in an increase in the power output, and the wiring has been tidied up wherever possible.

Thus we find that its receiving properties are substantially the same as the three-valve receiver, but with the additional advantage of a somewhat larger undistorted output, and there is evidence that the selectivity is improved.

Modified Detector Circuit.

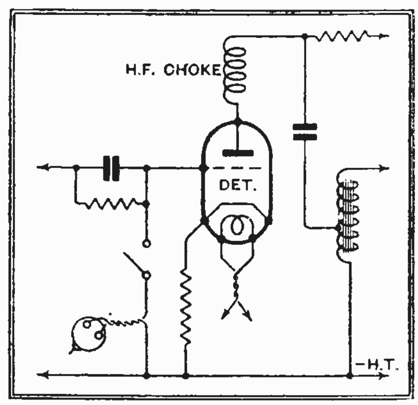
The small panel at the back of the set is retained, together with the push-switch with alternative on and off positions for interrupting the mains supply and the radio to gramophone switch. Sockets for an external loud speaker and the aerial and earth connections are carried on this panel also, and a wander plug is provided for utilising the mains as an aerial should it be inconvenient to erect one of the orthodox type.

When used as an electric gramophone the detector valve is converted into an amplifying stage by applying a small negative bias to its grid, a feature introduced since adapting the circuit for this model. In the earlier arrangement no provision was made for a negative bias when reproducing gramophone records.

For broadcast reception volume can be controlled by the reaction, and, also, by the selectivity control, but since both of these are of the pre-detector type, obviously they cannot be utilised as a volume control for gramophone reproduction. The control is embodied, therefore, in the pick-up arm, an advantage in many respects, for, having found the best adjustment to give the required output level, there is no need to disturb it on changing over to broadcast.

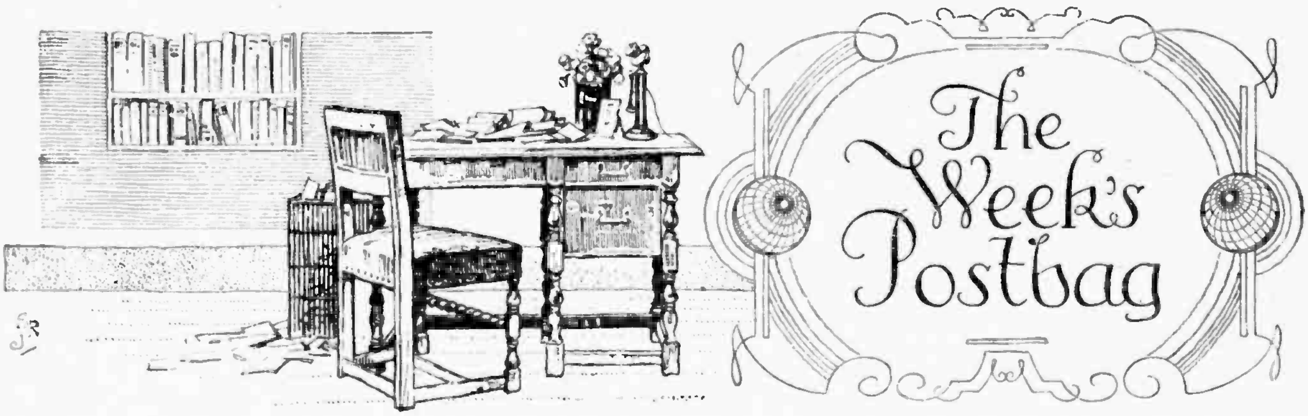
There is little we can add to our previous comments regarding the quality of reproduction, as this is most satisfactory. The same excellent response is obtained with gramophone records as with broadcast. Mains hum is barely audible, and there is not the slightest trace of interference from the electric gramophone motor. Needle scratch is most noticeable by its absence.

The extraordinary compactness of the Model 44A does not detract in any way from its performance, either as a medium for broadcast reception or as an electric gramophone,



Modified arrangement of detector circuit in Climax Model 44A radio-gramophone.

while the excellent reproduction afforded by the moving-coil loud speaker assures a full measure of enjoyment under all conditions. An adequate selection of broadcast programmes is available at all times, and when interest flags in this direction, selections from one's favourite gramophone records are available by the movement of a switch.



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

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

Is 5,000 Cycles Enough ?

IT has been my experience time and time again to wonder how men whom I know to be good technically could associate themselves with the results they were demonstrating to me as good. I have also been very disappointed at results by sets by gramophone makers whose names are world famous, the quality of the same sets having been favourably commented upon in your review columns.

The serious deficiency of the upper register is the prime cause of my disappointment, but it is frequently accompanied by serious booming in the bass register.

I agree with Mr. Hartley that anybody whose hearing is not defective will choose a receiver in which the frequencies from 5,000 to 10,000 are included in preference to one in which they are absent, but I will add this proviso—that people who have long been associated with sets with deficient high-frequency output, whether home made or mass production, are not competent judges.

To suggest that we might have to satisfy ourselves with an arbitrary cut-off of the order common to-day is equivalent to suggesting that we should all be condemned to wear spectacles passing a limited band of the colour spectrum only, say blue, or green, or red for evermore. We would still be able to see, but what a miserable face nature would wear!

The charm of many of the most beautiful passages in music is in the *contrast* between strings and wood-wind which are differentiated solely by the harmonics which fall within the band it is proposed to suppress. The reproduction of many sets (and expensive sets at that) tacitly assume that the listener has heard the various instruments of the orchestra at some time or other, and can therefore recognise the miserable counterfeits they provide.

There have been times when I have wondered if my own hearing were in some way defective and that the average set were good enough, but I have gradually collected enough evidence from impressions certain sets make on non-technical listeners to know that it is good enough. Besides, there is the simple test of comparing the reproduction with actual instruments.

More power to Mr. Noel Ashbridge and his B.B.C. colleagues! D. KINGSBURY, A.M.I.E.E.

Sutton Coldfield.

IT seems to me that this subject should only be approached from one angle—the necessity of reproducing the original performance as near as ever science can get to it.

The whole mechanism of transmission and reception must be regarded purely as a scientific unit to convey what art can give out from studio or hall. In other words, this scientific "unit" must be regarded simply as a channel for the transmission of all types of sound. Its one, and its greatest, virtue should be that it does not originate any sound of its own. In that respect it is therefore *not* a musical instrument.

If we restrict our channel to 5,000 cycles, definitely we are *not* getting all that the original performance is giving. This, as your correspondent, Mr. Hartley, points out, is not a question of opinion but of fact.

The reason why there can possibly be discussion on the matter is because 9,999 people out of 10,000 rarely listen to first-class music at first hand—they have not the opportunity very often. Consequently, they simply do not know what real beauty of sound means, if they did there would be an instant scrapping of thousands of so-called perfect sets.

Here's a little verse which illustrates my meaning and represents the type of listener referred to who listens to a full orchestra and organ at a symphony concert for the first time.

"O! doesn't it sound gorgeous, and doesn't it sound grand,
That great enormous organ, playing with the band.
Now in my set—that's perfect—it doesn't sound the same.
I *wonder* if the organ's right, or is the set to blame."

If we steadfastly refuse to restrict human needs to scientific achievement science will, in time, expand its achievement to accommodate human needs, which is the proper way to look at the matter. H. E. DU PRE.

Jersey.

THE solution would appear to be the reduction of the number of stations. Apart from the high-wave stations, Great Britain appears to have ten wavelengths allotted, covering a total of 90 kilocycles. If two of the stations could be eliminated, space would be available for each station to have eleven kilocycles separation, or if no use were made of the 200-metre allotment, which at the moment does not appear to be in use, twelve and a half kilocycles space would be available for each.

The two stations to cut-out would obviously be the two Nationals. They could easily be abolished if the Daventry Station were rebuilt and the power increased to, say, 200 kilowatts. This would give alternative programmes to practically everybody. F. PINK.

Southsea.

APART altogether from technical considerations, surely the obvious answer to this very important question must be, "*Naturally* not, since we are gifted with the ability to hear far above this!"

As many people must have foreseen, the question of quality in electrical reproduction is resolving itself into the frequency band-width problem—and it is well that *The Wireless World* is opening its pages to the various views that exist; if the matter is reaching a climax at last, all the better, since it is crucial.

The point that one most regrets is that up to now none of our recognised and established musicians has had anything to say in the matter (at least, I have not seen their names in correspondence), and one does feel that their views might be of considerable value, if indeed they should not rightly have the final word! and it is to be hoped that they will recognise the importance of repairing this omission.

As to the suggestion that reproducers should be regarded as "musical instruments," surely this is in direct contradiction of their purpose—which is to reproduce as faithfully as possible all and every sound offered to them; any "personality" or "character" of their own must be inimical to this function, and is only to be reckoned as a fault.

The danger of judging by ear would seem to arise from the fact that the balance is so heavily weighted in favour of any artificial reproduction. We know that it is not the "real thing," but an artifact, and we at once make unconscious allowances. We do not think "how near the real thing is to it!" but "how near it is to the real thing!" being aware, actually, of a very big difference, and using this realisation to make the artificial result appear all the more creditable by comparison.

It must not be forgotten that our education in the matter has been along most unfortunate lines. In the early days we learnt to admire and wonder at reproduction that would be intolerable to-day, but we had no artificial standard to compare it with. Even as reproduction began to improve our difficulty remained—we had never heard anything better.

Now that standards have become much higher throughout all processes, the rate of progress is naturally slowing up, or appearing to, since the days of gross and striking changes are over.

But the gulf between the artificial and the real must always remain appreciable, and can only be reduced by determined and unwavering efforts to extend the frequency range. Unless such efforts are made and maintained the boundaries of sound are more likely to be narrowed than widened.

We have made certain conditions for ourselves, and now, finding that we are hampered by them, we seek to compromise by adapting our activities to the restrictions imposed by them. Surely this is not the way to progress.

"Not failure, but low aim, is crime"!

Cheshire. NORMAN P. SLADE.

The First Telephony?

IN your issue of the 27th April, under the heading of "News of the Week," mention was made that a reader listened to wireless telephony tests at the Crystal Palace as far back as 1913. It is not stated what type of generator nor what power was employed.

It may interest some of your technical readers to know that songs were broadcast by myself in the summer of 1907, using a portable Poulsen arc equipment, consuming approximately 250 watts. A small travelling trunk contained the transmitting apparatus and a somewhat larger trunk the four-cylinder petrol motor coupled to a dynamo.

The demonstration was arranged for the benefit of the War Office, the transmitter being located in Aldershot, whilst General French and his staff listened on a crystal receiver with 'phones in the neighbourhood of Midhurst. Excellent reception was obtained.

I am inclined to the opinion that this was the first occasion that pure radio telephony was used in Great Britain, but I stand to be corrected. H. ANTHONY HANKEY.

Chiswick.

Amplifiers and Tone Correction.

IN commenting on my recently published letter dealing with the above subject Mr. Scroggie takes me to task for assuming the input impedance of a valve to be of infinite value.

Since I used the word "theoretical" to qualify my statement, it is obvious that I was fully aware of the limitations affecting the practical case.

Be that as it may, even though the ideal case never obtains in practice, it is not to be said that a sufficiently good practical approximation is likewise unobtainable (especially in connection with audio-frequency work, which is the case under discussion).

The point I wished to make, however, was, that in terminating certain types of filter structures into impedances which stimulate the "infinite" rather than the "match" condition in impedance relationships, some simplification of filter design is obtainable.

This desirable condition can quite easily be obtained by terminating a filter structure into the "grid-filament" circuit of a valve, because the valve, being a voltage operated device, requires no manifestation of "power."

Where power transference takes place a condition of impedance match has to be established, and this in turn demands the use of a more complicated type of filter structure.

Mr. Scroggie seems to dislike my referring to "tone correction" as an innovation of *The Wireless World*!

Admittedly, it is quite well known that the general principle of "tone correction" is not new, but surely some credit is due to *The Wireless World* for its ability to grasp a scientific truth of outstanding importance and for giving it the publicity it merits? GEO. E. POHU.

London, W.13.

The Amateur Transmitters.

THERE has been some nonsense said by recent correspondents to *The Wireless World* about the falling off of radio interest among the transmitting amateurs of Great Britain.

Allow me to deny this absurd supposition, and to say that interest is as keen as ever, if not more so.

The Manchester and District Hams have been holding enthusiastic monthly meetings for some time now, to say nothing of the Liverpool gang and other centres all over the country.

Activity has been somewhat curtailed owing to the poor conditions which have been prevailing on the 14-megacycle band for some considerable time. This band being our principal DX wave.

Activity has been concentrated on the 40- and 80-metre bands, and some very good DX has been worked on the stable 7-megacycle band. I myself have been in communication for a solid hour with VK2OC in New South Wales, Australia, and ZS2A South Africa, also for nearly an hour recently.

A possible explanation for your contributor's remarks may be that he hasn't heard any G stations lately. This being due to the lengthening of the skip distance. If he listens carefully on 40 metres he will no doubt hear quite a number of ground-waves from G stations.

Prestwich, Lancs. GILBERT H. VICKERS, G6GV.

The Lost Cause!

21 YEARS! Congratulations. My mind goes back to pre-war and pre-broadcasting days when you used to press the cause of the maritime wireless operator. How we used to love the articles and photos relating to our profession. Then the advent of more recent post-war legion!

The cause of the maritime operator gradually fades away. Nobody has since taken up the cause so enthusiastically. The maritime wireless operators are now sadly neglected, and I only wish *The Wireless World* could so plead their cause as to make their downtrodden lot more worth while.

The high degree of skill now required needs more consideration from higher authorities than is practised.

It requires a body which is recognised, such as the 21-year-old *Wireless World*, to place the profession of maritime wireless operator on a footing of prestige.

Apparently no more is thought of the operators' association than is thought of the operators themselves.

Drayton. ALBERT PARSONS.
Lecturer on Maritime Radio.

The Importance of Volume Level.

THE misstatement objected to by Mr. Barclay was deliberately made in order to simplify the argument: it is, of course, only true for lowish volume-levels. If, however, a high studio volume-level is assumed, so that for equal volume (apparent) the energy curve is roughly flat, and then a discriminatory volume-control is (rightly) used in reducing volume, this same volume-control will either over-emphasise low and high audible frequencies or suppress them in reducing volume whenever the apparent balance at the studio varies from equality. In other words, the argument of my article holds good: discriminatory volume-control (so-called "tone-control") is a makeshift, and a poor one at that. R. RAVEN-HART.

La Ciotat, France.

Informative Advertising.

CONGRATULATIONS on your "coming-of-age." As a reader from the first issue, I cannot express appreciation of the assistance I have received from *The Wireless World* and its sister journal, *The Wireless Engineer*. May the good work continue!

I would like to reply to Mr. R. N. Watson in your issue of the 20th April, on informative advertising.

To give the power output of a receiver in an advertisement would be sheer waste. The experimenter already has this information by knowing the undistorted output of the last stage, given him by test or the "Valve Data Sheet." The usual buyer of a complete set neither has, nor wants to have, the knowledge to appreciate such statistics. He is solely concerned with *results*. Even if such data were given him, complete with selectivity curves, frequency response, stage gain, and so on, he would still say: "Well, if that is the set you think meets my needs, bring it along and demonstrate."

As one dealing with the performance of receivers every day, I find the following points determine the sale of a set: Number of stations, with Radio-Paris as a *sine qua non*, followed by any two English stations, Rome, Toulouse, and Fécamp. Then selectivity, volume, quality as determined by the buyer's taste and the room in which the set is to be installed, appearance, and ease of operation, in that order. Price usually comes last, as the seller recommends a set he judges to be within the prospect's scope. In short, aural results determine the sale of a set. Statistics do more harm than good.

Again, such data could lead to abuse, as there are people who would give anode dissipation instead of undistorted power output. I have seen this practice in estimates for public address systems.

With regard to a car, such information as h.p. is necessary to compute such points as tax, insurance, consumption, and so on.

It is very satisfying to be able to appreciate technical data, but the sad fact remains that about 95 per cent. of the buying public, and 80 per cent. of the retail trade, do not understand, and do not want to understand, such matters.

Rhiwbina, Glam. W. SUTTON,
Service Engineer.

Quality and Frequency Range.

I MUST confess to some disappointment that more interest has not been shown in the letter that Mr. Merdler in *The Wireless World* for April 13th, for it put forward a very interesting point of view on an important subject.

His contention was, broadly, that there is no need to argue about the frequency range of receivers: that if it is found convenient to limit the range, then this fact should be faced. That the whole combination of studio, performer, transmitter, and receiver should be regarded as a new musical instrument with a definite frequency range and behaviour of its own, and that the artist (and perhaps the composer) must learn its special technique.

For comparison I will set down two other definite points of view. First, that which is being steadily pressed upon the unskilled listener by various interested parties—that the duty of a radio receiver, gramophone, or talking film is to make a pleasant noise, which may perhaps stir the memory by its general resemblance to this, that, or the other original performance, and that for this purpose a frequency range of 100 to 5,000 cycles is ample.

Second, that of the purist—that the *duty* of a radio receiver at any rate is to give an exact reproduction of the original performance, though in practice it may fail owing to certain inherent or external limitations.

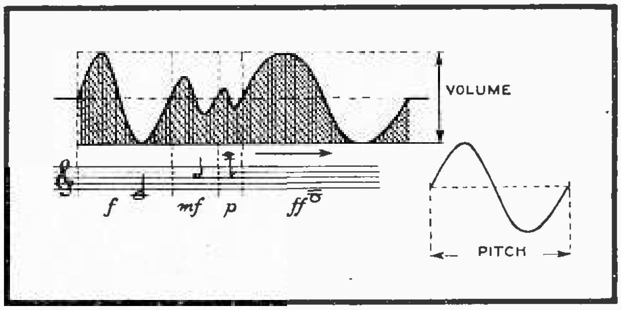
Now the choice between these various points of view is entirely a matter of personal taste. But there is a growing tendency to combine them. People claim to hold the purist view, but then add, first, that the practical limitations do reduce the possible band to that given above, and, second, that this is quite good enough not only for a pleasant noise, but for approximate reproduction. What are the facts?

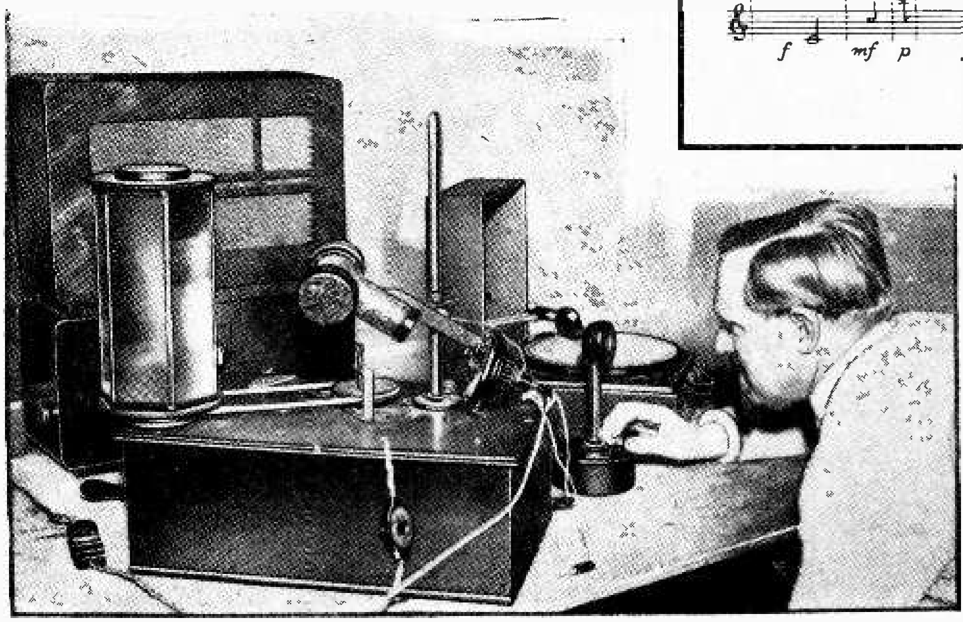
Mr. Merdler suggests that broadcasting should be regarded as a new musical instrument. Let us assume this suggested frequency range of 100 to 5,000 cycles, and see just what sort of instrument it is. Then we shall have a better basis for arriving at a verdict.

Just as a reminder, the frequency range *of fundamentals* of an organ is about 8 octaves, the successive C's being 16-32-64-128-250-500-1,000-2,000-4,000 approximately. The piano is the same except that most of the lowest octave is omitted. Now if the upper limit is 5,000 cycles, all notes above 2,500 will be reproduced shorn of all their harmonics, hence they are all of the same tone-colour, and one can't tell whether they come from organ, piccolo, or violin. Also, all notes above 1,700 will lose all but the second harmonic, and will so lose nearly all (in some cases *all*) their colour.

Next turn to the bass. We see that from 16 to 100 cycles—nearly four octaves—there will be no fundamental tone in the note "reproduced," and in the lower two octaves lack of the lower harmonics as well. The resulting tone-colour—harmonics greater than fundamental—is well known to be characteristic of reed instruments such as the bassoon and oboe.

So that our new musical instrument may be conceived as something like the following. Imagine a kinema organ, with a quite exceptional range of stops, capable of giving faithful imitation of all sorts of instruments *over the middle register*. But in the





"Drawn compositions" are the latest musical novelty in Russia. Dr. E. A. Scholpo, of the State Art-Historical Institute of Leningrad, is now reported to be composing music directly on to the film instead of through the medium of a music clef. In the left-hand picture the composer is seen preparing the sound strip ten times the size of its final appearance on the film. The upper picture shows a typical strip of drawn music and its equivalent in staff notation.

whole of the treble range of 1½ octaves, it has only one stop, of a mild flute like tone, and for the bottom three and a half octaves it again has only one stop, this time a very reedy bassoon.

And what of drama and talks? It has been proved that much of the "character" or individuality of speech, as apart from mere intelligibility, lies in the extreme upper frequencies, and so does the truth to life of "noise effects." Hence talks can just as well all be given by the announcers, and drama should be confined to situations where the characters speak to one another over the telephone (which has the still narrower range of about 200-3,000 cycles, as it is designed only to be understandable at minimum cost).

Frankly, this programme would not satisfy me.

On the other hand, if one admits the general theory of the purist—the ideal of exact reproduction—what are the practical limitations? *Can* we get anything really much superior to Mr. Merdler's truncated kinema-organ, and, if so, does it involve prohibitive cost or complication?

First, what are the requirements? There is now some definite published evidence, which exactly confirms what many of us already knew from unpublished results. In a series of tests in the Bell Telephone Laboratories, a large party of experienced listeners were asked (without knowing what changes were being made) to record when they noticed any change as the frequency response was altered by switching in filters. All the most important instruments of the orchestra were tried out separately, as well as a complete orchestra, singing and speaking voices, and also sundry "noise-effects." The most important results are:—

(1) A bass cut-off at 40 cycles made practically no difference. At 60 cycles it made some difference, but this limit was considered good enough for practical purposes.

(2) A top cut-off at 10,000 cycles made a slight difference, a cut-off at 8,000 a greater one, but the reproduction of music was considered reasonably satisfactory with this limit.

(3) Speech and noise-effects call for a higher treble limit than music if they are to be quite natural.

Speaking generally, one may expect that a range of 60 to 8,000 cycles will give a reasonably close approximation to the original, and 40 to 10,000 an almost completely satisfactory approximation. The results from a 100 to 5,000 range are definitely inferior.

Now look on the other side. What is the nature of the limitations on what the radio set can do? (I leave on one side the gramophone record and the film, which have special difficulties of their own.)

The limit in the bass is almost entirely in the loud speaker. The cost of extending the effective range of a radio set from 100 to 40 cycles is practically negligible. The moving-iron speaker of the reed type cannot reproduce these low frequencies; but the inductor dynamic and the moving-coil undoubtedly can, though it calls for a large baffle. Anyway, it can be taken as a definite fact that if one is prepared to use a large baffle or cabinet, the outfit can be made to go down to 60 cycles, and probably 40, with only a gradual decrease in output, as distinct from the sharp cut-off too often found at present.

As regards the treble, nearly everyone argues on the basis that a definite limitation is imposed by the separation of stations. But this is not so at all. It only applies because *it is taken for granted that the receiver is to behave alike on all European stations*, and wherever it is situated. I grant that if you are under the aerial of Brookmans Park and *must* receive Stuttgart, there are difficulties; but why should all reception be thought of on this basis? I put forward the alternative view that a receiver should be so designed that, while on the one hand it will get *something* from distant stations under difficult conditions, on the other hand it must do full justice to a near station when conditions are easy.

I state definitely that a receiver may easily and cheaply be designed to reproduce up to 8,000 cycles on practically all easy stations, and up to 10,000 on some (and these are just the stations musically worth hearing), while at the same time offering some amusement, though not true reproduction, when difficult stations are demanded.

This being so, we are left with the question of what the loud-speaker can do on frequencies between 5,000 and 10,000 cycles. Here, again, although most present-day commercial moving-coil speakers cut off badly, this is not due to limitations of complication or expense, but simply to careless design. The extra cost of extending the range to reproduce at a reasonable strength up to 10,000 cycles is of the order of 3s. to 5s.

Before concluding, I should like to reply in detail to one or two definite points in Mr. Merdler's letter.

(1) He asks ". . . if really low notes of the order of 20 cycles and high notes of the order of 10,000 cycles are supplied by certain instruments, does the performance gain very appreciably in musical value?" These notes *are* supplied by certain instruments; and if they are not reproduced there is a definite loss of quality, as witness the results of the test already mentioned.

(2) He asks, "Should not a radio receiver be regarded purely and simply as a musical instrument operated on by artists at the studio . . . ?" This is the whole crux of the matter. My view is "NO: it should be a *reproducing* instrument, for reasons given above."

(3) He says: "The piano-maker does not impose on us pianos . . . to cover wide ranges of frequency . . ." But he *does*. Doesn't Mr. Merdler realise that the frequency-band covered by the piano is from 27 to over 10,000 cycles? True, the *fundamental* of its top note is only 4,096 cycles; but even if reproduction of only the second and third harmonics is enough to give the true tone-colour, this still calls for 12,288 cycles as the top limit!

Summing up, the position of the "purist" is this:

(1) I am not content with a pleasant noise to remind me of past concerts: I want the nearest possible approach to an exact reproduction of the performance.

(2) A frequency-range of 60 to 8,000 cycles gives quite a good effect, 40 to 10,000 is practically exact, while 100 to 5,000 is definitely not enough.

(3) The required frequency range can be got without great extra cost, provided that—

(4) Exact reproduction is only demanded for stations fairly easily received: when I must have weak or difficult stations I am content with the "pleasant noise."

(5) It must not be forgotten that exact reproduction also involves certain considerations as to output power: but that is another matter, though here again there are no very great difficulties in getting the required results.

Windsor. P. K. TURNER, M.I.E.E.

IN reply to various critics of my original letter, I can only state that we are not yet in Utopia, and, while the idealist may theorise, the practical man must act. A restricted frequency range is desirable in the interests of the many, even though it be to the detriment of the selfish pleasures of the few. We cannot all sit in the front row of the stalls; the vast majority can, unfortunately, get no nearer than the gallery. For broadcasting to retain its universal appeal we must face up to the facts squarely.

Millions of pounds have been spent by various authorities on transmitting equipment, similar sums have been spent by the radio public on receiving equipment, and by manufacturers in producing plant. The number of stations required for a satisfactory broadcasting service in Europe is such that a separation of more than 9 kc. cannot be arranged, bearing in mind that the wavelength range provided on radio sets at present used is 200-500 metres and 1,000-2,000 metres.

To produce a satisfactory service to listeners spread over a wide area high transmitting power is required, with consequent interference to listeners outside its own service area. To eliminate this interference two alternatives present themselves: either to have specially designed and necessarily costly receiving sets or to limit the audio-frequency range of both the transmitter and receiver, the latter being the more practicable proposition in the present state of the radio art. The fixing of a definite if limited audio-frequency range would enable set manufacturers, component designers, and the general public to see exactly where they stood and negative the fantastic claims to the reception of the complete audio-frequency range.

I would conclude by stating that the secret of successful civilisation is security and confidence in the future, and this in itself prevents drastic measures being taken in either transmitter or receiver technique which would render present-day apparatus prematurely obsolete. L. R. MERDLER.

Acton, W.3.

READERS' PROBLEMS.

Three-electrode Condensers.

IN the "Hints and Tips" section of *The Wireless World* for April 27th it was mentioned that an Ormond "Midget" condenser, with its elements connected in series, could be used as a coupling condenser in a two-circuit aerial tuner. A reader, who proposes to make up a tuning unit as described in that paragraph, asks us to publish a sketch showing exactly how the external circuits should be wired to the condenser. He also seems to be rather uncertain as to why this method of connection was advocated.

The appropriate form of connection is shown diagrammatically in Fig. 1, in which the three "banks" of vanes—two stators and a rotor—are drawn as single vanes for the sake of clearness.

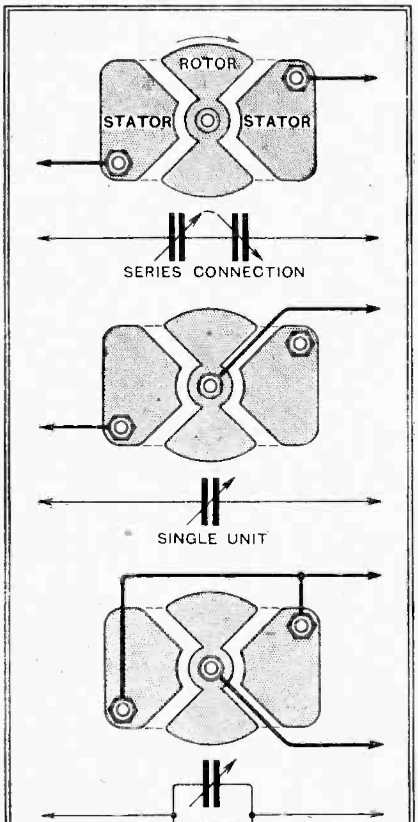


Fig. 1.—Three different capacity values are obtained by making the appropriate connections to a three-electrode variable condenser. The electrical equivalent of each form of connection is shown.

By adopting the series method of connection, the maximum—and, what is more important, the minimum—capacity of a condenser of this kind is reduced to the lowest possible value, as the two elements are in series.

When an intermediate capacity value is needed, the rotor vanes and one set of stators should be connected, while for maximum capacity the stators are joined in parallel. These alternative forms of connection are also illustrated for the sake of completeness.

"Monodial" Condensers.

SOME readers are not entirely clear as to the reason for the use of a number of different voltage-test condensers in the power unit of the "Monodial" A.C. Super. The highest voltage with which we are concerned exists across the rectifier valve, and consequently the highest test voltage condenser, the type L.S.A., is used at this point for C_{23}. The voltage drop in the smoothing and output chokes is quite small, however, so that the same types are employed for C_{21} and C_{22}.

With regard to C_{20}, the current has passed through the field winding of the moving-coil loud speaker, and so the voltage applied is considerably less; accordingly, a type L.S.B. condenser is used at this point.

Again, the voltage on condenser C_{18} is still lower, owing to the presence of the resistance feeding the tone-corrector stage, and a type B.C. suffices at this point. The voltage is lowest of all in the grid decoupling circuit, and so the lowest test voltage condenser, the type B.B., is employed for C_{19}.

Free Field Current.

A READER asks whether there would be any risk in inserting a loud speaker field winding rated at 125 volts (maximum) in a 350-volt H.T. supply circuit.

We think that some confusion exists here as to the basis on which the field winding is rated, and so a word or two of explanation is called for. The manufacturer intends that the maximum voltage applied across the field terminals shall not exceed 125 volts. By connecting it directly across the source of 350 volts, an excessive current would be driven through it, and damage would be done.

But we assume that in the case in question the instrument is to be connected in series with other resistances (valves, smoothing chokes, etc.) across which a large proportion of the total voltage input will be dissipated. Matters must be so arranged that the voltage dissipated across the field winding is not in excess of its rating. And, if this is done, the H.T. supply voltage is immaterial.

An example may help to make this matter clear. Taking the figures given by our correspondent, we will assume that the winding has a resistance of 2,500 ohms, and is connected in the H.T. feed circuit of a set consuming 50 milliamps. The voltage developed across the field will therefore amount to $2,500 \times 0.05 = 125$ volts.

THESE columns are reserved for the publication of matter of general interest arising out of problems submitted by our readers.

Readers requiring an individual reply to their technical questions by post are referred to "The Wireless World" Information Bureau, of which full particulars, with the fee charged, are to be found on the next page.

Forgetting the Screen.

WHEN determining the value of a "self-bias" resistance for a pentode valve, it should be remembered that the screen current should be added to that to be passed in the anode circuit. A reader, who asks us to check the arrangement of his proposed output stage, has obviously forgotten to do this, with the result that the bias resistance which he proposes to fit has a value which is much too high.

Information as to the average screen current of pentode valves is almost always given in the manufacturers' literature, and it also appears on *The Wireless World* Valve Data Sheet. If, however, the current is not known, it is useful to remember that with modern valves it will generally amount to, roughly, one-fifth to a quarter of the anode current.

Trouble with the Neighbours.

A READER tells us that his immediate neighbours have complained that their reception is impaired by the operation of his det.-2-L.F. set. He admits the necessity for using a fair amount of reaction, even for receiving the nearest station, but is emphatic in saying that the detector valve is never allowed to oscillate. Naturally, he is anxious to do the right thing, and asks for suggestions as to how his receiver might be prevented from causing interference.

The ideal solution would be the addition of an H.F. stage with a screen grid valve, and we strongly recommend this course to our reader. If he cannot manage it, then we recommend him to replace his present directly coupled aerial circuit by a more modern arrangement, in which a separate winding, or even a tapping, is used for the aerial circuit.

At the same time, we suggest that an effort should be made to improve the general efficiency of the set in order that less reaction may be necessary.

Novel Double-acting Volume Control.

WHEN volume control is effected by over-biasing an H.F. valve, it is desirable that arrangements should be made for a simultaneous reduction in input from the aerial. This applies, of course, to ordinary S.G. valves, and not to those of the variable-mu type.

A correspondent, who realises the advantages of a double-acting volume control system, asks for some suggestions in applying the method to his existing H.F.-det.-L.F. three-valve set, which employs a capacity-coupled band-pass input filter. A bias of 18 volts for the output pentode is developed across a resistance of about 300 ohms in the common H.T. negative lead, and he proposes to use an existing 50,000-ohm wire-wound potentiometer, connected across this bias resistance, both for controlling the bias of the H.F. valve and for imposing a progressive short-circuit across the aerial-earth system as bias is increased. Information is particularly requested as to how the aerial circuit input may be maintained at maximum possible value when the valve is biased for maximum sensitivity. This is the crux of the matter, as our reader cannot see how to arrange matters so that the increase of bias and the progressive aerial short-circuit shall work in the same direction.

These proposals are interesting, and we know from experience that this method of volume control is quite satisfactory. But we fear that, in order to obtain really satisfactory results, it will be necessary to complicate matters slightly and to use other components beyond the 50,000-ohm resistance mentioned. Possibly there are other ways of doing it, but we suggest that the volume control circuit can best be arranged as in Fig. 2.

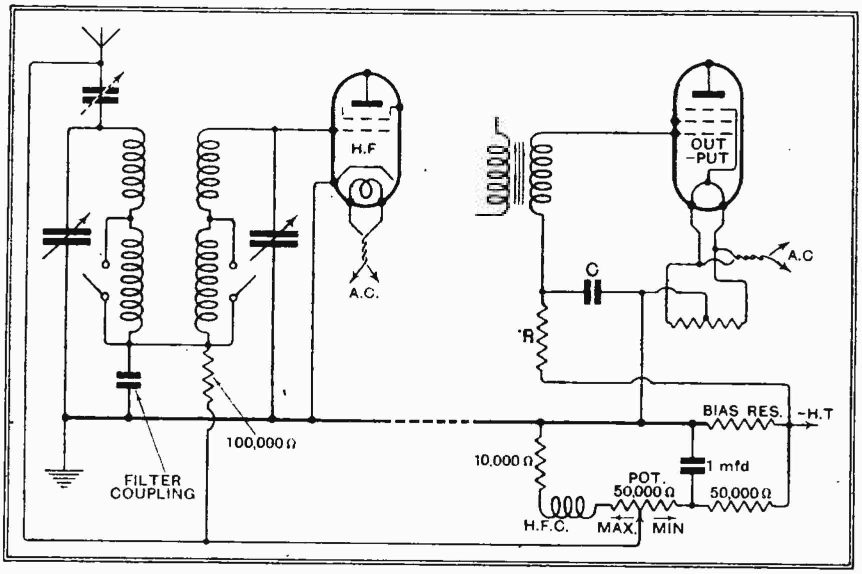


Fig. 2.—A volume-control potentiometer, arranged to produce sensitivity by over-biasing the H.F. valve and, at the same time, to apply a progressively increasing short-circuit between aerial and earth.

A few words of explanation should be added. The H.F. choke is interposed in order to prevent the aerial being more or less short-circuited to earth through the 10,000-ohm resistance, which in turn is inserted merely to provide approximately the optimum bias voltage for the H.F. valve when the potentiometer slider is at the end of its travel corresponding to maximum signal strength. Similarly, it is suggested that a 50,000-ohm fixed resistance should be connected in the bias circuit as shown, in order to improve the "double-acting" properties of the system by limiting the maximum bias voltage.

The relative values of the potentiometer, fixed bias resistor, and limiting resistor will depend on circumstances, but they should always have a total value many times greater than that of the main bias resistor across which they are joined.

The purpose of the 1-mfd. condenser shown is mainly to provide a low-reactance path from the aerial to earth as the slider approaches its "minimum" position. From this point of view, a very much smaller capacity would do, but a large condenser may often be employed with advantage, as it provides a certain amount of extra smoothing.

When Ganging Fails.

WE are asked to summarise the possible causes of failure to obtain accurate "ganging" in a conventional H.F.-det.-L.F. receiver with band-pass aerial input. It is stated that, by adjustment of the trimmers, accurate tuning may be obtained at any one wavelength, but that this adjustment does not hold good from one end of the scale to the other.

Our reader's experience would tend to prove conclusively that the coil inductance values are not properly matched, or that the ganged condenser units are not of identical capacity over the whole range of angular displacement.

Provided that the differences in stray capacity across the various circuits are not too great to be balanced by the trimmers, there are no basic causes of failure. The use of H.F. chokes of poor design may cause puzzling effects, as may also faults in the reaction circuits.

"THE WIRELESS WORLD"

Information Bureau.

CONDITIONS OF THE SERVICE.

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

(2) Communications should be addressed to *The Wireless World* Information Bureau, Dorset House, Tudor Street, E.C.4, and must be accompanied by a remittance of 5s. to cover the cost of the service. The enquirer's name and address should be written in block letters at the top of all communications.

(3) The fee of 5s. covers the reply to any wireless technical difficulty, but in special cases, where the enquiry may involve a considerable amount of investigation, an increased fee may be necessary. In such cases a special quotation will be made.

(4) Questions should be clearly written and concisely worded in order to avoid delay. Where enquiries relate to trouble experienced in receivers built to specifications in *The Wireless World* a complete account should be given of the trouble, and especially the symptoms.

(5) Where reference is made to published articles or descriptions of apparatus, the title of the article, the date of publication in *The Wireless World*, and the page reference number should be given, in order to facilitate reply.

(6) Full circuit diagrams, constructional details of apparatus, or values of components for home-designed receivers cannot normally be supplied, but circuit diagrams sent in with queries will be checked and criticised.

(7) Particular makes of components cannot, in general, be recommended, but advice will be given as to the suitability of an individual component for a particular purpose specified by the enquirer.

The Wireless World

AND RADIO REVIEW
(21st Year of Publication)

No. 664. WEDNESDAY, MAY 18TH, 1932. VOL. XXX. No. 20.

Editor: HUGH S. POCOCK.

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Advertising and Publishing Offices: DORSET HOUSE, TUDOR STREET, LONDON, E.C.4.
Telephone: City 2846 (15 lines). Telegrams: "Ethaworld, Fleet, London."

COVENTRY: Hertford St. Telegrams: "Cyclist, Coventry." Telephone: 5210 Coventry.
BIRMINGHAM: Guildhall Bldgs., Navigation St. Telegrams: "Autopress, Birmingham." Telephone: 2970 Midland (3 lines).
MANCHESTER: 260, Deansgate. Telegrams: "Iliffe, Manchester." Telephone: Blackfriars 4412 (4 lines).
GLASGOW: 26B, Renfield Street, C.2. Telegrams: "Iliffe, Glasgow." Telephone: Central 4857.

PUBLISHED WEEKLY. ENTERED AS SECOND CLASS MATTER AT NEW YORK, N.Y.

Subscription Rates: Home, £1 1s. 8d.; Canada, £1 1s. 8d.; other countries abroad, £1 3s. 10d. per annum.

As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

EDITORIAL COMMENTS.

The New Home.

WITH Saturday evening's programme the British Broadcasting Corporation officially terminated the occupation of the premises at Savoy Hill, which have been the home of British broadcasting for so many years.

The project for a new Broadcasting House has been under way since early in 1928, when the decision was made to acquire a site for the construction of a modern building designed specially to accommodate the ever-increasing activities of broadcasting headquarters. The opportunity was given to *The Wireless World*, a few days ago, of making a tour of the new building, Broadcasting House, at the corner of Portland Place.

The new headquarters are in every way a marvel of modern enterprise. It can be safely said that no other broadcasting organisation in the world can lay claim to anything approaching it in grandeur combined with efficiency. The building, down to the smallest details, has been planned having regard to the special requirements of the service which it is to house, and, although praise is due to all those who have participated in its production, the task performed by the engineering staff of the B.B.C. is one which, we feel, calls for special approbation. The engineers have had a very difficult task to perform. They have had to co-operate with the architects in the production of a permanent headquarters for broadcasting, whilst all the time bearing in mind the necessity for flexibility in the arrangements to avoid any possibility of the building becoming out of date or inadequate from the point of view of their special requirements as broadcasting progresses.

There are altogether twenty-two studios in Broadcasting House, and if any criticism can be levelled at the design of the building it would be that the administrative staff have, for the most part, had to economise in their accommodation in order that there should be no stinting of the space required for the service of broadcasting, which, after all, is the first essential. It is very much easier to extend administrative offices, should necessity arise, than to add studios requiring special construction and communication facilities.

Broadcasting House is an edifice of which British broadcasting may well be proud, and, in congratulating those responsible for its conception and final achievement, we feel that the listener also should be congratulated, because, after all, it is for his benefit, and the greater efficiency of the broadcasting machine will reflect itself, we believe, in greater satisfaction to the listener and better service.

International Programmes.

BROADCASTING tends to become more and more a service restricted neither by distances nor by nationalities, the range of the transmitters and the number of the listeners being dependent only upon the output power of stations and the sensitivity of receivers.

Distant reception is to-day more popular than ever before, and, except for news and similar items, the listening public of Europe appears to care little about the location of a transmitter and whether it is a foreign or home station which is providing the programme.

Does not all this foreshadow the possibility of a change in the broadcasting arrangements of Europe? Is it not possible that eventually each country will have, say, one transmitter for its own news and national programmes, and that all other stations in Europe will be of international ownership, maintained by funds mutually subscribed by the countries of Europe?

Super Regeneration and Short Waves

By H. B. DENT.

The Fundamental Principles Explained.

Notes on the Construction of a Receiver.

WHENEVER a number of wireless enthusiasts forgather it is reasonably certain that the subject of short-wave reception will come up for discussion, variations of the well-tried methods, as a rule, receiving greatest attention, with occasionally a discourse on some lesser-known arrangement. There is one system, however, namely super-regeneration, which is rarely mentioned, but possesses such obvious advantages that there is scope for further investigation, more especially since this system has not been thoroughly tried out on the short waves, although some quantitative measurements taken on wavelengths between 7 and 13 metres can be found elsewhere.[1]

Will this become the recognised system in the future when ultra-short wave transmissions are inaugurated? The present would be opportune to compile a few facts on the subject. Although ultra-short waves are not generally available for testing purposes at present, the general performance of the system can be gauged with reasonable accuracy by comparing the performance on wavelengths of about 20 metres, and on some higher wavelengths, say in the region of 80 metres.

In view of the possibilities offered by the forthcoming ultra-short wave tests to be undertaken by the B.B.C., this article on reception by the super-regenerative method should have a special appeal. The author not only treats the subject theoretically, but concludes with the description of an experimental four-valve receiver.

Recent experiments show that without a shadow of doubt there is a definite improvement at the lower end of the short-wave band, the particular advantages being simplicity of operation and absence of that annoying effect described as "threshold howling." The initial adjustments are not critical as those who have used this arrangement on broadcast wavelengths might seem to think. Indeed, the entire absence of any spurious effects, uncertainties and trickiness in the operation all lend weight to the suggestion that this system has much to commend it for the reception of the extremely high frequencies.

Now, what do we find on the debit side? First, the selectivity seems less good: this may not necessarily be a disadvantage, especially on the ultra-short waves. Secondly, background noises tend to increase, especially if the maximum amplification available is utilised. Possibly we must include also the inability to receive C.W. signals without the aid of a separate heterodyne, but this does not apply, of course, if our intentions are to develop a receiver for telephony reception only.

Negative Resistance Explained.

Now, before proceeding farther, it might be well to refresh our minds and consider a few fundamental facts relating to regenerative circuits in general, and super-regeneration in particular, since the two are closely interwoven. The effect of applying reaction to a circuit is to reduce its positive resistance, or, put in another form, it introduces a negative resistance tending to neutralise the existing resistance in the circuit. This negative resistance may be either less than, equal to, or greater than the positive resistance.

In the first case, when a signal is induced into the circuit the oscillations will build up to a certain definite amplitude determined by the effective positive resistance, and will be maintained so long as the signal continues. On cessation the oscillations die out.

When the negative resistance equals the positive resistance, the effect of injecting a signal E.M.F. is to cause oscillations to build up, which in time will attain an infinite amplitude, and these oscillations continue after the signal is interrupted, but without further increase in amplitude. The condition is similar to

[1] Tests on Five Ultra-Short Wave Receivers. *The Wireless Engineer*, April, 1932, page 186.

Super-Regeneration and Short Waves.—

one with which we are familiar, namely, when the set is in a state of self-oscillation. The injected E.M.F. need not come from the ether, any minute electrical change in the circuit being sufficient to start this process of building up oscillations. In a practical case, however, self-oscillation appears before the effective positive resistance is completely neutralised, since there are other factors which come into the picture at this stage.

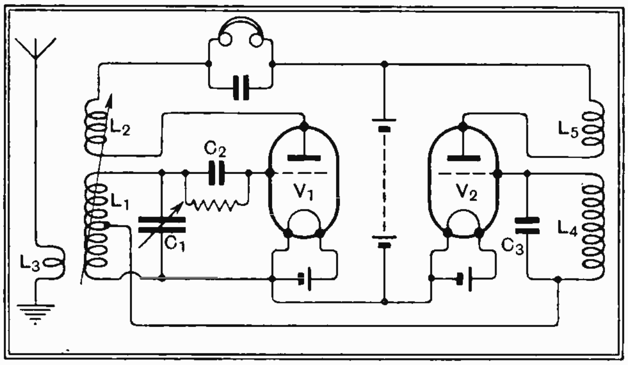


Fig. 1.—Fundamental arrangement for super-regeneration. V_1 is the detector - amplifier and V_2 the quenching oscillator.

So far as the third condition is concerned, namely, when the effective resistance is negatived, it will suffice here to say that it is a theoretical condition only, being the logical conclusion having regard to the sequence of events concomitant with regeneration, but not attainable in practice.

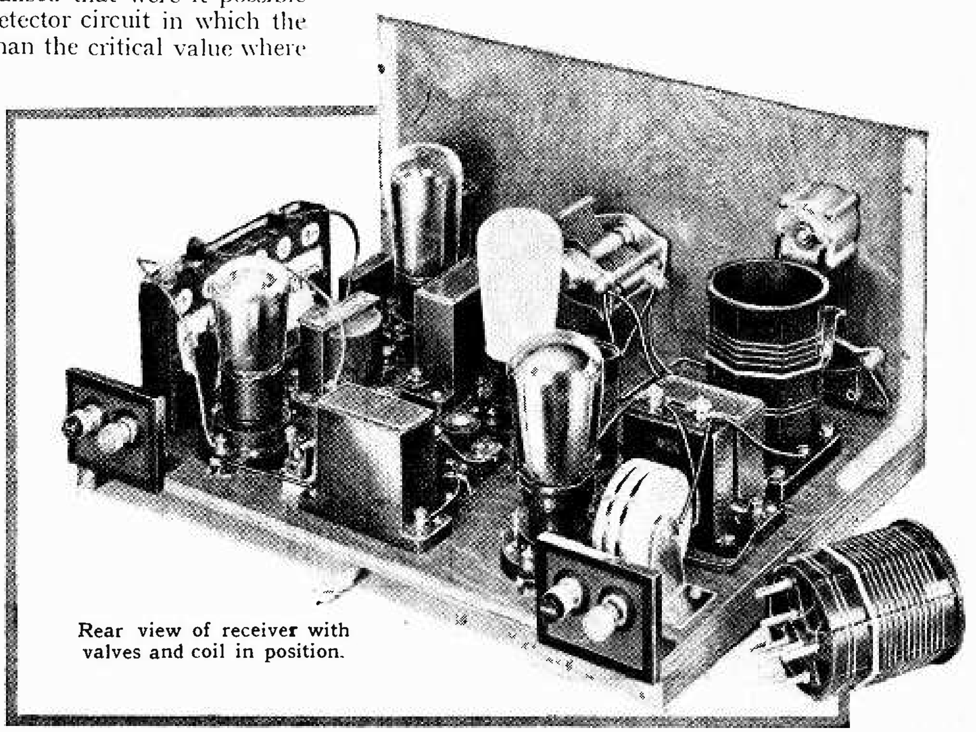
Although space permits only a brief survey of this subject, it will have been realised that were it possible to devise a stable reactive detector circuit in which the effective resistance is lower than the critical value where self-oscillation appears, we should possess a receiver in its most simple form with phenomenal H.F. amplifying properties.

Super - regeneration attains this end and in a very simple manner, as it is now proposed to show. The arrangement is the outcome of some experiments carried out by E. H. Armstrong many years ago, and in its simplest terms consists of periodically varying the positive and negative resistance of the circuit, the balance being arranged so that the average resistance is positive; the circuit will not oscillate, therefore, of its own accord, but during the intervals when the resistance is negative, induced signals will build up to large amplitudes. Since the average resistance of the circuit is positive, these oscillations will die out immediately the impressed signal is interrupted, and indeed follow faithfully any change in its amplitude, but at a much higher level.

There are various ways of obtaining this effect in practice, but one only will be discussed here, and the form this takes is shown in Fig. 1. Briefly, its action is as follows: Variation in the resistance of the receiving circuit L_1, C_1 is achieved by varying periodically the potential on the grid of the valve V_1 by means of a low frequency oscillating circuit L_4, C_3. When the oscillating potential of the grid of V_2 is positive, a conduction current flows from the tuned circuit, thus increasing its effective resistance. During the other half cycle, when the grid of V_2 is negative, no conduction current flows; the circuit of L_1, C_1 thus having a very low resistance, which is determined by the regenerative effect produced by the feed back, or reaction coil L_2. It is during this period that signal currents flowing in the aerial circuit, coupled by the coil L_3, build up, are rectified by the action of the grid detector V_1 and become audible in the headphones.

Intermittent Cessation of Signals.

The ear, being unable to respond to rapid changes, does not notice the intermittent cessation of signals at each half cycle of the oscillator V_2, and in this respect resembles the human eye, the retentive effect of an image on the retina precluding any determination of change in form if the variations are sufficiently rapid. This defect, if it can be regarded as such, makes moving pictures possible, so likewise does the accommodation of the ear render super-regeneration possible. It has



Rear view of receiver with valves and coil in position.

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been suggested in some quarters that for the reception of broadcast matter and telephony signals the quenching oscillations generated by V_2 should be above audibility, since obviously these will modulate the carrier wave and be superimposed on the signal. Recent experiments carried out by the present writer have shown, however, that the performance in general is better with a low quenching frequency, but practical considerations preclude the use of those much below 6,000 cycles per second, otherwise it cannot be filtered out after rectification without noticeable deterioration of the quality of reproduction.

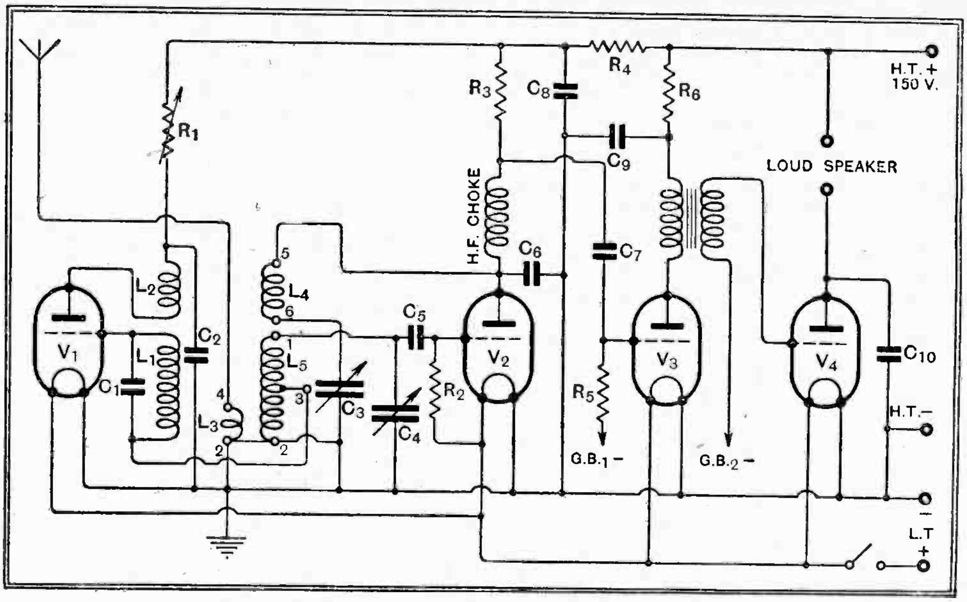


Fig. 2.—Theoretical circuit diagram of the Super-regenerative Four receiver for short waves. Values are as follows : C_1, 0.05 mfd. ; C_2, C_8 and C_9, 2 mfds. ; C_3, 0.0003 mfd. ; C_4, 0.00015 mfd. ; C_5 and C_6, 0.0001 mfd. ; C_7, 0.01 mfd. ; C_{10}, 0.001 mfd. ; R_1, 0-2 megohm variable ; R_2, 5 megohms ; R_3, 30,000 ohms ; R_4 20,000 ohms ; R_5, 2 megohms ; R_6, 10,000 ohms ; V_1, V_2 and V_3, H.L. type valves ; V_4, small power valve.

Armed with these few fundamental facts it only remains now to consider how best we can apply the principle of super-regeneration to a practical case, for there are certain features inherent in the system that tend to impose a limit to the amplification desirable at the detector stage. If the maximum possible amplification is extracted, background noise is inclined to be rather troublesome. This is due to the exceptional sensitivity of the detector-amplifier, which not only responds to minute electrical pulsations having a tunable component, but greatly amplifies the inherent valve noises brought about by very small changes in the operating state of the valve. For example, fluctuations in the electron emission from the filament normally passing unnoticed become audible in this system, but even with the valve operating well below its maximum the

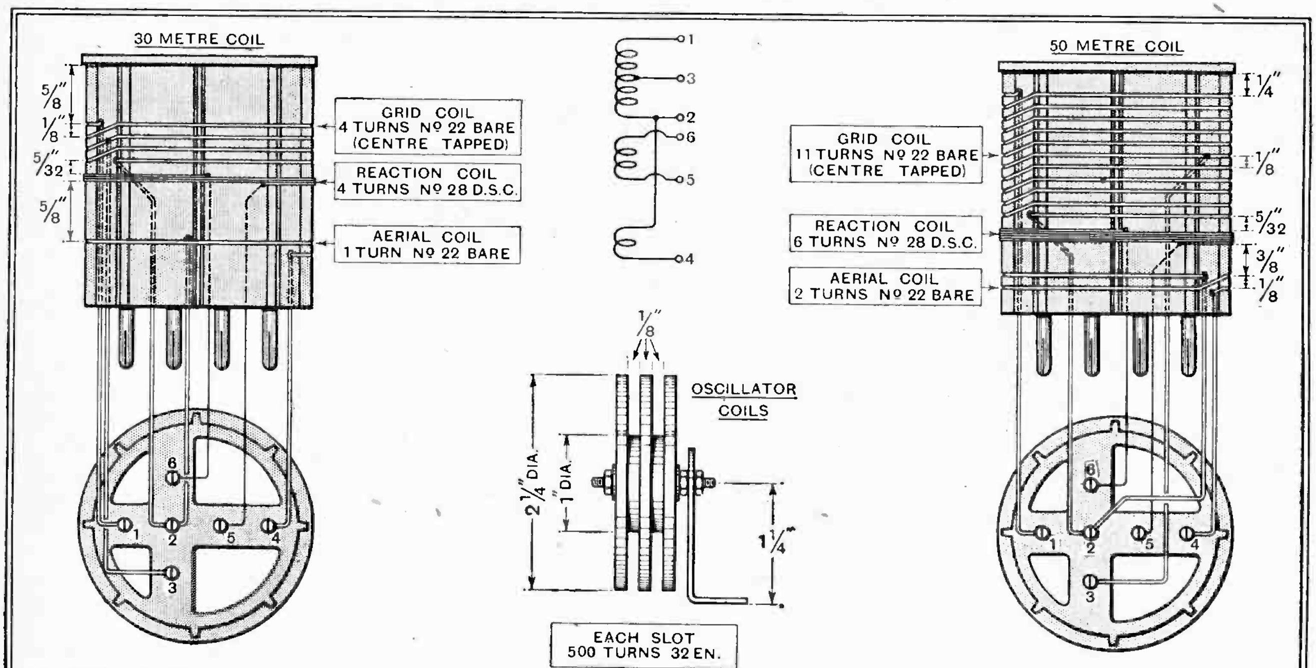


Fig. 3.—Details of coils and winding data, also dimensional drawing of wooden former for quenching oscillator coils.

amplification available is quite sufficient for all practical purposes. Under these conditions the background is then comparable with that present in any other arrangement affording an equivalent overall amplification.

Quenching Oscillations.

Therefore, in the receiver with which the experimental work was undertaken there were two L.F. amplifiers after the detector which, with the separate quenching valve, gives four valves in all. Since general-purpose valves are now obtainable at a reasonable price, there is no point in unduly complicating the issue by endeavouring to make one valve serve two purposes, such as combining the functions of quenching oscillator and detector.

The theoretical circuit is shown in Fig. 2, from which it will be seen that, with the exception of the quenching oscillator V_1, the circuit follows quite orthodox lines. Coils L_1, L_2, and condenser C_1 constitute the quenching circuit, the frequency of which is just within the audible range, and if the superimposed oscillations are found to be troublesome they can be suppressed by fitting a filter between the anode of V_3 and the primary of the L.F. transformer. One of the Heterodyne Whistle Filters made by Postlethwaite Bros. will serve quite well for this purpose.

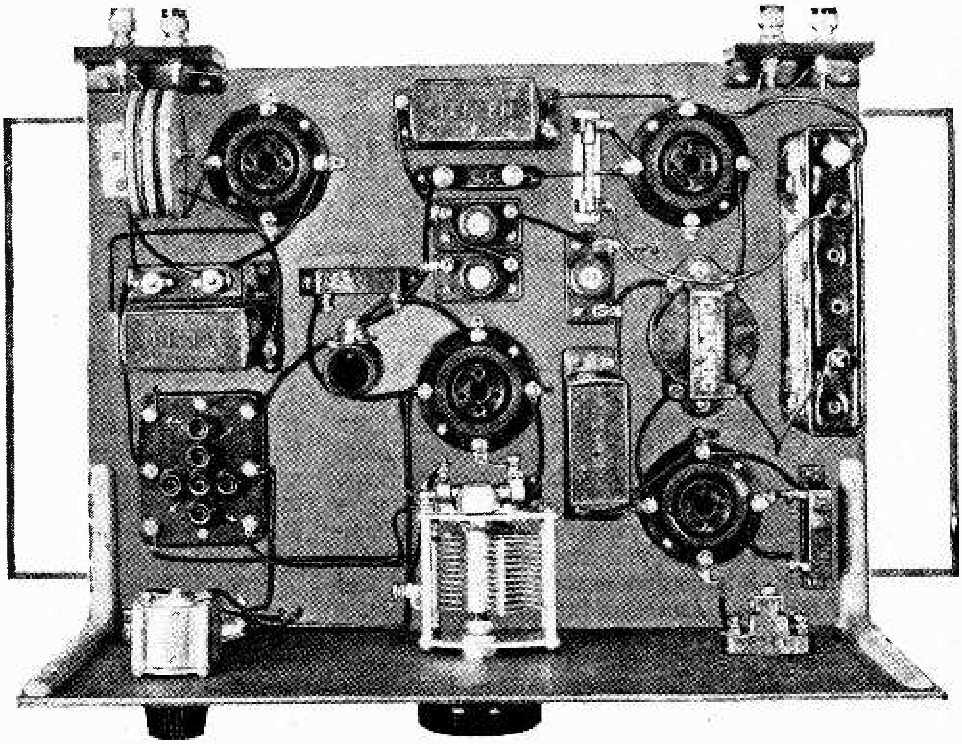
Details of the small wooden former supporting coils L_1 and L_2 together with the winding date, are given in Fig. 3. Oscillations generated by V_1 are controlled by a variable resistance in series with the H.T., since this is a more economical method than utilising a potentiometer arrangement, especially as the receiver was battery-operated. This resistance (R_1) is variable between 0-2 megohms, and can be a Clarke's Atlas Universal Rheograd or a similar type, but of different make. It should be adjusted so that the valve just oscillates. Strong oscillations are not desirable, and if they are too weak adjustment of C_3 to the point where the detector breaks into oscillation periodically suppresses the quenching oscillations and produces an effect akin to motor-boating. A fractional turn of R_1 corrects this and gives a satisfactory working condition. The reaction condenser is adjusted to give the best compromise between signal strength and background noise.

With R_1 adjusted so that the quenching valve is inoperative, the set can be used as a straightforward Det.-L.F. arrangement, in which condition C.W. signals are receivable in the normal manner. When a telephony station is heard, V_1 can be brought into action and the super-regenerative properties utilised to boost the signal for loud speaker reproduction.

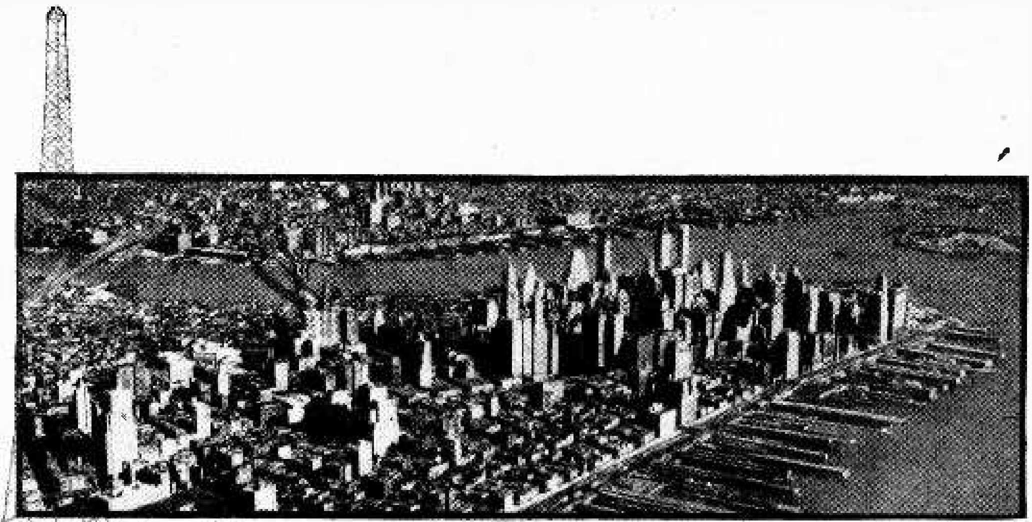
Under super-regenerative conditions more reaction capacity is required at C_3, which, of course, is in keeping with the theory, since the circuit L_3, C_4 will not reach the critical state for self-oscillation until its effective resistance is reduced to a lower level.

It will be noticed that the tuned grid coil L_5 is provided with a centre tap, to which point the grid return of the quenching circuit L_1, C_1, is joined. As one coil will not cover a sufficiently extensive waveband for normal purposes, and switching would be an undesirable complication, coils L_3, L_4, and L_5 are wound on a six-pin former. Two coil units have been prepared, which, in conjunction with the 0.00015-mfd. condenser C_4, cover wavebands from 21 to 36.5 metres and 35.5 to 76.5 metres respectively. The tuning system must be modified for ultra-short wave reception, special coils and condensers being essential.

So far as the disposition of the components is concerned, it will suffice to say that, provided the usual care is observed and that those constituting the tuned circuit are suitable for short-wave use, no special precautions seem necessary, and if the constructor desires to exercise his constructive ingenuity he is at liberty to do so within reason.



Plan view of Super-regenerative Four short-wave receiver with valves and coil removed and showing layout of the components. Filament and H.T. leads are run below the baseboard, and a four-way battery cable replaces terminals to preserve a neat appearance.



How they Broadcast in America

By A. DINSDALE.

Intricacies of the "Network" System.

IN these days when international rebroadcasts are becoming increasingly frequent, and more and more listeners are regularly using short-wave receivers, it occurs to the writer that American programmes might be made much more enjoyable, and more comprehensible to British listeners if they were in possession of more detailed information as to the structure and operation of the great American broadcast networks.

I think I am correct in saying that simultaneous broadcasting originated in England. The Americans tried out the idea tentatively for the purpose of linking up stations all over the country to broadcast nationally events of great national importance. Out of the success of these tentative experiments was born in November, 1926, The National Broadcasting Company,[1] and "chain" or "network" broadcasting (simultaneous broadcasting to us) became an all-day, everyday fact in the United States.

In 1927 rumours began to circulate that a rival broadcasting chain was in process of formation, and a few months later the beginnings of what is now known as the Columbia Broadcasting System made its bow to the American public.

It is of passing interest to note that when I discussed the first rumours of a rival chain with Merlin H. Aylesworth, President of N.B.C., and asked him if he did not feel alarmed at the prospect, he replied: "The only thing I am afraid of is that they will not go through with it. I welcome competition!" To-day, the Radio Corporation of America, of which the N.B.C. is a subsidiary, is under indictment by the United States Government for alleged infringement of anti-monopoly laws. Mr. Aylesworth's astonishing remark thus takes on a new significance.

From the beginning, the N.B.C. divided itself into two networks with key stations WJZ and WEAF in New York. The Columbia Broadcasting System has maintained itself as a single network, with WABC, New York, as its key station.

The Sponsored Programme.

The first impression gained by a stranger on entering the Columbia headquarters at 485, Madison Avenue, New York, is that there is scarcely room to move. Prowl round the building, and you will be sure to find structural alterations going on somewhere or other. This is the outward and visible evidence of the astonishingly rapid expansion of the organisation under the able direction of a young man only thirty years of age, Wm. S. Paley, President of C.B.S.

To-day the C.B.S. network embraces ninety-three stations, extending from Montreal to the Gulf of Mexico, and from New York to California. It is, in fact, the largest single network in the world. Since all the stations on a network must necessarily have a similar system of operation, we cannot do better than examine the procedure at headquarters to get a true picture of the operation of such a chain.

[1] See "The National Broadcasting Company of America," by A. Dinsdale, *The Wireless World*, May 11th, 1927.

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The first thing to be understood is that there are two kinds of programmes, known as sustaining and commercial. Sustaining programmes are produced and paid for entirely by the broadcasting system, while commercial programmes are produced and paid for entirely by nationally known firms (known as sponsors) who have a product to advertise. This leads me to explain here and now that for a complete understanding of an American broadcasting network one must make three distinct visualisations, or comparisons. (1) From the viewpoint of sustaining programmes it is a public service—but not paid for by the public. (2) From the point of view of commercial programmes it is an advertising medium, just like a newspaper or magazine. (3) From the viewpoint of operation, it is somewhat similar to a railway system.

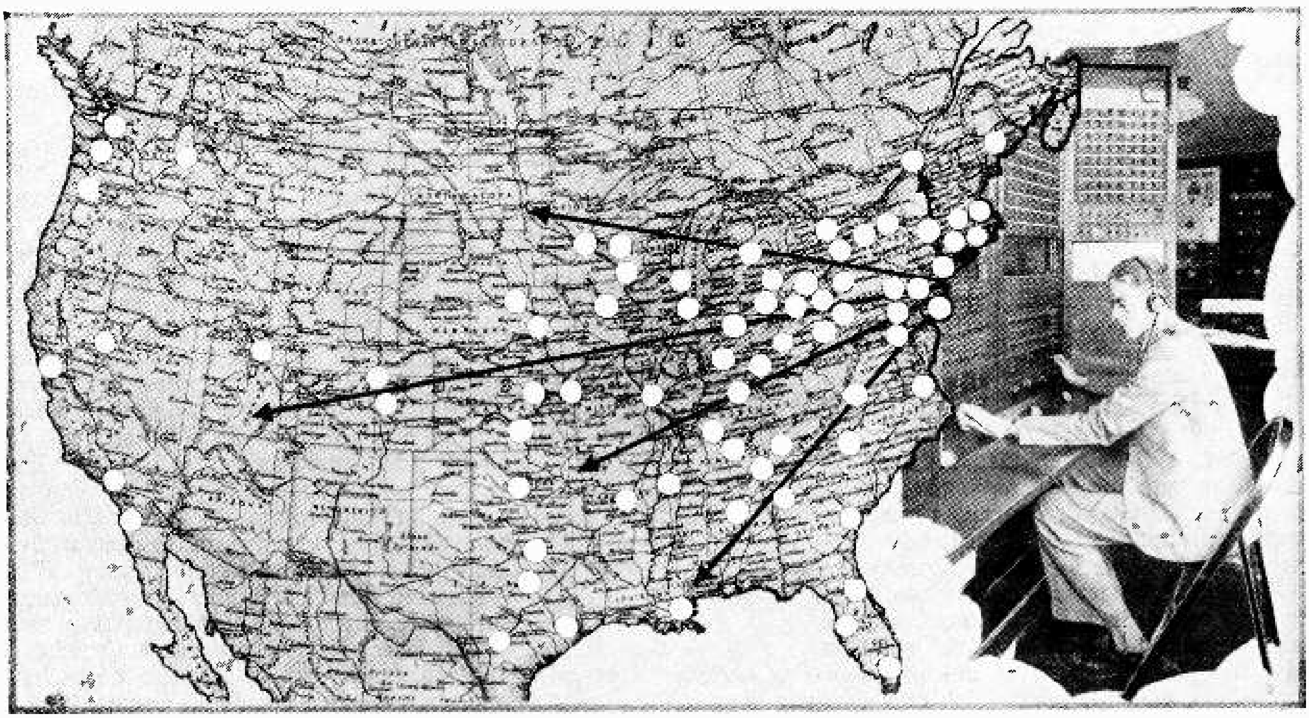
THE "stop watch" methods which govern American broadcasting have no counterpart in Europe; consequently many British listeners to the Transatlantic relays have found difficulty in appreciating programmes in which time saving seems to be a major consideration. This article, by one who is himself concerned with the presentation of American programmes, clears up many perplexities and shows how the advertiser calls the time as well as the tune.

Let us consider the first picture. For reasons incomprehensible to the average British listener, the more important American broadcasting stations must maintain service for about eighteen hours daily. The C.B.S. operates actually from 7.30 a.m. to 2 a.m. the next morning. From 11.30 p.m. to 2 a.m. only dance bands are broadcast. Those who like to stay up all night, or who work all night and demand radio programmes to keep them amused, can pick up stations farther west, and keep on moving west until 6 a.m. in New York, at which time the Californian stations are closing down at 2 a.m., Pacific Coast time.

Now, only certain hours of the day attract commercial sponsors. Certain morning and afternoon hours attract advertisers of goods of interest to women, e.g., home furnishings, foods and cookery, beauty aids, etc. The most valuable hours, from the advertisers' point of view, are between 7 p.m. and 11 p.m., local time, when everybody, presumably, is at home and in a receptive mood for entertainment and anything else that goes with it, such as some reference to the advertisers' products.

It will be seen that the networks have many hours to fill themselves, at their own expense. The key station, therefore, puts on sustaining programmes to fill these hours. Any station on the network which is short of material of its own with which to fill some time applies to the key station for a programme, or programmes, and for this service the network station pays the key station a small fee.

Sustaining periods, as the unprofitable hours are called, are used by the key stations to try out new artists and new programme ideas. An attempt is made to "build up" these artists and programme ideas in



The Columbia Broadcasting system at present covers 93 stations, extending from Montreal to the Gulf of Mexico, and from New York to California. The photograph on the right shows an operator at the main "network" control-board in New York.

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popular favour until, when the time is judged to be right, they are handed over to the sales department, which endeavours to sell them to a sponsor who may be looking for a new artist or an entirely new programme to fit his tastes or requirements. It is for this reason that the networks maintain artists' bureaux, and book engagements for artists, not only to perform on commercial programmes, but also at concerts or other outside entertainments not even remotely connected with radio. The artist first builds up a reputation on sustaining programmes and is then "sold," the artists' bureau (a subsidiary of the network) collecting a commission. Of course, whilst on sustaining programmes, the artist is in receipt of a comparatively moderate fee from the broadcasting company; when sold, the artist receives a much higher fee from the sponsor.

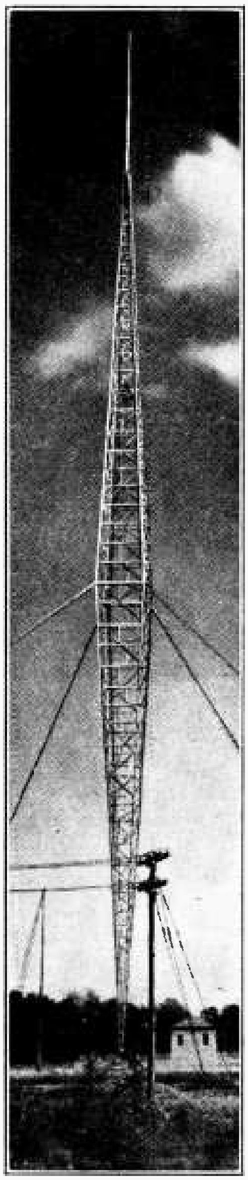
Audience of 15 Millions Reached.

Educational features, sports broadcasts, political addresses, national events, religious broadcasts, etc., all come within the scope of sustaining programmes. It is all a public service, the only profit to the network being the building up of public goodwill, sometimes referred to as a "regular audience" when a salesman is talking to a prospective sponsor.

It should be understood that member stations of a network are entirely independent, owned by persons or organisations not even remotely connected with the broadcasting system. They join a network for purely business reasons of their own. A newspaper has its own reporters, but it subscribes to a telegraph news agency for the purpose of getting news otherwise inaccessible to its own reporters. Independent stations join a network to get sustaining programmes at a price which is cheaper than the cost of putting on their own programme, or because equally good talent is not available to them. Similarly, when they have exhausted the local supply of commercial sponsors, it is to their advantage to sell their facilities to a network for the programme of a national sponsor. Publications have their own advertising canvassers, but they also accept advertisements from outside advertising agencies.

When a manufacturer is about to introduce a new product, or wishes to boost the sales of an old one, he embarks upon an advertising campaign. We are all familiar with such campaigns, which embrace such media as newspapers, magazines, hoardings, etc. The effectiveness of an advertising medium (and the advertising rates charged for its use) is based upon the number of people it can reach. It is for this reason that the front page of a large newspaper is more effective, and more expensive, than a page in a magazine.

I do not think there is any publication in the world which claims to reach more than five million readers.



Programmes from the Columbia Key station, WABC, New York, are sent out in medium and short waves. The photograph shows the adjustable short-wave aerial.

In America it is claimed that broadcasting. on a nation-wide hook-up, will reach an audience as high as fifty millions. Thus, in America, radio is regarded as the most effective advertising medium, and manufacturers use it to administer their sugar-coated pill, i.e., entertainment plus their brief advertising message. Naturally, radio is an expensive medium. The charges include the prices for the time of each station included in the network (the key station pays network stations to take commercial programmes—a reversal of the sustaining programme practice), the telephone company's wire charges, and the cost of entertainment talent. The sponsor himself chooses carefully those stations on the network which he wants to take his programme. His choice is influenced largely by the extent of national coverage he can get with the minimum number of stations. Thus, it is that only on occasions of great broadcasts of extreme national importance are *all* the stations of a given network hooked up together simultaneously; ordinarily, many of the stations will have programmes of their own on the air, either sustaining or commercial.

Commercial Bargaining.

Having determined to use radio as an advertising medium, the manufacturer calls in one of the large advertising agencies which have a radio department. If he has decided ideas on the sort of programme he wants, he instructs his agents accordingly. If not, the agents advise him and make suggestions. Then follows a long period of auditions, either in the private studios of the advertising agents, or in the studios of the selected broadcasting network, at which the manufacturer (now "the client" to the agency and the broadcasting officials) listens to different types of artists and programmes. Finally, the agency and the network officials, between them, build a programme which is to the client's liking. Perhaps, in the process, the network may succeed in selling some of its sustaining talent; alternatively, the agency brings in outside talent which it has had on its lists. Next, a contract is signed for a period of thirteen, twenty-six, or fifty-two weeks, rehearsals commence, and then comes the opening night when a new commercial feature starts its run on the air.

In the early days of the networks a full hour programme once or twice a week was very common, but

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gradually the period came to be reduced until to-day a full hour commercial programme is a rarity. Two important factors influenced this change. In the first place, the demand for "time on the air" grew to such an extent that there was not room for everybody on a one-hour basis, and programmes were reduced to half-hour, and, finally, to a fifteen-minute period. In the second place, with a one-hour programme once a week the sponsor can only deliver one message, occupying five or six minutes at most. With the now popular fifteen-minute programmes, three to six nights a week, the sponsor can deliver three to six advertising messages, varied in character, and aggregating more minutes per week. The underlying principle is "little and often."

Death of the Draped Studio.

Some sponsors, in an effort to cover the entire country at the most propitious times, put their programmes on twice a night. For example, the Columbia Broadcasting System has one fifteen-minute programme which goes on between 7.15 p.m. and 7.30 p.m., New York time. It goes out over the New York key station, WABC, and over stations in the network as far west as Chicago, and as far south as New Orleans, thus covering the eastern section of the continent. At 11.15 p.m., New York time, the programme is repeated, this time only for points west of Chicago, as far as the Pacific Coast, where it arrives at 7.15 p.m., Pacific Coast time. This is an example of a network being split into two for time-difference reasons.

One sponsor who manufactures a popular brand of cigarettes puts his programme on at 10.30 p.m., New York time, a period so favourable to the entire continent that seventy-eight stations take it. In addition, when the programme reaches the Pacific Coast it is relayed by short-wave to Honolulu, where it is rebroadcast over the local transmitter. According to reports, the rebroadcast is usually as good as a local studio production. The sponsor, of course, pays for the relay facilities, which are expensive over such an enormous distance.

So much for radio as an advertising medium. Let us now examine the American network from the operational angle, an angle of far greater interest to technical readers of this journal; my only excuse for going into the two previous angles is that some idea of them is necessary to a full understanding of the technical operations and the reasons for them.

Studio arrangement and operation in America have many points of difference from their equivalents at B.B.C. headquarters, and the modern American studio is a far cry from the original heavily draped rooms of the early days of broadcasting. The old draped studios had several bad faults, lack of adequate ventilation being not the least of them. Perhaps their worst fault was the unequal absorption of different sound frequencies by the drapes; high frequencies were almost entirely lost. Translated into everyday language, such studios felt "dead." Musicians complained they had to work very hard and yet did not seem to produce the sort of results they were accustomed to. As one saxophone player put it to me: "I blow my lungs out, and still the notes seem only to crawl out of the horn, fall on the carpet, and lie there, dead." A roll on a kettle-drum sounded, over the air, like somebody playing on a block of hardwood. This latter because of the not generally known fact that a kettle-drum is rich in frequencies of upwards of 6,000 cycles.

The usual complaint from listeners, concerning a performance from a draped studio, is that it sounds unnatural, by which they mean that they can hear no room noise, or echo, and thus they get no sense of the perspective to which they are accustomed. It was to combat this fault that the B.B.C., some years ago, introduced the now famous echo chamber.

America attacked the problem in quite a different way by designing studios without drapes, but having instead walls built of acoustic material so applied as to add "life" or resonance to the studio. All modern studios are built along these lines, and in the proportion ratio of length-breadth-height of 5-3-2. The floors are uncarpeted, consisting of thick, hard-packed cork, shellacked over and polished. The walls and ceilings are so treated that there are two ends to a studio, a "live end" and a "dead end." The microphone or microphones are always set at the dead end, where they will be free from the effects of local parasitic reflections, and yet pick up with full resonance effects all sounds originating towards the live end. Under this arrangement studios can be built very much larger, and much longer pick-ups can be employed—i.e., orchestras can be placed much farther away from the microphone, twenty or thirty feet, in some cases. The effect of a long-distance pick-up in a live studio is to permit of a better blending of instruments in an orchestra, together with the addition of a realistic resonance which gives perspective. In other words, instead of listening to a concert orchestra from the conductor's stand, as was the case with draped studios, you now listen from away back in the "best seat in the house."

At Network Headquarters.

Unlike the B.B.C. arrangement, every American studio has its own individual control-room, from which the occupants can survey the studio through a double plate-glass window. In the control room are the monitoring equipment and a loud speaker. There are several microphone outlets in each studio. Prior to a programme the studio engineer couples up the required number of "mikes," and the producer places the "mikes" to the best advantage. At network headquarters the production staff is a small but highly important body of men. At any given hour of the day you will find several of them on duty in different studios, attending either to auditions, rehearsals, or air programmes. They have supreme control of the studio and all its occupants, including the announcer and the engineer.

At the commencement of a rehearsal the producer directs the seating of the orchestra with a view to getting the best musical balance over the air, as checked by listening to the loud speaker in the control-room. Singers, speakers, or actors, and the microphones which

How They Broadcast in America.—they use, are also disposed in the most favourable positions. The producer then corrects faults during the rehearsal from his position in the control-room. His method of communication with those in the studio is by means of a "talk-back" system. By pressing a button on the engineer's control panel, all microphone circuits from the studio are rendered inoperative, and instead a microphone in the control room is switched into circuit. This reproduces his words in the studio through a loud speaker mounted on the studio wall.

Microphones are used in two ways. (1) Suspended from the ceiling by means of ropes, or (2) mounted on vertical stands with heavy bases. In either case, they can be moved about freely and their height from the floor adjusted in accordance with requirements.

Condenser microphones are used almost universally, although arrangements are being made to install the new dynamic instruments.[1] The condenser microphones contain within the housing one stage of amplification, the output of which is fed to a 2-stage amplifier in the control-room, after first passing through the gain control and mixer panels. The output of the control-room amplifier then goes to the master control-room, where there are further amplifier panels in long rows. From here the output of any studio can be "piped" to loud speakers in waiting-rooms throughout the building, to audition rooms, and to the monitoring speaker in the control-room of the originating studio.

(To be concluded.)

[1] See "New Moving Coil Microphone," by A. Dinsdale, *The Wireless World*, December 16th, 1931.

Nuts to Crack.

Instructive Problems and their Solution.

THE present series has been started by *The Wireless World* for the benefit of readers who like to work out little problems for themselves and be sure that the results they obtain are correct. At frequent intervals wireless problems are presented, and in the following instalment the answers are given with the methods of working them out, and hints on possible points of difficulty. Problems 44 to 46 have been previously given, and below the answers appear, whilst another set of problems is included this week for treatment in the next instalment.

QUESTION 44.—**What is the natural wavelength of an aerial of which the inductance is 10 μH. and the capacity 0.00025 mfd.? If a tuning inductance of 150 μH. is placed in series with it, what is now the resonant wavelength?**

Answer—94 *metres*; 377 *metres*.

The formula for the natural wavelength of a series resonant circuit is $\lambda = 1{,}885\sqrt{LC}$ in which λ is in metres, and L and C are the inductance and capacity of the circuit expressed in μH. and mfds. respectively.

In the present case, $\lambda = 1{,}885 \times \sqrt{10 \times 0.00025} = 1{,}885 \times 0.05 = 94$ metres (approx.).

With the addition of the tuning inductance of 150 μH., the total inductance of the circuit becomes 160 μH. The resonant wavelength is now $\lambda = 1{,}885 \times \sqrt{160 \times 0.00025} = 1{,}885 \times 0.2 = 377$ metres.

QUESTION 45.—**If we assume that the total inductance of the aerial circuit in the above question is concentrated in the tuning coil, what parallel capacity is required to tune to 500 metres?**

Answer—0.00019 *mfd*.

Let C mfds. represent the extra capacity required. Since this is placed across the tuning inductance, it may be considered to be in parallel with the existing natural capacity of the aerial, so that the total capacity across the tuning circuit is (C+0.00025) mfd.

The required wavelength is given as 500 metres. Applying the same formula as before,

$$1{,}885 \times \sqrt{160 \times (C + 0.00025)} = 500.$$

$$\therefore\ 3.77 \times \sqrt{160 \times (C + 0.00025)} = 1.$$

Squaring both sides of this equation,

$$14.2129 \times 160 \times (C + 0.00025) = 1,$$

$$\text{i.e.,}\ 2{,}274 \times (C + 0.00025) = 1$$

$$\text{therefore } C + 0.00025 = 0.00044$$

$$\text{therefore } C = 0.00019 \text{ mfd.}$$

QUESTION 46.—**A certain receiver consumes 46 mA. at 250 volts, the current being supplied through a smoothing choke of 25 H. If the actual D.C. output from the eliminator is at 270 volts, what is the resistance of the choke? The H.F. and det. valves are supplied with 8 mA. through a special smoothing choke of 200 H. and 3,000 ohms. What is the voltage drop in the special choke?**

Answer—435 *ohms*; 24 *volts*.

This is a very simple exercise in the art of "dropping volts." The voltage supplied to the H.T. terminals of the receiver is 250 volts, while the actual eliminator voltage is 270. The difference of 20 volts represents the "IR drop" across the choke, the symbol R, of course, referring to the resistance and not to the inductance of the coil, the latter of which exercises no effect whatever upon direct current. Of this IR product, the current value I is known to be 46 mA. or 0.046 A. Thus we may write

$$20 = IR = 0.046 \times R$$

$$\therefore\ R = 20/0.046 = 435 \text{ ohms.}$$

The IR or voltage drop across the special choke is similarly found. Here

$$IR = 0.008 \times 3{,}000 = 24 \text{ volts.}$$

Such a slight voltage loss is, of course, immaterial in the case of valves in the positions specified.

NEXT SERIES OF PROBLEMS.

QUESTION 47.—**It is desired to use 75 per cent. of the possible voltage amplification of a triode in a resistance-capacity coupled L.F. stage. If the μ and A.C. resistance of the valve are 22 and 18,000 ohms with 100 volts on the plate, what resistance load is necessary in the anode circuit?**

QUESTION 48.—**If the anode resistance of the above question is connected directly to the output of an eliminator supplying current at 300 volts, what mean current is taken by the L.F. valve?**

QUESTION 49.—**The maximum deflection of a certain galvanometer occurs when the current is 40 mA. If its internal resistance is 15 ohms, what is the greatest P.D. it can measure directly? What series resistance would it be necessary to use if readings up to 10 volts were desired?**

QUESTION 50.—**If it is desired to use the above galvanometer as an ammeter reading up to 5 amps., how should it be arranged?**

NUTCRACKER.

UNBIASED

By

FREE GRID.

Cash Down.

I WAS very pleased to read the other day that the City Fathers of the ancient town of St. Edmundsbury, where Mr. Pickwick had his remarkable adventure in a young ladies' seminary, have decided to give a cash equivalent to owners of mains-driven radio receivers and H.T. eliminators now that a change-over in the supply arrangements is about to be made. The more usual practice of merely exchanging A.C. for D.C. apparatus has always caused a certain amount of friction, because, although in many cases the supply authorities have been generous and given first-class A.C. gear in return for a D.C. eliminator of very doubtful origin, in most cases which have been brought to my notice they have done the opposite and given a squidgy-looking A.C. eliminator often incapable of supplying the needs of the humblest det.-L.F. set.

—in order to surrender same.

I do not know whether they propose to give a flat rate to all comers equal to the price of a good A.C. eliminator, but, if so, many people who now use merely a dilapidated-looking choke and a couple of decrepit condensers will be in clover. I *have* heard of cases—but in my heart can scarcely believe that human nature could be so depraved—where people deliberately knock up a Heath Robinson arrangement, using the secondary of a burnt-out transformer as a choke, in order to surrender same, as they say in business letters, to the authorities in exchange for an A.C. eliminator.

Bunk about Junk.

IN spite of the fact that broadcasting has been with us for nearly a decade and that technical information has been available to all and sundry, it has always been a source of surprise to me how so-called home constructors are gulled by cheap-jack radio dealers who offer obsolete sets at what they call enormous sacrifices. I can well understand the ordinary listener with little knowledge being taken in by these people, but it amazes me that experienced home constructors literally scramble over each other for the rubbish offered.

The fact that the experienced are also taken in was strikingly brought home to me the other day when I happened to be standing on the fringe of a crowd gazing at a junk radio shop in a district which is rather notorious for them. By the judicious use of my umbrella I managed to worm my way to the front of the crowd and, whether you approve of the practice or not, deliberately listened—I refuse to take cover under the polite fiction of "overheard" — to various conversations.

It did not take long to disentangle the home constructors from the ordinary members of the public who were gazing dumbly into the window with that typical bovine expression which a crowd of people assume when they are looking at something beyond their comprehension. Not only were the former completely taken in by a coil with a weird and wonderful name, which was in the window, but they were all agog concerning some handsome-looking commercial neutralised sets of about 1927 vintage which were being offered at scrap-iron prices. I ventured to point out to them that the things were not even worth the knock-out prices at which they were offered, and—such is man's ingratitude—nearly got knocked out myself for my pains.

The wily shop owner had labelled everything with the original list prices of five years ago, just as though the handsome-looking junk was in the manufacturers' current catalogues. This price was crossed

I deliberately listened.

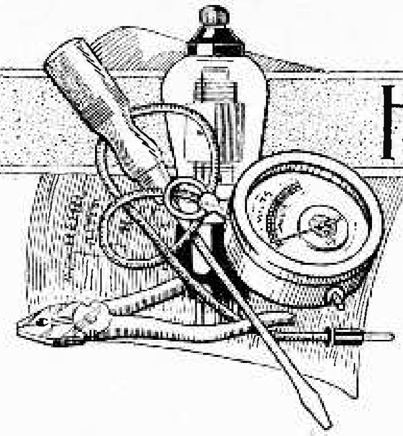
out and the new one substituted. This hoary old arrangement seems to have as profound an effect on the suckers as ever, and I felt a sense of shame that such people called themselves by the honoured names of "home constructor" or "amateur experimenter."

Shaken Faith.

I WASTED several hours the other day trying to track down trouble in a new set solely because I had taken the insulation resistance of all components for granted. I thought that we had progressed sufficiently far from the days when big chunks of ebonite had scarcely a high-enough resistance to act as a grid leak, for this sort of thing to be impossible, but at present my faith is badly shaken.

A manufacturer to whom I mentioned this point rudely suggested that it would be very much better if my liver were badly shaken instead.

Practical Hints & Tips



Simplified Aids to Better Reception.

IN the "Hints and Tips" section of *The Wireless World* for April 27th it was shown that a highly sensitive meter was necessary in order to take direct measurements of the rectified current delivered by a diode valve connected in the modern manner.

Rectified Current Meter.

It might have been added that if one is content with an indirect measurement—which, after all, is almost equally useful and informative—a good indication of what is taking place may be obtained by inserting an ordinary milliammeter in series with the anode of the succeeding L.F. valve.

This may sound wrong; it is generally accepted as an article of faith that for distortionless reproduction the direct anode current of any L.F. amplifier should remain steady and be totally unaffected by the signals. But here we are dealing with an exceptional case; the mean working grid potential of the diode valve shown diagrammatically in the paragraph referred to might be derived from two sources; first, from an automatic bias resistor, and secondly, from the voltage built up across the coupling resistor by the rectified carrier wave. The first is a fixed quantity, while the second is influenced by the strength of the signals, by the efficiency of the preceding tuned circuit, etc., and by the efficiency of the H.F. amplifier, if one be included. Consequently, the mean anode current of the succeeding L.F. valve will vary in sympathy with the mean rectified current, which is what we want to measure in this case. An increase in anode current will indicate an increase in signal current and voltage, and vice versa.

It will be fairly obvious that this method of measurement is not applicable when the grid of the L.F. valve is "blocked off" from a diode coupling resistance by means of a fixel condenser.

For use in this manner the maximum milliammeter current reading should be slightly greater than the normal current consumption of the L.F. valve.

THOSE who have struggled with a set in which the high-frequency amplifier is lacking in stability do not need to be told that the disturbing H.F. potentials are sometimes transferred from circuit to circuit in a quite unaccountable manner. In bad cases instability may persist in spite of the observance of all the normal precautions.

Earthing Condenser Rotors.

As an example of a transference path that is certainly not obvious, one may take the rotor spindle of a ganged tuning condenser which is used to control both input and H.F. coupling circuits. As this rotor is earthed, it would seem to be a most unlikely intermediary for passing H.F. voltages between the grid and plate circuits of the valve, but it is a demonstrable fact that such transference does actually take place in some cases, and it is to avoid these unpleasant possibilities that most modern condensers have an earthing contact on the spindle between each set of rotor vanes.

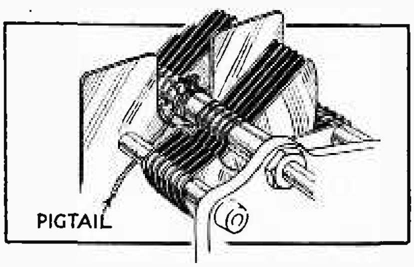


Fig. 1.—An extra earthing connection on the rotor spindle of a ganged condenser.

When this refinement is not included in the original design, it is not always an easy matter to improvise a satisfactory form of contact. Even if it were possible to do so, one would hesitate before attempting to solder a connection on to the spindle, for fear of doing damage to a relatively expensive condenser; equally, it is risky to disassemble the rotor, as, without skill of a special order, it is most difficult to put it together again correctly.

A method of making a connection that proves to be satisfactory in most cases is illustrated in Fig. 1. This consists of a light metal clip of circular form, which is clamped to the spindle. A thin strip of brass, copper, or even tin will do, and as a fixing, a short brass screw and nut, about 6 or 8 B.A. in size. A flexible connecting "pigtail" should be soldered or otherwise fixed to the clip before it is placed in position.

WHEN a receiver includes a satisfactory form of post-detection volume control, it is generally wasteful and unnecessary to fit the usual variable potentiometer for regulating the input from a gramophone pick-up.

Tapped-off Pick-up Voltages.

As often as not, this device may be joined directly across the first valve of the amplifier, which is generally the detector, when it is performing its normal function.

But it may happen that this valve will not accept the full voltage of a sensitive pick-up without overloading, and so some means of restricting input must be included. In such cases, the pick-up arrangement of the "Power Radio-Gram" offers a solution; in this receiver, the pick-up was shunted across a fixed potentiometer consisting of two resistors in series, matters being arranged as in Fig. 2, in which the elements of the potentiometer are marked R and R_1. By making the ohmic value of R equal to two-thirds of the total value of R and R_1 combined, it was arranged that only one-third of the total pick-up voltage should be applied to the grid.

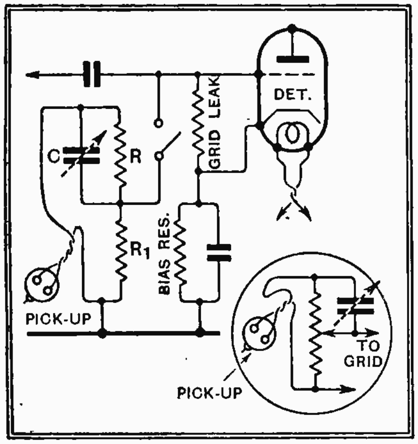


Fig. 2.—Fixed potentiometer for regulating output from a pick-up, combined with adjustable capacity compensation for loss of high notes.

If a greater or lesser proportion of the available pick-up voltage is required, it may easily be obtained by varying the relative values of the two elements, but it should be borne in mind that their total value should not differ greatly from that advocated by the maker of the pick-up as suitable for connecting across the instrument.

There is some inevitable loss of high notes when a relatively small proportion of the total voltage is tapped off for application to the grid; this is due to the fact that the resistance R is in series with the grid circuit capacities. Fortunately, this may be compensated in a simple but satisfactory manner by shunting the resistance in question by a condenser, which tends to restore the balance, as it offers an alternative path which decreases in reactance with increase of frequency. A semi-variable condenser is convenient for use here, as its value may be adjusted to suit one's personal tastes; a maximum value of 0.001 mfd. is a good choice in average circumstances.

This principle of controlling relative intensity of high notes is also applicable when a conventional variable potentiometer is used with a pick-up; connections for the controlling condenser are shown in the inset of Fig. 2.

An Extemporised Aerial.

WHERE it is difficult to erect an efficient outdoor aerial, and particularly in cases where long-distance reception is not an essential requirement, it should be remembered that the wiring of an electric bell system often makes a surprisingly effective collector of energy.

The word "often" is used advisedly; like most other extemporised aerials, the efficiency of this particular form is likely to be a varying quantity, for reasons that are not generally apparent. But, at the worst, no harm will be done by trying it, as nothing more is required than a connection, through a small semi-variable condenser, between the nearest point on the wiring (generally a bell-push) and the aerial terminal.

Measuring Dynamic Resistance.

MANY of the methods of measurement and testing that are described in the "Hints and Tips" pages are admittedly of the "rough-and-ready" order, with few pretensions to extreme scientific accuracy. This is inevitable; bricks cannot be made without straw, and those to whom wireless is merely a hobby cannot be expected to have a laboratory-full of instruments. But much may be done with common-sense and simple apparatus, if it is borne in mind that a margin of error will probably exist.

Partly on account of these limitations, no attempt has yet been made to describe here a method of ascertaining the dynamic resistance (or the equivalent parallel resistance) of a tuned circuit. True, the uses of the absorption method of making a comparative test have been discussed, but this may be of little value unless one has standards of comparison. A measurement of equivalent parallel resistance is practically a direct index to the efficiency of a coil, and further, a knowledge of this property is necessary before the more abstruse problems of design can be tackled.

So far as procedure is concerned the problem is not a difficult one, the only drawback being the virtual necessity for a valve voltmeter. But, after all, this is basically nothing more complicated than a valve detector with a meter in series with its anode, which can be improvised and calibrated by methods already described.

To make a measurement, the apparatus is set up as shown in Fig. 3, in which L and C comprise the circuit under test, which is energised through a fixed coupling from an oscillator working on the desired wavelength. With the resistance R disconnected entirely, a measurement of the H.F. voltage existing across the circuit is first made. The same process is then repeated, but with R in position, and the ohmic value of this resistance is adjusted until the original voltage reading is exactly halved. The resistance value necessary to effect this scheme is equal to the dynamic resistance of the circuit.

This sounds simple enough, and, indeed, very few complications are likely to arise. Points to watch are the oscillator output, which must not change under small variations of load, and the resistance R, which must be non-inductive, of reasonably low capacity, and of a type which does not introduce appreciable dielectric losses. Constant oscillator output is best assured by the use of ample power, and, with regard to the resistance, modern metallised resistors are generally suitable for the purpose. On connecting the resistance across the test circuit, a slight compensating adjustment of the tuning condenser C must generally be made, in order to maintain exact resonance.

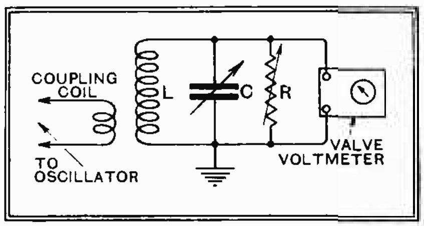
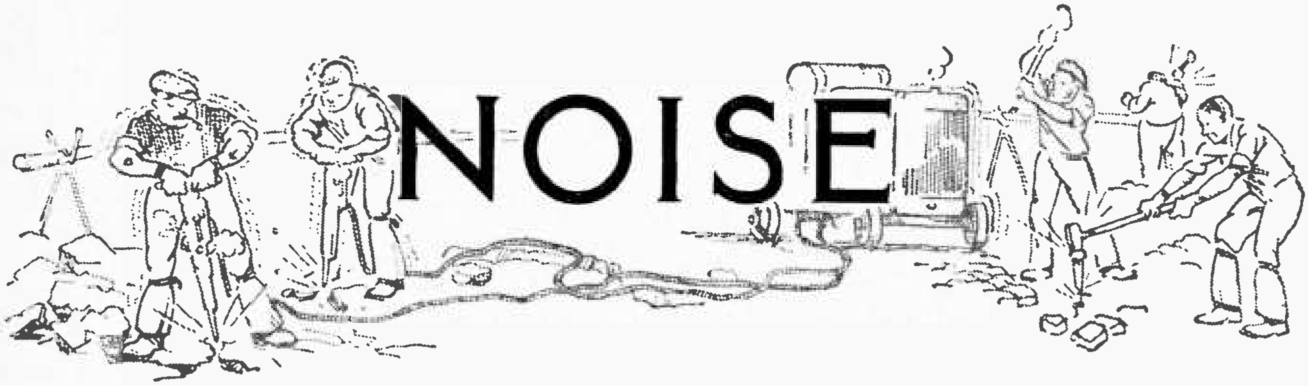


Fig. 3.—Illustrating a simple method of measuring the dynamic resistance of a tuned circuit.



NOISE

The Peculiarities of the Human Ear.

By N. W. McLACHLAN, D.Sc., M.I.E.E., F.Inst.P.

ALTHOUGH we all know perfectly well what is meant by a noise, few of us would care to undertake a rigid definition in a truly accurate sense. I believe some of the text-books on sound on which our forefathers browsed, did hazard some definition or other, stating that noise meant sounds which were unrhythmical and unmusical. Personally, I should define noise as something of an acoustic variety which annoys our senses; all of which brings us back to the old gag that "a noisy noise annoys an oyster." Of course, I do not know exactly what portion of the frequency spectrum the acoustic organs of the oyster prefer. They might lie in what we term the super- or ultra-sonic region above 20,000 cycles per second.

One reads quite a lot in newspapers—and occasionally in *The Wireless World*!—about loud speakers which cause annoyance. This can be put down to three things: (*a*) too great a loudness; (*b*) continual or intermittent use, for one can have too much of a good thing; (*c*) bad reproduction. Obviously, technical people would settle on (*c*) as the cause of the trouble.

UNMUSICAL noises which may soothe, musical sounds which may irritate, noises that may reduce psychological activity to zero—these and other phenomena are dealt with in this article. Dr. McLachlan, who is an authority on acoustics, explains that the listener's reaction to noise depends not only upon its strength, but upon its main frequencies.

One might be tempted to say that noises are sounds which cannot be classified as music. But, although the roar of a full-grown lion in the jungle would scare the average person and sound a terrific noise, to the big-game hunter, armed with the necessary rifle and high-velocity ammunition, it sounds as music—to soothe the savage breast. And, again, to many people, otherwise normal or supposed to be, real, genuine music, like Bach, Chopin, Liszt, and Tchaikovsky, acts as a strong irritant.

An Era of Acoustic Marvels.

All this points to one's reaction to noise being, in part at any rate, largely dependent upon physiological and psychological processes in any particular individual.

Now, there are undoubtedly—as in any other common experience—certain noises which we all agree are objectionable. The terrific din in tubes and railway trains, against which ordinary conversation calls for vocal horse-power!; the roar of vehicular traffic in busy streets, particularly in provincial cities, the proud possessors of cobble-stones which won't wear out; the din ot the modern aeroplane, which we see at an altitude of thousands of feet but hear as if it were close by; all these and other sounds of a distressing character have to be taken for granted in an era which boasts a hundred and one acoustic marvels where sounds are blended to a nicety and controlled with precision. There is no doubt that continual noise acts as an irritant to the nerves. It is extraordinarily difficult to think if one is surrounded by powerful noises. They seem to drive our thinking apparatus up to the flat part of the psychological saturation curve.

Recognising the detrimental effects of much noise from large electric generators and motors, certain enterprising manufacturers have devised means for measuring and analysing noises emitted by their products of manufacture. By so doing it is possible to discover which part of the machine is most responsible for the noise concerned, and then the design can be modified accordingly.

Readers of *The Wireless World* know full well that when measurements are made it is necessary to have some units by means of which the results can be expressed. Current is measured in amperes, and power in watts. What about noise? Doubtless, the term "decibel" will not be unfamiliar to the reader. It is the unit of sound or sensation, and has been used a good deal in these pages during the past year or so.

There are several ways of gauging the intensity of a noise. One is to use a note of a certain frequency whose strength is varied until the noise is just inaudible, or vice versa. Having found the strength by observation, it is a simple matter to calibrate the apparatus so that the strength is read off in decibels. But we

Noise.—

must not fall into the error of assuming that the greater the number of decibels the more irritating the noise. The exhaust of a motor cycle measured in decibels is quite large, but it is not proportionately irritating. This is solely because the sound is mainly of a low-frequency character.

If we stand near a Klaxon horn going at full strength, the irritation is very considerable, because the frequencies involved are much higher than those from the exhaust of the motor cycle. Much more annoyance is caused by high notes than by low ones. In fact, there is rather a peculiarity as the pitch of the note rises. With a fairly loud note the loudness and the corresponding annoyance are about equal up to one octave above middle C on the piano (512 ~). Above that frequency, even if the loudness is preserved constant, the note becomes increasingly annoying as the frequency rises. An extremely irritating noise is a bugle call at close quarters. The pitch and the intensity conspire to reduce one's psychological organs to absolute inactivity.

All this points to the fact that when there is a noise—which, of course, is a complex note containing many frequencies—the degree of irritation depends not only

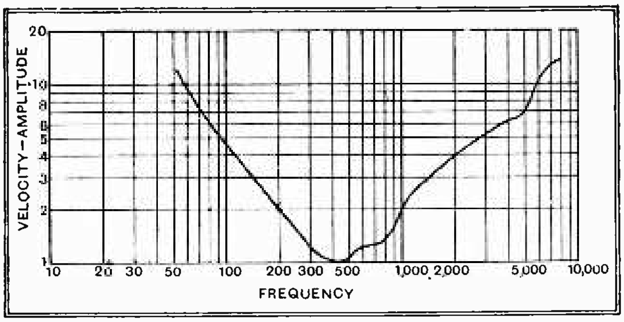


Fig. 1.—Analysing the noise made by needle scratch in a gramophone record. The range covered is from 60 to 8,000 cycles and refers to the outer portion of the disc.

upon its strength, but upon the main frequencies into which it can be analysed. If these main frequencies are low the noise will not be so annoying as if they are mainly higher frequencies of the same strength. This is entirely due to the peculiar properties of the human ear, which is more sensitive to high than to low frequencies of moderate strength. When the intensity exceeds a certain value low frequencies may become not so much irritating as actually painful. This, however, is an extreme case which seldom occurs in practice.

The majority of readers are interested, either directly or indirectly, in the reproduction of gramophone records. The reproduction is always accompanied by a certain amount of needle scratch, although in general it is only audible on very soft passages or just before the record begins or after it finishes. If we listen very carefully to the noise, after the record is finished, it consists of more than a high-pitched scratch. By means of special instruments it is possible to analyse the scratch noise and to ascertain the main frequencies to which it is due. This has been done by Dr. E. Meyer, and some of his results are shown in Figs. 1, 2 and 3.

The curve of Fig. 1 shows the frequency band covered by the scratch, the strength of each frequency

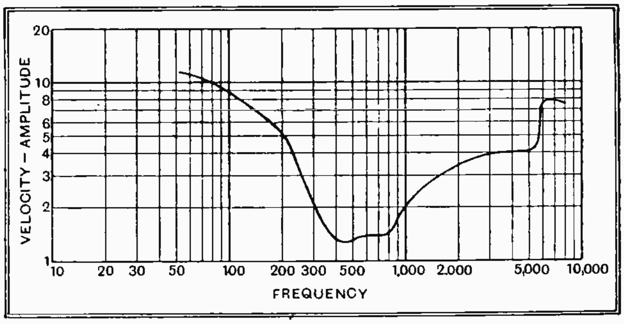


Fig 2.—Here the frequency of the noise produced by the needle at the central portion of the disc is shown.

being represented by the ordinates of the curve. We see that the range covered extends from 60 to 8,000 ~ —about as extensive as atmospherics and mush in the band of radio frequencies. This curve refers to the outer portion of the disc before the point of the needle has been ground off. The frequencies above 3,000 are more powerful in this case than for the central and inner portions of the disc, which are shown in Figs. 2 and 3. The noise can be divided broadly into two components: (*a*) low frequency, (*b*) high frequency.

The Frequency of Annoyance.

The low-frequency band is probably due to the recording or reproducing motor. Actually this band is inaudible, except at the beginning and end of the record, where there is no recording. Of course, in certain radio-gramophones there may be induction or microphonic action of the driving motor on the valves, etc., but that effect is not included in Fig. 1. The high-frequency portion of the noise is the more important owing to the greater sensitivity of the ear, and at such frequencies the annoyance is greater. In some cases it is necessary to use a cut-off filter prior to the first

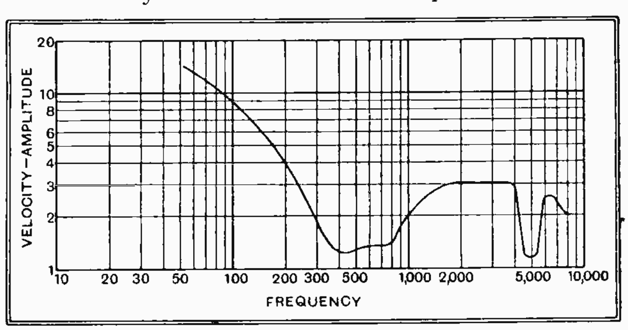


Fig. 3.—The inner margin of the disc where the point of the needle has been ground off.

valve in order to limit the scratch to a reasonable value. This depends upon the type of pick-up. If its main resonance is in the region 6,000 ~, then a suitable cut-off filter, say at 4,000 to 5,000 ~, may be very useful.

A familiar noise, particularly to those who are amateur craftsmen—and so many have to be in this

Noise.—era of mechanical transport!—is that of a hammer on an iron plate. This is actually in the nature of an impulsive sound which can be regarded as consisting of (*a*) the impulse or blow which covers the entire frequency spectrum, (*b*) the natural frequencies of the hammer and plate, or whatever the hammer strikes.

Waveform of Irritating Noises.

A curve denoting this type of noise is exhibited in Fig. 4, and it will be seen that the noise covers a wide frequency band. Owing to the variation in sensitivity of the ear, the curve does not show exactly how the noise will affect the aural organs. The nearer to the hammer the lower will the pitch appear, and it will alter as the listener gets farther away. In general, however, the low tones are too weak in comparison with the upper tones for them to be appreciably noticed by ear.

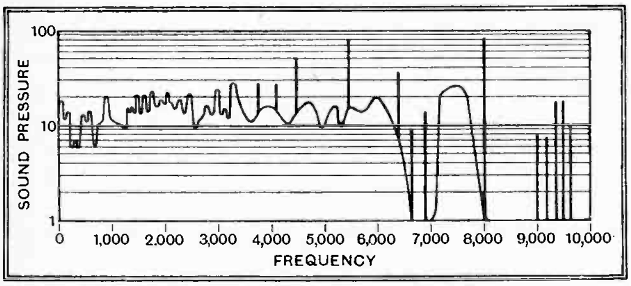


Fig. 4.—The noise produced when a hammer hits an iron plate. A complicated impulsive sound results which can be seen to cover the entire frequency spectrum.

For the low tones to be of primary importance from an aural viewpoint the curve would have to be of the form illustrated in Fig. 5. With very loud sounds the sensitivity of the ear becomes fairly uniform over a wide frequency band, but I am referring now to a moderate degree of loudness.

If the ear were equally sensitive to all frequencies Fig. 4 would accurately depict the effect of the sound upon one's sense of perception. But the curve of this diagram is merely an electrical analysis of a mechanical noise. It does not convey an accurate idea of the acoustic effect of the hammer blows. If the sound is to be perceived by the ear at all frequencies in the proportions indicated in Fig. 4 we ought to have a curve of the form indicated in Fig. 5. This is a modification of Fig. 4, where the intensity of the low frequencies has been increased to cope with the insensitivity of the ear in the lowest register. To get an accurate idea of the impression made on the ear by hammer blows whose sound spectrum is shown in Fig. 4, we should have to reduce the low-frequency amplitude (vertical scale) of that diagram. In other words, it would have to fall away where Fig. 5 rises.

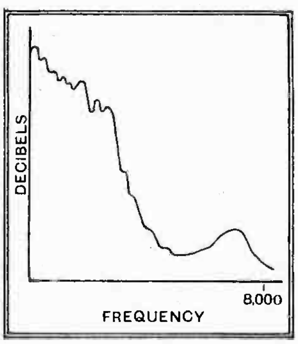


Fig. 5.—If low tones are to be of importance from an aural point of view the sound curve would have to be as here illustrated.

From experience we know that the pitch of hammer blows on an iron plate is moderately high. Who has not heard the village blacksmith? This is readily deduced from Fig. 4, and the known insensitivity of the ear to low frequencies.

Finally, as a distinct contrast to Fig. 4, we have the curve of Fig. 6, which refers to a wooden hammer on a wooden board. The range of frequencies is now much more restricted than that of the metal hammer, and, consequently, the noise is much less irritating to the ear. Little wonder, therefore, that carpenters' noises are much more popular than those let loose by the modern mechanic. The days of padded cells and acoustic damping devices are surely not far distant, and we shall live in an era when the silence of the countryside is emulated by that of the city. Let us earnestly hope that it will come soon.

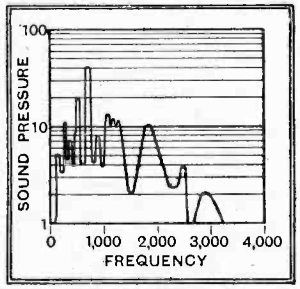


Fig. 6.—The sound produced when a wooden board is hit by a wooden hammer. The range of frequencies is somewhat restricted.

BOOKS RECEIVED.

G.P.O. Handbook for Wireless Telegraph Operators.—1932 edition. Revised in accordance with the Radiotelegraph Convention of Washington, 1927, and including the use of the Automatic Alarm Signal, with appendices giving the International Morse Code, List of authorised abbreviations and "Q" code, Scale of Signal Strengths, Service Advices, Necessary Qualifications for Candidates for Operators' Certificates, and International Radiotelephone Procedure. Published by H.M. Stationery Office, price 9d., postage extra.

First Principles of Television, by A. Dinsdale, M.I.R.E.—The principles and practice of Television, with descriptions of typical systems and notes on the present state of the art in various countries. Pp. 241+xv, with 130 illustrations and diagrams and thirty-eight full-page plates. Published by Chapman and Hall, Ltd., London, price 12s. 6d.

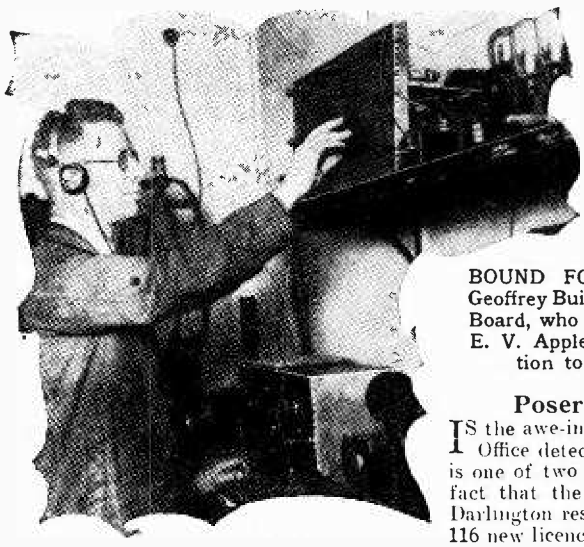
The Recording and Reproducing of Sound, by A. G. D. West, M.A., B.Sc.—A series of cantor lectures delivered before the Royal Society of Arts, March, 1931. Including the various methods of obtaining gramophone and phonograph records and their manufacture, reproducing apparatus, loud speaker horns, measurements of sound, etc. Pp. 95 with 78 illustrations and diagrams. Issued by the Royal Society of Arts, London, price 3s.

Physics in Sound Recording, by A. Whitaker, M.A., F.Inst.P.—The seventeenth lecture in the "Physics in Industry" series given before the Institute of Physics, November, 1931. A brief account of the various methods of recording and reproducing sound, including photographic recording and "talkie" films. Pp. 24 with 12 illustrations and diagrams. Published by the Institute of Physics, London, price 1s. 2d., post free.

Die Akustik des Tonfilmtheaters, by W. Gabler. The acoustic problems of "Talkie" cinemas. Pp. 37, with 19 illustrations and diagrams. Published by Wilhelm Knapp, Halle (Saale), price R.M.1.20.

NEWS of the WEEK.

Current Events in Brief Review.



BOUND FOR THE ARCTIC. Mr. Geoffrey Builder, of the Radio Research Board, who will accompany Professor E. V. Appleton on his radio expedition to Tromso in July next.

American Programmes from Athlone?

THE possibility of American sponsored programmes emanating from the new high-power station of the Irish Free State at Athlone is now being rumoured. This station, which will have a power of 60 kilowatts, will command a large service area in Western Europe, and will thus be second only to Luxembourg in the extent of its commercial influence.

It is expected that the station will be temporarily operating in time for the Eucharistic Congress in June, although it will not be put into regular commission until several months later.

Plane-Train Radio Talks.

IT is understood that an interesting wireless experiment may be made on or about Friday next, May 20th, by Imperial Airways, co-operating with the London and North-Eastern Railway Company. According to the suggested arrangement, an air liner will leave Croydon for Glasgow, and during the journey radio telephony conversations will take place between the air liner and an express train, which will leave King's Cross, London, at about the same time.

The Luxembourg Tests.

THE experimental station at Luxembourg, which is paving the way for the inauguration of the 200 kilowatt transmitter at the end of July, is transmitting gramophone records each evening from 5.30 to 6 o'clock. The wavelength is 1,250 metres and the power 200 watts.

Course on Fault Finding.

A SHORT laboratory course on "Fault Location in Broadcast Receivers" will be given during the forthcoming summer evening session of the College of Technology, Manchester. The lecturer will be Mr. A. Glynne, M.A., A.M.I.E.E. The first class will be held on May 31st from 6.45 to 8.30 p.m., and intending students will be enrolled from 6 o'clock on that evening. The fee for the course is 10s. 6d.

Poser for Post Office.

IS the awe-inspiring influence of the Post Office detector van on the wane? This is one of two possible explanations of the fact that the recent visit of the van to Darlington resulted in an addition of only 116 new licences. The Post Office is faced with this question: either Darlington is the most honest town in Britain or the detector van has ceased to exert its customary spell.

We prefer to think that Darlington is fundamentally honest, and that, consequently, the detector van can still roam this green and pleasant land unashamed.

No "Depression" Among Amateurs.

THE suggestion that radio transmission is a cheap hobby comes from an American correspondent, who declares that these days of commercial depression are proving an unexpected stimulus to amateur radio. Applications for new amateur licences are being received by the Federal Radio Commission at the rate of from 400 to 1,000 weekly; indeed, if the present demand continues, there should be 30,000 licensed amateurs in the United States by June 30th.

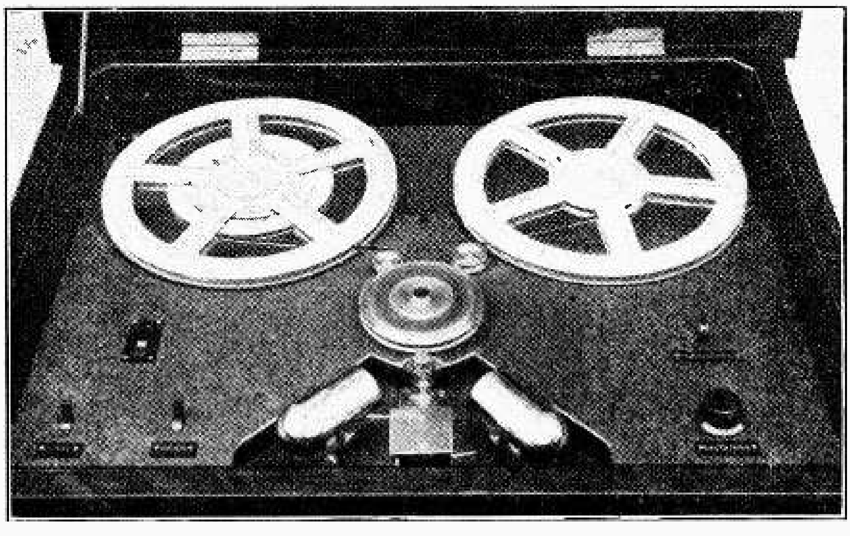
Radio on the Prince's Planes.

THE Two Puss Moth planes owned by the Prince of Wales have just been equipped with the latest wireless and direction-finding equipment. This is in conformity with the general practice with machines which make frequent use of the Continental air routes. Mr. E. F. Fielden, the Prince's pilot, is a fully qualified wireless operator.

The Wavelength Problem.

SOME secrecy prevails concerning the points for discussion at the Annual General Assembly of the *Union Internationale de Radiodiffusion*, which is to be held on June 1st and the following days, at Montreux, on Lake Geneva. The Union has, of course, only advisory powers as an expert body on European wavelength questions, but we understand that every effort will be made to put a strong case before the Madrid Conference for the extension of the European broadcast wavelength band. It is generally realised that the conference of Governments in Madrid will not spend very much time on the relatively small question of European broadcast wavelengths, but it is hoped that the European members of the Conference may be persuaded to "take an afternoon off" to consider questions affecting broadcast listeners in Europe.

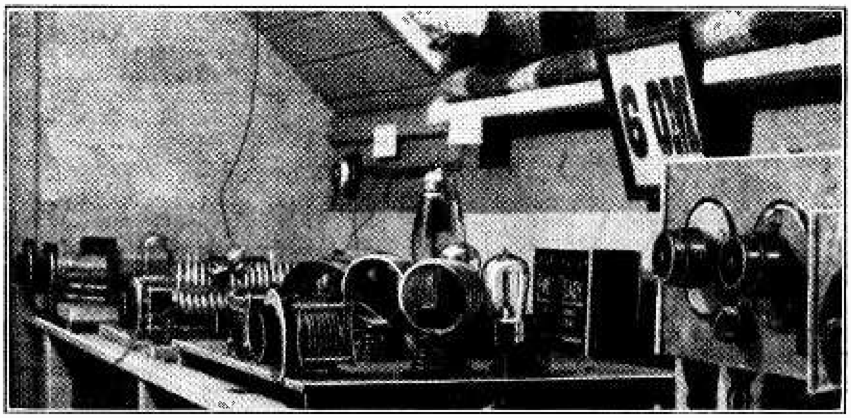
Another suggestion is that a world broadcasting conference should be held immediately after the Madrid meeting. It is, however, very unlikely that the delegates, after the tiring sessions in Madrid, will feel inclined to wrangle over broadcasting questions, and the probability is that broadcasting next winter will be carried on under conditions very similar to those obtaining to-day, with the un-



MUSIC ON TAPE. The new "Selenophone," ready for home use, which has made its appearance in Vienna. A full description of the "Selenophone" appeared in *The Wireless World* of February 4th, 1931.

pleasant addition of some 20 new high-power stations, whose presence will not be fully realised until the return of the long evenings.

The only solution to the problem would appear to lie at the receiving end. In other words, listeners will have to work out their own salvation by means of highly selective apparatus capable of making the most of the restricted frequency separation available.



AN ATTIC TRANSMITTER. G6OM, owned and operated by Mr. I. D. Auchterlonie at Heswall, Cheshire, is the result of eight years' transmission experiments. The 3.5 mc. and 7 mc. transmitter is seen at the extreme left, the 14 mc. set in the middle, and the two receivers at the right-hand end of the table. The station is active on all these wavelengths and has worked most countries of the world.

Radio in French Election.

FRENCH listeners are not encouraged by the results of the general elections. Candidates known to be sympathetic to radio have suffered badly, among them being M. Edouard Belin, the inventor of the Belinograph and television apparatus, who was beaten in his fight for the Paris suburban constituency of Nogent-sur-Marne. MM. Hippeau and Camargue, two staunch supporters of radio, retired when they saw no chance of winning, while M. Etienne Fougère, who is in charge of the Eiffel Tower transmissions, "fell at the first round."

Record Applause.

ACCORDING to our Paris correspondent, there are some good wireless election stories in circulation, but, as he remarks, they seem to be exactly the same as certain "genuine" tales we met with in 1928. Here, however, is a new one. At the close of a broadcast speech by a very influential deputy, listeners heard loud cheers of an intensity and duration that did not seem normal. The explanation was that the organisers of the meeting were using applause records, and had inadvertently omitted to switch off after a reasonable interval.

Criminal Eavesdropping.

THE new American pastime of listening-in on the police short waves has met with a setback. It seems that the paladins of the law are finding that gangsters and bootleggers, by intercepting the police broadcasts, are often able to make their escape or reach strategic points before the arrival of the police themselves. The Federal Radio Commission has now decided that all who listen-in to police radio messages and use the information to their own advantage are liable to punishment to the tune of a 5,000-dollar fine or five years' imprisonment with each and every offence.

Ultra Short Waves in U.S.

ULTRA short-wave fever has gripped America. A few days ago, from the top of the 555ft. Washington monument, transmissions were carried out on 5 metres and picked up on portable apparatus carried by officials in the street. It is stated that the complete transmitting and receiving equipment weighs 20 lb. with batteries, and can all be contained in a small box. Good results were obtained when the receiver was mounted on a car, so long as the car remained within optical range of the transmitter.

U.S. Broadcasters Forewarned.

AN encyclopædia of American radio, detailing every conceivable aspect of broadcasting as it is established and operated in the United States, is shortly to be made available for the scrutiny of the American Senate and the public by the Federal Radio Commission. According to our Washington correspondent, the survey is intended to form the basis for future legislation regulating "commercial blurbs on the air." Though no immediate legislation will come of this survey, it is believed that the disclosures will have the wholesome effect of prompting broadcasters and advertisers to "clean house" voluntarily in order to avoid restrictive legislation. It will be interesting to watch whether any outstanding change is discernible in American broadcasting before the whole question of sponsored programmes comes to be considered in the American Senate.

Increased Profits.

OUR congratulations to the Ever Ready Co. (Great Britain), Ltd., for the continued expansion of the company's business. The net profits for the past year, viz., £332,484, represented an increase of £26,373 over those of the previous twelve months. The growth of the battery business and the almost complete cessation of foreign imports necessitated large factory extensions costing £115,000. Less than half of this additional equipment was in production during the past year, but the whole of the new equipment will be in operation shortly.

The Station Finder Chart.

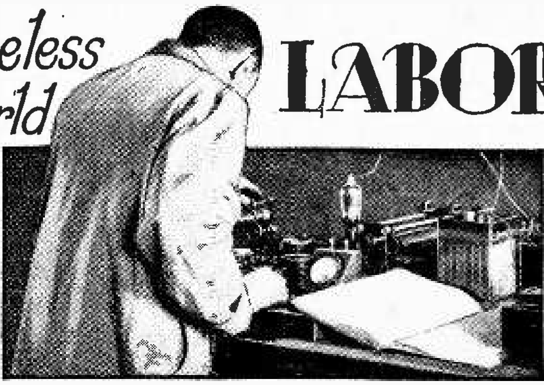
SOME additional copies of the Station Finder Chart published with the 21st Birthday Number of *The Wireless World* are now available, and can be obtained, price 3d. each, post free, on application to the Publishers, Dorset House, Tudor Street, London, E.C.4.

B.B.C. Studio Acoustics.

MANY readers will be interested in the acoustic treatment of the new B.B.C. studios in Broadcasting House. The following list gives the reverberation times which experience has shown to be most suitable for different types of programme. The total number of studios is twenty-two.

Studio.	Volume Cubic ft.	Reverberation Time (Secs.)	Principal Use.
BA	30,000	1.1 secs.	Vaudeville, Light musical programmes.
BB	10,000	0.85 secs.	Octets, Chamber music, Recitals, Dance Bands.
Concert Hall	125,000	1.75 secs.	Orchestral and Band Performances.
3A	10,000	0.6 secs.	Children's Hour and Dance Band.
3B	1,500	0.35 secs.	Talks.
3C	1,500	Dead	Talks.
3D	1,500	0.35 secs.	Talks.
3E	7,000	0.8 secs.	Religious Broadcasts.
4A & 4B	670	Dead	News.
6A	10,000	0.85 secs.	Large Productions in studio.
6B & 7B	3,200	0.6 secs.	Speech in plays and piano music.
6C & 7C	3,200	Dead	Speech in plays.
6D	8,300	Dead	Effects.
7D	1,400	Dead	Small effects.
6E & 7E	860	Untreated	Gramophone effects.
7A	1,500	Dead	Speech in plays.
8A	27,000	1.1 secs.	Orchestral and Band Music.
8B	2,100	0.45 secs.	Debates and Discussions.

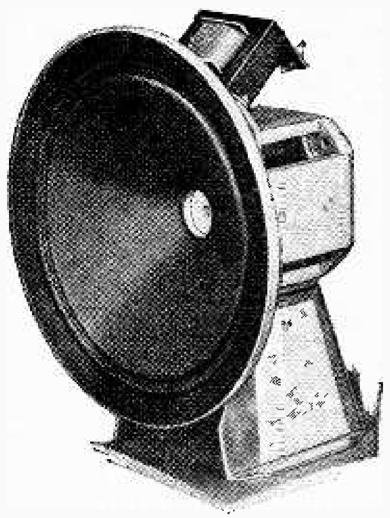
Wireless World LABORATORY TESTS



Review of New Radio Products.

W.B. TYPE PM4 LOUD SPEAKER.

The design of this loud speaker is based on that of the well-known type PM3 already reviewed in the pages of this journal. The magnet system is of the built-up type with four cobalt steel bar magnets fitting into laminated end plates. It has a total weight of $4\frac{1}{2}$ lbs., and is guaranteed to retain its magnetism for five years. The unit is mounted on a pressed-



W.B. type PM4 permanent magnet moving coil loud speaker and output transformer.

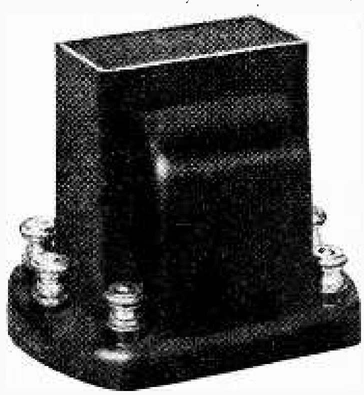
aluminium pedestal, and an output transformer is mounted on brackets in an accessible position above the permanent magnet. Three ratios are provided of 45 : 1, 55 : 1, and 70 : 1, the latter being suitable for pentode output valves.

The outstanding performance of this loud speaker is the excellence of the reproduction of speech, which would merit a special mention in any loud speaker regardless of price. The reproduction of music is pleasing, and is characterised by crispness in the upper register. In the bass the output is good down to 100 cycles, but falls off rapidly below this frequency. In spite of a resonance at approximately 175 cycles, there is no suggestion of boom in the quality either of speech or music.

On the score of sensitivity the PM4 unit, although slightly below that of the PM3 already mentioned, should more than hold its own with the majority of permanent magnet loud speakers in the same class. The price of the unit is 35s., or 42s. with output transformer, and the makers are the Whiteley Electrical Radio Co., Ltd., Nottingham Road, Mansfield, Notts.

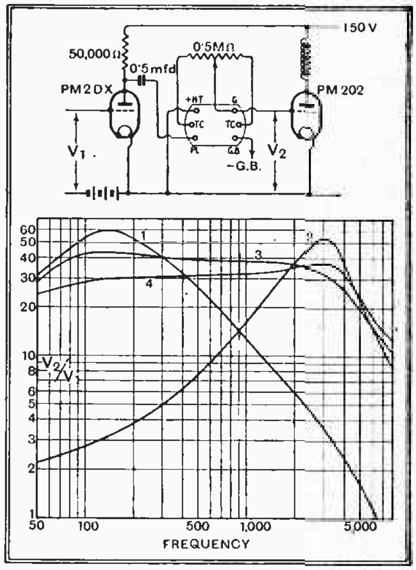
A VARIABLE TONE-CONTROL TRANSFORMER.

The technique of tone correction in broadcast sets will receive a considerable impetus from the introduction of a specially designed intervalve transformer which has recently been marketed by the Multitone Electric Co., Ltd., 95-98, White Lion Street, Islington, London, N.1. Known as the Toco 4/1, this transformer, which has a nominal ratio of 4 : 1, is so designed that its amplification-frequency characteristic can be varied at will between wide limits. It is provided with additional terminals for an 0.5 megohm potentiometer, which can be conveniently mounted on the front panel of the receiver, and provides the tone control. With the slider at one extreme of the winding, curve (1) is obtained, in which the base is accentuated at the expense of the higher frequencies, while at the other extreme the converse condition shown by curve (2) is obtained. Between these limits a wide variety of frequency characteristics are available, of which curves (3)



Multitone type Toco 4/1 tone-compensated L.F. transformer.

and (4) are typical examples. The curves were obtained in conjunction with a PM2DX valve, using the well-known indirect feed type of circuit. The transformer gives a similar performance, however, with the simple direct-feed connections, and under these conditions can be operated with a D.C. current through the primary up to 6 mA. The variation of the inductance of the primary with



Frequency response curves of the Toco 4/1 tone-compensated L.F. transformer ; (1 and 2) with potentiometer control at limiting positions ; (3 and 4) two typical intermediate curves.

different values of superimposed D.C. is shown in the following table :—

D.C. (mA.).	Inductance (Henrys).
0	50.0
1	44.0
2	35.5
3	29.8
4	25.3
5	22.3
6	19.7

The inductance was measured at 50 cycles with 6 volts A.C. across primary and is seen to have a good average value.

We are of opinion that the introduction of this transformer is an event of first importance to the discerning experimenter, for it enables him to adjust the frequency response of the L.F. side of his set to compensate for the many factors in reception militating against good quality of reproduction. Compensation for such effects as side-band cutting and differences in the response of the loud speaker are obvious, but the range of usefulness of the transformer is not by any means limited to effects of this kind. For instance, the L.F. response can be adjusted to compensate for differences in the modulation characteristics of foreign transmitters, and in a radio-gramophone there is ample scope for the use of the tone control when changing over to records from broadcasting. The transformer is housed in a neat, moulded case, and the overall dimensions ($2\times3\times2\frac{1}{2}$in.) are comparable with those of the latest types of nickel-iron transformer. The price is 17s. 6d.

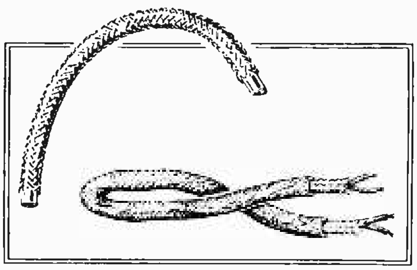
LEWCOS SCREENED SLEEVING.

Made by the London Electric Wire Co. & Smith's, Ltd., Church Road, Leyton, London, E.10, this armoured sleeving consists of a specially prepared oiled cotton insulating tubing encased in an outer covering of open-mesh braided metal. It is available with either a $1\frac{1}{2}$ mm. or a 2 mm. bore, the price per 10ft. length being 2s. and 2s. 3d. respectively.

The outside diameter is approximately the same in both sizes, and the difference in the bore is obtained by employing insulated tubing with thicker walls for the $1\frac{1}{2}$ mm. size. Although this effectively maintains the conductor central in the tubing and so well spaced from the metal casing, the capacity to earth is lower with the 2-mm. size when conductors of the same diameter are used in each case. This is understandable, since in one case the wire is largely air spaced, while with the $1\frac{1}{2}$ mm. size there is a preponderance of solid dielectric.

The measured capacity using No. 24 S.W.G. wire was found to be 15.3 m-mfds. per foot for the $1\frac{1}{2}$ mm. size and 14.5 m-mfds. for the 2-mm. variety.

An armoured twin-flex suitable for pick-up leads is available also, and in this case the metal casing is protected by an outer covering of braided cotton. The capacity



Lewcos screened sleeving and armoured twin flex for pick-up leads.

between the two conductors was found to be but 24 m-mfds. per foot, which is exceptionally low for this style of screened wire. The price is very reasonable, being 1s. for a 10-ft. length.

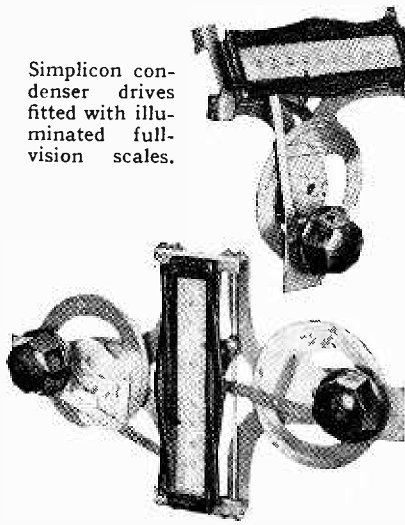
SIMPLICON FULL-VISION SCALES.

The special feature of these new Simplicon condenser drives is that the scale is stationary while a small travelling pointer indicates the setting of the condenser; the pointer being operated through an ingenious system of links by the reduction mechanism. Translucent material is employed for the 0-100 division scale, the markings are neatly executed, and when illuminated from the back the scale stands out boldly, but is not obtrusive.

On the single condenser model the scale is mounted horizontally, while in the case of the double model a vertical scale has been found more convenient as the two condensers are mounted on either side, but with independent controls and separate pointers.

As the two control knobs rotate in opposite directions it is essential that the left-hand condenser should increase in capacity when rotated in a counter clockwise direction, but the right-hand unit can be the usual standard type.

These scales are very robust and exceptionally well finished, and the price is 7s. 6d. for the single model and 13s. 6d.



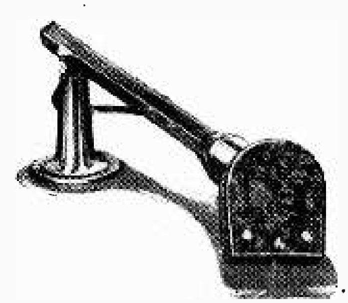
Simplicon condenser drives fitted with illuminated full-vision scales.

for the double pattern. They are made by Williams and Moffat, Ltd., Ladypool Road, Sparkbrook, Birmingham.

"TRUCURVE" PICK-UP.

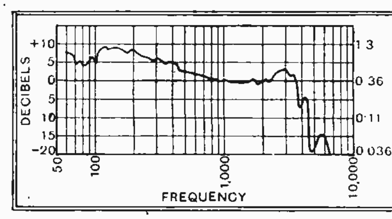
This is a neat and well-finished accessory which bears ample evidence of careful and scientific design. It is compact, the length from the needle point to the tone arm pivot being 8in., and the pick-up head is set at an angle to give correct needle track alignment. A spring-loaded swivel joint with positive locating stops facilitates the replacement of needles.

The movement is of the "full-rocker" or balanced armature type, and the armature is of unusually generous cross-section. A cobalt-steel permanent magnet is em-



"Trucurve" pick-up and spring-compensated tone arm with swivel head.

ployed and the sensitivity is good, the average output being of the order of 0.6 volt R.M.S. The output curve is of good general form, and it is interesting to note that the pick-up follows the standard fre-



Characteristic curve of "Trucurve" pick-up.

quency records down to 50 cycles without signs of chatter. It may be inferred from this that the wear on ordinary records will be negligible. Incidentally, the weight of the tone arm is compensated by a spring.

The price of the "Trucurve" pick-up complete with tone arm is 21s., and supplies are obtainable from Messrs. Clark and Moir Sales, 147, Newington Causeway, London, S.E.1.

CHANGE OF ADDRESS.

The City Accumulator Co. announce that they have acquired new premises at 7, Angel Court, Strand, London, W.C.2, the new telephone number being Temple Bar 8520.

o o o o

A new London office has been acquired by the Runbaken Magneto Co., Ltd., at 3, Furlong Road, Holloway Road, London, N.7, the telephone numbers being North 2483-4-5. The sales office and repair service are still housed at 280, Deansgate, Manchester, as formerly.

CATALOGUES RECEIVED.

Garrard Engineering and Mfg. Co., Ltd., Newcastle Street, Swindon, Wilts, has issued a new folder dealing very fully with their range of spring- and electrically-driven gramophone motors.

o o o o

Watmel Wireless Co., Ltd., Imperial Works, High Street, Edgware, Middlesex, has issued a circuit folder, which is available to all interested traders, containing eight typical receiving circuits, included in which is *The Wireless World* Super Selective Five" battery model.

o o o o

Burne-Jones and Co., Ltd., 296, Borough High Street, London, S.E.1, has prepared an illustrated folder describing fully their model "T" short-wave adaptor. A comprehensive list of the principal short-wave stations and their hours of transmission in G.M.T. is included.

Next Week's Set Review :—

BROWNIE DOMINION GRAND S.G. THREE.

Broadcast Brevities

By Our Special Correspondent.

Touring the New Headquarters.

TO "do" Broadcasting House, to explore its labyrinthine passages and examine its studios and control rooms, its apartments devoted to heating, ventilation, administration, information and manifold other activities; to "do" all this takes every minute of two hours. The "Grand Tour," which I was privileged to undertake last week, begins three floors below street level, amid the whirr of the air cleansing plant and the roar of the oil-fuelled boilers, and only stops when the visitor arrives panting on the roof.

Multum in Parvo.

It is not the stairs that take one's breath away; progress amid so many exciting distractions is too slow for that. It is the thought that so much work is being accomplished, that so many people are "hard at it"—performing, rehearsing, devising schemes, executing business—in such a comparatively small space. "Broadcasting House" really is a hive of activity, and the fact is not forgotten when one steps on to the roof and is caught in a gust of warm, vitiated air from a ventilating shaft.

The Control Room.

Now that the move from Savoy Hill is completed it is possible to compare the working of the new machine with that of the old. Without doubt the listener stands to gain immensely by the change.

To take the control room alone. All the bitter lessons learnt in the old, cramped quarters at Savoy Hill have been turned to account, and for the first time the engineers can now rely on an adequate standby equipment. Switching by relays has been developed to enable the complete chain of transmission between any studio and any outgoing land lines to be brought into action in the absolute minimum of time. Again, any breakdown in the amplifier system can be spotted in a few moments by warning lights.

Studio Acoustics.

The acoustics of the twenty-two studios are of special interest, and the official list of "reverberation times," which may be useful to readers who wish to do some checking on their own account, appears on another page.

A Hustle in Birmingham.

IT is good to know that the B.B.C. are not concentrating all their architectural and technical energies on Broadcasting House to the exclusion of the provinces. The new Birmingham studios are being proceeded with at high speed, and I hear that whereas, according to the contract, the studios should be ready in eight months' time, actually they will be habitable before the end of September.

The Western Region.

The provinces, generally, are being well served in the matter of broadcasting premises. Northern Regional can boast of excellent studio facilities in that other "Broadcasting House" in Piccadilly, while Edinburgh, in the converted Queen's Hall, has a broadcasting centre worthy of the country which it serves.

It remains to be seen whether the Western Region will also have suitable broadcasting premises. Cardiff at all events will remain the centre of activity.

Scientific Talks.

THERE is plenty to think about in the second half of the season's broadcast talks which start in the week beginning May 23rd. On Friday, May 27th, for instance, Sir J. Arthur Thomson will give the first talk of the series on "Biology in the Service of Man." He will deal with great scientific investigators—William Harvey, Claude Bernard, Pasteur, Huxley, and Ray Lancaster—men whose work merits the closest attention by scientific students.

Broadcasting from Hyde Park.

The evening programme of May 24th will include excerpts from the Festival of Empire which is to take place in Hyde Park, London. Listeners will hear the community singing and the music of the Band of the Coldstream Guards.

Canada "Escapes."

I WONDER how many British listeners realise what a victory has been scored in the decision of the Canadian Government to establish broadcasting on what is generally described as "the B.B.C. basis?" Mr. Gladstone Murray, the sole representative of Great Britain at the enquiry, was submitted to an examination lasting two days, during which he gave a remarkably succinct account of how broadcasting is managed in this country without the aid of the advertiser.

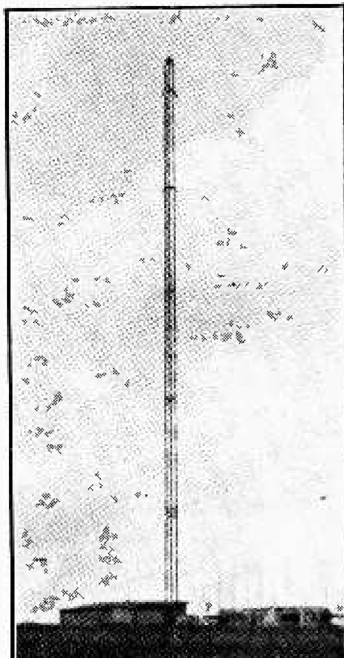
Bach Without Backchat.

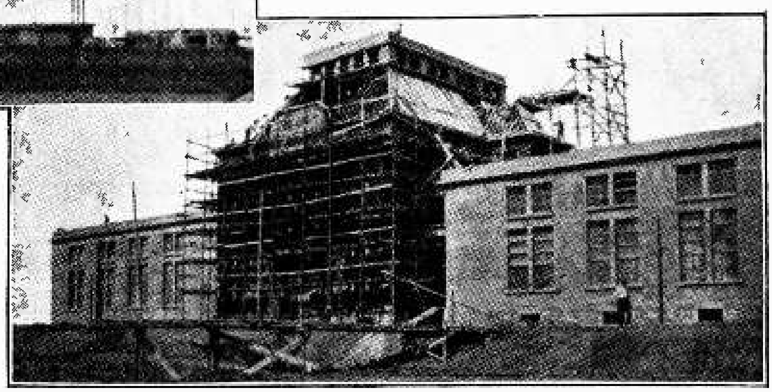
American interests, which were strongly represented, pressed for sponsored programmes, but as the decision shows, the Canadians have failed to be impressed by the argument (which, by the way, is firmly believed in by the American broadcasting chiefs) that the ordinary listener really wants advertisers' announcements, and would not be happy with Beethoven or Bach without a leavening of "blurb."

Wanted: A Canadian "D.G."

THE Canadians will need an experienced Director-General, with an expert knowledge of broadcasting conditions on the B.B.C. model, and I should be surprised if they have not already cast a covetous eye upon Mr. Gladstone Murray himself, who has the added attraction for them that he is Canadian-born.

Personally, although I consider that the Canadians could make no happier choice, it would be a disservice to our broadcasting to even suggest the departure of one who has proved himself to be the ideal liaison officer between broadcasting and the world of print.

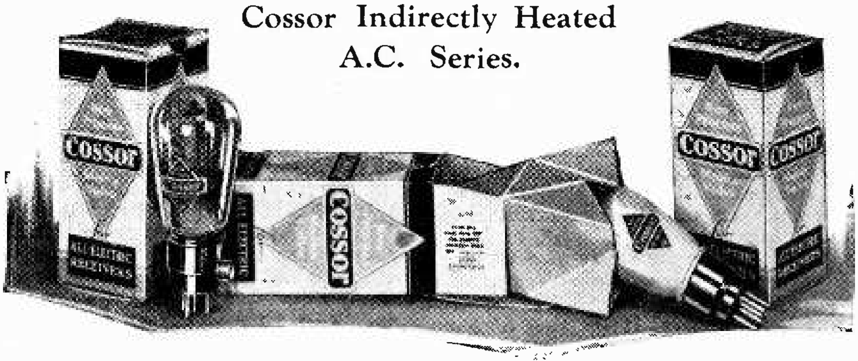




SPONSORED PROGRAMMES OVER EUROPE. By the end of next month it is expected that the new 200-kW. broadcasting station at Luxembourg will be ready to start its campaign of disseminating sponsored programmes collected from all parts of Europe. These, the first photographs of the station to reach this country, show construction in progress.

VALVES we have TESTED.

Cossor Indirectly Heated A.C. Series.



THE latest series of Cossor A.C. valves contains some twelve different types in all, and while a few are identified by the same type numbers as a year or so ago, their characteristics are widely different. As an example we need cite but two as typical of the substantial improvements effected. In the 1930 series the 41 MP had an A.C. resistance of 5,000 ohms, an amplification factor of 13, and a mutual conductance of 2.6 mA. per volt. It provided an undistorted output of about 260 milliwatts. The latest version of this valve has a mutual conductance of 7.5 mA. per volt, and the amplification factor has soared to the exceptionally high figure for a power valve of 18.7. That the valve falls within this category is exemplified by the power output figures, which are given as 1,250 milliwatts.

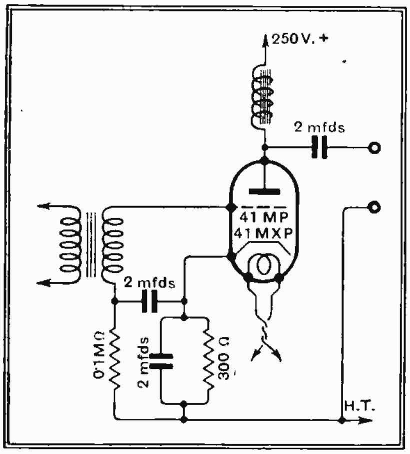


Fig. 1.—Typical circuit arrangement for output stage showing grid decoupling and bias resistance.

The 41 MXP is another outstanding example, as, having the same mutual conductance as the 41 MP, it gives some 2,000 milliwatts output and has an amplification factor of 11.2. Both of these valves give their respective power outputs with quite modest input voltages, so that they can follow immediately after the detector and be coupled to it by a transformer affording a 1:3 or 1:3½ step-up ratio.

The correct operating voltages for the 41 MP are −7.5 volts grid bias, with 200 volts on the anode, while the 41 MXP requires −12 volts grid bias with the same anode potential. In a practical case these voltages will be derived by the potential drop across the ends of a resistance connected between the cathode and the main H.T. negative, with suitable decoupling in the grid return lead from the secondary of the L.F. transformer, as shown in Fig. 1.

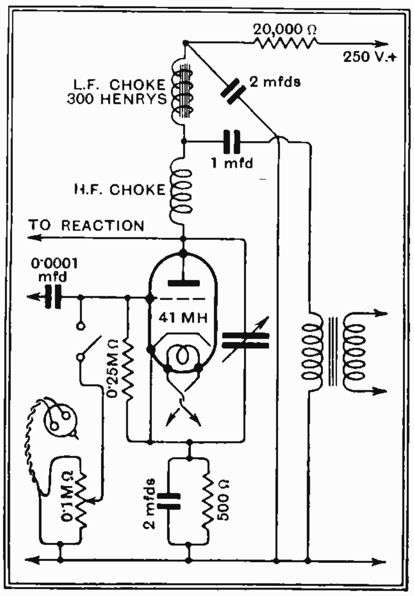


Fig. 2.—Connections for power grid detector showing one method of including a gramophone pick-up.

It is interesting to record that the same value of bias resistance would seem to serve for either the 41 MP or the 41 MXP, which may be intentional on the part of the designers or come about by a happy chain of circumstances; we prefer to accept the former as the explanation. Be this as it may, the fact remains that the one valve can be removed and its larger brother substituted should an increase be desired in the power output. This may be achieved without modification to the circuit, provided there is sufficient latitude in the H.T. supply to make up the difference between 24 mA. and 40 mA., which are the respective anode currents for these two valves.

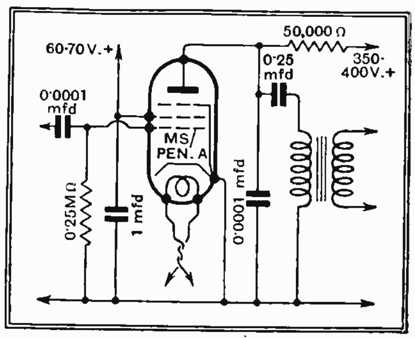


Fig. 3.—Special high impedance pentode used as a power grid detector.

The Detector.

For the detector stage preference might be given to the 41 MH valve, although under certain conditions the 41 MHL could be employed. Any of the three recognised methods of detection can be used, but as the power grid arrangement is now one of the most popular a suitable circuit would be as shown in Fig. 2.

A suggested method of arranging for gramophone reproduction is included in the circuit, and suitable values are included for the components, assuming an "A" type rectifier is employed giving 250 volts D.C. on the full load. Where a higher voltage is available the 300-henry choke could be replaced by a resistance of not less than 30,000 ohms.

In the space available it is impossible to deal with all the valves in this series, but before concluding mention must be made of two special types, namely, the MS/Pen.A. and the 41 MDG. Although the first mentioned is a pentode in that it has five electrodes, its function is that of an H.F. amplifier, and consequently falls in the same category as the screen-grid tetrode. Its particular features are that it will accept a large input voltage and that the grid volts-anode current characteristic is much more linear than the usual S.G. valve. In addition to its claims as an H.F. amplifier, it offers possibilities as a detector, especially of the power grid variety, the circuit for which is shown in Fig. 3.

The 41 MDG is a bi-grid valve developed as a combined detector and oscillator in supersonic hetero-

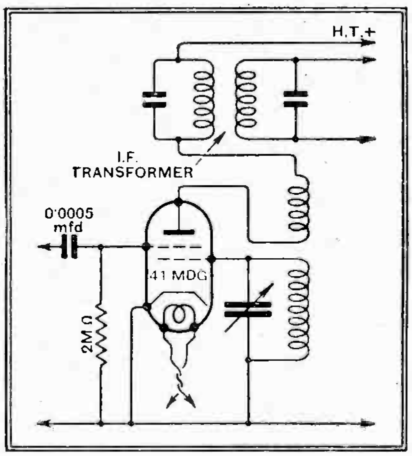


Fig. 4.—Circuit connections for a single-valve frequency changer in a super-het. using a bi-grid valve.

dyne receivers, a typical circuit, together with suggested values for the necessary components, being illustrated in Fig. 4.

Tests have been made with various specimens of the new series of A.C. valves, and their performances were highly satisfactory, being fully in keeping with the exceptionally good characteristics exhibited by these valves. In no case did we find the slightest trace of reversed grid current, showing that the vacuum is dead hard, and the anode currents agreed substantially with the makers' figures for the various operating conditions specified.

WIRELESS ENCYCLOPEDIA

Brief Definitions with Expanded Explanations.

No. 15

GRID RECTIFICATION.—The system of detection based on the unilateral conductivity between the grid and cathode (or filament) of a three-electrode valve.

If the grid potential of a triode is not made sufficiently negative with respect to the cathode (or to the negative end of the filament, in the case of a battery valve) it naturally attracts to itself some of the electrons emitted from the cathode, resulting in the flow of grid current. The intercepted electrons comprising this current pass round the external circuit back to the cathode, and the value of the grid current depends on both the grid potential and the anode potential.

Typical grid-voltage/grid current curves are given in Fig. 1 for two general-purpose valves, one being of the indirectly heated cathode type and the other of the filament type, the anode voltage being constant in each case. The curves show that when the grid potential exceeds a certain negative value no grid current flows, but such current does flow for more positive values of grid voltage. It is this one-way or

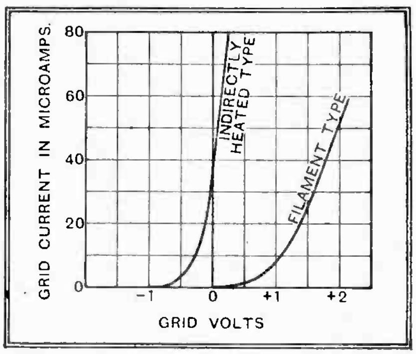


Fig. 1.—Grid current curves for two types of valve. On the left is that of the indirectly heated type and on the right that of the filamented valve.

unilateral conductivity between grid and cathode that makes grid rectification possible.

Now as the effect of rectification has to be transferred to the anode circuit of the valve to enable the L.F. component variations to be passed on to the succeeding valve, special arrangements have to be made in the grid circuit to effect this transfer. A modulated alternating voltage applied to the grid in the ordinary way would not produce any rectification. A condenser of low capacity must be connected in the grid lead in such a way that the flow of grid current, when a signal voltage is applied, causes this condenser to be charged to an extent depending on the amplitude of the H.F. voltage. The usual arrangement is

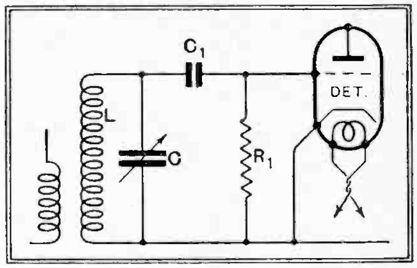


Fig. 2.—The method of connecting a grid condenser and leak.

shown in Fig. 2, where C_1 is the grid condenser referred to and R_1 is a high resistance, known as a "grid leak," whose function is explained below.

Automatic Bias.

Assume for the present that the resistance R_1 is omitted and that grid current just commences when the grid potential is -1 volt. The grid condenser C_1 has one side electrically connected to the cathode and the other to the grid of the valve. With no signal oscillations in the tuned circuit LC the fact that grid current flows for all voltages more positive than -1 will ensure that the potential of the grid side of C_1 will fall to at least -1 volt. Suppose, then, that this is the state of affairs when an oscillation voltage whose amplitude is 2 volts is suddenly applied between the cathode

Wireless Encyclopedia.—

and the left-hand side of the grid condenser. During each positive half-wave the potential of the grid will enter the region where grid current flows, whereas during the negative half-waves no grid current can flow.

Now this unidirectional grid current, flowing in a circuit including the condenser C_1 in series, is in the nature of a charging current. The

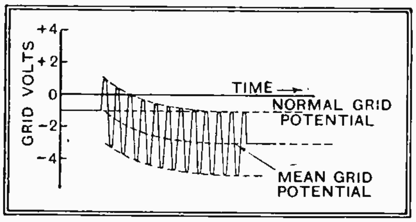


Fig. 3.—Showing how the mean grid potential falls when a signal voltage is applied.

result is that C_1 acquires a charge, the mean potential of the grid side becoming more negative in the manner shown by Fig. 3. The fall in potential will continue until the peak of each positive half-wave no longer encroaches into the region where grid current flows; that is, until the peaks of the waves just reach the value of -1 volt. This being the case, it follows that the mean grid potential must have fallen just two volts, being the amplitude of the applied oscillation.

The Function of the Grid Leak.

If now the applied oscillation suddenly ceases the grid condenser will retain its charge, the potential of the grid side being negative and in the region where no grid current flows, so that no discharge can occur. But for the detection of modulated waves it is necessary that the mean grid potential shall vary in accordance with the modulation, and for this reason the high resistance R_1 is connected between the grid side of the condenser and the cathode, providing a leakage path through which the condenser will discharge as soon as the high-frequency signal oscillation ceases.

The fundamental idea of grid rectification is that as soon as the grid potential tends to rise above a certain critical value grid current flows and prevents any appreciable further rise, the grid condenser being charged instead. The grid leak is provided to allow the grid potential to return to its normal value when the oscillation ceases, or to take up a mean value depending on the amplitude of the oscillation.

When the amplitude of the applied oscillation is varying as in Fig. 4 (a) the effect of the grid current is to bring all the positive peaks of the oscillation to approximately the same level on the grid side of the condenser, as in Fig. 4 (b), without appreciably changing the total "grid swing," or double amplitude. The mean potential of the grid then

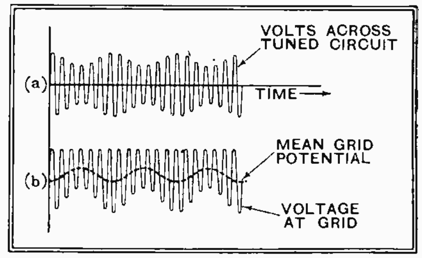


Fig. 4.—How a theoretically perfect grid rectifier operates on a modulated wave.

varies *at the modulation frequency*, as shown by the broken-line curve.

The effect is transferred to the anode circuit by the usual amplifying action of the valve, the mean anode current varying in almost direct proportion to the change in mean grid potential.

(Power Grid Detection will be dealt with separately.)

Letters to the Editor.

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

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

Early Radio Telephony.

WITH reference to the question of early telephony tests, some time in 1909 (I believe about March) I heard a transmission of phonograph records from the Poulsen station at Lyngby on a wavelength of what was probably just over 1,000 metres. Very weak telephone strength was obtained on an aerial composed of a disused telephone wire with "perikon" crystal detector of the breed illustrated as from No. 1 "W.W." I believe this transmission was also received in Berlin, and the arc power was stated by voice to be 900 watts, and I think six microphones in series were mentioned. Some of the transmission was in French and some German as well as Danish.

In June of the same year I also heard a transmission from Cullercoats (Newcastle) under the call signal "CC" calling Lyngby by voice, and a bad cough appeared to be troubling the operator.

In 1909 (or 1910, I have no written record) the Prince of Monaco's yacht s.y. "Hirondelle," cruising the North Sea, and fitted with a Lepel arc transmitter of about six kilowatts, played tunes on his "arc" with a series of resonant audio circuits, and I believe these were heard throughout a good deal of Great Britain—hardly telephony but certainly "music"—of sorts. The call was "CQD"—rather unfortunate choice on somebody's part. P. DENISON.

Snape Wood, Sowerby.

Technicalities at the Show.

"FREE GRID'S" semi-serious paragraph about the dearth of technical information obtainable—or, as he points out, not obtainable—at stands at the exhibition, raises a point which must be really serious to the majority of the general public.

Going back as far as the exhibition at the Horticultural Hall in 1921 and the Ideal Home Exhibition at Olympia in 1923, as a technical man I have found that the public rarely seem to ask any other than technical questions. They can be roughly divided into three sections: those that know as much as the technical expert and desire an opinion, those that know a little and desire to improve their knowledge, and those that frankly admit that they know hardly anything but are willing and anxious to learn.

It may be argued that the two main selling points of a receiver are appearance and reproduction. This is largely true, but other questions do contribute to the sale of a set. A common argument is that manufacturers are selling a product of known quality and performance, and therefore why should they turn themselves into a technical information bureau on wireless in general. Perhaps it is not necessary that they should, but, to refer to "Free Grid's" remarks and to extend them a little farther, in ninety per cent. of cases the salesmen and other "fauna" of the stands cannot give the most elementary information on their own products. This is not their fault. It is the fault of the organisation behind them. They do not even know the values of the various components in their own sets. This does not need technical knowledge after all; it could very easily be given to the salesmen on a printed form, which would be better than a horror-stricken look round to see if there is a technical man on the stand when a *potential customer* asks an innocent question such as "what value grid-leak do you use in your sets?"

Surely the formation of a technical sales staff is not difficult? I might also mention that retailers are very big offenders in this matter. HOWARD H. ROBINSON.
London, S.W.9.

"W.W." and the Clubs.

MAY I thank you on behalf of the Society for your paper's great assistance during the past session? I repeat that which I have said many times, that each club report brings new enquiries for membership, an enquiry re a report even reaching me two days before the "end of season" dinner. Nor is *Wireless World's* pulling power confined to Britain, for we recently had a letter from the Latvian Radio Society, and it is suspected that your paper found its way there. Thus, in helping home radio societies, you are at the same time ensuring that "Nation shall speak peace unto nation."

E. L. CUMBERS,
Hon. Sec., South Croydon and District Radio Society.

Volume Level.

I HAVE read Mr. Noel Ashbridge's letter in your issue of May 4th, 1932, with a good deal of interest; probably he rarely listens! On hundreds of occasions I have listened to orchestral items, received at good strength, but well within the capabilities of my output valve, and then comes the horrid bawl of the announcer, deafening one and grossly overloading the set. I am no judge of decibels, but I should say the modulation of the announcer's voice was a good six decibels *above* the music.

At other times it is difficult to get reasonable strength from a symphony concert, as the detector is overloaded by the carrier before one can attain any strength worth mentioning.

There might be some excuse for giving the news bulletin somewhat loudly, but the normal announcement of the musical items is of very little consequence even if a few people do not hear it, and anyway, if it is necessary to shout to make listeners hear, then the musical items themselves can have little entertainment value. F. G. SACKETT.
Edgbaston.

The Monodial A.C. Super.

I MUST congratulate you on the excellent design of the Monodial, and can easily say it is the best "superhet" published in any journal. I also must mention my appreciation of the unbiased opinion given on all sets reviewed in *The Wireless World*. PETER A. JOHNSTON.
Cathcart, Glasgow.

HAVING completed the Monodial Super I have been assembling, I am writing to express my admiration of the set. The selectivity is simply amazing, there being silent points between stations that formerly were badly mixed, e.g., Prague, North Regional, and Langenberg. One or two of my friends have seen it, and join with me in saying that there is nothing like it!

I am very grateful to *The Wireless World* for presenting it so soon, and I feel sure that next season's sets will be largely "supers" with or without tone control.
Exeter. FRANK L. HOSSELL.

I FEEL impelled to write and tell you what an *outstanding success* your new Monodial A.C. Super has proved. Not only is the construction simple and the preliminary adjustments easy, but the performance quite amazes me.

I have done a lot of construction with "Stenode" receivers and other complex circuits, but have never been able to get such splendid results with such ease. Heartiest congratulations.
Cranbrook, Kent. A. E. DARNTON.

100 Division or 180 Degree Scales?

WE are offered two alternatives, a 100 division or 180 degree scales. A 180 degree dial, however, in present-day practice means a 90 division scale, every two degrees being, of course, marked off. If these are the only alternatives then we must choose the 100 division scale. But is it not possible to use finer marking and to divide the scale by 180 separate markings? Surely this is called for to-day. I realise that many users do not require this accuracy, and would not be willing to pay the possible additional cost of the more accurate manufacture necessitated. But if the user does not desire a 180-degree scale he will not be so critical as to quibble about the relative merits of a 100 division and a 90 division scale.

I should like, though, to bring a much more important need for standardisation in the matter of condensers. Why cannot the manufacturers decide on the size of shaft for use in all condensers of all types? How easy life would be if one knew when one ordered a condenser, or for that matter a variable resistance and a switch, just what size of dial one would require. I do not forget that a knob is usually supplied with the component, but the average listener does not want his panel covered with knobs of assorted sizes and colours.
Sowerby Bridge, R. HINDLE.
Yorkshire.

Is 5,000 Cycles Enough?

YOU ask whether those responsible for broadcast transmission should tread the primrose path that leads to the depravity of a 5,000 cycle cut-off, or continue to struggle up the straight and narrow way towards quality transmission.

It is most earnestly to be hoped that the former plan will be rejected with withering contempt!

I disagree entirely with your correspondent who suggests that the broadcast receiver and loud speaker can be regarded as a musical instrument. It most certainly is not, but is merely a reproducer of real musical instruments. As a reproducer it is usually bad, and often worse!

If one agrees that it is to be regarded as a reproducer, then a 5,000-cycle cut-off must very seriously impair its efficiency, since practically every musical instrument produces overtones of greater frequency, the retention of which is essential if reproduction is to be at all realistic and satisfying.

Your suggestion that the generation now growing up may take as their standard of musical quality that of electrical reproduction is almost too horrible to contemplate! If it be true, then it constitutes the final and unanswerable reply to the 5,000-cycle school.

The remedy for the present highly unsatisfactory state of affairs is either a reduction in the present quite excessive number of European broadcasting stations, or else an increase in the portion of the spectrum at present allotted to broadcasting. It would seem that broadcasting has now reached such importance in all countries that this step may well be demanded.

I heartily agree with Mr. H. A. Hartley that the 5,000-cycle school must be quite devoid of the ability to appreciate music.

To listen to so-called music with a 5,000-cycle cut-off would be equivalent to being condemned to subsist solely and forever upon a diet of treacle pudding!
Darlington. W. CRICHTON FOTHERGILL.

Deaf Aids.

ON reading your correspondent's article on the calibration of deafness, I feel that whilst endorsing the principle we cannot agree with the assumption that the best results could be achieved with an audiograph chart covering frequencies of 125 to 4,000, and after ten years' experience of audiometers during which period the writer has invented two, and spent periods of research both in this country and in America, our practice with many thousands of cases has driven us to the conclusion that the only method that will be universal, if it is possible to be more so than it is at present, is the decibel calibration, as adopted by present audiometer makers and standardised in the new 2B model from which we have had the peak performance of our various deaf aids newly charted.

Experience leaves the impression that audiometer tests and co-operation will only be successfully achieved by the help of actual otologists or operators who have received a clinic course in the handling of the instrument; on the other hand, an audiometer in the hands of a "showman" is likely to add one more burden of technicality upon a deaf public who have suffered perhaps more than their fair share.

London, W.C.2. LESLIE V. K. REIN, Capt. (F. Charles Rein and Son).

The Condenser Microphone.

I NOTICE in *The Wireless World* for April 20th, on page 414, a remark to the effect that the use of a long cable with a condenser microphone causes high note loss.

I should be glad of an opportunity of correcting this common error.

A condenser microphone, considered as a generator of L.F. currents, generates charges. The voltage produced by a given charge varies inversely as the capacity which has to be charged, and is independent of frequency.

Suppose, for example, that a microphone of 0.00015 μF capacity is used with a 30ft. cable having a capacity of 0.0009 μF. The total capacity will be 0.00105 μF and the voltage available at the first grid will be $\frac{0.00015}{0.00105}$ or ⅐th of that which would have been available if no cable had been used.

The disadvantages of a long cable are loss of volume, and the troubles introduced by the additional amplification, not frequency distortion as so often supposed.

P. G. A. H. VOIGT, B.Sc., A.M.I.E.E.
Upper Norwood, S.E.19.

Frequency Tests by the B.B.C.?

I HAVE read for some weeks past the most interesting discussions and opinions, concerning the higher audio frequencies.

You have certainly created a keen desire to know more about this very fascinating subject, and I trust that these articles will continue, and that practical constructive schemes will from time to time be published dealing with the improvement of our reproduction.

I am of the opinion that manufacturers should publish frequency data of their speakers in order that the ideal electrical frequency output characteristic can be arrived at. If the B.B.C. were to transmit "frequency tests," say, every Sunday morning, we could then determine the amount of, and the place for correction.

More technical and practical information on filters and correctors would, I feel sure, be highly appreciated by a large number of your readers.

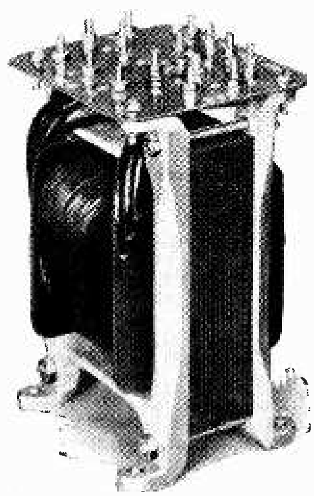
London, N.W.10. C. E. HALL.

THE MONODIAL A.C. SUPERHETERODYNE.

Manufacturers' New Components.

MAINS TRANSFORMER.

COMPONENTS for the Monodial A.C. Superheterodyne receiver continue to come to hand, among those received recently being a mains transformer made by Sound Sales, Ltd., Tremlett Grove, Junction Road, Highgate, London, N.19. It is wound on a core of adequate size, and all output voltages have been carefully adjusted under the load conditions obtaining in the set. Each L.T. winding was found to be within 0.05 volt of its marked value when correctly loaded and with 100 mA. flowing in the H.T. circuit.



Sound Sales mains transformer for Monodial A.C. Super.

Using a Mazda UU120/350 rectifying valve, the unsmoothed D.C. is a shade under 380 volts.

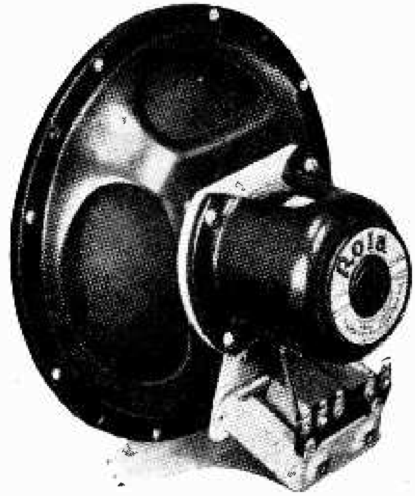
The transformer is robustly constructed and well finished; the primary winding being screened by a layer of copper foil earthed to the core. By removing the four corner screws holding the terminal plate in position and using the holes for fixing purposes the transformer can be mounted so that the terminals protrude through the base, allowing the wiring to conform with the published layout.

This component is satisfactory in every respect for the purpose for which it is intended, and the price is 36s. 6d.

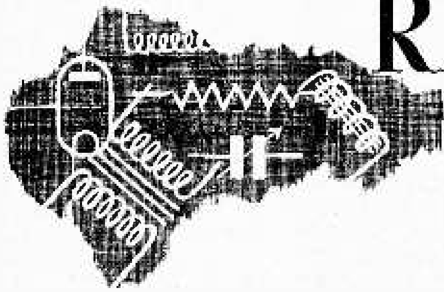
ROLA LOUD SPEAKER.

MADE by the British Rola Co., Ltd., Brondesbury Works, 1a, Willesden Lane, Kilburn, London, N.W.6, this loud speaker has been submitted as being suitable for *The Wireless World* Monodial A.C. Super. It is of the moving-coil type, with a 2,500 ohms. field winding, rated for a current of from 40 mA. to 70 mA. A low-resistance moving coil is fitted and drives a small-diameter buckram cone, while the transformer is of such ratio that the average primary impedance is about 4,000 ohms, the correct value for a P.X.4 valve. A good, and rather unusual, point is the fitting of a hum-bucking coil, so that smoothing of the field supply is unnecessary. This, of course, is not an essential feature of a speaker for use with the Monodial, but its presence is in no way harmful, and it renders the speaker more generally useful. A 7in. diameter hole is required in the baffle board or cabinet.

The speaker has been tested with a Monodial A.C. Super, and proved capable of excellent results. The bass is well reproduced, and without marked resonance, while the high-frequency response is well maintained, although at a somewhat lower level than usual, for the high frequency resonances normally found with paper cones appear to be less marked. Speech is clear-cut and distinct, and free from any "boomy" effect, and the tone on music is well balanced. In spite of its small size, the power handling capacity is high, and it shows no sign of strain when dealing with the full 2,500 milliwatts output of a P.X.4. The efficiency is also high, for the volume to be obtained with a given input is noticeably greater than usual. In view of its satisfactory performance, this speaker can be confidently recommended for use with the Monodial A.C. Super; it is listed as type F.2,500, and at the price of 35s., complete with transformer, it represents excellent value.



A hum-bucking coil is fitted to this Rola model moving-coil speaker.



READERS' PROBLEMS

Useless Screening.

WE are always very much at a loss when asked to suggest methods of avoiding interference from electrical apparatus and machinery, etc. Indeed, the general consensus of opinion is that interference of this kind can only be prevented by taking proper measures at its source.

In particular, it is almost useless to expect that any good will be done by screening the receiver itself; most of the interference reaches the receiver *via* the aerial-earth system or the mains.

Accordingly, we are inclined to advise that a correspondent who proposes totally to enclose his set in a metal box should not go to this trouble, as the possibility of its doing any good is remote.

A High-pitched Whistle.

A CONSTRUCTOR of the "Autotone" receiver states that the tuning and tone control circuits are working satisfactorily, but that reproduction is marred by a "whistle" of very high pitch, of which the pitch and intensity is not affected by tuning adjustments.

An effect of this nature is generally attributable to acoustic reaction, which in turn is aggravated by a microphonic detector valve. The remedy is to mount the detector valve holder on a block of sponge rubber or other shock-absorbing material, and to slip over its bulb a light cardboard cylinder loosely packed with cotton wool. The whistle often disappears when the receiver is mounted in its cabinet. It should be noted that a metallised detector valve can often be used with advantage in this receiver.

Another cause of whistling is an inefficient earth connection of high resistance. Here the real remedy is obvious, but, as a palliative, a cure may be effected as a rule by reversing the primary of the first L.F. transformer. Care should also be taken to see that the aerial and loud speaker leads are not running in close proximity to each other.

THESE columns are reserved for the publication of matter of general interest arising out of problems submitted by our readers.

Readers requiring an individual reply to their technical questions by post are referred to "The Wireless World" Information Bureau, of which full particulars, with the fee charged, are to be found on the next page.

Unstable Detector.

OUR help is sought in overcoming a defect in a conventional H.F.-det.-L.F. set, of which the detector valve tends to oscillate uncontrollably over a large part of the medium-wave tuning scale, even when the reaction control condenser is set at minimum capacity. It has been found that the oscillations can be checked by disconnecting the reaction condenser from the anode.

One is inclined to say in a case like this that the reaction coil is too large, or that the reaction condenser has an inordinately high minimum capacity, and so is unsuited for its function. A contributory cause may be an error in connecting the grid leak; if this is not arranged to give the usual positive bias, there will be less damping in the circuit, and more "liveliness" in general.

The remedies for these defects are obvious, but before closing the subject, we would point out that similar effects are sometimes traced to the action of a faulty H.F. choke in the detector anode circuit. A section of the choke may be short-circuited internally, and if the remainder of the winding, with the associated stray capacities, tends to resonate at a frequency in the broadcast waveband, the effect described may be produced.

Pick-up and Diode.

IT should be appreciated that a diode rectifier does not act in any way as an amplifier, and so it is impracticable to connect a pick-up in its grid circuit in the manner customarily adopted when dealing with a grid detector of the conventional kind.

This a reader has discovered for himself by attempting to apply the conventional method of gramophone adaptation. In answer to his query as to where the pick-up should be connected, our reply is that it must be joined in the grid circuit of the L.F. valve which immediately succeeds the diode.

Another correspondent has evolved the ingenious idea of making the diode coupling resistance serve also the purpose of a pick-up potentiometer for volume control purposes. He is using with satisfactory results a 0.25 megohm resistance for coupling, and asks whether it would be satisfactory to substitute for this a potentiometer of the same value, and to connect the pick-up through a switch across the potentiometer resistance. The set embodies A.C. valves, and details of the best method of connection are requested.

This plan is quite practicable, and we suggest that matters should be arranged as in Fig. 1, which is almost self-explanatory.

For radio reception, the pick-up switch S_1 is opened, while S_2 is closed. The purpose of this second switch is to prevent the application of pick-up voltages to the diode grid.

To put the pick-up into operation, the switch settings are reversed, S_1 being closed and S_2 opened. The potentiometer will be operative as a volume control for both forms of reproduction.

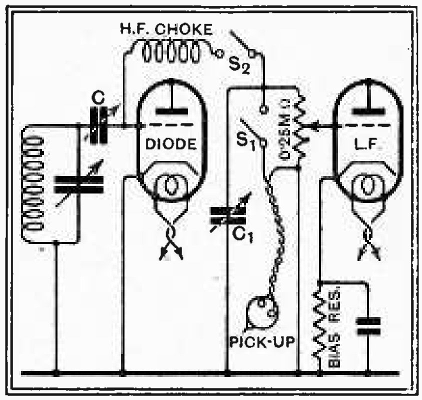


Fig. 1.—A gramophone pick-up connected to a receiver with diode detection; the two switches may be mechanically linked. The diode coupling resistance acts also as a volume-control potentiometer.

In our diagram, C and C_1 are, respectively, the rectifier blocking condenser and the H.F. by-pass condenser; semi-variable capacities of 0.0001 mfd. maximum are generally used in these positions. Of course, the capacity of the switches to earth will be additive to that of C_1, and so this condenser should be set at a rather lower value than normally.

There is one minor "snag" in this arrangement; the L.F. valve succeeding a diode connection in the manner shown should normally have rather less negative bias than usual, for the reason that the rectified carrier wave builds up a negative grid potential across the coupling resistance. This difficulty may be circumvented by employing the lowest possible value of bias resistance for the L.F. valve that is compatible with the avoidance of grid current when the pick-up is in use, or, as an extra refinement, by arranging for the appropriate change of bias resistance by means of an extra blade on the radio-gramophone change-over switch

Two Hours a Penny.

THE "Wireless World D.C. Three" is as economical in the matter of current as any set well can be which operates on direct current mains, and provides a reasonable power output. Its total consumption of current from the mains, including that required for heater and anode circuits, is under 0.3 ampere.

A prospective constructor of this set, who is unfortunate enough to pay for his direct current at the relatively high rate of eightpence per unit, has naturally to consider the question of upkeep, and asks us how much it will cost per hour to operate it.

He omits to mention the voltage of the supply, but this does not greatly affect the cost of operation, which will actually amount to about a halfpenny an hour. If the supply voltage is low—in the neighbourhood of 200 volts—it will be a trifle less.

Violent Oscillation.

IT is important that everyone who builds wireless receivers, or even who handles them, should be able to recognise the signs of self-oscillation, as H.F. instability is still the most fruitful source of trouble in receivers with H.F. amplification.

For instance, a correspondent says that signals disappear entirely when the potentiometer volume control of his set is advanced to "maximum." This is almost a certain indication that, when loading is removed from one of the tuned circuits, the H.F. valve passes into a state of violent self-oscillation, with the probable result that the succeeding detector-grid circuit is choked. There remains, of course, the faint possibility that there may be a short circuit in the potentiometer, which comes into effect at the position in question, but this is unlikely.

Parasitic Oscillations.

A READER, who has made up a simple two-valve D.C. mains set on the lines of that described in the "Hints and Tips" section of *The Wireless World* for January 27th, is troubled by severe hum, but only when the receiver is used for radio reception. Among the modifications introduced are provision for gramophone work and an L.F. intervalve coupling, which provides considerably more magnification than that originally suggested. He is quite sure that the hum is not due to inadequate smoothing, as the H.T. feed circuits have been connected experimentally to another receiver, with admirable results. It is added that the background is exceptionally silent when the set is used with a pick-up.

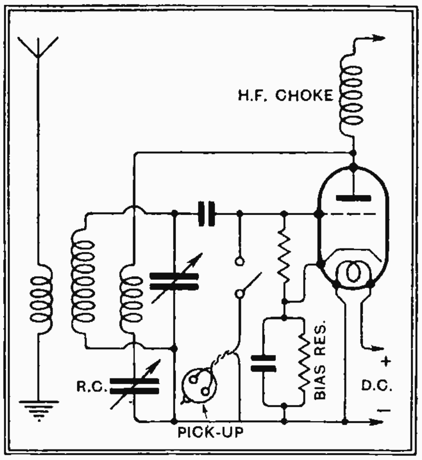


Fig. 2.—A combined detector and gramophone amplifying valve, fed from D.C. mains, as used by a reader.

From our experience with similar circuits, we are inclined to think that this trouble is not due to true hum, as the expression is generally understood, but to a form of parasitic oscillation in the detector, of which the cause is admittedly obscure. An easy cure is often effected by short-circuiting the detector grid bias resistance when using the set as a wireless receiver; this resistance, of course, is operative only when the detector is converted into an amplifier for operation with the pick-up. The short-circuiting switch may conveniently be combined with the radio-gramophone change-over switch.

The circuit actually used by our querist is reproduced in Fig. 2.

The "Monodial Super."

SEVERAL readers have asked for extra information regarding the "Monodial Super," of which the description has recently been completed in the pages of this journal.

It has been asked whether it would be permissible to mount the local-distance switch on the front panel; this is an alteration that cannot be advocated, as instability would in many cases be produced by running the aerial lead in close proximity with anode circuit components and wiring.

In the "List of Parts" the 2-mfd. and 1-mfd. condensers were given in error as being of the "400-volt test" type; actually they should be capable of working at this voltage.

The overall height (inside measurement) of the receiver base compartment is three inches.

Maximum Volume.

TO obtain the greatest volume and the maximum carrying power from a loud speaker for outdoor work, it is often a good plan deliberately to sacrifice a part of the frequency range of the amplifier. By doing so greater intelligibility may be attained.

This is because the average set tends to be overloaded more readily by signal impulses in the lower register than by higher notes. A querist who raises this point would therefore be well advised to try the effect of some temporary alteration which tends to restrict bass response without interfering with the middle and upper registers. He might connect across the primary of the L.F. coupling transformer an air-cored choke of, say, 0.3 henry in series with a variable resistance of many thousand ohms. When this resistance is set at a very high value the combination will have little effect, and by reducing its resistance the amount of low-note loss can be regulated to a nicety.

"THE WIRELESS WORLD"

Information Bureau.

CONDITIONS OF THE SERVICE.

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

(2) Communications should be addressed to *The Wireless World* Information Bureau, Dorset House, Tudor Street, E.C.4, and must be accompanied by a remittance of 5s. to cover the cost of the service. The enquirer's name and address should be written in block letters at the top of all communications.

(3) The fee of 5s. covers the reply to any wireless technical difficulty, but in special cases, where the enquiry may involve a considerable amount of investigation, an increased fee may be necessary. In such cases a special quotation will be made.

(4) Questions should be clearly written and concisely worded in order to avoid delay. Where enquiries relate to trouble experienced in receivers built to specifications in *The Wireless World* a complete account should be given of the trouble, and especially the symptoms.

(5) Where reference is made to published articles or descriptions of apparatus, the title of the article, the date of publication in *The Wireless World*, and the page reference number should be given, in order to facilitate reply.

(6) Full circuit diagrams, constructional details of apparatus, or values of components for home-designed receivers cannot normally be supplied, but circuit diagrams sent in with queries will be checked and criticised.

(7) Particular makes of components cannot, in general, be recommended, but advice will be given as to the suitability of an individual component for a particular purpose specified by the enquirer.

The Wireless World

AND RADIO REVIEW
(21st Year of Publication)

No. 665. WEDNESDAY, MAY 25TH, 1932. VOL. XXX. No. 21.

Editor: HUGH S. POCOCK.

Editorial Offices: 116-117, FLEET STREET, LONDON, E.C.4. - - Editorial Telephone: City 9472 (5 lines).

Advertising and Publishing Offices: DORSET HOUSE, TUDOR STREET, LONDON, E.C.4.
Telephone: City 2846 (15 lines). Telegrams: "Ethaworld, Fleet, London."

COVENTRY: Hertford St. Telegrams: "Cyclist, Coventry." Telephone: 5210 Coventry.
BIRMINGHAM: Guildhall Bldgs., Navigation St. Telegrams: "Autopress, Birmingham." Telephone: 2970 Midland (3 lines).
MANCHESTER: 260, Deansgate. Telegrams: "Iliffe, Manchester." Telephone: Blackfriars 4412 (4 lines).
GLASGOW: 26B, Renfield Street, C.2. Telegrams: "Iliffe, Glasgow." Telephone: Central 4857.

PUBLISHED WEEKLY. ENTERED AS SECOND CLASS MATTER AT NEW YORK, N.Y.

Subscription Rates: Home, £1 1s. 8d.; Canada, £1 1s. 8d.; other countries abroad, £1 3s. 10d. per annum.

As many of the circuits and apparatus described in these pages are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.

EDITORIAL COMMENTS.

Has the Radio Trade a Bad Name?

WE have become accustomed to the persistent complaints regarding the slowness in delivery of new products in the radio industry. This problem of deliveries has become a byword throughout the industry, and the position has almost reached the point where nobody expects delivery of new sets or components until a month or two after they have been announced.

Many excuses can be found for this state of affairs with regard to a new set or component, such as that the demand has exceeded the expectations of the manufacturer and he is unable to keep pace with his orders. But such explanations are becoming too commonplace to satisfy the public, and it is to be hoped that, with the Exhibition a month earlier than usual this year, a determined effort will be made to overcome manufacturing difficulties and enable orders to be met within a reasonable time.

There is, however, another direction in which the radio industry is getting itself a bad name; we refer to general slackness in the matter of routine business arrangements, resulting in an inexcusable delay in dealing with correspondence and acknowledging orders. Often one cannot blame a manufacturer if he is temporarily unable to supply certain of his products, but he can be held responsible when orders or enquiries respecting these products are left unacknowledged for one, two, three weeks, or perhaps even longer, until the customer is exasperated. Almost daily we receive complaints of this nature, and since so many firms are involved in these reports it cannot be regarded as bad business management on the part of a few individual firms, but rather as a disease which has, with certain outstanding exceptions, attacked the radio industry as a whole.

It is surely worth while in every business, of whatever size it may be, to see to it that at least the correspondence is attended to by a responsible individual.

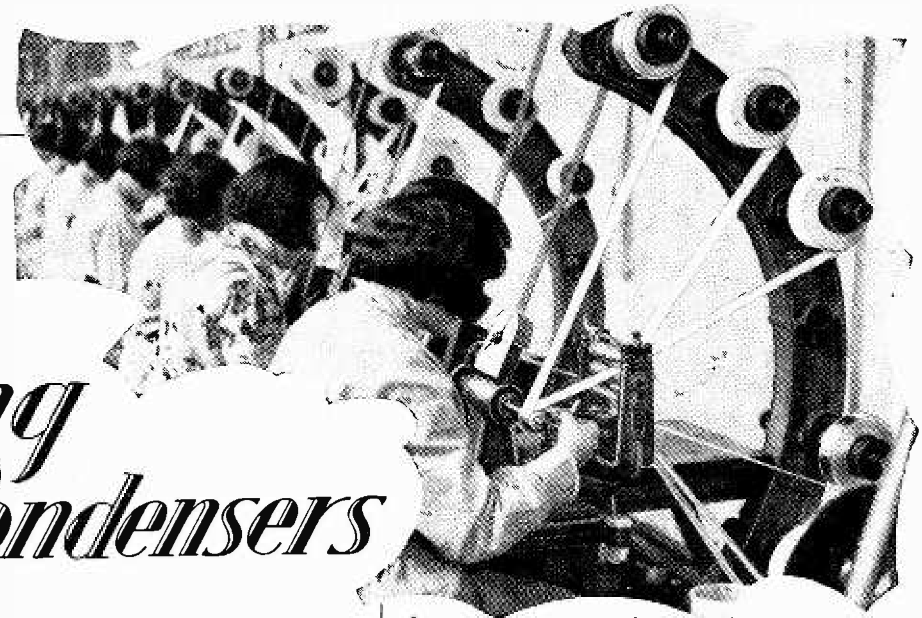
Individuality in Design.

AT this time of the year manufacturers are busily engaged in the preparation of the designs for new receivers for next season, and it is an occasion when we think it well to urge once more that the designers should endeavour to show more individuality and aspire to make their products distinctive from those of their competitors.

There is to-day more scope than ever for distinctive features, and yet the tendency seems to be towards standardisation of sets, leaving the public with very little variety to choose from. The point has been reached where a three-valve receiver, for instance, if manufactured by a reliable firm, is likely to be very nearly identical in performance with one by a reliable competitor. There is, however, plenty of room for distinctive features in the matter of cabinet design, controls, and general arrangement.

As we have pointed out before, and by way of example, we believe there is still a demand for receivers where the loud speaker is separate from the set, and certainly, from the point of view of sales arguments, there are excellent reasons to be put forward to justify the separation of the two units.

Above all, let us avoid slavishly following fashions which were not created in this country. We have surely enough imagination to devise distinctive receivers of our own and avoid becoming mere copyists.



A battery of paper condenser winding machines in action.

[Photo by courtesy of The Telegraph Condenser Co., Ltd.

Choosing Paper Condensers

The Question of Voltage-rating.

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

OWING to the somewhat haphazard methods of voltage-rating of condensers still existing, it is often difficult to select the right value to suit any given set of conditions. A paper condenser in a mains receiver may have to withstand speech volts, surges and ripple volts in addition to the steady working voltage of the anode supply. The author gives simple rules for the choice of a condenser which will allow the right margin of safety.

IN buying paper condensers for a set it is desirable to choose those which are rated to work at a voltage a little higher than the maximum to which they will be subjected in the receiver. The higher the voltage-rating the more expensive the condenser, and as one wishes neither to pay for a robustness that is not needed, nor to land oneself with the annoyance and expense of breakdowns, it becomes necessary to consider each of the condensers individually to determine the voltage which it will be called upon to withstand. And it is not only the steady D.C. voltage that is maintained across it in use that we have to consider, but the peaks and surges, if there are any, which may occur momentarily when the set is switched on or off.

In a battery-operated set of normal type there is nothing much to worry about; the absence of heavy iron-cored chokes and transformers removes most of the danger of surges, while the overall voltage is not usually so high as to endanger the life of even the most modestly rated condensers. We will therefore transfer our attention straightaway to mains sets, and consider the maximum voltages likely to be developed across condensers used in different parts of the circuit.

In Fig. 1 there is shown the circuit of the H.T. supply system of a receiver consuming 60 milliamps. at 250 volts. It contains two condensers; C_1 is a reservoir condenser immediately following the rectifier, and C_2 is the smoothing condenser following the iron-core choke L. If the rectifier is of the standard "A" type, each section of the H.T. secondary of the power transformer will have to deliver 250 volts when on the full load of 60 mA. The question is, what should be the voltage-ratings of C_1 and C_2?

High Instantaneous Voltages.

To some extent this depends on the set with which the eliminator shown is to be used. If, for example, all the valves in it are of the indirectly heated type, and if, in addition, there is no potentiometer (for screen-voltage, or other similar purpose), the set will draw no current from the eliminator until the valves have warmed up. During this period C_1 will charge up to a voltage equal to the highest that is applied, even momentarily, to the anodes of the rectifier.

The transformer, we have decided, is to be rated at 250 volts each side of the centre tap. This, however, is an A.C. rating, and is expressed in root-mean-square (R.M.S.) volts. It is one of the possible ways of expressing the mean voltage; since an alternating voltage has necessarily to pass through zero every time it reverses direction, it is quite clear that there must be instants when it exceeds, by a considerable margin, its R.M.S. value. Assuming

Choosing Paper Condensers.—
perfect wave-form, the peak voltage will be 1.4 times the R.M.S. voltage; in the case considered the peak will be 354 volts. It follows that during the period elapsing after the rectifier has begun to work, and before the indirectly heated valves of the set have begun to draw current, the condenser C_1 will acquire a D.C. charge of this magnitude. If the voltage-wave from the transformer is not a pure sine-wave, this figure may be appreciably exceeded. A condenser rated to work at 350 volts will therefore barely be adequate as reservoir condenser.

But there are other factors at work. The windings of the transformer have some resistance, and they have been designed to maintain 250 volts at a rectified current of 60 mA. When no current is being taken there will be no voltage-drop in the windings, so that the terminal voltage will inevitably rise above 250. How great the rise will be depends entirely upon the conscience of the transformer-maker; it may be five volts, or it may be fifty, though the latter figure implies a design in which cost of production has been cut to the bone. Over-estimating the probable rise of voltage so as to be on the safe side, we will allow that the peak voltage rises from 354 to a round 400 volts through the absence of load.

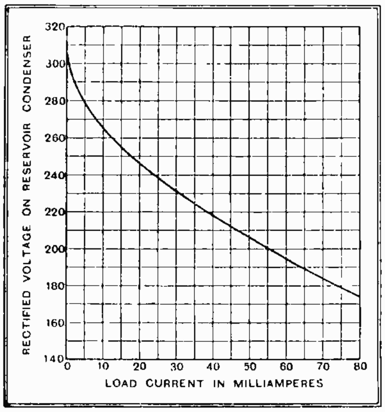


Fig. 2.—Variation of rectified voltage with load current. The very rapid drop as soon as a small current is taken is especially noticeable.

Already a condenser rated at 350 volts is beginning to look inadequate, and even yet we have not exhausted the sources of voltage across C_1. The output from the rectifier is not pure direct current (if it were, no smoothing circuits would be needed), but contains a very appreciable A.C. component. That is to say, the voltage across C_1 is not dead steady at 400 volts, but fluctuates about this value at double the frequency of the mains. The alternating voltage on C_1 depends on a number of factors, but is usually found to have a value of 25 to 40 volts peak. Adding 40 volts to 400, we get 440 as the maximum voltage developed across this unlucky condenser. Moreover, we have to remember the indisputable fact that the paper dielectric definitely dislikes an alternating voltage. The paper will "tire" and break down more quickly with a voltage fluctuating rapidly from 200 to 400 and back again than it will if the voltage is maintained steadily at 400 volts. We shall therefore have to make generous allowance for the A.C. ripple superposed on the D.C. output; let us say, to be on the safe side, that the 40-volt ripple is about equivalent to another 60 volts of plain D.C. That brings us to a condenser rated to work at 500 volts, and allows a margin of 40 volts only on the safe side. If we are to be fully safeguarded against breakdown in the circumstances described this must be our choice for the voltage rating of C_1.

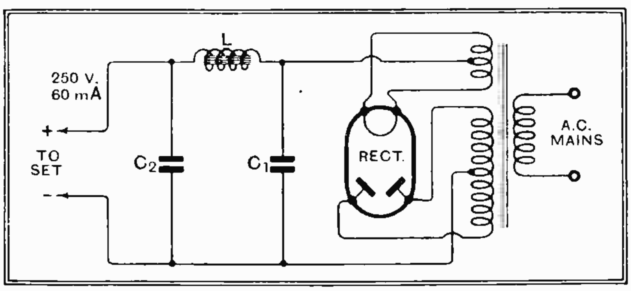


Fig. 1.—The H.T. supply system of an ordinary mains set. The voltages which C_1 and C_2 have to withstand are discussed in the text.

By taking all these points into consideration we have come to the conclusion that for the case discussed we need a condenser rated for steady use at double the working voltage of the set. And even now nothing has been said about surges at the moment of switching off; if condensers were like fuses, and "blew" the moment their rated voltage was exceeded, the writer would cheerfully bet a pound to a penny that he could puncture a 500-volt condenser in the position of C_1 within a couple of minutes. But this would mean deliberately mishandling the set, and we can rely upon the generosity of the condenser-maker, who always gives us rather more robustness than we actually pay for, to cover this possibility now that we have allowed for all the other dangers.

So far as steady voltages are concerned, C_2 gets exactly the same treatment as C_1, but the choke protects it from the A.C. ripple that falls with full force upon its more exposed companion. If it is rated to work at 400 volts, C_2 will be quite happy.

R.M.S. and Peak Voltages.

The conditions in most sets are not quite as severe as those we have been discussing; there are few sets that do not contain a potentiometer to supply voltages below the maximum to some valve or other, and this will draw at least a little current as soon as the set is switched on. It will therefore be an exceptional set in which the rectified voltage rises to the full peak voltage of the transformer, especially as even quite a small current drops the voltage well below this maximum. The curve of Fig. 2 shows the relationship between rectified voltage attained and current delivered for the case where the transformer voltage does not vary with load; the variation is thus entirely due to the characteristics of the rectifier-condenser combination. The fact nevertheless remains that the voltage on the reservoir condenser will be higher before the valves warm up than it is when the set is fully running. The A.C. ripple, too, will always be present.

One would therefore suggest that the reservoir condenser should be rated for a steady working voltage about equal to the peak voltage given by the transformer under normal running conditions, allowing this

Choosing Paper Condensers.—
rather generous estimate of the extra voltage from one source to cover all minor sources as well. The following table gives the peak voltages corresponding to various R.M.S. voltages likely to be encountered:—

Rated Voltage. (R.M.S.)	Peak Voltage.
200	283
250	354
300	425
350	495
400	565
450	635
500	707
550	780

In the case of C_2 there are no appreciable ripple voltages to be guarded against; it would be quite safe, therefore, to choose for this position a condenser rated to work at a voltage some twenty per cent. greater than the normal running voltage.

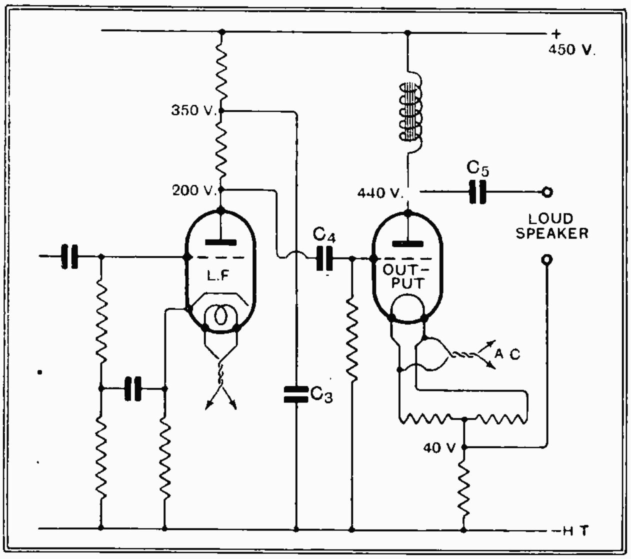


Fig. 3.—The last two valves of a high-voltage receiver. Suggested ratings are: C_3 and C_4, 500 v. working and C_5, 800 v. working.

Fig. 3 shows the circuit of the last two valves of a powerful receiver of the type of the "Power Radio-gram," using a directly heated high-voltage output valve. This section of the receiver contains three condensers, for which the choice of voltage-rating is not quite as evident as it might appear at first sight. The voltages developed at different points when the set is working are indicated on the diagram.

The decoupling condenser C_3 operates normally at 350 volts, since 100 volts are dropped in the decoupling resistance which separates it from the main H.T. *plus* line at 450 volts. But until the directly heated valve warms up it takes no current; there is therefore no voltage-drop on the decoupling resistance, and C_3 receives, for this interval, the full 450 volts. Not appreciably more, because the output valve, being directly heated, takes current as soon as the set is switched on, so that the 450 volts is only exceeded by a trifling amount. A.C. ripple, whether in the form of mains hum or speech currents, does not occur in any amount across C_3; if it is rated to work at some 500 volts D.C. there will be a reasonable margin of safety.

Comparison of this condenser with C_4 will show that the latter works under much the same conditions from the D.C. point of view; it has to pass speech in addition, but since the grid leak will be so chosen that practically all the signal voltage occurs across it, and not across C_4, this need hardly be taken into account. The rating may therefore be the same as that of C_3.

The output condenser C_5 is subjected to a D.C. voltage of 400 as soon as the set is switched on. In addition, it has to carry the whole of the signal current passed on by the last valve to the speaker, so that considerable speech voltages can arise across it. In the worst possible case, where C_5 tunes the inductance of the speaker to the frequency of the signal being received, the peak signal voltage across C_5 may rise nearly to the working voltage of the valve. In the case under consideration this would mean a peak signal of 400 volts superposed on the steady D.C., running the total up to 800 volts. Since, in addition, this extra voltage is alternating, it will be much more dangerous to the life of the condenser than the same D.C. voltage; in choosing the condenser rating we ought, in strictness, to count it as equivalent to at least 600 volts rather than 400, making C_5 a condenser rated for 1,000 volts D.C.

Indirectly Heated Rectifiers.

In practice it is not necessary to go as far as this, because the output valve is never likely to be fully loaded with a signal at the dangerous frequency. But an output condenser should always be rated to work at a D.C. voltage double that applied to the anode of the output valve, or there will be serious danger of eventual breakdown owing to the dielectric "tiring" under the violent stresses of the signal voltages. This higher rating will also take care of the surges occasioned by switching off the set while a current is flowing through the output choke.

In several cases the excessive voltages that we have been considering arise because the rectifier begins to deliver current almost immediately after switching on the set. One maker offers us a range of indirectly heated rectifiers, whose emission begins at about the same time as that of the receiving valves. If we employ a rectifier

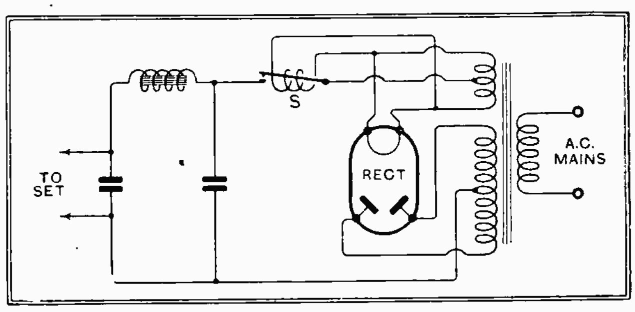


Fig. 4.—Thermally controlled from the rectifier filament winding, the delay-action switch S closes only after all the valves in the set have had ample time to warm up.

Choosing Paper Condensers.—
of this type a certain saving can be made in condensers, for they will no longer have to withstand such high voltages. A condenser placed like C_3 of Fig. 3, for example, need only be rated to work at the voltage it receives under running conditions. Owing to the fact that indirectly heated rectifiers are only available for sets running at 250 volts or less, the safeguard they offer is denied us in high-voltage receivers, where the saving they would permit would be at its greatest.

The same end can be achieved if we insert a delay-action switch in the H.T. circuit, as shown in Fig. 4; this is naturally applicable to any set irrespective of the anode voltage used. In the "Power Radiogram" this was done, the cost of the switch being a small matter compared with the saving effected by being able to employ condensers rated only to withstand their working D.C. voltages, *plus* A.C. ripple where this was likely to occur. Where resistance-coupling is used, or where decoupling is extensive, a switch of this type is often an economy rather than an expense.

"Test Voltage" of No Real Value.

We have made frequent reference to the voltage-rating of condensers, meaning in every case the voltage at which the condenser may safely be allowed to work. It is necessary to draw attention to the fact that there are many condensers on the market which carry no more information than a "test voltage" which they have withstood momentarily before leaving the maker's hands.

The magnitude of this test voltage is a matter which concerns the manufacturer only, and there appears to be no reason why it should be communicated to the public, who are not interested in the tests that the manufacturer chooses to apply to his products. In some factories the test voltage is double that at which the condenser is expected to work in actual service, while in other cases it is not advisable to run a condenser at more than one-third of the test voltage. It is possible that the discrepancy arises through varying duration of test; a condenser to work on 200 volts might be adequately tested either by a momentary application of 600 volts or by having to stand up to 400 volts for a longer period. It is, in any case, quite certain that a condenser grandiloquently marked "500 volts" is only reliable, in the absence of any more detailed information, for voltages up to about 180 at most.

The more modern makers either mark their condensers with working voltages, or at the least give this information in their catalogue, by stating the working voltage corresponding to each test voltage. In any case, it is the user's responsibility to choose a condenser which its maker guarantees as safe for operation at the voltage which he proposes to apply.

SCOTLAND'S NEW REGIONAL STATION.

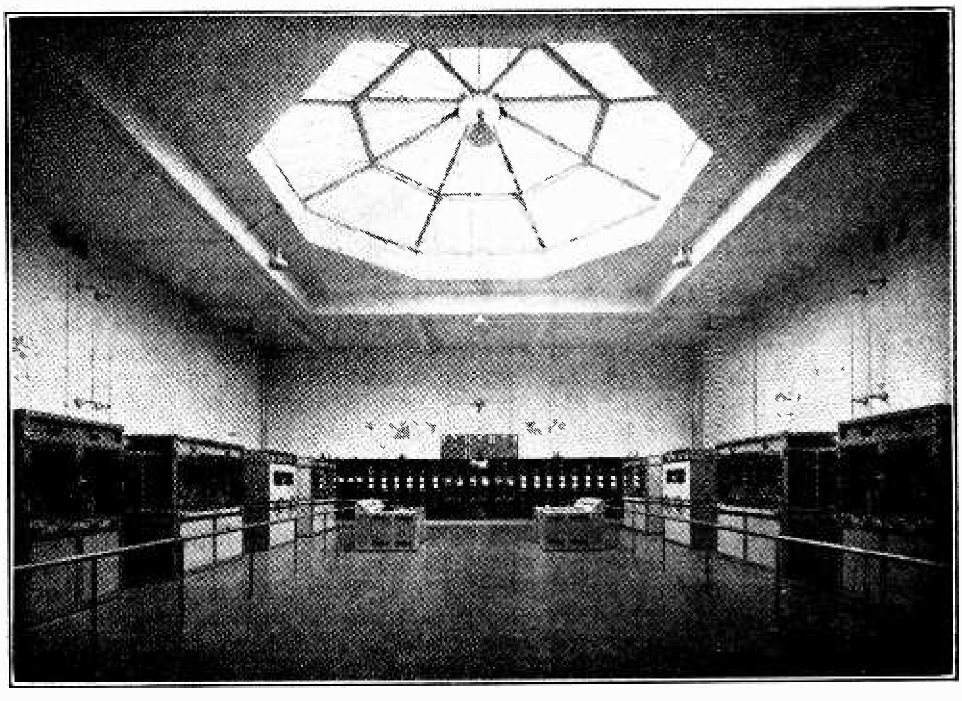
THIS week sees the inauguration of regular broadcasts during programme time by the B.B.C. Regional transmitter at Falkirk. According to the present schedule the station can be heard on 376.4 metres daily during the 10.15 a.m. to midday period, and again during the late dance music from 10.30 p.m. onwards.

In general plan the twin-wavelength station at Falkirk resembles the others of its class at Brookmans Park and Moorside Edge, and is designed to give the best service to the greatest number of people in its region.

Alternative Programme.

The National transmitter, with which tests will begin when the Regional has taken over its complete service, will operate on 288.4 metres.

Despite satisfactory reports within the service area, it is to be feared that Scottish Regional will fail to serve all parts of Scotland, and the B.B.C. may be compelled to devise other methods of supplying a satisfactory service to Inverness and places farther North.



The main transmitter hall of the B.B.C.'s Scottish Regional Station at Westerglen, near Falkirk.

Unbiased

by Free Grid

Bring Out Your Gear.

THE other day I found myself parked outside a large London departmental store while Mrs. Free Grid entered to buy a hat, or whatever it is that women waste other people's money on at this season of the year. After allowing a decent interval to elapse I myself went inside and wended my way to the Radio Department. In the course of my peregrinations through the welter of plutocratic-looking radio gramophones I was delighted to stumble (literally) across a piece of out-of-date apparatus that I happened to want which was being offered at a bargain price. The instrument was actually a moving-coil loud speaker by a well-known firm,

Ransacked the department.

which for some esoteric reason best known to themselves, they have withdrawn from the market in favour of one which, in my opinion, is definitely inferior.

I immediately ransacked the department for some other things of which I stood in need, but without avail. By this time, however, my hunting instincts had been thoroughly roused, so, speedily descending to the street, I hailed a passing taxi and proceeded to make a tour of the radio departments of several other large stores. I was rewarded by yet another find, and my joy was such that Mrs. Free Grid was quite forgotten, but who could count the day as lost?

What I particularly noticed was the enormous amount of "bargain" apparatus that was to be had—gear which many an experimenter might be seeking—and it occurred to me to wonder why all this useful equipment should remain hiding its light under a bushel when it might find a ready home by being advertised month by month in some suitable medium. The gear to which I refer is thoroughly sound in wind and limb, and of considerable use to the pukka experimenter; it has nothing in common with the junk which you see daily in certain shops and to which I referred recently.

Common Informer.

NOT long ago, when the day was already far spent, I stood in urgent need of a ganged condenser, so hastily wended by way to one of my favourite hunting grounds. Elbowing and prodding a path for myself through the crowds, I eventually reached the radio counter and succeeded in engaging the attention of a young man who graciously inclined his ear to me.

Unfortunately, however, I was unable to make my wants known, as several loud speakers were at the time blaring out the first news bulletin from London National. I raised my voice and attempted to repeat my request, but was cut short by a spasm of coughing due to the presence of certain thoracic irritation. I fear that the physical discomfort resulting from my vocal efforts in trying to drown the news bulletin must have shortened my temper in an unpardonable manner, for at that moment the idea crossed my mind that I could turn common informer and avenge myself on the departmental manager, who was presumably responsible for all this hullabaloo. I instantly demanded to see him.

"I shall be obliged," I told him, "if you will show me your permit to rediffuse news bulletins to the public in defiance of the recent warning by the B.B.C."

"But this is not a public place within the meaning of the Act!" he spluttered, gazing askance at the official-looking notebook which I had withdrawn from my pocket.

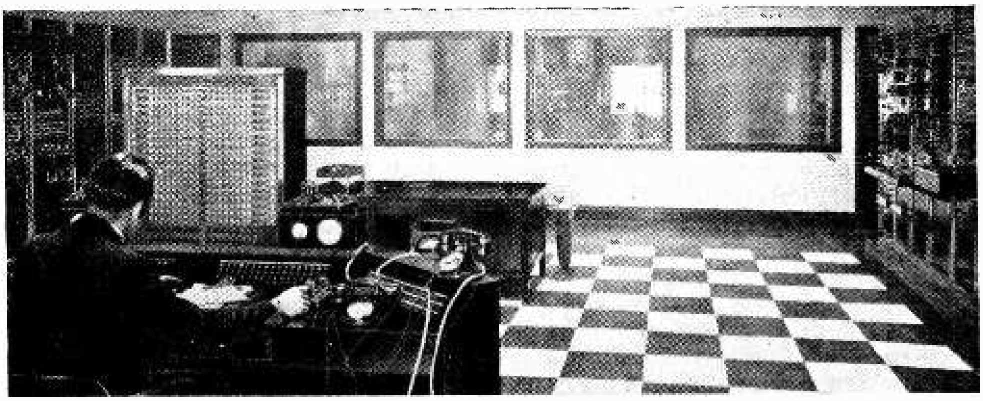
"Don't quibble," I retorted, "you are perfectly well aware that you can rediffuse no news whatever, either by loud speaker or printed slip, other, of course, than the emanations of your tape machine, for which you pay; you will hear further of this matter," and I closed my notebook with a snap and took my departure, conveniently forgetting the original purpose for which I came in.

Whether it was the psychological effect of my notebook or whether it was the result of my legal arguments I cannot say, but before I had crossed the floor of the department on my way out the news bulletin was cut off amid the protests of a number of customers and other listeners.

Infringement of copyright.

I trust that if this paragraph should catch the eye of managers of other departmental stores they will take heed before it is too late; the same thing, of course, applies to the bar parlour of country pubs, in a large number of which it is customary for mine host to infringe copyright by means of loud-speaker reproduction of news bulletins and fat stock prices.

How they Broadcast in America



A glimpse of the control room of the N.B.C. station in Chicago.

by A. DINSDALE

Part II.—When Programmes are Timed to the Second.

THE ingenious timing arrangements for dovetailing the programmes of from fifty to a hundred American broadcasting stations are described in this, the concluding instalment of Mr. Dinsdale's article. "At exactly 7.59.30 the announcer will say: 'This is the Columbia Broadcasting System.' At 7.59.35 the announcer will press a button . . . At 7.59.50 . . . the producer's arm goes up . . . Exactly at 8 p.m. to the second, down comes his arm." Listeners can check their clocks by the start of the programme.

IN America the duty of Master Control engineers is to check the signal level of outgoing programmes, *but not to correct;* if anything goes wrong they telephone immediately to the Studio Engineer, who wears a breast telephone set, and has an open line to Master Control all the time he is "on the air." Master Control engineers also attend to the despatching of outgoing programmes, switching the succeeding studio on to the outgoing lines at the conclusion of a programme, and connecting the outgoing lines to the WABC transmitter, to the short-wave transmitter W2XE, and to the telephone company's headquarters for nation-wide distribution. On occasions there may be as many as four programmes going out at once, each programme going to a different section or sub-division of the network.

It is the duty of the Studio Engineer, while his studio is on the air, to control the outputs of the various microphones and mix them properly. Only those microphones in actual use are kept switched on. Thus, when the engineer sees an actor, singer, or announcer getting ready for action, he switches on the appropriate microphone, and cuts it when finished with. Sometimes, when cues come without visible or audible warning, the producer, following the script, warns the engineer a few seconds in advance, so that the appropriate mike can be switched in.

In monitoring a programme, the control-room loud speaker is only a secondary guide to the engineer; his main guide is a volume indicator on his control panel, the needle of which has a range of from 5 to 60 db. While on the air the needle should not fall below 10 db. for more than ten seconds at a time. This is because, over long telephone lines, the signal would be apt to be drowned out by the prevailing noise level. It is thus necessary sometimes to bring up long pianissimo passages.

At the other extreme, the volume indicator needle should not consistently pass 30 db. It may reach instantaneous peaks as high as 60 db., but such high peaks should be avoided if at all possible. If the needle stays consistently above 30 db., transmitters all over the network are likely to be overloaded, causing distortion and possibly tripping their circuit breakers, thus putting them off the air. Hence, it is sometimes necessary to reduce the volume of long fortissimo passages. From an artistic viewpoint this necessity for compressing volume range is one of the shortcomings of broadcasting as at present conducted.

The operation of a network has been compared with that of a railway system. A network has its stations, its traffic (programmes), its signalling system (cues), and its emergency communication system (Morse wires to all stations). Time is a factor of prime importance.

How They Broadcast in America.—

Each station has its own schedule for the day. If that schedule calls for it to broadcast an important programme of its own at, say, 8 p.m., and it is taking a network programme just prior to that time, the network programme must terminate on time to the second to enable the station to withdraw from the network in time for its own studio programme. Similarly, it must terminate its own studio programme exactly on time in order to cut in on the network to take a network programme.

In addition, if a sponsor pays for fifteen minutes of time on a network of thirty stations, he wants his full fifteen minutes of time on each and every one of those stations. Hence, programmes have to be worked out to the second. That is the producer's job, and he uses a stop-watch to help him do it. Every verse and chorus of every musical number, every page of a script, and every scene of a play is separately timed, so that if the dress rehearsal shows that the programme is either too short or too long, a suitable place can be found to pad or cut it.

Not a Second's Delay.

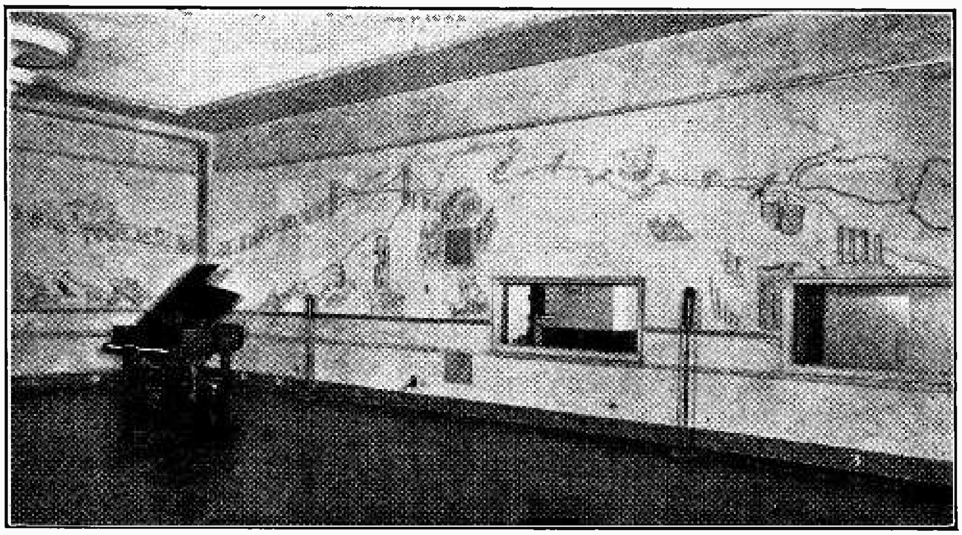
The general effect of these circumstances and conditions is that, to the ears of British listeners, an American programme proceeds at a breath-taking pace, without a second's delay at any point. I read in a British paper just such a criticism of the first C.B.S. special programme, entitled "Hello, Europe," which was rebroadcast in England on January 11th of this year. To those who heard that programme it may be of interest to add that I had charge of that section which featured Morton Downey, tenor, with Jacques Renard's orchestra.

Let us now step into a studio and watch a fifteen-minute programme being broadcast at, say, 8 p.m.

Approximately five minutes before air time, Master Control will signal the Studio Engineer for a test, whereupon the latter will open up a microphone and pick up whatever noise is going on in the studio. Master Control will express satisfaction with the result by switching through "cue," which means that the preceding programme, just terminating, will be audible on both control-room and studio loud speakers. Musicians and others take their places. The producer walks into the studio and makes a final check-up on the positions of musicians, artists, and microphones.

At exactly 7.59.30 the announcer on the preceding programme, having read his closing announcement and signed his name, over a moderate background of music, will say, "This is the Columbia Broadcasting System." This phrase is the cue for the entire network, and British listeners who hear it over W2XE may, with assurance, set their clocks by it, to the second. The word "System" comes half a minute prior to the quarter-hour, half-hour, three-quarter hour, or full hour.

The music continues after the cue phrase. At 7.59.35 an announcer in another studio specially reserved for the purpose will press a button and announce "WABC, New York." This goes to the local transmitter only, not to the network. Immediately thereafter he will press another button connecting his microphone to the short-wave transmitter and announce, "W2XE, New York." Meanwhile, acting on the cue phrase, announcers all over the network have made their own local station identifications, as required by Federal Radio Commission ruling.



A typical American studio—one of the Columbia Broadcasting System. There is no draping, and the walls and ceiling are composed of Celotex, the floor consisting of cork blocks. The control room window is in the centre. The clients' listening room can be seen through the window on the right.

At 7.59.50 the musical background will have faded out entirely. Then follows silence for ten seconds, during which time Master Control disconnects the studio which has just been in use, switches on to the studio about to be used, and makes the necessary land-line connections for the proper despatching of the forthcoming programme. Simultaneously, all over the network, stations leaving the network cut out, while those joining the chain cut in. Stations already on the network, and remaining on it, naturally "stay put."

The N.B.C. chains operate in a manner exactly similar in principle, but differing slightly in detail. Their programmes terminate exactly on the hour, quarter-hour, half-hour, or three-quarter hour, the next programme starting thirty seconds later.

Back in the studio of the forthcoming programme,

How They Broadcast in America.—when the cue music fades out at 7.59.50, the producer's arm goes up, and he calls out a warning that the studio is about to take the air. The producer's eyes are on the large red second hand of a big electric clock. Exactly at 8 p.m., to the second, down comes his arm, pointing directly at the person concerned with the opening of the programme, and the watching engineer switches on the mikes. If the programme opens with a few bars of theme music, that person will be the orchestra leader or pianist; if the announcer opens the programme "cold," the cue will be given to him. Listeners may re-check their clocks by the programme opening; only on rare occasions is it late.

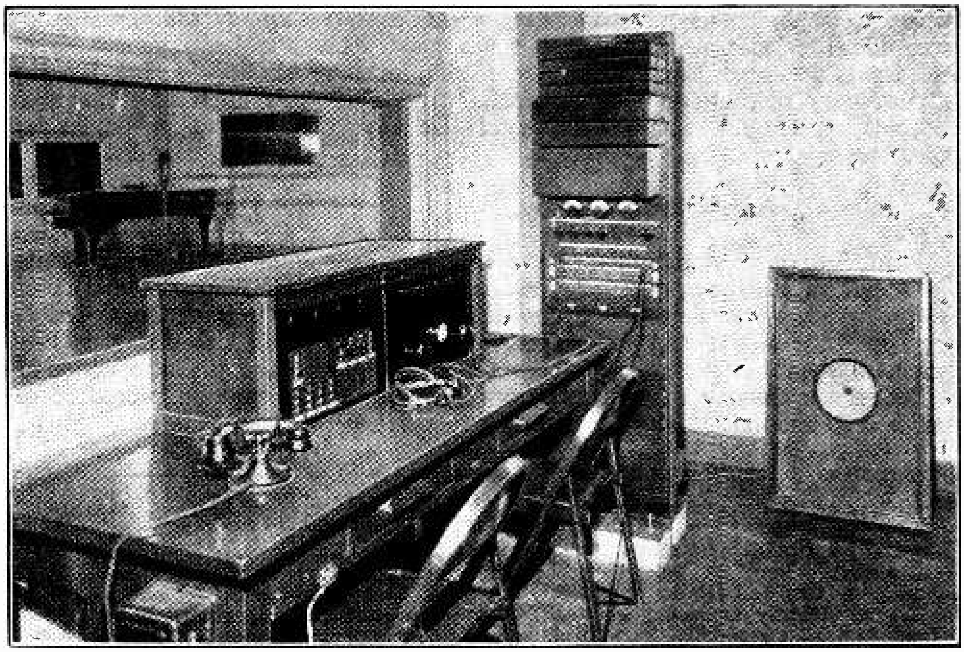
If no more cues are necessary, the producer will then retire to the control-room, there to check reproduction on the loud speaker, check the timing of the programme as it progresses, and keep an accurately timed log of the proceedings. If any artist or musician fails to follow instructions regarding his or her position relative to the microphone, if the programme proceeds too rapidly or too slowly, as checked against rehearsal timings, the producer will signal accordingly through the glass window, or go out into the studio and signal, or, if necessary, whisper to the person concerned. He will also be found in the studio if cues are required during the programme. In a large studio, with sensitive microphones, a cast of actors working on their own microphone in one corner of the studio may easily be almost inaudible to the orchestra leader who has to come in, on cue, with musical interludes between the scenes of a sketch. Or the sound-effects people, working on another mike in another corner, may need cues for the same reason.

In the Event of Breakdown.

As the end of the programme draws near the producer will again be found in the studio to see that the programme terminates on time. In extreme cases this may entail his giving instructions to an orchestra leader to cut, at a certain point, a musical number he is then playing, or, if the programme is running short, to add another chorus or movement. On cue from the producer, the announcer commences his closing announcement, ending with the cue phrase: "This is the Columbia Broadcasting System." The orchestra or pianist continues theme music, while everybody else remains still until, thirty seconds later, the opening of the succeeding programme is heard over the studio loud speaker. Not till that cue is heard does the producer release the occupants of the studio.

Comparing B.B.C. Methods.

Should a last-minute technical fault prevent the next studio from going on the air, the producer whose programme has just terminated may, at a moment's notice, have to call upon those in his studio to carry on with an improvised programme until the trouble is rectified. It will be clear that, in the event of breakdown, especially with programmes not originating in New York, instant intercommunication is essential to the smooth working of such gigantic networks.



A studio control room. The vertical panel in the background houses a 2-stage microphone output amplifier. The window behind the control panel gives a view of the whole studio.

The short-wave station W2XE (6,120 kc., 5 kW.) is in daily operation from 7.30 a.m. to 2 a.m. the next day (12.30 p.m. to 7 a.m., G.M.T.). Between 8 and 11 p.m. in the evening, however (1 a.m. to 4 a.m., G.M.T.), the transmitter is used to broadcast the sound part of a television programme broadcast by W2XAB) (2,800 kc., 200 watts). Since the television programmes are experimental, they are not accurately timed as described above. During the rest of the day W2XE relays the WABC programme.

Three points of difference in procedure emerge from the foregoing, by comparison with B.B.C. methods. (1) American announcers still almost invariably sign their names at the end of their programmes. (2) Sound effects are produced in the same studio as the programme, not in a separate studio. (3) The rule of the American networks is that, if it can be humanly avoided, "dead air" shall not last longer than ten seconds, no matter what the cause of the interruption may be. You

How They Broadcast in America.—

never hear such announcements as "One moment, please," or "Please stand by." The chief reasons for this ruling will be apparent from what has already been written. A further reason is that there are so many competitive stations for the listener to choose from that, in the event of a long pause in the activities of the station to which he is listening, he quickly loses patience and tunes in another station. It will be apparent that an American broadcasting station can no more afford to lose its audience than a newspaper can afford to lose its readers. Hence the reason for the extraordinary precautions taken against "dead air," and this reason also acts in favour of fast-moving programmes.

An Awkward Delay.

When European programmes are rebroadcast over the American networks, the long pauses in some of the programmes sometimes cause consternation to the team on duty in the stand-by studio. On one such occasion, when I had charge of the stand-by for one of the regular Sunday rebroadcasts from London, the preliminary announcement had gone out to the effect that we were going to broadcast a programme from London. London somehow missed the cue and was fifteen seconds late in coming on with the London opening announcement, which was to the effect that "We are taking you over to the Albert Hall." There followed a silence which seemed interminable, but which actually lasted for only about a minute. As the seconds flew by both the engineer and the announcer became increasingly restless, looking to me for guidance. Finally the engineer turned to me and said: "Guess the line's gone. Shall I cut it and switch to the studio?" Had I not known the ways of the B.B.C. an interesting broadcast might have been lost to the American public for ever. As it was, since the circuit did not sound dead, I replied: "Wait. They'll come on in due time." A few seconds later the announcer at the Albert Hall opened up, and the engineer beside me mopped beads of perspiration from his brow, muttering darkly the while anent the incomprehensible idiosyncrasies of B.B.C. procedure.

It is perhaps possible that continued interchange of broadcasts between Europe and America may in time cause the introduction of slight modifications in the technique and procedure employed on both sides of the Atlantic.

BOOK REVIEW.

INTERMEDIATE ELECTRICAL THEORY. By H. W. Heckstall-Smith, M.A. Pp. xii+518. with 241 Figures. Dent and Sons, Ltd., London. 1932. Price 10/6 net.

THE allied studies of "stinks" and "shocks" have as much appeal nowadays as they had twenty years ago for the scientifically inclined youngster, but in one respect especially the path of knowledge has been immeasurably smoothed for the youth of to-day. The text-books are becoming at once more human and more scientific. Elementary electricity and magnetism are, admittedly, difficult subjects for the schoolboy; if a proper conception of fundamentals is not grasped much time and labour will inevitably be wasted subsequently. Mr. Heckstall-Smith, who is Science Tutor at Stowe, has brought his wide teaching experience to bear on the adequate presentation of the initial difficulties, and the results, which are embodied in this volume, are wholly admirable.

Not only is the subject-matter of electricity a novel and unexplored territory for the budding candidate for the higher certificate or University Entrance Scholarship, but the mathematical tools which he has to use are still in process of forging. It is no easy task to present the elements of an essentially exact science to those whose mathematical powers are as yet immature. The dangers, as the author observes in his preface, are two—to avoid discouraging the mathematically minded by confusing description with analysis, and to refrain from overwhelming the weaker mathematicians with an overdose of symbolism. His method of overcoming the difficulty is to divide the book into two parts, of which the first uses a minimum of mathematics and no calculus at all, while the second is more analytical and makes free use of calculus methods. In this way the whole range and treatment of the subject-matter is brought into sharp focus, the more descriptive passages occurring in the first part, and the relative theory treated more rigorously in Part II. It should be emphasised, however, that even in Part I the author is at all times careful to insist on the advantages of mathematical treatment. It is difficult to see how this plan could be bettered.

But the outstanding feature of this book, and the one which chiefly commended itself to the present reviewer, is what he will venture to call its "human interest." Surely never before has a text-book on Electricity and Magnetism condescended so far from the beaten track as to recount stories of how great discoveries were made—of how, for instance, Oersted was "playing about with the apparatus on his bench with some students at the end of a lecture" when he made his classic discovery, and of how —whisper it—poor Georg Ohm actually lost his teaching post because of his famous "Law." Admirable, too, is the account of Faraday's discoveries, including extracts from his Diary and a facsimile reproduction of the page whereon is recorded the discovery of electro-magnetic induction. Such matters are the very stuff of history, and are an inspiration to all who care for the advancement of knowledge.

In lighter vein, too, the author shows that he is not above making his subject palatable by a deft touch that would have scandalised the pundits of a former generation. Thus, the "Corkscrew Rule" will be the better remembered for the Scotsman whose left-handed corkscrew would seem to invalidate it. But what shall be said of the Very Outrageous Pun which occurs on the very next page to the Scotsman?

Space would fail to describe chapter by chapter the contents of this fascinating book. Instead, the reviewer would ponder, a little sadly, upon his own schooldays, and reflect upon the electrical teaching which he then imbibed. It was his fortune to receive instruction at the hands of one who, in all other respects a worthy man and a sound scholar, was obsessed with the importance of Mance's method of finding the internal resistance of a battery. Every now and then the blackboard would swarm with hieroglyphics in praiseworthy effort to expound the mystery, but in the case of one pupil at least the result was unsatisfactory. Mance's method does not appear in the index to Mr. Heckstall-Smith's book, though on p. 159 it is just mentioned as one among a number of possible experiments. *Sic transit gloria Manci.*

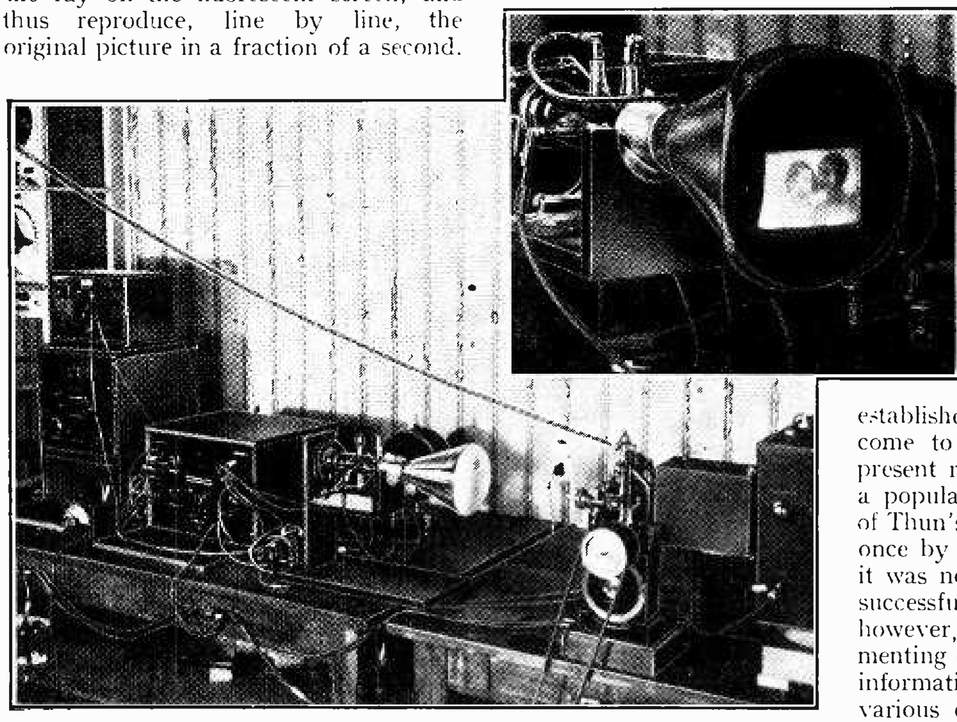
No review is, of course, complete without that hint of adverse criticism which demonstrates the entire impartiality of the critic. In the present instance the only departure noticeable from the consistently high standard of the book was found in the author's treatment of vectors—admittedly only a single page, but not very clear. In addition, the reviewer is old-fashioned enough to prefer to see arrows marked on a vector diagram. Apart from this, he has nothing but praise for the book.

In conclusion, mention should be made of the numerous worked examples and numerical exercises to which answers are appended at the end of the volume. The type is clear, and great care has evidently been expended on the production, misprints being remarkably few for a first edition. The book should have a wide and enthusiastic welcome. W. A. B.

NEW TELEVISION SYSTEM.

Modified Cathode Ray and "Variable Speed" Principle.

BARON MANFRED VON ARDENNE'S work on cathode-ray television is well known, and a short description of his recent achievements was given in *The Wireless World* of September 9th, 1931. In the system described, the principles follow the orthodox practice of a cathode ray, both at the transmitter and at the receiver, travelling along its pre-ordained path, line after line, with a constant speed of movement. At the receiver the constant speed of movement is accompanied by a varying intensity of ray, governed by the incoming signals and corresponding to the varying light and shade of the picture being scanned at the transmitting end. These intensity variations in the ray produce, of course, corresponding variations in the brightness of the "spot" traced by the ray on the fluorescent screen, and thus reproduce, line by line, the original picture in a fraction of a second.



Experimental television station designed by von Ardenne for transmitting cinematograph film. (Inset) An enlarged view of the cathode ray tube which, owing to its freedom from inertia, is found an essential part of the equipment.

A New Idea.

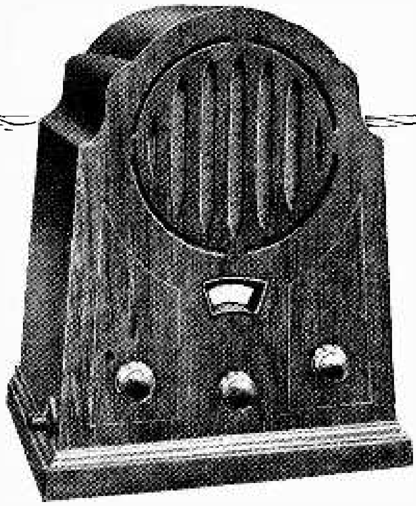
An entirely new idea, departing entirely from these conventional principles, was suggested some time ago by R. Thun. "Why complicate matters at the receiver in the way you do?" argued this original thinker. "Your ray must, I agree, move along line after line so as to cover the whole picture surface; and in doing so it must also reproduce the variations in light and shade representing the original subject. But you go to endless trouble to control it so that it travels with a uniform speed, in exact synchronism with the uniform speed at the transmitter; and, having done this, you have to produce your light and shade by making your signals control—in addition—its intensity. Surely this is rather like cutting a large hole in the door for the big dog, and a small second hole for the puppy? For if you make your ray travel quickly where you want shade, and slowly where you want light, you will kill three birds with one stone. First, you will save time over the dark parts, where detail is not so essential, and have that extra time to spare for the bright parts, where you want all the detail you can get. Secondly, you will get your light and shade without the complication of having to modulate the *intensity* of your ray, since the more slowly it moves over a certain spot the brighter will it make that spot; and, finally, since the ray can now be kept always at its highest intensity, you will raise the whole level of brightness of the image."

Certain Difficulties Overcome.

It is probably some bright idea like this, departing entirely from established notions, which will one day come to transform television from its present rather unsatisfactory state into a popular success. The attractiveness of Thun's suggestion[1] was recognised at once by many workers, but obviously it was not an easy thing to carry out successfully. During the past year, however, von Ardenne has been experimenting on parallel lines, and the latest information is that he has overcome the various difficulties so successfully that he can already transmit and receive 10,000 element pictures by this system. The need for very rapid and accurate variations in the vast speeds of travel involved in television calls for the use of a cathode ray—with its marvellous freedom from inertia—at the transmitter as well as at the receiver. The transmitter, in its experimental form, is shown in the illustration. One of the peculiarities of the system is that the picture being transmitted appears on the end of the transmitting cathode-ray tube.

[1] A paper by Thun on the pros and cons of his suggestion may be found in the German journal "Fernsehen," No. 3, Vol. 2, 1931.

BROWNIE DOMINION GRAND S.G. THREE



An Inexpensive Self-contained A.C. Receiver.

GIVEN *carte blanche* in the matter of cost and components, it is easy to design an imposing set with a performance approaching perfection; it requires infinitely greater skill to produce comparable results with an equipment in which the question of price must be considered at every turn. The addition, for instance, of large and expensive condensers and chokes will always reduce hum in a mains receiver, and stability can often be bought at a price where meticulous care has not been exercised in the layout. When, however, one comes to consider the satisfactory all-round performance of the Brownie Dominion Mains Three, which costs but thirteen guineas, including built-in balanced armature loud speaker, one realises that by means of skilful design and economy high price is not a necessity when tackling such difficulties as background noise and instability.

The three valves are arranged as the popular combination of H.F.-Det.-L.F., and the couplings between them are of the type which ensures stability at both high and low frequencies. At the input to the set there is a series aerial condenser which acts as a volume adjuster and also controls the selectivity to a considerable extent. It was found that an interfering station could often be silenced by making judicious use of this control. The wanted station was reduced to a lower volume level than was desirable from the point of view of entertainment, and then made sufficiently loud again by the use of reaction. An aerial transformer is used prior to the first valve—an AC/SG—and the single condenser tuning the secondary of the input circuit is linked to the intervalve tuned transformer condenser giving one-dial control. The translucent illuminated dial, calibrated in wavelengths and engraved in black and red for the medium and long waves respectively, considerably assists in identifying foreign stations.

The detector—an AC/HL valve—is fed from a tuned transformer having a diameter of 2 inches. Both this coil and the aerial inductance are totally screened, and it was noticed that the aluminium covers made an exceptionally good electrical junction with their bases—a point of importance not always appreciated by the designers of sets with H.F. stages.

An important refinement is the inclusion of a continuously variable potentiometer for the feed to the screening grid of the H.F. valve. Its position inside the set and not on the panel at once makes the designer's intention clear. Its function is not to control volume, incidentally at the expense of quality, but to arrive at the optimum H.F. stage gain, and once adjusted there should be no need to interfere with its setting until the S.G. valve is replaced.

> **FEATURES.**
>
> **General.**—*Self-contained three-valve all-mains receiver with built-in loud speaker and one-dial tuning control.*
>
> **Circuit.**—*One H.F. stage coupled by tuned H.F. transformer to power grid detector. Low-frequency amplifier contains three-to-one L.F. transformer and pentode output valve. Comprehensive decoupling. Valve rectifier. Provision for mains aerial, external loud speaker and gramophone pick-up.*
>
> **Controls.**—*(1) Single dial tuning (illuminated) with wavelength calibration. (2) Series aerial condenser volume control. (3) Differential condenser control of reaction. (4) Waveband switch.*
>
> **Valves.**—*Mazda AC/SG; AC/HL; Pen.425. Rectifier, UU.60/250.*
>
> **Price.**—*13 guineas.*
>
> **Makers.**—*The Brownie Wireless Company of Gt. Britain Ltd., Nelson Street Works, Mornington Crescent, London, N.W.1.*

Detector Damping Reduced.

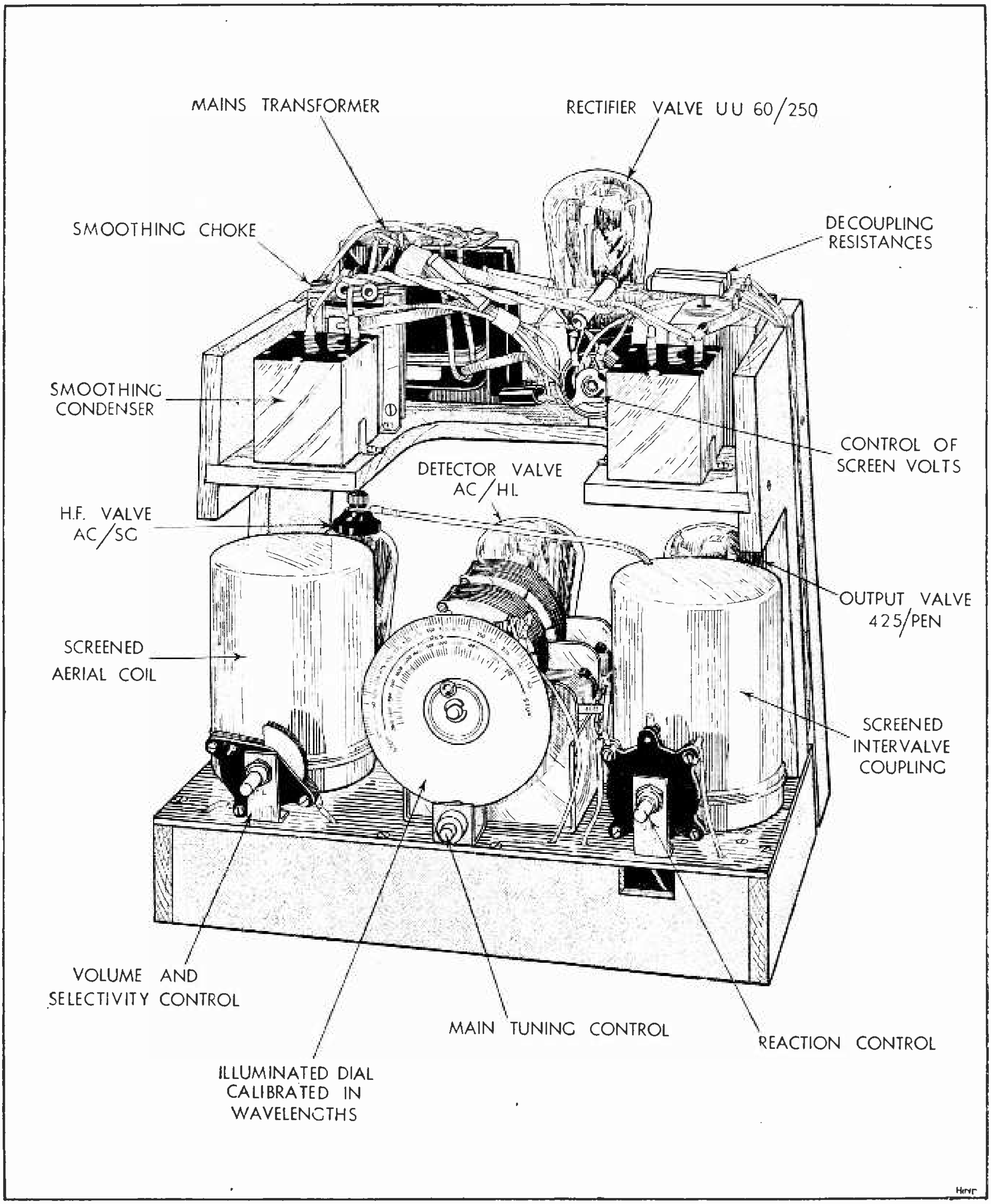
Reaction by means of a differential condenser with earthed rotor is applied to the intervalve coupling and is controlled by the right-hand knob on the panel. There is no H.F. choke in the anode circuit of the detector; it must thus be inferred that the primary of the L.F. transformer has sufficient inductance and a low enough self-capacity to ensure a barrier to H.F. currents. The grid stopper of 250,000 ohms working in conjunction with the input capacity of the pentode should prevent any stray H.F. components from reaching the output stage, which would otherwise cause instability.

The grid detector operates with a little more than 100 volts applied anode potential and is capable of delivering sufficient output when amplified by the three-to-one transformer to load the pentode (Pen. 425) fully.

Input damping when a power grid detector is connected across the whole tuned circuit is considerable, and the selectivity of the intervalve coupling would be much reduced were it not for the fact that the makers have adopted the praiseworthy expedient of tapping the grid into the coil, thus reducing the load imposed both by grid current and Miller effect. The undistorted output is rather more than half a watt, which is handled by the cone speaker without any signs of distress.

No output choke for the pentode is

ALL-MAINS RECEIVER WITH BUILT-IN LOUD SPEAKER.

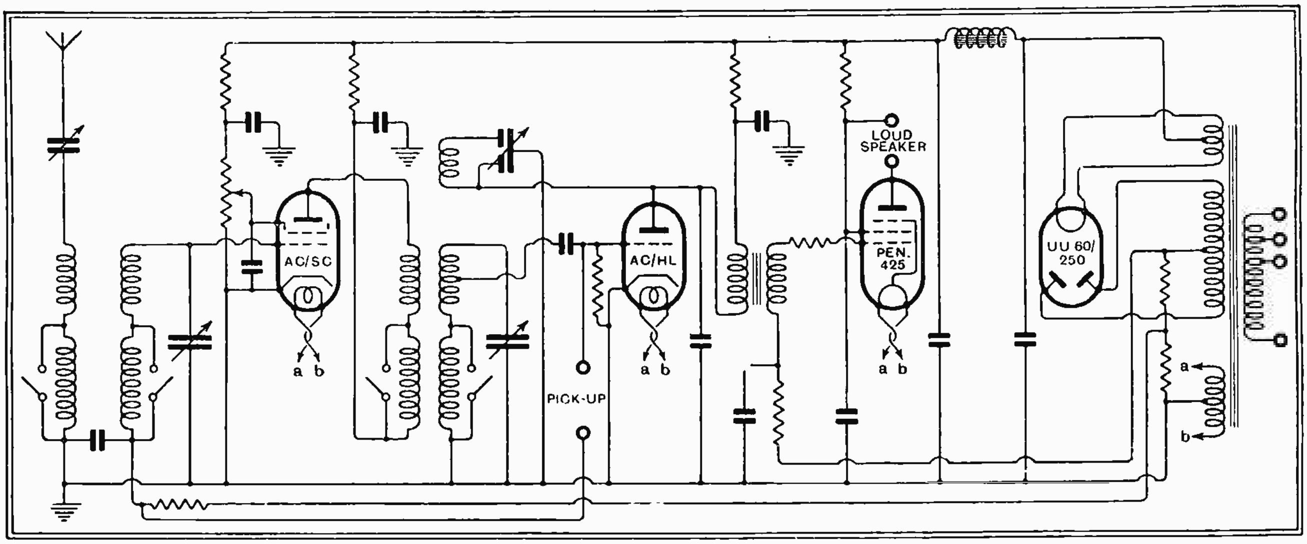


The chassis of the Brownie Dominion Grand Mains S.G. Three. In the under-baseboard compartment the waveband switching and L.F. transformer are housed.

Brownie Dominion Grand S.G. Three.— provided, but an examination of the circuit diagram will reveal the wealth of decoupling equipment in all other anode and screen circuits, and no signs of motor-boating could be induced to occur even when the set was on the verge of H.F. oscillation. Neither is decoupling confined to the anode circuits, for we find filter resistances and condensers in the grid neighbourhood of 3,000 cycles, due to lack of compensation of the pentode, are delivered at full brilliance and give rather a pleasing effect, especially where speech is concerned.

When the set was tested some 18 miles south of London, no fewer than 20 stations came in on the medium waveband at good loud speaker strength. On the long waves, some eight stations were received satisfactorily, but Königswüsterhausen could not be entirely freed from Daventry.

To sum up, the Brownie Dominion Mains S.G. Three sets a high standard of efficiency in inexpensive self-contained A.C. receivers, and both with regard to range and selectivity will give a good account of itself in home and foreign reception.



Complete circuit diagram showing that comprehensive decoupling has been carried out in anode, screen and grid circuits.

circuits of the H.F. and output valves. An economy has been effected in the mains transformer windings; although the output valve is directly heated and the other valves indirectly heated, there is only one filament winding, but the comprehensively decoupled grid bias circuits ensure that no feedback effects occur.

The all-round performance of this receiver is quite up to the average standard, and the selectivity with the series aerial condenser set at maximum is quite good, and can be increased considerably by judicious handling of this control, as explained earlier. The dynamic resistance of the screened tuning coils is well above the usual value; this undoubtedly contributes to the sensitivity.

Reaction was found to work smoothly, there being no signs of backlash and only the very slightest effect on the ganging could be traced. Reproduction from the cone speaker is marked by a well-pronounced bass, in spite of the rather small baffle area provided. Frequencies in the

The Wireless World INFORMATION BUREAU.

Conditions of the New Service.

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

(2) Communications should be addressed to *The Wireless World* Information Bureau, Dorset House, Tudor Street, E.C.4, and must be accompanied by a remittance of 5s. to cover the cost of the service. The enquirer's name and address should be written in block letters at the top of all communications.

(3) The fee of 5s. covers the reply to any wireless technical difficulty, but in special cases, where the enquiry may involve a considerable amount of investigation, an increased fee may be necessary. In such cases a special quotation will be made.

(4) Questions should be clearly written and concisely worded in order to avoid delay. Where enquiries relate to trouble experienced in receivers built to specifications in *The Wireless World* a complete account should be given of the trouble, and especially the symptoms.

(5) Where reference is made to published articles or descriptions of apparatus, the title of the article, the date of publication in *The Wireless World*, and the page reference number should be given, in order to facilitate reply.

(6) Full circuit diagrams, constructional details of apparatus, or values of components for home-designed receivers cannot normally be supplied, but circuit diagrams sent in with queries will be checked and criticised.

(7) Particular makes of components cannot, in general, be recommended, but advice will be given as to the suitability of an individual component for a particular purpose specified by the enquirer.

NEWS of the WEEK

Current Events in Brief Review.

Another Luxembourg Surprise.

ACCORDING to exclusive news from Junglinster, the little village near Luxembourg at which the giant propaganda broadcasting station is nearing completion, a short-wave installation is also to be erected on the same site for the reception of "sponsored" programmes from America for distribution over Europe by the 200-kW. transmitter.

The three masts of the high-power station are now completed, and are each over 500ft. high. The power plant, consisting of two 800-h.p. Diesel motors, with their generators, has also been installed, and the inauguration of the transmitter has been definitely fixed for July. Provision is made for doubling the present aerial power to 400 kW., should occasion arise.

The announcements will be made in English, German and French by speakers in the countries originating the programmes.

The Radio Encyclical.

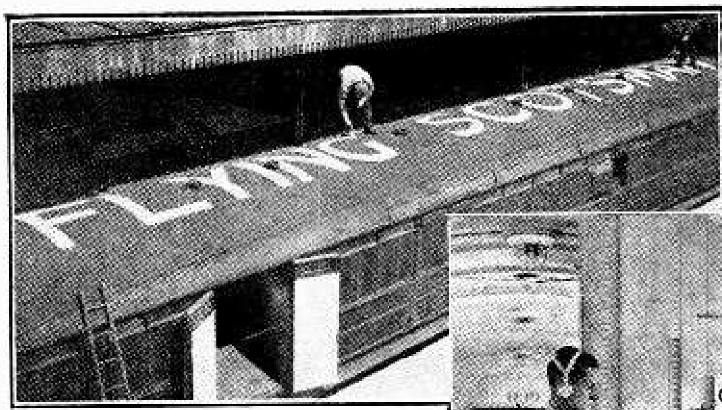
ONE of the most noteworthy wireless events of the past few days has been the world-wide dissemination of the Pope's Encyclical by means of the Vatican short-wave station. This message of counsel to the world in its time of economic distress was broadcast in many languages, and we believe that this was the first occasion on which such an appeal from the Holy See has been circulated *via* the ether.

Televising the Derby.

WE understand that Mr. J. L. Baird is superintending arrangements for giving a view of the Derby by television on a 12ft. cinema screen some miles from the racecourse. Six cables are to be laid across the course to a spot near the winning post, the television transmitter being housed in a caravan opposite the grand stand. A commentator will describe the race and name the horses as they pass by.

Depression Hits U.S. Broadcasters.

DESPITE the trade depression the revenues of the U.S. broadcasting concerns have continued to soar, but, according to a New York correspondent, the approach of summer shows a serious decline in business. As a result, economies are in vogue. The Columbia Broadcasting System has reduced its staff and the salaries of those remaining, discontinued short-wave transmissions over W2XE, and cut its television transmissions down to two hours daily, omitting the sound accompaniment.



'PLANE-TRAIN TALKS. Imperial Airways and the London and North Eastern Railway Co. arranged radio-telephony conversations between a train and an air liner on Friday last. The photos show the train, marked for the pilot's guidance, and the transmitter in the brake van.

Calls from the Fair.

A DARING innovation was permitted by the Hungarian broadcasting authorities at the recent Budapest fair. A broadcast studio was erected, and visitors to the fair, on payment of a fee, were permitted at stated intervals during the day to broadcast to their friends short messages of not more than forty words. Messages went out from Radio Budapest with an aerial power of 23 kW., so the speakers had a fairly large audience.

A Racing Commentary.

"STRAIGHT from the horse's mouth" seems to be the motto of America's Columbia Broadcasting System. Recently listeners were entertained with a broadcast from an express train. We now learn that a running commentary of the Indianapolis motor races is to be given from one of the competing cars!

Developing Personality.

GERMAN listeners are dissatisfied with the impersonal type of announcing, and a scheme is now being considered whereby announcers will be required to develop an "individual" manner. The Berlin station has already introduced the personal element in the early morning concert announcements; many listeners have already registered enthusiasm regarding the new announcer, who is considered to be a comrade as well as a broadcasting official.

In America the personal touch was carried to such extremes of familiarity that a popular revulsion of feeling ensued. As a result there is now a semblance of dignity at the U.S. microphones.

Runbaken Magnetos.

IT was inaccurately stated in our last issue that Runbaken Magneto Co., Ltd., had acquired new offices at 3, Furlong Road, Holloway Road, London, N.7. These premises are occupied by Messrs. S. W. Lewis and Co., who are acting as the London agents of Messrs. Runbaken.

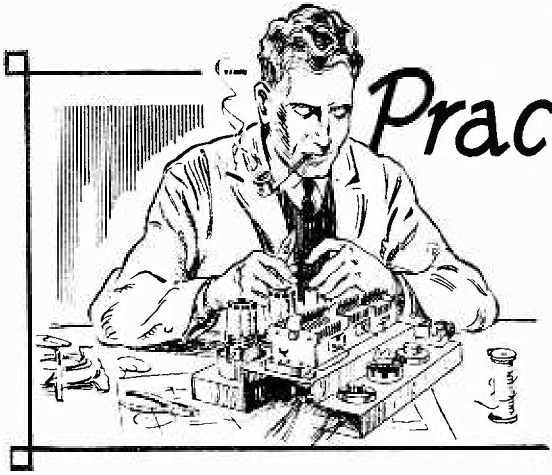
The Times on Tone Correction.

THE growing recognition of the importance of the Stenode principle for selective reception was interestingly described in *The Times* for Friday last, May 20th. "It was perhaps unfortunate," says the writer, "that Dr. Robinson's proposals were put forward at a time when certain authorities were supporting the mischievous view that broadcasting could be carried out on a single frequency alone, and that 'side bands' do not exist. As time has gone on, however, the real value of Dr. Robinson's contributions to receiver technique has become apparent, and it is now clear that it is not necessary to reject the 'side-band' treatment to explain the performance of the Stenode. . . . For listeners of a technical turn who wish to build receivers on Stenode lines themselves, a reliable design has recently been published by *The Wireless World*."

Our esteemed contemporary is, of course, referring to the Monodial A.C. Super, described in our issues of April 13th, 20th, and 27th last.

A Curious Omission.

CONSIDERABLE surprise is felt in New Zealand at the omission of any representative of musical interests on the Advisory Council appointed to control the programmes of the New Zealand Broadcasting Board. Amateurs are well represented by Mr. F. T. Davis, 2ZF, who is president of the Taranaki Radio Society.



Practical Hints and Tips

Simplified Aids to Better Reception.

THERE is no standardisation among manufacturers as to the physical arrangement of windings on power transformers, and two designs of equivalent output and of equal technical merit may behave quite differently in the matter of inducing "hum" voltages in an L.F. transformer. This form of interaction is often responsible for a noisy background.

Power Transformer Field.

The moral of this is that, when constructing a mains-operated receiver from a published design, the possibility of encountering "hum" troubles as a result of substituting a transformer of different make from that specified should be borne in mind. Before finally mounting the power and L.F. transformers, a test should be made, in order that their relative positions may be changed experimentally, if the need for doing so should arise.

IN last week's issue a method of measuring the dynamic resistance of a tuned circuit was described, and it was stated that a calibrated valve voltmeter was necessary. Several different ways of carrying out the operation of calibrating have been suggested in the past; here is another, which, if it does not make for extreme accuracy, is found to be sufficiently near to the truth for most practical purposes. For the particular purpose in question it is entirely satisfactory, as there is no need for the instrument to be calibrated in any particular units if the relationship between the units is correct.

Calibrating a Valve Voltmeter.

As is well known, valve voltmeters may be calibrated against low-frequency A.C. voltages, which, of course, must be measured by a suitable meter. A meter of this kind is expensive, and so it is fortunate that a fairly satisfactory substitute can be found by using a source of known voltage of suitable magnitude in conjunction with a potential divider; such a source of voltage exists in almost every mains-operated set in the form of one of the low-tension windings of the power transformer. A winding rated to deliver four volts is convenient, and this voltage, on normal loads, is likely to be maintained with an accuracy of 5 or 6 per cent.—quite close enough for most practical purposes.

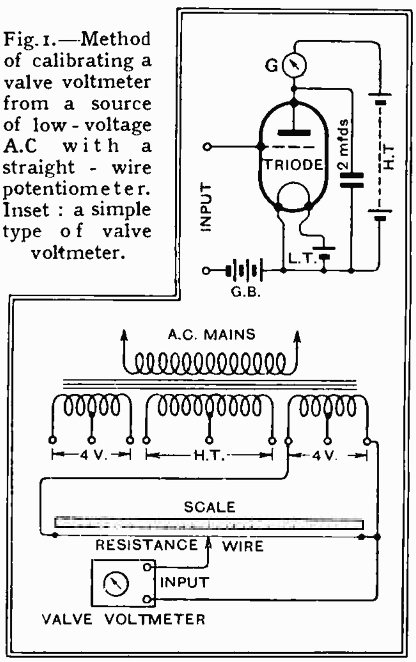


Fig. 1.—Method of calibrating a valve voltmeter from a source of low-voltage A.C with a straight-wire potentiometer. Inset: a simple type of valve voltmeter.

To obtain any fraction of this total voltage for purposes of calibration, a convenient potential divider may consist of a straight length of Eureka resistance wire, No. 36 S.W.G., measuring exactly one yard in length. This wire may be stretched between two terminals mounted on a strip of wood, to which a suitable linear scale—a yard rule will do—is secured, as indicated in Fig. 1. It is safe to assume that the potential gradient along the wire will be uniform; that is to say, the voltage existing across any fraction of its length will be proportional to the total voltage derived from the transformer secondary.

Anode Current and Equivalent Voltage.

It is usual to prepare a graphical calibration chart by plotting a number of voltage points against their corresponding galvanometer readings on a sheet of squared paper, and then joining together the points.

For the benefit of those who are unfamiliar with valve voltmeters, the circuit arrangement of the simplest type is included in Fig. 1. This is basically an anode-bend detector with a meter (preferably a sensitive galvanometer, but a milliammeter will do) connected in series with the anode circuit. It will hardly be necessary to add that a calibration will only hold good while operating conditions such as filament voltage and H.T. voltage are kept constant; if any of these factors undergo a change, the instrument must be recalibrated. Grid bias for the voltmeter valve must always be greater than the voltage to be measured, and it is sometimes convenient to make several calibrations for different voltage ranges, with the most appropriate value of grid bias for each.

It should perhaps be stated that calibration should be carried out while the transformer which is used as a source of A.C. voltage is actually supplying its normal current to the receiver; the resistance wire which is suggested for use as a potential divider will consume about a quarter-ampere, which is negligible in comparison with the normal load. When it is desired to calibrate for higher voltages there exists the possibility of connecting two L.T. windings in series, but this means that the transformer must be disconnected from the receiver, and so, to get fair accuracy, an artificial load must be substituted.

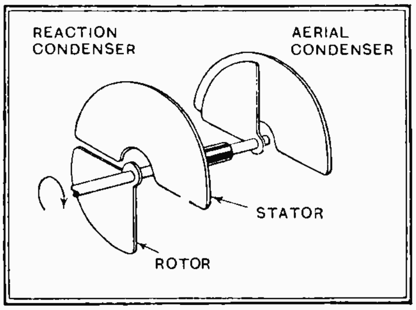
Linked Controls.

MULTIPLE controls, by means of which two or more operations are effected simultaneously by the operation of a single knob, are deservedly in favour. No one would wish to sacrifice efficiency by slavishly attempting to keep down the number of knobs to the irreducible minimum, but, on the other side of the picture, it is distinctly annoying to have to carry out, say, the operation of reducing volume by operating two separate knobs when it is quite obvious that the spindles of the pieces of apparatus controlled by these knobs might be linked together mechanically. This principle is employed in a number of well-known receivers.

An ingenious variant to existing double-acting volume-control systems is suggested by a reader (Mr. G. R. Chambers). This consists of a pair of differential condensers, driven by a common rotor spindle, which is, however, insulated.

One of these condensers serves to regulate the aerial input, while the other controls reaction in the normal way. The principle of operation will be clear from a consideration of the accompanying sketch. Starting at "minimum" volume, the aerial and reaction condenser rotors are both at minimum capacity, neither being interleaved with their stators. As a result of rotation through the first 90 degrees, the aerial feed capacity is increased to its maximum, and the reaction-condenser rotor is on the point of engaging with its stator. For the remaining 90 degrees of rotation the aerial section is always at maximum capacity, while the reaction section is progressively increased from minimum to maximum.

Thus there is obtained a smooth and progressive control of intensity: minimum aerial coupling and no reaction; full aerial coupling and no reaction; full aerial coupling and full reaction. These results are brought about by the use of 90-degree rotor segments in place of those of the usual semi-circular type.



Diagrammatic sketch showing the action of "ganged" volume control and reaction condensers, which give progressive single-knob control of intensity from "minimum" up to the point of self-oscillation.

A pair of "J.B." differential condensers were used in building up the volume-control device which is illustrated on this page.

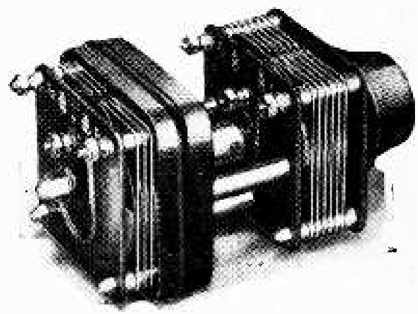
Apparent H.T. Leakage.

UNTIL recently it was fairly safe to formulate the rule that a test should show complete insulation between the H.T. positive and H.T. negative terminals of a receiver at all times except when the filaments or heaters of the valve are supplied with current. When this rule held good, it was a fairly easy matter to locate the source of an H.T. short-circuit by disconnecting each anode circuit in turn.

But since the general adoption of screen-grid valves this rule has become obsolete, at any rate with regard to mains-operated sets. In most cases the screening grids are fed through a potentiometer arrangement, which, in effect, is joined internally between H.T. positive and H.T. negative, and so a test between the corresponding external terminals will always show a fairly serious leakage even though everything may be in order. This steady leakage is a source of embarrassment when one is attempting to find a complete or partial "short" in the anode circuits, and it is an excellent plan to disconnect the screen-grid potentiometer, whether of the fixed or variable type, before starting the work of testing.

Single-circuit Aerial Tuner.

BEFORE the advent of the variable-mu valve it was rightly considered that the correct place for a band-pass filter was in the aerial circuit—that is to say, between the aerial and the grid of the first high-frequency amplifying valve. This practice need no longer be considered as an immutable rule; when a variable-mu H.F. valve is employed the overall selectivity of, for example, a receiver with one H.F. stage, and a total of three tuned circuits, can be equally good if the two-circuit band-pass filter is employed as an H.F. coupling, the aerial being connected to a plain single-tuned circuit.


Double-acting volume and reaction control unit, built up with two differential condensers, one of which is screened by a metal box cover.

In some cases this arrangement may prove more convenient than the alternative and more conventional scheme; the sole objection to its use is connected with the fact that reaction between anode and grid circuits of the detector valve is unlikely to be as effective as with the simple type of intervalve H.F. coupling.

Laboratory Tests

ON NEW RADIO PRODUCTS.

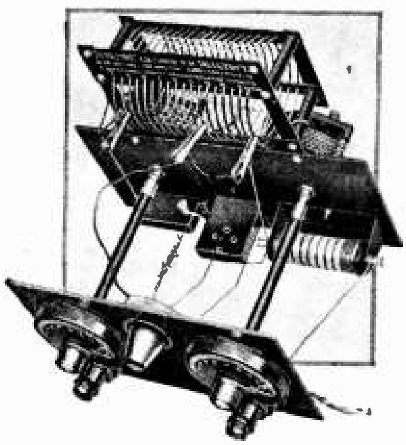
"DYNATONE" SHORT-WAVE KIT.

Made by the Scientific Supply Stores, 126, Newington Causeway, London, S.E.1, this kit of parts contains all the components required to build a short-wave unit which can be used with any battery receiver by removing the detector valve and replacing it by a special adaptor. The valve is then inserted into the valve-holder on the separate unit, and without further change in the receiver most of the principal short-wave stations can be received, using an aerial of average size.

The construction is quite simple, as all components are very accessible, and the unit can be assembled and tested during the course of an evening. It embodies the well-known Hartley circuit, which is particularly efficient on the short wavelengths, but the exceptionally good results we obtained can be attributed in no small measure to the careful design and thoughtful layout. Maximum efficiency has been the guiding factor in the design; dielectric losses are reduced to a minimum, especially in the coil, which is largely self-supporting and is the key component in the assembly.

Heavy gauge wire is used, with the turns well spaced, and when tuned by the 0.00015 mfd. condenser, covers a waverange of from about 14 metres to a little over 60 metres. Clip connections are provided for the anode, L.T. negative, and aerial leads, suitable adjustment giving the best ratio of capacity and inductance for every part of the waveband covered. Adjustment of the earth tap is helpful in obtaining smooth reaction, while the detector efficiency is governed by the setting of the potentiometer.

Since the moving and fixed vanes of the tuning and reaction condensers are at high oscillating potential, they have been



Complete short-wave unit built from "Dynatone" kit of parts.

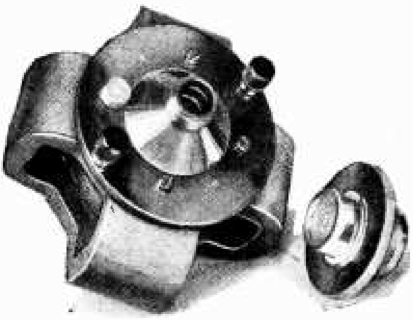
mounted well back from the control panel and operated by long extension rods. Dials embodying a reduction drive are fitted.

Tuning is quite simple and soon mastered once it is appreciated that to maintain the circuit in its most sensitive state when searching for stations the reaction condenser requires continual adjustment. Simultaneous increase of the reaction capacity with progression of the tuning condenser is all that is necessary to keep the circuit feebly oscillating over the tuning range covered by any portion of the coil.

This is one of the most sensitive short-wave adaptors, other than those of the superheterodyne variety, that we have tested so far, and at the attractive price of 25s. 6d. for the complete kit represents good value. With the exception of the "Dynatone" inductance unit, any reliable short-wave component can be used in its assembly, as all parts are listed separately. The price of the special coil is 4s. 6d. Blue prints cost 4d. each.

F.I. LOUD SPEAKER UNIT.

There is ample evidence of a revival of interest in horn-type loud speakers now that units of the moving-coil type are available to the public. There can be no



Film Industries moving-coil loud speaker unit for use with logarithmic horns.

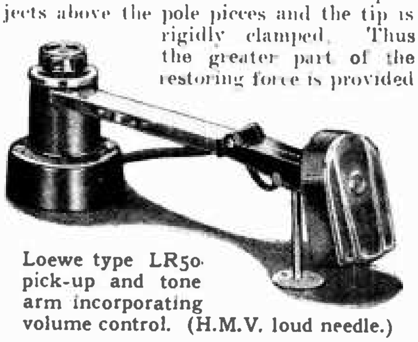
doubt that, provided space is available for a logarithmic-type horn of suitable dimensions, the reproduction obtainable is, for many purposes, superior to that of the conventional moving-coil cone loud speaker. It is significant that horn-type loud speakers are practically universal in talking-film reproducers.

One of the first firms to produce a horn-type moving-coil unit for domestic use is Film Industries, Ltd., 60, Paddington Street, London, W.1. This unit, known as type LS4, has a coil impedance of 7 ohms, and will handle power inputs up to 4 watts. It is fitted with a cross-type permanent magnet giving a flux density of 9,500 lines per sq. in.

Our tests were carried out with a folded horn having a flare 24in. square, and it was found that the useful frequency response ranged from 250 to 6,000 cycles. The bass response would, of course, be improved by using a horn of larger dimensions. However, although under the conditions of test the reproduction of music was somewhat high-pitched, the reproduction of speech was decidedly above that of the average moving-coil cone type loud speaker. The dimensions of the unit are 5½in. diameter and 3¼in. high. The weight is 4 lb., and the price £5 5s.

LOEWE TYPE LR50 PICK-UP.

An interesting feature of the Loewe pick-up in its latest form is that the rubber damping is not applied directly to the active portion of the armature. The armature is thinned down where it projects above the pole pieces and the tip is rigidly clamped. Thus the greater part of the restoring force is provided



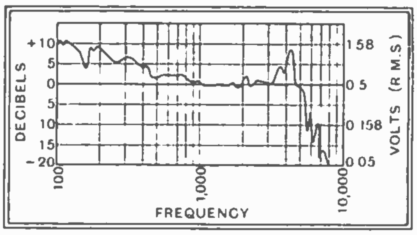
Loewe type LR50 pick-up and tone arm incorporating volume control. (H.M.V. loud needle.)

by the flexing of the extension piece and ample movement is permitted to the needle point.

Replacement of needles is an extremely simple process; not only is the tone arm hinged, but the usual needle set screw has been dispensed with and the needle is held in position magnetically and by the weight of the pick-up head. In practice there is no evidence of any tendency for the needle to rotate in the holder.

The armature resonance has the advantage of being higher in frequency than the majority of pick-ups, and occurs at 4,200 cycles. It is followed by a sharp cut-off at 5,200 cycles, with the result that needle scratch is negligible. The average output is about 0.6 volt R.M.S.

A logarithmic volume control potentiometer having a total resistance of 40,000 ohms is incorporated in the tone arm



Characteristic of Loewe type LR50 pick-up with volume control at maximum.

pillar. The price of the complete unit is 33s., and the makers are The Loewe Radio Co., Ltd., 4, Fountayne Road, Tottenham, London, N.15.

TRIOTRON VALVE LIST, 1932.

The latest catalogue of Triotron valves issued by the Triotron Radio Co., Ltd., 91, Gt. Russell Street, London, W.C.2, contains characteristic curves and other useful data relating to some 43 different types. Particulars are given of a resistance lamp for use in D.C. sets which maintains the current constant at 100 mA., irrespective of mains fluctuation.

LOUD SPEAKERS IN OPERA PRODUCTION.

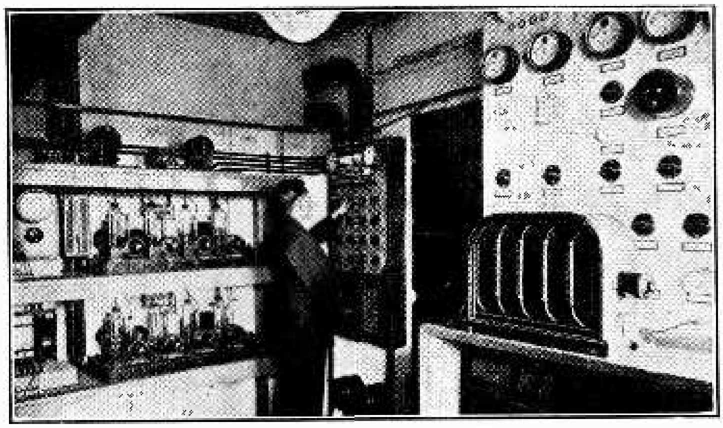
Voices "Off Stage" by New Methods.

By R. RAVEN-HART.

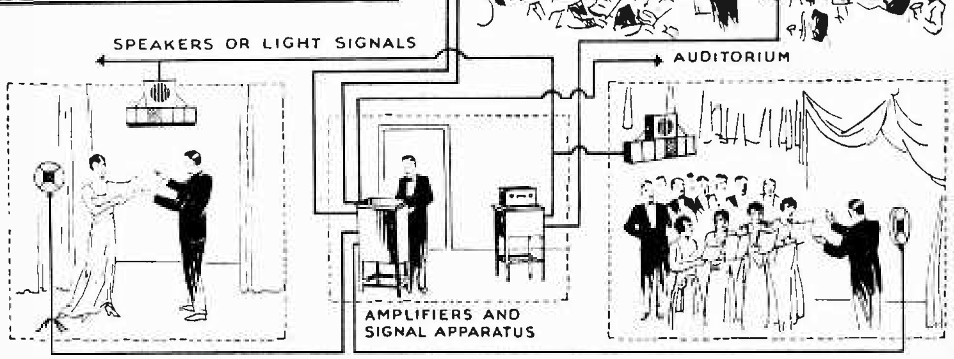
GHOSTLY choruses, spirit voices, and the like, are among the most difficult things to "put over" in opera, ranking with Wagner's dragons, swans, doves, and cable-railway spears. The Berlin City Opera House at Charlottenburg is now using wireless methods to overcome the trouble—a solution suggested, incidentally, by the present writer some eighteen months ago.

In works such as *Don Giovanni, The Flying Dutchman,* and *Der Freischutz,* the ghostly singer or chorus performs in one of two studios, the result being wanted. The possibilities attached to alteration of the resonance of the studios (especially as compared with the deadened effect inevitable when the singers are masked by the proscenium-arch) and to slight distortion at the amplifier in special cases are obvious. Incidentally, thanks to the absence of this proscenium damping, smaller choruses can be used than previously.

In order to keep the studios informed of the progress of the performance loud speakers are installed in the studios, and also in the rooms of the producer, technical director, etc. As those in the studios cannot remain in



A view in the amplifier room of the Berlin City Opera House. The amplifiers on the left—each of 100-watts output—feed the stage loud speakers. The operator is controlling the loud speakers in the studio.

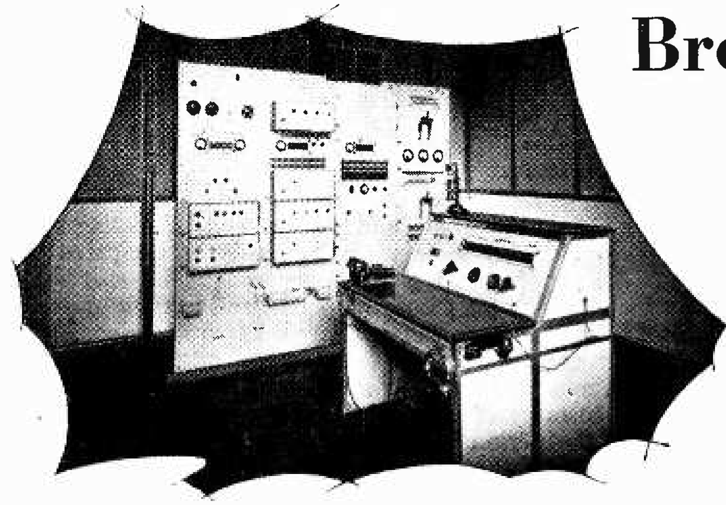
The diagram shows how spirit voices, supposedly issuing from the clouds, are actually produced by a choir or a soloist in studios behind the scenes.

amplified and put out through six loud speakers; two in the wings, two above the proscenium arch, and two in the auditorium, these three groups being combined in the proportions required to obtain the desired effect. In each group one loud speaker is of the normal moving-coil type, the other being a "Riffel," which uses a corrugated aluminium membrane to which the moving coil of an electrodynamic system is attached, this handling the high notes especially well.

The advantage of the system from the point of view of the artistes needs little stressing; instead of being perched insecurely in the flies or jammed up in the wings they can sit in comfort in their studio until circuit when the studio microphones are switched on they are replaced at that moment by a system of illuminated "conductors" operated from the conductor's desk. Alternatively, the studio conductor can wear headphones. The microphones of this second system are also used for broadcast transmissions.

It is interesting to find that the Berlin *Hochschule für Musik* is using similar methods, as one would expect from this progressive institution; the effect in a recent performance by students of the chorus of ghost seamen in the *Flying Dutchman*, especially in contrast with the "flesh and blood" seamen, was particularly striking.

Broadcast Brevities.



HUB OF SCOTLAND'S BROADCASTING. The control desk and amplifiers at the new Falkirk transmitter.

By Our Special Correspondent.

The First Sunday Dinner Programme.

RESTRAINT characterises the programme chosen by the B.B.C. for the first Sunday dinner broadcast, to be given on June 5th. From 12.30 to 1 p.m. Mr. G. D. Cunningham will accompany the *hors d'œuvres* with an organ recital from the Queen's Hall. And then, while we assail the baron of beef, Reginald King's orchestra will fortify us with selections from "Rose Marie," "The Moonbeams' Dance," and "Love Came Back to Me."

The Useful Gramophone.

Over the nuts and wine, from 2.15 to 3 p.m., we shall listen to a gramophone recital of the classics as rendered by famous Continental orchestras.

Continental Leanings.

The Continental flavour is becoming more noticeable in the B.B.C. transmissions, and it will be still more apparent next winter if present plans materialise. These provide for a number of relays from the stations of the German Rundfunk Gesellschaft, including certain operatic transmissions which will be broadcast exclusively to this country and not to German listeners.

Under this category comes the relay of Act. II of Saint-Saëns' "Samson and Delilah" from the Berlin State Opera on June 22nd, and also the relay of Verdi's "Sicilian Vespers" (Act III) from Unter den Linden, Berlin, on July 1st.

We Must Return the Compliment.

In addition to these there are to be a number of German studio broadcasts for British listeners. No arrangements for reciprocal programmes have yet been made, but we must assume that the B.B.C. will be ready to return the compliment

It is pleasant to have nation speaking peace unto nation in this fashion, but our national modesty must not lead to the establishment of one-way traffic in the European ether.

By the way, it is interesting to note that the two German relays referred to will be of French and Italian operas.

What's Happening in Scotland?

"CALL me white or call me black," said the famous actress to the dramatic critics, "but for Heaven's sake call me something!"

The same mood possesses the B.B.C. engineers at Falkirk, who are not a little peeved because their efforts are being damned with faint praise. Whether the public are really indifferent to the opening of their new station, or whether Scottish caution is once more asserting itself, is the question now at issue. I incline to the view that Scots listeners are canny with the postage stamps, and that each imagines that his neighbour has written to the B.B.C.

This Week's Tests.

This week the Regional transmitter at Falkirk is broadcasting from 10.15 a.m. till lunch-time daily, and also during the late dance music period. Perhaps a few Sassenachs could send the engineers a line or two of encouragement?

Whether Scotsmen like it or not, the transmissions will be easily audible south of the Tweed. Perhaps a deputation of Scotsmen will now call on Cleghorn Thomson, the Scottish Regional Director, demanding that Scotland's waves be kept for Scotland.

Broadcasting the "T.T."

AN eye-witness account of the Junior T.T. Race will be given by Major Vernon Brook on June 8th, his description being relayed to London Regional listeners from the Northern Region. Major Brook's story will also be heard by North Regional listeners.

On June 10th, three commentators will combine in a running commentary on the Senior International Auto-Cycle T.T. Race in the Isle of Man. "Ixion," of our sister-journal, *The Motor Cycle*, will describe the race from the Grand Stand, Major Vernon Brook from the Craig-ny-Baa Hotel, and Mr. Victor Smythe from the Hairpin Bend, Ramsey. This commentary will be a North Regional programme item, and it will be relayed to London Regional listeners.

That "Good-bye" Programme.

ANXIOUS to vindicate their honour in face of suggestions that the "Farewell Savoy Hill" programme was a fake, B.B.C. officials tell me that the affair actually was staged at Savoy Hill, and that the only portion of Broadcasting House involved was the Control Room. I don't think the B.B.C. will ever hoax listeners; they learnt their lesson after the famous Father Ronald Knox episode of six years ago.

As for the "Good-bye" programme, I thought it quite amazingly dull. The Blattnerphone was used as a blatherphone.

A Literary Critic on Broadcasting.

THE last word of criticism concerning the B.B.C. will not be said until Broadcasting House has crumbled to dust. But the latest word has just been said in the June *Nash's and Pall Mall* by no less an authority than Mr. Frank Swinnerton, who has hitherto limited his critical vision to literature.

According to Mr. Swinnerton, the B.B.C., although "a monopoly managed by Civil Servants," makes no pretence, as the tax collectors do, of being "our obedient servant"; on the contrary, "its attitude is one of benevolent despotism."

The One Human Touch.

He urges that the B.B.C. should lose its "genteel horror of the popular," and praises as the one human touch in the B.B.C. "the extraordinary kindliness and sympathy of the announcer's final 'Good-night, everybody . . . good-night.'"

Will the increasing mechanical excellence of modern broadcasting mean a still more impersonal B.B.C.?

Mr. Ashbridge and the "Ultra Shorts."

THE seven-metre project seems a long time in materialising at Broadcasting House. Mr. Noel Ashbridge, the Chief Engineer, told me a few days ago that the preparations were "seventy-five per cent. advanced," so perhaps the watchful amateurs on the ultra short wavelengths may soon have a surprise item.

In the Honours List?

A NATIONAL "daily" last week referred to "Sir Adrian Boult."

Sez He.

AFTER the Press visit to Broadcasting House, a famous journalist who had "seen too many of the world's wonders to burst into rhapsodies" wrote this:—

"Far down underground were oil-heated boilers providing temperatured air to all boxed-in-studios. High up, near the roof, were the dynamos driving the batteries which send the wavelengths through the ether. Plates with switches and tiny globes twinkling red and blue and opal, indicated the 'brain room,' for here were the engineers actually doing the broadcasting."

Letters to the Editor.

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

Correspondence should be addressed to the Editor, "The Wireless World," Dorset House, Tudor Street, E.C.4, and must be accompanied by the writer's name and address.

Broadcast Reproduction.

I NOTE that in his article on "Broadcast Reproduction," the first part of which appeared in your May 4th issue, Mr. Hartley states that the frequency of the highest partial tone of the treble C pianoforte note is 2,500 cycles, and that the highest partial of the tenor C note (two octaves lower) is 3,304 cycles. This means that as one ascends the keyboard the overtone development diminishes, thus accounting for the purer tone of the upper register due to the heavy damping effect of the large soundboard. I believe this to be the generally accepted view. How then does Mr. Hartley arrive at the conclusion that the overtones of the piano are developed as high as 20,000 cycles? Moreover, if the highest partial of the 512 cycle note is, as he says, 2,560, then presumably that of the 640 cycle note is not more than 3,200. Yet on his chart the writer of the article shows that a 5,000 cycle cut off transmission would deprive us of all pianoforte notes above 640 cycles, whereas it is obvious that we should be able to receive notes up to 1,000 cycles.

I note also that the compass of the organ is given as 32 to 2,048 cycles, whereas, of course, its fundamental frequencies range from 16 to 8,192, and in some examples to 16,384. In any case the organ should be given a special chart to itself, since its inclusion in a general chart only serves to convey an inaccurate idea of the effect of radio apparatus on its reproduction.

Again, Mr. Hartley states that a cut off at 5,000 cycles "compels one to concentrate to a degree which makes the listening to a talk or play a definite effort." And yet the fact remains that gramophone records of speech cut off at this limit and can be followed with the utmost ease (e.g., Columbia DB86 "Gillie Potter has a brother"). Personally, I am with Mr. Hartley in hoping that the B.B.C. will not reduce the present high-frequency limit of their transmissions, but I fear that some of his statements and arguments in an otherwise excellent article will not be regarded as unassailable by the opposition.

Hampstead, N.W.6. NOEL BONAVIA-HUNT.

MAY I be allowed a few remarks on the articles entitled "Broadcast Reproduction" in a recent number. The first part of this article dealing with the nature of sound, etc., is very interesting and instructive for those of your readers who have not previously studied the subject. The chart of frequency ranges—not previously published—is particularly interesting and useful, but when Mr. Hartley begins to make theoretical deductions from this chart, one begins to rub one's eyes and to wonder what it is that the ordinary broadcast listener with a reasonably good set has been listening to! He says "we can see at a glance" what proportion of the usual musical sounds is reproduced by apparatus of varying degrees of excellence, meaning by this, apparatus such as loud speakers, which will only respond to certain limited ranges of frequency. But surely, since this chart shows only the *ranges* or *limits* of the frequencies of fundamentals and partials and gives not the slightest indication of the intensities or relative importance of the fundamentals and partials, it requires more than a mere glance to enable one to make deductions of any value at all. Yet Mr. Hartley proceeds to state that with an instrument which does not reproduce frequencies above 5 kc. "only one-sixth of the violin remains," only two-thirds of the piano, half the 'cello, etc., and that distortion of the human voice is so great as to be unpleasant to sensitive ears, and to require a definite effort of concentration to listen to a talk or play! What exactly is meant by the statement, "only one-sixth of the violin remains," requires some elucidation, but anyhow it seems obvious that a loud speaker limited to anything like 5 kc. gives out a mere travesty of the music it is intended to reproduce. How is this to be harmonised with the opinions of various experts in these matters recently expressed at a discussion on the subject at the Institution of Electrical Engineers? The chief engineer of the B.B.C. said (1) that many loud speakers *could* register well above 5 kc., indicating that in the general case they did not. (2) That Daventry 5XX transmitter is considerably *down* at 5 kc. (3) That the average broadcast engineer is not much interested in frequencies above 4,500!

Another speaker said the truth must be told, that the normal Reisz microphone cuts off not much above 6 kc. Other speakers gave evidence to the effect that *very few* people can notice the difference produced by cutting off all frequencies above 7 kc., and that *experienced* listeners to *orchestral music* considered the reproduction 95 per cent. perfect when frequencies from 70 to 8,000 were covered. Compare these statements with Mr. Hartley's theoretical deduction from his chart, that even with a cut off of 12 kc. one-half of the violin, one-third of the viola, two-thirds of the oboe are affected, and that at any rate in the case of the oboe and violin this loss (due to cut off at 12, not 8 or 9 kc.) is serious! Perchance, Mr. Hartley is going to take the sting out of these alarming deductions in a future article, but it seems a pity to give the uncritical reader of *The Wireless World* the impression that anything like a pleasant reproduction of music and speech is hopeless without a receiving set which will respond to all frequencies up to 12 kc., to say nothing of the question as to whether the B.B.C. really transmits such frequencies with any appreciable amplitude!

Woolwich. R. A. WEST, A.M.I.E.E.

I AM glad of the opportunity of replying to the letters of the Rev. N. Bonavia-Hunt and Mr. R. A. West, as it is impossible to include in a rather elementary and general article everything that one would like to say on the subject. My opinion as to what should be omitted is bound to be different from that of my readers, and correspondence gives me the chance of clearing up points that might otherwise be obscure.

To the Rev. Bonavia-Hunt's query about pianoforte reproduction I would say this. The pianoforte is the only musical instrument about whose art I have more than an elementary knowledge; as for its science, I have no reason to believe, from a study of the data available, that the highest note on the keyboard has less than five partials. If the fundamental frequency of this be taken, in round numbers, at 4,000 cycles per second, this gives us 20,000 cycles as the frequency of the highest partial. Even so, the matter is not so simple as this. Different *makes* of piano give different frequency spectra, and my diagrams, Figs. 4 and 5 (p. 446), illustrate the decreasing overtone development *of the particular piano used to obtain these diagrams.* I had no justification for taking the results of that experiment as a positive basis for my chart. The compilation of this was rendered laborious because I had to collect information from as many sources as possible, strike a mean (for such data is, as a rule, only approximately correct), and plot the results. For this reason I say that the chart is as nearly accurate as I could make it, and it is reliable for every instrument it includes, with the exception of the organ.

The organ is unique inasmuch as its make-up can vary within very wide limits. I agree that, to do it justice, a separate chart is called for, but my chart was not intended to be completely comprehensive. The compass of each organ manual is 61 notes, from C to c^{iv}, and the pedals extend this to C_1 in the bass. The 8ft. stops sound this fundamental range (as shown by the chart), and although I know quite well that we get 16ft. and 32ft. stops as well as 4ft., 2ft., and even smaller, I could not include everything. My article is bound to be disappointing to a specialist such as the Rev. Bonavia-Hunt, but my contribution was intended to appeal to the general reader.

As to speech, I can only say that it has been my experience that, unless I can get the subtle inflexions of individual voices, I cannot enjoy a radio play. I am very fond of these, and, until I was able to improve my reception to the extent I have, I could not, without effort, reconstruct the, shall we say, "dramatic layout" of the production. I will admit that one can hear the news bulletin quite intelligibly on a set which cuts off at 5,000 cycles, but can one have, say, A. J. Alan's *personality* reproduced on such a receiver? I contend that one cannot.

I welcome the Rev. Bonavia-Hunt's letter for honest constructive criticism, and I hope my reply will satisfy him. Mr. West, unfortunately, is not so sound. His letter was written before the publication of Part II of my article, and he assumes that I demand reproduction up to 12,000 cycles. But on p. 446 I said : "At this stage in the argument . . . all this is necessary, since we must assume for the moment that the ear would detect any departure from perfection . . . but, in the next article, it will be shown that . . . absolute perfection is not necessary." As he says, I made theoretical deductions from the chart, and, at the end of Part II, I concluded that one required a frequency response of 32-9,000 cycles for something like reproduction. Mr. P. K. Turner's letter in the same issue gives results of the Bell Telephone Laboratories' tests, with which I was not acquainted when I prepared my MSS., and we find 40-10,000 cycles to be the required range, determined experimentally. Surely my theoretical deductions were not wide of the mark!

I will clear up some other points for him. Certainly the chart does not give "the slightest indication of the intensities or relative importance of the fundamentals and partials" for the simple reason it is not necessary it should. Whether a fundamental or partial has a great or small intensity is immaterial; it must be reproduced in its correct proportion. The point occurred to me when I was preparing the chart, but a moment's reflection showed such elaboration to be needless. When I said that "only one-sixth of the violin remains" I meant that, at the 5,000 cycle cut-off, only one-sixth of the compass of that instrument was reproduced without distortion. Again, that "a loud speaker limited to anything like 5 kc. gives a mere travesty of the music it is intended to produce" is a fact which I am prepared to prove any time by actual demonstration.

As for his comments on the I.E.E. discussion, I am afraid that he has misconstrued some of the remarks. The chief engineer of the B.B.C. said that he believed that many loud speakers could register well above 5,000 cycles, *but they might be hopelessly non-linear.* He said that 5XX was considerably down at 5,000 cycles, but that *the public in general did notice the difference between 5XX and the London transmitters.* But he also pointed out that, while people were contending that 9 kc. station separation was enough, there was 11 kc. between London and North Regional stations and their neighbours in frequency, and that America (the original home of top cut-off) was considering, in putting down broadcast cables, that they must have practically linear response up to 8,000 cycles.

One speaker, quite well known as an engineer, said that he believed, and he regarded it as a godsend to receiver designers, that it was possible for us to cut top at the receiving end and obtain quality unimpaired. Therein is a state of affairs whose ridiculous nature cannot be perceived by many people. A man's technical qualifications do not entitle him to speak with authority on matters of art. Messrs. Ashbridge and Kirke, if they will permit me to say so, are purveyors of music by electrical methods, and they know that 5,000 cycles is not enough. So do many men, distinguished in radio circles, who have musical knowledge also. That is necessary for a designer. Finally, Mr. West says "one begins to rub one's eyes, and to wonder what it is that the ordinary listener with a reasonably good set has been listening to." Exactly; what *is* it? H. A. HARTLEY.

Isleworth.

The Monodial A.C. Super.

MAY I congratulate you on the success of the A.C. "Monodial" (incorporating the "Stenode" principles)? This receiver appears to offer no difficulties of construction; it has convinced those who have made it of the value of the "Stenode" principles, and has proved that sidebands can be overlapped without the unsatisfactory results experienced before the advent of the "Stenode."

My Corporation have in the past given every facility to amateurs to use the "Stenode" patents under licence, and, in view of the popularity of the A.C. "Monodial," the British Radiostat Corporation, Ltd., are making an announcement in the issue of *The Wireless World* for May 25th, granting a free licence to bona-fide amateurs to construct the A.C. "Monodial" for their own private use. JAMES ROBINSON.

London, W.1. British Radiostat Corporation, Ltd.

Old Comrades.

IN connection with a work of reminiscence, I am anxious to obtain photographs (in uniform) of the following gentlemen who during the European War were members of the R.F.C. wireless section :—

Lieut. Meech (No. 7 Squadron, Proven), believed to be in Canada.

Lieut. Marriott (No. 12 Squadron, Overseas-le-Compte).

Lieut. Hunter (No. 7 Squadron, Proven).

Major Childs (No. 42 Squadron, Ballieul).

A.M. "Tammy" Moore (No. 8 Squadron in 9th Heavy Battery, etc.).

A.M. Dainton (No. 8 Squadron. Field Battery Lymm Cutting, etc.).

A.M. Gunning (No. 8 Squadron. 91st Siege. etc.).

A.M. Jardin (No. 12 Squadron, 65th H.A. Group, etc.).

A.M. Edgar (No. 7 Squadron. 65th H.A.G., etc.).

Corporals Russell, Jones. and Smith (No. 7 Squadron).

If the above "Old Comrades" can oblige, I shall be very grateful for their assistance. but, owing to possible indefinite period of retention, would prefer that they allowed me to keep the photographs, all of which are required for publication, and to which I hope there will be no objection.

41, Salcombe Road, W. T. LOWE.
Leyton, London, E.10.

Amplifiers and Tone Correction.

I CAN find nothing in my previous letter which would justify Mr. Pohu in inferring that I denied *The Wireless World* credit for publishing information on tone correction. If he re-reads it he will see that, on the contrary, I gave *The Wireless World* credit for publishing such information four years earlier than he had supposed! M. G. SCROGGIE.

Upper Norwood, S.E.19.

Quality and Frequency Range.

I BEG the hospitality of your columns to thank Mr. Merdler for his very diverting letter in your issue of the 11th inst.

I have to admit that I should never have dared to claim the title of "the many" for those curious enthusiasts whose ideal is to log as many stations as possible just above the static level.

But why is he so half-hearted in his proposals? Surely the correct course is to shut down all the English transmitters entirely.

After all, the majority (as opposed to "the many") do not matter; they pay for the B.B.C. it is true, but then we are shutting them down, and if they cannot afford to build distance-getting sets then there will be fewer oscillators!

Wireless is almost the only chance that most people have of hearing good music, still, do not let us allow that to deter us.

Counting up the letters in *The Wireless World* proves conclusively that we are "the many." JOHN R. BENSON.

Lichfield, Staffs.

The Old Days.

I CANNOT go back twenty-one years, but I bought my first inductance coil with two sliders on March 30th, 1914, and the detector was like that you illustrate. I roofed it in with glass from old negatives. What present-day people hardly realise, I feel sure, is the huge price we paid for valves. An R type Mullard cost 25s. in 1920, a P.M.6 cost 22s. 6d. in 1926, and when I built "The Wireless World" Neutrodyne receiver in 1924 I put in four D.E.5 valves, which cost 35s. each! Think of that now; one could buy the whole receiver for the money. Brown headphones were, I think, £3 16s. each; but there were a lot of war-surplus ones on sale, so that one's pocket was saved; but even so I paid 36s. each for four pairs of 120 W. second-hand ones in 1923. In 1924 the Sterling Primax speaker cost £7 7s., though its "works" were of the most elementary design. There was, however, the huge royalty of £2 on it. In France the price was only 35s., and a friend of mine had one brought over by aeroplane. I wonder how many of your present readers could read the Morse words across your Marconigraph cover?

Braintree. H. E. ADSHEAD.

READERS' PROBLEMS.

THESE columns are reserved for the publication of matter of general interest arising out of problems submitted by our readers. Readers requiring an individual reply to their technical questions by post are referred to "The Wireless World" Information Bureau, of which full particulars, with the fee charged, are to be found on page 542.

Potentiometer Volume Control.

A HIGH-RESISTANCE potentiometer, with the aerial joined to its slider, and the resistance element connected across the aerial and earth terminals of the receiver, makes an effective, if somewhat crude, pre-detection volume control. Provided that the resistance is reasonably high in value, the connection of this device should not introduce any appreciable loss of signal strength when the slider is set at the maximum position.

A querist who has added this form of volume control to an existing receiver finds that signal strength is seriously reduced, even when the slider is at the extreme end of its travel. We expect that this is due to the fact that the potentiometer does not provide "zero" resistance; possibly when the slider is turned hard against its stop there remains in circuit a certain amount of resistance track or wire winding. The other possibility is that the total resistance of the potentiometer element is too low. A value of 25,000 to 30,000 ohms should do well for an ordinary aerial circuit, in which coupling to the tuned coil is fairly loose.

Non-Interchangeable Valves.

UNLESS we are mistaken, here is a case where a logical process of deduction can provide a definite answer to a somewhat puzzling problem.

A reader uses "H.L." valves of the same make for his detector and first L.F. stages; these two valves should, therefore, be interchangeable, but it is found that on inserting the L.F. valve in the detector socket no signals whatever can be received. A number of other valves, all of which are known to be in good working order, have been tried as replacements in the L.F. amplifier, including the original detector valve. Although the set is dumb, the detector anode current is normal.

It is fairly safe to say that this is due to lack of contact between the grid pin and the corresponding socket of the valve holder. There are microscopic differences between individual specimens of the same make and type of valve; valve A (the normal detector) happens to make contact, while valve B (normally used as an L.F. amplifier) fails to do so. Possibly the grid pin of one of the valves is slightly bent.

Our reader will perhaps be good enough to let us know whether this diagnosis is correct, and, in the meanwhile, others may like to search for other plausible solutions of the problem.

No Wandering H.F. Currents.

IT is an axiom in the design and construction of wireless receivers that leads carrying H.F. currents—and, to a lesser degree, those in the L.F. speech-frequency circuits—should be short and direct. However, thanks to the general adoption of decoupling, it is possible to take liberties with, say, the "direct current" portion of an H.F. grid circuit, and to extend the connecting wires to practically any desired extent.

This disposes of a question raised by a correspondent, whose present pre-detection volume control consists of a bias-regulating potentiometer for the H.F. valve. He now wishes to control volume from the next room to that in which the set is installed, but supposes that the action of what are described as "wandering H.F. currents in the grid circuit of the H.F. valve" would be prejudicial to stability.

Provided that the grid circuit in question is adequately decoupled, H.F. currents in the potentiometer circuit should be quite negligible, and on this account there is no objection to mounting the potentiometer externally and connecting it with long extension leads. In our correspondent's set, bias for both the H.F. and output valves is derived from a resistance in the H.T. negative lead, control for the first valve being obtained by means of a 25,000 ohm potentiometer shunted across the bias resistance. The connections of the remote control potentiometer in this case are indicated by dotted lines in Fig. 1. In this diagram the decoupling resistance R may have a value from 50,000 to 100,000 ohms, while the associated by-pass condenser C may be of 1mfd.; this component should be non-inductive.

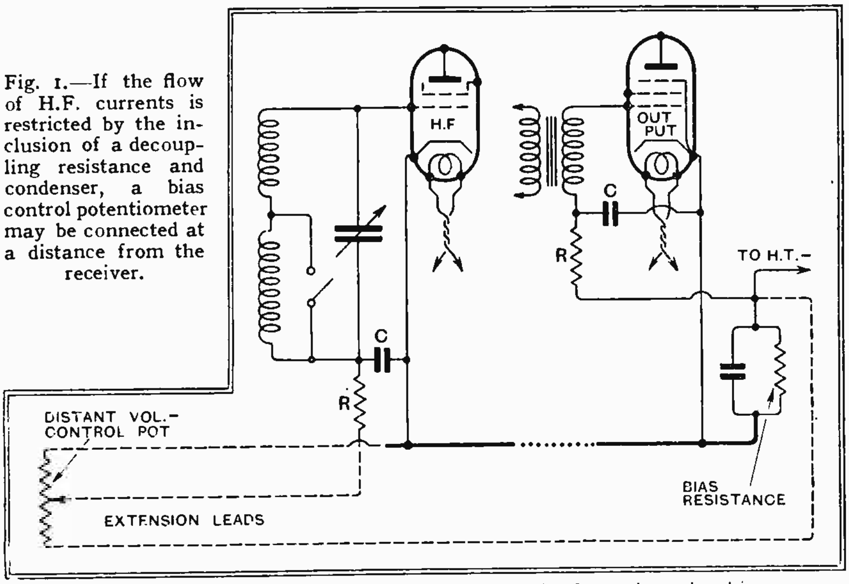


Fig. 1.—If the flow of H.F. currents is restricted by the inclusion of a decoupling resistance and condenser, a bias control potentiometer may be connected at a distance from the receiver.

An Easy One.

IN an effort to trace the cause of an annoying background of hum, a correspondent has adopted the expedient of disconnecting the H.T. feed of each of the valves in his A.C. mains receiver in turn. The result of this is that the hum intensity is not affected to any noticeable extent, and it still persists when all the anode circuits are "dead."

It is logical to deduce from this experience that the trouble is due to the supply system for the field winding of a moving-coil loud speaker, although our reader does not say that he is using an instrument of this type.

There is, of course, a faint possibility that a leakage of A.C. current is taking place through the windings of the loud speaker or of its transformer, and a still more remote chance that there is direct induction from the mains supply.

As the loud speaker circuits are comparatively simple, the fault should not be a difficult one to trace by a process of elimination.

We should add a warning that this method of procedure in testing is open to criticism. As a result of disconnecting all the anode circuits, the H.T. rectifier is relieved of load; its voltage will accordingly rise, and there is a possibility that the smoothing or by-pass condensers may be damaged.

Problems of Trimming.

WHEN any one of the trimming condensers used in a multi-circuit receiver is found to be "all in" or "all out," there is (or should be) an uneasy feeling that the circuit of which the condenser forms a part is incorrectly aligned with respect to the others, and so, in such cases, it is generally worth while to investigate matters.

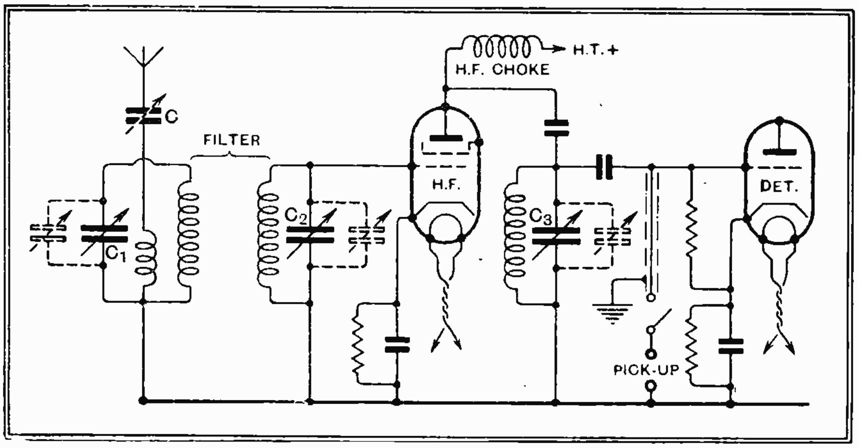


Fig. 2.—Illustrating the method of procedure to be adopted when the stray capacities across one of the tuned circuits are of abnormally high value.

For instance, a querist, who sends a circuit diagram of his H.F.-det.L.F. three-valve set, tells us that after carrying out the operation of trimming in the usual way, the trimming condenser across the aerial section of the filter is found to be about "half in," that of the filter secondary "three-quarters in," while the H.F. coupling circuit trimmer is "all out." Although the set gives very good results, he feels that it might be improved, as the last-mentioned circuit may be out of tune with the others.

A skeleton diagram of part of his circuit is reproduced in Fig. 2, which helps to make quite clear the fact that the trimmer settings as described are more or less what might be expected in the circumstances. Taking the circuits in order, it will be apparent that a certain proportion of the aerial capacity will be transferred to the tuned circuit, of which C_1 forms a part. Consequently this circuit will require less trimming capacity than the next (tuned by C_2), on which the relatively small input capacity of a screen grid valve is imposed. Stray capacities across the H.F. coupling circuit (tuned by C_3) are obviously the greatest, as they include the anode-screen capacity of the H.F. valve, the self-capacity of the H.F. choke, and the detector valve capacity; last, but possibly not least, there is the capacity of a screened wire, which is used to connect the pick-up switch.

It is, therefore, not hard to see that relatively much more trimming capacity will be needed across C_1 and C_2. We suggest that, having found what is apparently the best adjustment by his original method, our correspondent should increase the settings of the trimmers across these condensers by an equal amount—say by half a turn. The next step is to rotate the ganged tuning condenser knob until signals are again at maximum strength, and then to reset all the trimmers in the normal manner. If, after doing this, it is found that the trimmer across C_3 is still at "minimum," the whole process should be repeated. In the unlikely event of there being insufficient latitude in the capacity adjustment of C_3—which may be regarded as the master adjustment, as this circuit has the lowest stray capacities—it will be necessary to add a small amount of external capacity. This can be improvised quite easily with a couple of lengths of insulated wire twisted together and joined across the condenser terminals.

Two-circuit Tuner Coils.

REQUESTS have been received for information as to the most suitable types of coil for the two-circuit tuner which was described in *The Wireless World* of April 27th.

Without affecting the basic principles of a circuit of this kind, almost any type of commercial two-range coil could be employed, and such modifications as a different method of aerial coupling or wave-range switch, and a single common reaction coil in place of two windings, would be more or less permissible. Whatever types of coil are chosen, they should be well screened with relation to each other.

It should be emphasised that good—which, unfortunately, also means large—coils are definitely worth while in this tuner, and, where space can be found for them, windings similar to those described for the "Autotone" receiver are eminently suitable.

Reaction Affects Gramophone Reproduction.

A BUILDER of the "Power Radio-Gram" (*The Wireless World*, January 27th) has noticed that when gramophone records are being played reproduction can be stopped almost entirely by rotating the reaction condenser knob. It is asked whether this should be taken as an indication that something is wrong.

In the "Power Radio-Gram" the gramophone pick-up is arranged in a rather unusual manner, with the result that it applies rather less damping than usual to the tuned circuit when it is in operation. Accordingly, by the application of reaction, it is quite possible that self-oscillation will be produced, and when this takes places the first valve will no longer function satisfactorily as a gramophone amplifier.

The rule, therefore, is that reaction control should be set at minimum when the set is used for gramophone reception.

Another Source of Hum.

INTERACTION between an H.F. choke in the detector anode circuit and the power transformer is a possible source of hum; A.C. voltages induced into the circuit will be communicated to the grid of the succeeding L.F. valve.

Without being definite on the matter, we are inclined to think that this may be responsible for the troubles of a correspondent, who has introduced several modifications into a published design. He has substituted a large-sized choke of high inductance, which consequently has a considerable external field, and has altered the lay-out in such a way that this choke is much nearer to the power transformer than in the original design.

FOREIGN BROADCAST GUIDE.

FLORENCE (1FI)

(Italy)

Geographical position: 48° 37′ N., 11° 20′ E.

Approximate airline from London: 750 miles.

Wavelength: 500.8 m. Frequency: 599 kcs. Power: 20 kW.

Time: Central European (coincides with B.S.T.).

Standard Daily Transmissions.

08.15 B.S.T., news, 09.40, news; carillon and High Mass relayed from San Giusto Cathedral, Trieste (Sun.); 12.30, concert (Sun.); 13.00, Time signal, news; 15.30, dance music (Sun.); 18.15, news. talks; 21.00, main evening programme. Exchanges programmes with Milan, Trieste, Turin and Genoa.

Opening Signal: Gramophone record, as Rome (q.v.).

Interval Signal: Song of Nightingale.

Call: (phon.) *Eh-yah! Radio Alt'Eetal-ee-ya.*

Announcer: Woman.

Closes down as other Italian stations followed by National Anthem and Fascist hymn.

Associated transmitters: Trieste, 247.7 m. (1,211 kcs.) 10 kW.; Turin, 273.7 m. (1,096 kcs.) 7 kW.; Genoa, 312.8 m. (959 kcs.), 10 kW.; Milan, 331.5 m. (905 kcs.), 7 kW. (*later*, 60 *kW.*); Bolzano, 368.1 m. (815 kcs.), 1 kW.

The above is the first of a series of panels supplementing or bringing up to date the Foreign Broadcast Guide which was completed with the panel published on March 30th last.